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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

HONORARY MEMBER OF THE ROYAL IRISH ACADEMY, &c. &c. &c.

"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

VOL. XXXI.

For JUNE, JULY, AUGUST and SEPTEMBER, 1808.

LONDON:

PRINTED BY RICHARD TAYLOR AND CO., SHOE LANE:

And sold by RICHARDSON; CADELL and DAVIES; LONGMAN, HURST, REES, and ORME; SYMONDS; VERNOR, HOOD, and SHARPE; HARDING; HIGHLEY; London: BELL and BRADFUTE, Edinburgh: BRASH & REID, and D. NIVEN, Glasgow: and GILBERT and HODGES, Dublin.

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THE

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PHILOSOPHICAL MAGAZINE.

I. *Description of a new Eudiometer, invented by* H. DAVY, *Esq., S. R. S., for the Combustion of Oxygen and Hydrogen Gases. By* R. KNIGHT, *Esq.*

To Mr. Tilloch.

SIR,

THE enclosed drawing (Plate I.) represents a eudiometer we lately made on the suggestion of Mr. Davy, for the more commodious display of the formation of water, by the combustion of the two gases, oxygen and hydrogen, by means of the electric spark.

The instrument consists of a strong cylindricalglass tube A, to receive the gases; open at the lower end, of the capacity of two cubic inches, and graduated into decimal parts; and a stand to which the tube is attached, by a clasp B, and screw S. The stand is composed of the clasp and screw B, S, and an iron cylinder C, containing a strong spiral spring, on the principle of the pocket steelyard, the spindle or central bar of which is fixed on the three feet D, in order that it may be secured firmly on the side of a mercurial bath, with the mouth of the tube immerged in the quicksilver.

By this arrangement, the sudden and violent expansion which takes place at the moment of the combustion of the gases is relieved by the elasticity of the spring, which, by yielding, allows the glass tube to be heaved up a little way, without being driven from its situation. The success of the experiment is thus secured, and all danger of accident to the apparatus is effectually prevented.

II. *Life of M.* Le Roy.

To Mr. Tilloch.

SIR,

The following account of Julien Le Roy, the celebrated watch-maker*, is an abridgment of that given by his son, in a work of his entitled *Etrennes Chronométriques;* and if you think it will prove interesting to any of your numerous readers, it is very much at your service.

I remain, sir, yours, &c. &c.

T. S. Evans.

Royal Military Academy,
Woolwich.

Julien Le Roy was born at Tours in 1686, and died at Paris in 1759. He had hardly attained his twelfth year when his taste for clock- and watch-work first showed itself. His hours of recreation were constantly employed in finishing some pieces of mechanism, and in reading with avidity all books relating to that subject and natural philosophy. About the age of thirteen, he constructed some small pieces of clock-work; and finding the day not sufficiently long for him, he sat up during the night, to study how he might improve their motions.

With so remarkable a desire to increase his knowledge in this art, which his parents lost no opportunity of improving and applying to the best advantage, it was impossible for him not to make a very rapid progress. At the age of 17, he went to Paris, and was admitted in 1713 into the company of watch-makers of that city.

His merit having introduced him to the acquaintance and esteem of the most distinguished men of his time, he very shortly became celebrated for the excellence of his workmanship; and for a quickness of execution that appeared almost

* Father of Pierre Le Roy, who wrote the Memoir on the best method of measuring time at sea, which you have honoured with a place in your Magazine, (vol. xxvi. p. 40,) and the inventor of the compensation balance, which has since been improved and applied with such success by our English artists.

almost incredible: so much so, that he very soon left all his masters far behind him.

It is well known that the English, on account of their numerous discoveries in this art, had enjoyed such a reputation for the excellence of their clocks and watches, that they universally found a market in preference to any others in all parts of the known world; and that the French themselves were obliged to purchase theirs in England. Julien Le Roy had the honour of removing part of this pre-eminence, and of transferring it to the French artists. We must refer to the account itself given of him for the various means which he employed to effect this, as they would be superfluous here; and it will be sufficient to mention in a few words the principal discoveries which he made:—His repeating clocks and watches: his improved seconds and horizontal clocks: his universal compass card with a sight; an extremely useful and simple contrivance for drawing a meridian line, and finding the declination of the needle: his clocks and watches of three parts, and his new universal horizontal dial. It is to him also that watch-makers are indebted for the method of compensating for the effects of heat and cold in the balances of chronometers, by the unequal expansion of different metals; a discovery of the greatest importance, which has been brought by our English artists to a state of perfection hardly credible, although it had been condemned and thrown aside by the inventor's son, M. Pierre Le Roy. See vol. xxvi. p. 200, of the Phil. Magazine.

Such a number of things so happily invented, and executed, procured him the reputation of the first artist in his profession. The celebrated Graham once paid him the following compliment before several persons, when a repeater of Le Roy's was shown him by lord Hamilton. After having examined it for some time, he said, "I could wish I were younger, that I might work from this model." Which justice done to his merit by the first watch-maker in Europe at that time, was afterwards universally rendered him by all artists who had arrived to any degree of excellence in the art.

The general eagerness to obtain watches of his invention soon became so great, that the watch-makers of Geneva engraved his name, instead of those of Tompion and Graham, on the common watches made at that place *.

It was not among foreigners only that he enjoyed so flattering a consideration. In his own country he was distinguished as he merited. He obtained in 1739 apartments in the galleries of the Louvre, and the title of clock- and watch-maker to the king. Cardinal Fleury, when he sent him this title, told him that his majesty, pleased with his services, might hereafter add to this favour by granting him a pension. Our artist, however, thought that a sovereign, like the father of a family, could not settle one of his children above the level of the rest, without altering in some degree the patrimony of the others; and therefore, that the wishes of an honest man and a true patriot ought to be satisfied when he has obtained some mark of esteem and benevolence from his sovereign.

"If this celebrated artist," adds his son, "has enriched clock- and watch-work so much by his discoveries and workmanship, his generous conduct to those who, under his direction, cultivated this art, has not less contributed to its perfection. I appeal to all those who were acquainted with him, to prove the truth of this assertion. Never was any man more accessible, more communicative, or more prodigal of his knowledge. Has he not taken as much pains to place his work before the eyes of the gentlemen of the art, as the English took at first to hide theirs? What artist is ignorant of the trouble which he gave himself to expose new inventions, when they were as rarely known as they are now common? Who does not know that he sacrificed a part of his fortune? that he did not confine himself merely to the encouraging of them by his example, but that he even added

* I met with the following anecdote lately in a French work:

Voltaire called one day on Pierre Le Roy the son, and the conversation happened to turn upon the father's improvements in watch- and clock-work. After Le Roy had expatiated on them for some time, Voltaire replied, "Yes, yes, my friend, marshal Saxe and your father have beat the English."—T. S. E.

recompenses,

recompenses, as far as his circumstances would permit? After a life so spent, can we be astonished at the concourse of workmen who followed his funeral? Can we be surprised at their expressing with sorrow, that they had lost their supporter! their friend! their father?"

After having considered the good qualities for which Julien Le Roy was so much admired and cherished as an artist by all who were intimate with him, let us turn to a few traits in his life, from which we may judge of those that distinguished him as a man and a member of society. He had been very intimate with Henry Sully; and the pleasure which these two celebrated men found in discoursing together of their art, so far from exciting envy, had formed between them the bond of the closest and most sincere friendship. When the watch-manufactories of Versailles and St. Germain were broken up, Sully tried to persuade his friend to accept a pension from the English ambassador, and to go and reside in London: but it was to no purpose; he never would consent to expatriate himself, and carry his discoveries and knowledge out of his native country. When Sully died, which happened in October 1728, Julien Le Roy was pressed to solicit the pension from the king, which Sully had received; but he constantly refused it, because madame Sully had requested the king to continue it to her. The same zeal engaged him to undertake every thing that could do honour to the memory of his departed friend; and it is to him we are indebted for the little that is known of Sully's life. Notwithstanding his continual occupations, Le Roy undertook the reprinting one of his works, and enriched it with every thing that could recommend it. He might have intermixed his own subjects with Sully's; but he chose rather to bring forward his name and writings after those of his deceased friend, and to print a part of his Memoirs at the end of the *Règle artificielle du Temps*.

Such was this celebrated man; *to whom was given*, if I may use the expression of a celebrated journalist, *the art of chaining down time, and forcing matter to represent with the utmost precision the rapid flight of our years.* The king deigned to honour him with his regret when he heard of his death. By his marriage with Jane De Lafons he left four sons worthy of such a father; and who have all distinguished themselves in the departments which they have chosen:—Peter Le Roy, the eldest, who has succeeded his father as clock- and watch-maker to the king, and who is the inventor of the marine watches; John Le Roy, of the Royal Academy of Sciences; Julien David Le Roy, professor in the Royal Academy of Architecture, and of the Institution of Bologne, author of the Ruins of Greece; and Charles Le Roy, of the Royal Academy of Montpellier, correspondent of the Academy of Sciences of Paris, and professor of medicine in the University of Montpellier.

III. *An Essay on Commerce, as at present carried on by different Nations; with some Hints, which the Writer thinks would tend greatly to the Advantage of every Country. By Mr.* JAMES GRAHAM, *of Berwick-upon-Tweed**.

COMMERCE has long been the distinguishing characteristic of this country: it is the great source of our national wealth as well as individual riches. It is commerce that rouses and calls forth the adventurous spirit of our merchants and the persevering industry of our manufacturers. To carry the various produce of our country to the remotest part of the earth gives employment to our sailors, whose valour and intrepidity are the admiration of Europe, and give to Britain that preeminence amongst the nations which she now possesses.—If such are the great advantages derived from commerce to this country, it surely ought to be the study of every individual, as far as his abilities, situation, and circumstances in life will admit, to be acquainted with its nature, and to trace its various connections.

To make some observations on the first principles of trade, or the beginning of commercial intercourse with different countries, and to point out what to me appears the most

* Read before the Literary Society of Newcastle-upon-Tyne.

likely

likely means of bringing commerce to its highest degree of perfection, is the design of this essay.

If we take a survey of this earth, even those places where nature seems to have been most bountiful, and to have poured out her whole luxuriance, even there we shall find some wants, some articles or produce, which, if obtained, would add either to the ease or comfort of the inhabitants. If we cast our eyes on the more northerly climates, where the sterility of the soil is rendered more barren, from the small degree of that solar warmth which gives life to the whole creation, yet even there we find a superfluity of some articles extremely necessary to the inhabitants of more favoured situations. Such indeed is the diversified nature of the earth we inhabit, that there is no country, however highly it may be favoured, which can produce all that is necessary for the comfort, health, protection, and security of its inhabitants.

From these causes commerce is certainly nearly coeval with man: and if men had duly observed these immutable laws of their Creator, and regulated their conduct accordingly, all intercourse would have been so reciprocal, that both national and individual interest, as well as social happiness, would long have continued to bless the world.—But jealousy, envy, and ambition, the most dangerous passions of the human breast, soon made man lose sight of his true interest. When kings, governors or rulers, by whatever name they are called, once turned their attention to raising a revenue, whether for the support of their own kingdom, or to gratify their own ambition, and increase their greatness, the idea of taxing the produce of neighbouring states seems very soon to have engrossed that attention. To a weak short-sighted politician the idea is no doubt flattering: he vainly thinks he shall raise a revenue and increase the resources of his own people by taxing his neighbours, not recollecting how soon and how easily all will be retaliated. Whoever may have had but small opportunities of observing the intercourse of different nations, and comparing the commercial laws and regulations by which they are governed, will easily see with what exactness they endeavour to counteract each other. I could illustrate this in a variety of instances, but it would lead me to too great a length for what I intend, viz.—only a short essay. Let one observation suffice: Compare the duty on wine in this country with the duty on English malt liquor in some others. The people in foreign countries are as much astonished to hear the low price at which our ale and porter can be made, as we are to hear the price at which the cultivator of the grape can sell his wine. One can scarcely be prevented from thinking that it is surely a mistaken, not to say a cruel, policy, which thus prevents the great bulk of the people from enjoying those bounties of Providence which the earth sends forth in such abundance. If my memory is to be trusted, it is to this commercial jealousy we owe most of the wars which for more than a century past have tormented mankind, and destroyed millions of the human race: and, what yet is a more melancholy reflection, this dæmon of discord seems only to be increasing in strength and plotting fresh inroads on the happiness of mankind. I will, however, beg leave to observe, that the idea of universal empire, encouraged by successive victories, and of commanding the trade of the world into one emporium, however flattering to the conquering hero or adventurous merchant, both alike are destructive to the general happiness of mankind: and I am persuaded, that as soon will the immutable laws of the universe be changed,—the different climates of this earth send forth the same productions,—as either will be realized. A small recollection of history will fully convince us, that ambition had no sooner supposed that her wishes were to be gratified, than the mighty fabric has tumbled in pieces, and brought the vain projector to a premature death, or to linger out a few years covered with shame, disgrace, and remorse. Such, I am persuaded, will be the natural consequence of all overstrained ambitious speculations. I make no doubt but many will recollect several instances of some persons in this country, of large fortunes, extensive credit, and wide-spread connections; who, not satisfied with all these, but prompted by ambition, wished to bring all under their grasp; and in the pride of their hearts have declared, My warehouses, or my granaries, shall be the general depôt of such or such an

article;

article; I will then fix my own price, and riches will flow from every quarter. How few, very few, of such have succeeded, but brought ruin on themselves, and misery on all their connections! I am apt to think, that what is the case of individuals will in a certain degree be the case with nations. I am persuaded that God, in pity to mankind, has set some bounds to ambition which it cannot pass.

I must here beg leave to make one observation, to prevent my being misunderstood; and that is, It is not my intention to argue in the smallest degree against duties; it is likewise highly expedient to tax some articles more than others;—it is only the extreme to which many duties are carried that I would combat, together with that ambitious monopolizing spirit, whether in an individual or a nation, which wishes to counteract the very laws of nature, by bringing the whole produce of the earth and the industry of its inhabitants into the vortex of their own power. I will also endeavour to answer an objection which is commonly brought forward, and by many thought unanswerable, viz.—Money must be had; and how can it be obtained but by increasing the duties? That an additional duty may for a while give a larger return I will admit: but I am very certain it can only be of a temporary duration; because every advance in the price of any article will in a certain degree lessen its consumption; and add to this, it increases the smuggling of the article:—from these two causes the decrease of the revenue will naturally follow. I could produce many instances, but this would lead me to too great a length. Suffice it to observe, that smuggling and illicit trade are carried to a greater extent in almost every article where the prospect of much gain holds out a strong temptation: and of all the evils which can afflict a nation, I believe smuggling, if its various consequences were taken into consideration, is the most dangerous:—it estranges the mind from all the regular habits of industry, and insensibly makes inroads on the moral principle of the human heart. Let any person take but a glance at the numerous laws and statutes to prevent smuggling in its various branches, with all the pains and penalties annexed:—the mind will shrink

shrink with disgust, if not with horror, from the perusal:—and, as if all were not enough, oaths are introduced as an additional barrier. A recourse to them is most alarming to every serious mind; it is sapping the very pillars of virtue, and with gigantic strides rendering the mind indifferent, if not callous, to the most serious and the most useful of all appeals—I mean the solemnity of an oath.

The closest politician may please himself with framing additional laws and more severe restraints, but all will be found ineffectual while the present system is pursued: the more timid or conscientious will be restrained, and all their exertions of industry paralysed; but the daring and adventurous will spring up in every direction. This, however, with some other particulars to prove and illustrate the proposition I have here laid down, may be the subject of another essay, if this should be thought worth the attention of the Society. I will at present only mention one instance, which must be in the recollection and knowledge of many—I mean the small amount of the revenue on tea before the reduction of the duty took place: and yet, to secure the revenue, every law and regulation which human ingenuity could contrive were put into practice.

It now only remains for me to say what is the line of conduct, or plan, which a wise statesman and true patriot ought to pursue. A thorough knowledge of his country is certainly the first and most essential requisite; to be well acquainted with all its more natural productions; and to bring these to the highest possible perfection, his constant aim and study. I do not mean to say that any check should be given to the experimental agriculturist,—quite the reverse,—but only that the principal concern of the government should be to give the greatest encouragement to the productions which, by observing the laws of nature, there is reason to believe can be brought to the highest degree of perfection. The next and most essential, I conceive to be, To study the genius of the people; carefully to observe their natural disposition; to note their turn of mind and principal propensity, with all the anxious concern with which a wise parent would watch and study the rising dispositions, the natural talents and various

inclinations

inclinations of his children, and put them to such professions as there is good reason to think they would most excel in. I am fully persuaded that it is as impossible for the inhabitants of any country to excel in the manufactory of every article, as it would be by any degree of cultivation to cause the earth in any one country to produce or bring forth the various productions of other climates. To inquire into the cause of this is not the design of the present essay; I only mean to state facts. The gin in Holland, the brandy in France, the rum in the West Indies, occur to my mind, at present, as in point. Notwithstanding the great capital of the English distillers, their persevering industry and diligence, aided by every chemical knowledge and improvement,—how different are our productions from those mentioned! Yet in France, Holland, and the West Indies, these operations are often carried on by mere novices (if I may so speak) in the profession. I will now contrast English malt liquor with what is made any where in Europe. I believe it will be generally found that our ale and porter as far exceed those of all other countries, as the brandies in France and the gin in Holland excel ours. I would likewise mention our excelling in almost every article in the manufacturing of iron: I might contrast some of what may be called the loom manufactory. I am well aware that in many of these we either excel or have arrived at a great degree of perfection: still in many others we fall far short. I have, however, at present only mentioned those which I think are almost generally known and acknowledged.

From a review of the whole, it appears to me self-evident, that the true interest and real riches of every country consist in having a reciprocal intercourse with each other; to have no prohibitory duties, nor any so high as to create too great a temptation to illicit trade. By these means the whole revenue or duty could be easily collected, and with less than half the present number of officers. Traders and merchants would then be much more upon an equal footing in regard to excise regulations; the more timid and conscientious

would

would rejoice under the protection of the law, and the more daring and adventurous would feel little temptation to transgress its boundaries. The present code of excise laws, at which the most resolute shrink back with disgust, and which cause the more serious to heave a sigh at the inroads they are making on religion and morality, would assume all the mildness of the jurisprudence of the English constitution. The wise politician would feel no anxiety at the prosperity of any neighbouring state: the more they cultivated the natural production of their soil or climate, and the higher degree of perfection to which they brought some branches of manufactory,—on the more easy terms could his people be supplied; and as they increased in riches, so much the more would be the demand for the natural productions of his country, as well as for all the articles of manufactory in which his people might excel. Pursuing this plan, every nation would see its true greatness and real riches so connected with that of others, that it could not hurt another without the greatest injury to itself. Jealousy and envy would find no place in the human heart; trade would be found only in its infancy; its extension, I am persuaded, would be far more than we are apt to conceive; and peace might continue to bless the world.

But I must here suppress my feelings, as my design is only to use fair reasonings, and to draw just conclusions.

J. G.

IV. *Analysis of the lately discovered Mineral Waters at Cheltenham; and also of other Medicinal Springs in its Neighbourhood. By* Frederick Accum, *M. R. I. A. Operative Chemist, Lecturer on Practical Chemistry and on Mineralogy and Pharmacy, &c.*

Of all the mineral waters which have acquired celebrity within our own times, the springs of Cheltenham hold a most distinguished rank. Their fame is the more solid, and their character will be the more permanent and flourishing,

ing, as they owe their reputation less to the caprice of fashion, patronage, or popular opinion, than to their own intrinsic properties.

Here at first the afflicted resorted in search of health. They found the goddess propitious to their prayers; they returned again to pay their vows, and brought beauty and elegance in their train. The lately discovered mineral springs of Cheltenham belong to those few fountains of health met with in Great Britain, which have not been discovered by accident: our knowledge respecting them being the result of actual labour, undertaken with a view to remedy the prevailing scarcity of the waters of other springs, which have long given celebrity to the town of Cheltenham, and which scarcity is said to have prevented many invalids from visiting that place. These complaints no longer exist. The exertions of several individuals have completely remedied this evil;—to Dr. Jameson, a resident physician of Cheltenham, is due the honour of having discovered, in the year 1804, a saline spring near that town; and to the spirited exertions and indefatigable enterprises of Henry Thompson, esq., of Tottenham, the public will for ever remain highly indebted for the discovery of the mineral springs which form the chief subject of this paper; and who has also spared no expense and labour to improve the natural beauties of the place, so as to render the accommodations of these wells worthy of the company who visit them from all quarters. It is under the direction of this gentleman, likewise, that baths, both cold and warm, have been erected in a style superior to those usually met with, which do signal honour to the town of Cheltenham.

Before I proceed to state the result of the analyses of the waters I was called upon to undertake at the fountain head, I beg leave to remark, that I do not mean to exhibit invidious comparisons, nor do I contend for superior medicinal properties which they may be found to possess, when compared with other springs of a similar nature, which have long gained a distinguished place in the catalogue of medicated waters, and the efficacy of which long experience has permanently fixed and sufficiently established. Unbiassed as I stand, a humble labourer in the field of chemical science, it is merely my wish to furnish a clear idea of the nature and composition of those fountains of health, so as to present truth in a simple form, and to establish it upon legitimate foundations; in order to enable the medical practitioner to select in a judicious manner the springs so bountifully given to the spot by the hand of Nature, and to apply them with advantage in the routine of his profession. Should the following pages, therefore, prove usetul, by collecting under one point of view the leading features of these springs, my view will be amply fulfilled, and I shall flatter myself with having contributed to the improvement of the science of medicine, as well as to the progress of chemical knowledge.

NAMES OF THE WELLS.

It must be confessed that a degree of confusion has hitherto prevailed, and still does prevail, with regard to the mineral springs of Cheltenham. A variety of names have been arbitrarily given to many of them, which has led to confusion and perplexity. It was to prevent this that the springs which are the subject of this inquiry are distinguished by the following appropriate names, which express the leading characters of each, namely:

THE CHALYBEATE STRONG SALINE WELL.
THE CHALYBEATE WEAK SALINE WELL.
THE STRONG SULPHURETTED SALINE WELL.
THE WEAK SULPHURETTED SALINE WELL.
THE CARBONATED STEEL WELL.
THE MILK WELL*.

ANALYSIS OF THE CHALYBEATE STRONG SALINE WELL.

I. SITUATION OF THE SPRING.

The spring known by this name is situated in a dry verdant and gently-rising field, called *Montpellier Ground*, 600 feet from the centre of the town. The site of this spring

* The name of this well is derived from its taste, which greatly resembles that of skimmed milk.

appears

appears to be one of those choice and suitable spots that are said to be particularly favourable to the curative effects of medicinal waters. The dryness and gradual elevation of the land around this spot as it recedes from the town, the uncommon fertility of the soil, with its multifarious productions and romantic scenery which are equalled by few in the kingdom, present a picture dear to the man of taste as well as to the invalid.

The upper stratum of the soil to a considerable distance from the well is a sharp fine sand, and the heaviest rains that fall here seldom prevent the exercises of walking or riding for any length of time after they have ceased; a circumstance certainly not unworthy of regard in a place frequented by valetudinarians of leisure and opulence.

The mild and genial breezes which constantly prevail here, and which are doubtless owing to the disturbed equilibrium of the air passing through the funnel-shaped and craggy openings of the opposite hills, cause the atmosphere of this spot to be considered equally salubrious with, and not unlike, that which prevails in the south of France. It is the totality of these circumstances that has induced several persons of distinction to fix their residence in this neighbourhood; and hence *Cambray*, which was known not four years ago as a mere pleasure meadow, is now covered with villas and houses, that in point of taste and elegance may vie with any modern buildings whatever.

The country round these springs consists of fields of every shape, mostly open and uninclosed, here and there interspersed with gardens, orchards, and cottages. It produces plenty of wood, both for timber and fuel. And as the Cheltenham waters professedly sharpen the appetite, it may perhaps be pleasant for visitors to know, that the rearing of poultry of all kinds is carried on with particular assiduity and success, and that the town is supplied with all kinds of provisions of excellent quality, and on much more moderate terms than in some places of resort, less fashionable, for pleasure and health.

The geological constitution of this part of Cheltenham is alluvial land, composed on one side of the town of a tenacious blue clay, which, as it deepens, passes into a foliated argillaceous marl; on the other a stratum of sand prevails.

In the former the spoils of organized beings of the ocean are found in great abundance, and in a high state of preservation. And although the remains of these animals have strikingly changed their state of existence, their shape and structure are so well preserved, that the species to which many of them originally belonged may still be pointed out among the living inhabitants of the sea; whilst others again, which have long disappeared, (or are perhaps removed beyond the sight of men, by inhabiting the greatest depths of the ocean,) have thus their memory preserved in those archives, where Nature has recorded the revolutions of our globe. Intermingled with the wrecks of these creatures, are here and there found the trunks, branches, and roots of trees, with layers of reed, and timber of every kind, wholly converted into clay, and easily separable from their beds.

These awful memorials clearly announce that this spot was once deeply submersed under the waters of the ocean, or that it formed perhaps part of the bottom of the sea; for wherever we dig into the ground, marine shells which are known to belong to shores under climates extremely remote from each other, are found promiscuously mingled together. The mineralogical constitution of the Coteswold Hills, which take their rise within half a mile from this well, and which they surround like a brow, give ample proofs of this suggestion. The beds of these hills, which are all of secondary formation, furnish abundance of lime-stone, often wholly composed of gryphites, entrochites, nautilites, ostracites, belemnites, &c. The rest of the strata of these eminences, the highest of which does not exceed 500 feet, (where the spectator should pause to contemplate the surrounding country,) are composed of secondary lime-stone resting on red sandstone, free-stone, and grit. In the northern horn, red clay slate and foliated chlorite slate abound. The speculative geologist will find many of these and other individuals worthy of research.

The country around the town of Cheltenham is known to be uncommonly prolific in natural beauties. In the vicinity

cinity of the town, which stands on the north side of a high ridge of hills in the vale of Gloucester, are many handsome and pleasantly situated villages, picturesque landscapes, and solitary richly variegated hills, which render Cheltenham an object of attraction, even to those who cannot be biassed by native partiality.

Nothing can be affirmed with certainty in regard to the derivation of the name of this town. According to some, it is from a brook which rises in the parish of Dowdeswell, and takes its course on the south side of the town. It long flowed " unknown to fame," but is supposed to have originally been called the Chelt. Others again find the origin of Cheltenham in the Saxon word *Chilt*, which signifies an elevated place, and *ham*, denoting a farm or village. It is situated 94½ miles W.N.W. from London. Its population, according to the late survey taken by order of parliament, amounts to 2,639 inhabitants, which number is increased during the summer season by an almost equal number of transient visitors.

Cheltenham and its neighbourhood (indeed Gloucestershire in general) is said to be famous for the healthiness of its inhabitants and the longevity they reach. In the reign of James I., eight old men, all belonging to one manor in that county, whose ages added together made as many centuries, danced a morrice-dance. That several neighbours should reach the age of a hundred is nothing very wonderful in several situations and countries, but that they should be able to dance is certainly a singular circumstance.

About two miles north of Cheltenham lies the delightful village of *Presbury*, a place secluded by orchards and trees of every kind, so as to form a sylvan scene round almost every house; and about April and May, when the fruit-trees are in blossom, no situation in the neighbourhood can afford a richer prospect than this.

At a distance of about three miles and a half is the famous *Seven Wells Head*, or the source of the Thames, which being the highest point of the most illustrious British streams, will infallibly attract the notice of every person of taste who visits the neighbourhood.

At a distance of four miles on the London road, and situated on the steep side of a hill, is *Dodswell*, one of the most elegantly and pleasantly situated villages in the kingdom, sheltered by lofty and venerable trees.

At a distance of ten miles stands *Tewkesbury*, where lies buried the ill-fated Edward prince of Wales, son of Henry VI., who was cruelly murdered a few days after the battle which decided the fortune of his house. Many other charming situations and remarkable places of this neighbourhood might be pointed out, were this a topic on which we meant to treat; but as it is not, we shall hasten to the subject more immediately under consideration.

II. Physical Properties of the Water.

The water of the Chalybeate Strong Saline Well, taken fresh from the pump, has a distinct saline taste with a slight impression of bitter. It is colourless, perfectly transparent, without smell, and possesses a strong refractive power. Its temperature was 53° at 29·5 barometrical pressure, the temperature of the air being 65° Fahr. Its specific gravity was as 2·039 to 2·036. On pouring the water at the fountain head from one vessel into another, and leaving it exposed to the air, it emits a multitude of exceedingly minute air-bubbles, which firmly adhere to the inner surface of the vessel. Exposed to the open atmosphere for eight days, it suffered no material change. This spring yields upwards of 800 gallons of water in 24 hours in every season of the year.

III. Examination by Re-agents.

Experiment I.—To 15 cubic inches of distilled water, contained in a glass vessel, tincture of cabbage was added sufficient to impart to it the slightest tint of blue that could be distinguished when the vessel was placed between a sheet of white paper and the eye.

Experiment II.—A like portion of the same tincture was dropt into 15 cubic inches of the saline water taken fresh from the well, and contained in a similar vessel. On viewing both glasses by reflected light against a sheet of white paper, the latter appeared distinctly red, the former blue.

Experiment

Experiment III.—The same experiment was repeated with saline water of the well that had been boiled, but no such effect took place.

Experiment IV.—One cubic inch of concentrated sulphuric acid, mingled with six cubic inches of the saline water, occasioned a copious disengagement of air-bubbles, and a slight turbidness ensued.

Experiment V.—To 130 cubic inches of the water introduced into a tubulated retort, the neck of which terminated under a wine-glass filled with strontia water, and standing inverted in the same fluid, were added 36 cubic inches of sulphuric acid. A disengagement of air-bubbles took place, which rendered the strontia water turbid. The cloudiness disappeared by the admixture of muriatic acid.

Experiment VI.—Six cubic inches of fresh prepared lime-water, mingled at the fountain head with ten of the saline water, formed a cloudy mixture, which again was rendered transparent by a few drops of nitric acid.

Experiment VII.—Papers slightly stained with carmine, with an infusion of rhubarb, and with turmeric, suffered no change when immersed in the water of this well.

Experiment VIII.—Two grains of crystallized hydrate of strontia, dropt into three cubic inches of the saline water, produced an abundant precipitate, both in the water taken fresh from the well, and in such as had been previously concentrated by boiling. Muriatic acid did not redissolve the precipitate.

Experiment IX.—Concentrated nitric acid, and muriatic acid, did not produce a change when added either to the fresh or to the boiled water.

Experiment X.—Two grains of oxalic acid, dissolved in one cubic inch of water, either fresh, or concentrated by boiling, occasioned a considerable turbidness: the same effect took place, when five grains of oxalic acid were added to three cubic inches of water previously mingled with two grains of potash.

Experiment XI.—Fluate of soda and oxalate of ammonia produced a copious precipitate, both in the fresh water and such as had been concentrated by evaporation.

Experiment XII.—One cubic inch of a solution of fresh prepared green sulphate of iron, obtained (according to Davy) by boiling sulphuret of iron in dilute sulphuric acid, when added to 12 cubic inches of water kept in a corked phial, exhibited the following properties:

1. In 6 hours the mixture acquired an opal colour.
2. In 12, it was sensibly turbid.
3. In 24, a coloured precipitate ensued.
4. In 36, it became again transparent, having deposited a yellowish brown precipitate.

Experiment XIII.—200 grains of fresh prepared white prussiate of iron, (not dried, but still wet,) on being diffused through 20 cubic inches of water at the fountain head, acquired a blue colour after having been kept in a closed phial for 24 hours. Water that had been previously boiled, changed the colour of the white prussiate very slightly.

Experiment XIV.—Silver leaf, gold leaf, and copper leaf, did not lose their lustre on being immersed in the water.

Experiment XV.—Two grains of nitrate of silver, dissolved in five cubic inches of the water, either fresh from the pump or concentrated by boiling, produced a copious white precipitate, which retained its colour in the dark: the same effect took place with water previously mingled with a few drops of nitric acid.

Experiment XVI.—Two grains of sulphate of silver occasioned a dense cloud in two cubic inches of fresh, or in a like quantity of boiled water: nitric acid did not restore its transparency.

Experiment XVII.—Five cubic inches of liquid ammonia, added to 15 of water highly concentrated by boiling, effected much turbidness after suffering the mixture to stand for 24 hours.

Experiment XVIII.—Seven grains of muriate of barytes dropt into six cubic inches of the saline water, produced an abundant precipitate, which was insoluble in muriatic acid: the same effect ensued when nitric or muriatic acid had been previously added to the water.

Experiment XIX.—Ten drops of acetate of barytes rendered two cubic inches of the saline water turbid.

Experiment

Experiment XX.—The water which had been acted on by acetate of barytes in the preceding process, after having been filtered, became strongly milky on letting fall into it a few drops of acetate of silver: the precipitate was soluble in liquid ammonia.

Experiment XXI.—Acetate and nitrate of lead, added in the proportion of one grain to the cubic inch of the saline water, occasioned a white cloud.

Experiment XXII.—Five grains of phosphate of soda produced no change in two cubic inches of water highly concentrated; but an abundant precipitate ensued when one cubic inch of a neutral solution of carbonate of ammonia was added.

Experiment XXIII.—One cubic inch of fresh prepared solution of hydro-sulphuret of strontia, agitated with ten of water highly concentrated, instantly occasioned much precipitate.

Experiment XXIV.—Twelve grains of crystallized acetate of lime effected no change in four cubic inches of saline water. If the same quantity of nitrate of lime was added to three cubic inches of the water concentrated by boiling, a copious white powder fell down.

Experiment XXV.—Five cubic inches of alcohol, mingled with ten of strongly concentrated saline water, occasioned an abundant crystalline precipitate.

Experiment XXVI.—Four grains of arseniate of potash, dissolved in four cubic inches of the water, produced no change after having been suffered to stand 24 hours.

Experiment XXVII.—Five grains of crystallized potash rendered three cubic inches of the water turbid; a flocculent precipitate floated on the surface, after suffering the mixture to stand undisturbed for six hours.

Experiment XXVIII.—Tincture of galls, either prepared with or without alcohol, produced no sensible change, whether in the fresh or boiled water; but if to one cubic inch of water, concentrated by evaporation, three grains of oxymuriate of potash and six of nitrous acid were added, tincture of galls and succinate of soda then produced a dark-coloured precipitate.

Experiment XXIX.—Neither prussiate of potash nor prussiate of lime produced any change when added to the water; but when a few grains of nitrous acid and oxy-muriate of potash were previously dissolved in it, a blue precipitate was then obtained.

From these preliminary observations we are led to believe, that this water contains carbonic acid, oxygen gas, salts with a base of lime, salts with a base of magnesia, with oxide of iron, with sulphuric acid, with muriatic acid, &c.

Examination of the Gaseous Contents of the Water.

924 cubic inches of the saline water, fresh taken from the spring, were introduced into a retort connected with the mercurial trough. The water was made to boil, and the gaseous products collected over mercury. After the apparatus had again acquired the temperature which prevailed at the commencement of the operation, it was found, by the addition of barytic water, that 48·28 cubic inches of carbonic acid gas had been disengaged, of which 12·7, therefore, are contained in one gallon of water. The residuary gaseous fluids, on being examined by the test of phosphorus and by the action of hydrosulphuret of lime, were found to be composed of 4·84 parts of atmospheric air and 16·12 parts of oxygen gas. Hence the gaseous contents of one gallon of the saline water are:

	Cubic inches.
Carbonic acid gas -	12·07
Oxygen gas - -	4·03
Atmospheric air -	1·21
	17·31

ANALYSIS.

Experiment I.—924 cubic inches of the saline water being evaporated in a glass retort to eight cubic inches, were reduced to dryness in a glass bason at a temperature of 224° Fahr. The mass was of a brilliant white colour; it tasted strongly saline and bitter. Its weight amounted to 2296 grains,

grains, which, divided by four, gives 574 grains of solid matter for every gallon of the water*.

Experiment II.—This product, being levigated with alcohol, was digested in that fluid in the cold for six days. The solution was decanted, fresh portions of alcohol were added, and the operation repeated successively. The insoluble residue was laid aside for further examination.

Experiment III.—The alcoholic solutions being mingled with a small quantity of water, were rendered turbid by acetate of ammonia and sulphate of silver; phosphate of soda employed (according to Wollaston) in combination with carbonate of ammonia, produced much cloudiness.

Experiment IV.—The mass which was not soluble in alcohol (Experiment II.) was digested in eight times its own weight of distilled water, suffered to boil, and filtered.

Experiment V.—The insoluble residue of the preceding process was boiled in 60 times its quantity of water; but as no complete solution could be effected, it was filtered, and the insoluble part collected.

Experiment VI.—This insoluble powder, which resisted the action of boiling water, being dried, was covered with muriatic acid, which speedily effected a solution. The fluid was decomposable by gallic acid, and by succinate of ammonia it was evaporated to dryness; over the dry mass, nitrous acid was abstracted repeatedly, and lastly the whole was re-dissolved in muriatic acid.

Experiment VII.—The obtained muriatic solution, being concentrated to the consistence of oil, was mingled with liquid ammonia until it ceased to produce a precipitate. The oxide of iron thus obtained weighed 19 grains, which indicated 7·15 carbonate of iron in each gallon of the water.

Experiment VIII.—The alcoholic solution (Experiment II.) being suffered to stand exposed to the air in an open vessel for six days, was covered with a multitude of crystals; it was evaporated till no more salt appeared, and then suffered

* If the same bulk of water was evaporated in a glazed bason of Wedgewood-ware, the product was seven per cént. less.

to

to cool. The crystallized muriate of soda weighed seven grains.

Experiment IX.—The fluid from which this salt had been removed, being concentrated, was covered with sulphuric acid and evaporated to dryness. The glass bason with its contents was lastly heated until the colour of litmus paper, employed for covering it, remained unaltered.

Experiment X.—The solid residue, being triturated, was transferred into a Florence flask, and digested in four times its quantity of water, and the insoluble part collected on the filter.

Experiment XI.—The saline liquid which passed the filter having been highly concentrated by evaporation, was mixed, boiling hot, with a solution of sub-carbonate of potash until no further precipitate fell down.

Experiment XII.—The carbonate of magnesia produced being dissolved in muriatic acid, and the solution evaporated to dryness, yielded 160 grains of muriate of magnesia : 40 grains of muriate of magnesia had therefore been contained in one gallon of the water.

Experiment XIII.—The insoluble part left in Experiment X. was boiled with six times its quantity of sub-carbonate of potash, which rendered it soluble in nitric acid : the nitric solution was decomposed by sub carbonate of ammonia, and the produced precipitate converted into muriate of lime in a direct manner. It yielded 144 grains of muriate of lime, which gives 36 grains of muriate of lime to each gallon of water.

Experiment XIV.—To render the nature and presence of the substances so far detected as certain as possible, an alcoholic solution equal to that operated on was evaporated to dryness, covered with sulphuric acid, heated, and again evaporated to dryness.

Experiment XV.—The dry mass being digested in water, the fluid filtered and evaporated, yielded sulphate of magnesia. The remaining insoluble substance was dissolved in boiling water, and decomposed by nitrate of barytes ; and lastly, another portion of the substance extracted by alcohol was digested in muriatic acid decomposed by sub-carbonate

of

of potash, and the product heated to redness. Thus the presence of the obtained carbonate of iron, of muriate of lime, and muriate of magnesia was established.

Experiment XVI.—The aqueous fluid left in Experiment IV. being concentrated, did not disturb the solution of muriate of platina, nor was it rendered turbid by oxalate of ammonia: it was therefore mingled with alcohol till no more cloudiness ensued, evaporated till a strong pellicle appeared, and the crystalline mass dried. The remaining fluid was again evaporated and suffered to crystallize; the salt produced being muriate of soda, could not be obtained free from sulphuric acid; it was dissolved in water, together with that portion obtained in Exper. VIII., and then decomposed by nitrate of silver. The precipitate produced taking 235 grains of muriate of silver to be equal to 100 of muriate of soda, indicated 219·75 muriate of soda in each gallon of the water.

Experiment XVII.—The fluid being completely freed from muriate of soda was highly concentrated, and mingled whilst hot with a solution of sub-carbonate of potash; a copious precipitate fell down, which, being thoroughly ignited, indicated 98·25 sulphate of magnesia in each gallon of water, taking 136·68 of magnesia to be equal to 100 of sulphate of magnesia.

Experiment XVIII.—The fluïd left in the preceding experiment was again evaporated, the sulphate of potash introduced separated, by causing the whole to crystallize into a solid mass, heating it slowly, and decanting the liquid sulphate of soda by adding a few drops of water. On repeating this operation for several times successively, the sulphate of soda was obtained pure from the sulphate of potash; it amounted to 80·01 in the gallon of water.

Experiment XIX.—The fluid left in Experiment V. was rendered turbid by nitrate of barytes and oxalate of ammonia, which, together with its great insolubility, proved it to be sulphate of lime; it was decomposed by barytes water: the solution (taking 100 parts of sulphate of barytes to be produced by 71 of sulphate of lime) indicated 85·01 sulphate of lime to be contained in each gallon of the water.

The

The analysis leaving nothing further to be done, the contents of this water may be stated as follows, viz.

	Contents in one Gallon. Grains.	*In one Pint.* Grains.
Muriate of soda - -	219·75	27·46875
Sulphate of magnesia	98·25	12·28125
Sulphate of soda -	80·01	10·00125
Muriate of magnesia	40·00	5·
Muriate of lime - -	36·00	4·5
Carbonate of iron -	7·15	·89375
Sulphate of lime -	85·01	10·62625
	566·17	70·77125
	Cubic inches.	Cubic inches.
Carbonic acid gas -	12·07	1·50875
Oxygen gas - - -	4·03	·50375
Atmospheric air - -	1·21	·15125
	17·31	2·16375

[To be continued.]

V. *Essay upon Machines in General. By M.* Carnot, *Member of the French Institute, &c. &c.*

[Concluded from vol. xxx. p. 320.]

Fourth Corollary.

XXVI. I have proved (XIX) that the indeterminate equation (F) contains all the laws of equilibrium and of movement in hard bodies: I now go further, and I say that this equation agrees equally with bodies which are not so, and consequently this general law extends indiscriminately to all bodies in nature. In fact, when several bodies, which are not hard, act upon each other, in any given manner, if we conceive the movement that each particle would have taken, if it had been free, as decomposed into two, one of which is what it would have really taken, the other will be destroyed; whence it evidently follows, that if the bodies had been hard, and had not had other movements

ments than the latter, there would have been an equilibrium: these destroyed movements are therefore subjected to the same laws, have the same relations to each other, and, lastly, may be determined in the same manner as if the bodies were hard, *i. e.* by the general equation (F). This equation (F) is not confined therefore to hard bodies, it also belongs to all the bodies in nature, and consequently contains all the laws of equilibrium and of movement, not only for the first, but even for all the others, whatever may be their degree of compressibility: but the difference consists in this; that we may, with respect to hard bodies, suppose $u = V$; in such a manner that $s\,m$ V U cosine $Z = 0$ becomes one of the determinate equations of the problem, whereas this does not take place when the bodies are of a different nature: it is therefore this determinate equation, which is the same with the first fundamental equation (E), it is, I say, this determinate equation which characterizes hard bodies, and consequently it is absolutely necessary to employ it at least implicitly in all questions concerning these bodies; and with respect to any other kind of bodies, we must, besides the determinate equations, which we may obtain by ascribing to u in the indeterminate equation (F) different known values—we must, I say, also extract from it one which is analogous to the equation (E), and which expresses in some measure the nature of these bodies, in the same way as the latter (E) expresses that of hard bodies. But as this inquiry has but a very indirect relation to machines properly so called, we shall at present confine ourselves to examining the case where the degree of elasticity is the same with respect to all bodies, *i. e.* Let us suppose, that in virtue of elasticity the bodies exercise upon each other, pressures n times as great as if the bodies were hard, n being the same for all the bodies of the system; let us next suppose that the pressure and the restitution are made in an indivisible instant, although in strictness that would be impossible. This being done:

The reciprocal pressures F becoming n F, will have among them the same relations as if the bodies were hard; therefore their results m U will not have changed their directions,

rections, but will merely have become n times as great as they would have been if the bodies had been hard: this being done, since W is the result of V and U, we have V cosine Z = W cosine Y — U: thus the equation (E), for which we are seeking one analogous, may be put under this form $s\,m$ W U cosine Y $- s\,m\,U^2 = 0$. Now, according to what has been said, we must, in order to apply this equation to the case in question, place $\frac{U}{n}$ in place of U, without any change upon Y: therefore in the case we are examining the equation will be $s\,m\,W\,\frac{U}{n}$ cosine Y $- s\,\frac{m\,U^2}{n\,2} = 0$; or by multiplying by n^2, $n\,s\,m$ W U cosine Y $- s\,m\,U^2 = 0$; or on account of W cosine Y = V cosine Z + U, we shall have $\frac{n}{1-n}\,s\,m$ V U cosine Z $= s\,m\,U^2$: thus this equation will be, with respect to the bodies in question, what the equation (E) is with respect to hard bodies; and even the latter is the particular case where we have $n = 1$, as is evident.

When $n = 2$, it is the case of bodies perfectly elastic, and the equation becomes $2\,s\,m$ V U cosine Z $+ s\,m\,U^2 = 0$; but this equation relative to bodies perfectly elastic may be expressed in a known and more simple manner, as follows: Since W is the result of V and U, we have by trigonometry $W^2 = V^2 + U^2 + 2$ V U cosine Z; and therefore $s\,m\,W^2 = s\,m\,V^2 + s\,m\,U^2 + 2\,s\,m$ V U cosine Z. Adding to this equation that found above, and reducing, we have $s\,m\,W^2 = s\,m\,V^2$, which is precisely the principle of the preservation of active forces, *i. e.* this preservation is, with respect to perfectly elastic bodies, what the equation (E) is with respect to hard bodies, as we undertook to prove.

First Remark.

XXVII. I shall not dwell on the particular consequences which I might draw from the solution of the preceding problem; but shall merely remark, that the velocities W, V, U, being always in proportion to the three sides of of a triangle, trigonometry may furnish the means of giving a great number of different forms to the fundamental equations (E) and (F); and I shall content myself with indicating one of them, which is remarkable on account of the method contrived by geometricians, of referring movements to three plans perpendicular to each other; which gives a great deal of elegance and simplicity to the solutions.

Let us imagine, therefore, at pleasure, three axes perpendicular to each other; and let us conceive that the velocities W, V, U and u, are each of them decomposed into three others parallel to these axes. This being done, let us call

Those which answer to	W,	W′	W″	W‴.
Those which answer to	V,	V′	V″	V‴.
Those which answer to	U,	U′	U″	U‴.
Those which answer to	u,	u',	u'',	u'''.

Now if we pay a little attention, we shall easily see that the first fundamental equation (E) may be placed under this form, $s\,m\,V'\,U' + s\,m\,V''\,U'' + s\,m\,V'''\,U''' = 0$; and the second (F) under the latter $s\,m\,u'\,U' + s\,m\,u''\,U'' + s\,m\,u'''\,U''' = 0$; because in general every quantity which is the product of two velocities A and B, by the cosines of the angle comprehended between them, is equal to the sum of three other products $A'\,B' + A''\,B'' + A'''\,B'''$; $A'\,A''\,A'''$, being the estimated velocity A of these three axes, and $B'\,B''\,B'''$ being the estimated velocity B in the ratio of these same axes: *i. e.* A′ being the velocity A, and B′ the velocity B, estimated parallel to the first of these axes; A″ and B″ the same velocities A and B′ estimated parallel to the second axis, A‴ and B‴ the same velocities estimated parallel to the third axis: this is easily proved by the elements of geometry.

In the case of equilibrium, the first of these transformed equations is reduced to $0 = 0$; and the second, because in this case $W = U$, becomes $s\,m\,u'\,W' + s\,m\,u''\,W'' + s\,m\,u'''\,W''' = 0$; which expresses all the conditions of the equilibrium.

When the movement changes by insensible degrees, we have found (XXV.) that the fundamental equations become $s\,m\,V\,p\,t$ cosine $R - s\,m\,V\,d\,V = 0$, and $s\,m\,u\,p\,d\,t$ cosine

$r - s\,m\,u\,d$

$r - s\,m\,u\,d$ (V cosine y) $= 0$; therefore by decomposing p into three other forces parallel to the three axes, if these component forces are designated by p', p'', p''', the preceding equations will become, the first, $s\,m\,V'\,p'\,d\,t + s\,m\,V''\,p''\,d\,t + s\,m\,V'''\,p'''\,d\,t = s\,m\,V'\,d\,V' + s\,m\,V''\,d\,V'' + s\,m\,V'''\,d\,V'''$; and the second, $s\,m\,u'\,p'\,d\,t + s\,m\,u''\,p''\,d\,t + s\,m\,u'''\,p'''\,d\,t = s\,m\,u'\,d\,V' + s\,m\,u''\,d\,V'' + s\,m\,u'''\,d\,V'''$: finally, in the case of equilibrium, the first will vanish, and the second will be reduced to $s\,m\,u'\,p' + s\,m\,u''\,p'' + s\,m\,u'''\,p''' = 0$.

Second Remark.

XXVIII. Hitherto I have regarded wires, rods, levers, &c. as bodies making of themselves part of the system. And this hypothesis entirely conforms to nature; but one thing indispensably necessary to observe is, that, strictly speaking, there is probably no absolutely fixed point in the universe, no obstacle absolutely immoveable; the fulcrum of a lever is not so, because it is supported upon the earth, which is not fixed itself; but the mass of which is almost infinitely great in comparison of those the action and reaction of which upon each other we generally consider in machines: in order to move the hypomochlion of a lever, we must also put in motion the globe of the earth; and it is so in fact, however feeble be the powers which act upon the machine *: the quantity of movement which they produce upon it, is equal to the resistance of the hypomochlion; but this finite quantity of movement distributing itself into a mass almost infinitely great, there results to this mass a velocity almost infinitely small, and this is the reason why this movement is not sensible, and may be neglected in practice.

Hence it follows, that what we call immoveable obstacles in mechanics, are nothing else than bodies the mass of which is so considerable, and consequently the velocity so small, that their movement cannot be observed. We shall therefore approach nearer nature, by considering the obstacles,

* M. Carnot does not exhibit here his usual accuracy. If the power applied to the lever belonged to any other system than that of the earth, the earth would be moved; but in the case of the fact here assumed, it is not moved, even in an infinitely small degree.—*Edit.*

or fixed points, as moveable bodies, as well as all the others; but of a mass infinitely large, or, what comes to the same thing, as bodies of an infinite density, and which do not diffef from all the other bodies of the system except in this point. Hence a considerable advantage will result, as we shall be able to make the system into which these bodies enter, take any given geometrical movements; for the instant we suppose these obstacles moveable like all other bodies, they will become susceptible of assuming any movements, and the general system must be regarded as an assemblage of bodies perfectly moveable: consequently, the quantities of movements absorbed by the obstacles may be estimated as with respect to all the other parts of the system; in such a manner, that if we call R the resistance of any given fixed point, this quantity R will be in the equation (F), with respect to the point in question, what *m* U is with respect to the body *m*: we shall therefore find by this equation, this same quantity R like all the other forces *m* U, which could not be the case by considering the obstacles as absolutely immoveable, without having recourse to some new mechanical principle, which we must have made concur with the general equation (F), in order to attain the complete solution of each particular problem. Thus this method of considering the fixed points is not only the most conformable to nature, as we have said before, but also the simplest and the easiest.

As to the wires, rods, or any other portions of the system, the masses of which may be supposed to be infinitely small, we may neglect, *i. e.* suppose each of their molecules *m* equal to zero, or, what comes to the same thing, regard their density as infinitely small, or as nothing: our equation (F) will therefore become independent of these quantities, *i. e.* the same as if we had abstracted these masses from the bodies; and it is thus that we shall easily find the mathematical theory of each machine, *i. e.* by making the abstractions spoken of (VIII.)

XXIX. From this remark it results, that although there is only a single kind of bodies in nature, we distinguish them however, for the facility of calculations, into three different classes, which are, 1st. Those which we consider as what they really are, and as nature presents them to us, *i. e.* which are of a finite density. 2d. Those to which we ascribe a density infinitely great, and which, for this reason, must be regarded as sensibly fixed and immoveable. 3d. Those to which we ascribe a density infinitely small, or null, and which, consequently, by their inertness, oppose no resistance to their change of state. In practice we generally regard as such, wires, rods, and generally all bodies which do not influence sensibly, by their proper mass, the changes which happen in the system; but which are solely regarded as means of communication between the different agents which compose it.

Third Remark.

XXX. After having treated of equilibrium and of movement in general, as much as my principal object permitted, I shall pass to what regards more particularly what we commonly understand by machines; for although the theory of every kind of equilibrium and movement always enters into the preceding principles, since there are only, according to the first law, bodies which can destroy or modify the movement of other bodies; nevertheless there are cases where we make abstraction of the mass of these bodies, merely for the purpose of considering the effort they make: for example, when a man draws a body by a wire, or pushes it by a rod, we do not introduce into the calculation the mass of this man, nor even the effort of which he is capable, but solely that which he exerts upon the point to which he applies it; *i. e.* the tension of the wire, if it is by drawing that it acts, or the pressure, if it be by pushing; and without considering whether it be a man, an animal, a weight, a spring, or a resistance occasioned by any obstacle, or by the *vis inertiæ* of a moveable body*, a friction, an impulse caused by

* Any body which we force to change its state of repose, or of movement, resists (XI.) the agent which produces the change; and it is this resistance which we call *vis inertiæ*. In order to find the value of this force, we must decompose the actual movement of the body into two, one of which is that which it will have the instant afterwards; for the other will be evidently that which must be destroyed, in order to force the body to change its state; *i. e.* the

by a current of air, or water, &c. We give in general the name of power to the effort exerted by the agent, *i. e.* to that pressure or tension by which it acts upon the body to which it is applied; and we compare these different efforts without regarding the agents which produce them, because the nature of the agents cannot change the forces which they are obliged to exercise in order to fulfil the different objects for which machines are destined: the machine itself, *i. e.* the system of fixed points, obstacles, rods, levers, and other intermediate bodies, which serve to transmit these different efforts from one agent to another; the machine, itself, I say, is considered as a body stripped of its inertness: its proper mass (when it is necessary to have regard to it, whether on account of the movement which it absorbs, or on account of its gravity or of other motive forces with which it may be animated,) is regarded as a foreign power applied to the system; in a word, a machine properly so called, is an assemblage of immaterial obstacles, and of moveable particles incapable of reaction, or deprived of inertness, *i. e.* (XXIX.) a system of bodies the densities of which are infinite or nothing. To this system we imagine that different external agents, in the number of which we comprehend the mass of the machine, are applied, and transmit their reciprocal action by the intermedium of this machine. It is the pressure or other effort exercised by each agent upon this intermediate body, which we call force or power; and the relation which exists between these different forces, forms the subject of the inquiry, which has for its object the theory of machines properly so called. Now, it is in this point of view that we proceed to treat of equilibrium and of movement; but a force taken in this sense is not the less a quantity of movement lost by the agent which exercises it, whatever this agent may be in other respects, whether it acts upon the machine by drawing it by a cord or by pushing it by a rod; the tension of this cord, or the pressure of this

i. e. the resistance which it opposes to this change, or its *vis inertiæ;* whence it is easy to conclude, that the *vis inertiæ of any body is the result of its actual movement, and of a movement equal and directly opposed to that which it should have the instant afterwards.*

rod, expresses both the effort which it exercises upon the machine, and the quantity of movement which it loses itself by the reaction it undergoes: if, therefore, we call F that force, this quantity F will be the same thing with that which is expressed by m U in our equations*. Thus, if we call Z the angle comprehended between this force F, and the velocity u, which the point would have where we suppose it applied, if we make the system assume any geometrical movement, the general equation (F) will become s F u cosine Z = 0 (AA). It is therefore under this form that we shall immediately employ this equation, by means of which we may apply whatever we can mention, to any imaginable kind of force; and the principles exposed in this first part will serve us to develop the general properties of machines properly so called, which are the object of the ensuing division of the present work.

[To be continued.]

VI. *On the Stratification of Matlock in Derbyshire, pointing out a Mistake of the late Mr.* JOHN WHITEHURST, *relative thereto; and on the Transmutation of Lime to Silex. By Mr.* JOHN FAREY, *Mineralogical Surveyor.*

To Mr. Tilloch.

SIR,

THE late Mr. *John Whitehurst*, in his "Inquiry into the original State and Formation of the Earth," has given sections of the strata to be found in various parts of Derbyshire,

* It is evident that the quantity of movement lost m U, is the result of the movement which the body m would have had the instant afterwards, if it had been free, and of the movement equal, and directly opposed to that which it will really assume: now the first of these two movements is itself the result of the actual movement of m, and of its absolute motive force; therefore m U is the result of three forces, which are: its absolute motive force, its actual quantiy of movement, and the quantity of movement equal and directly opposed to that which it should have the instant after: but according to the preceding note, these two last quantities of movement have for their result the *vis inertiæ*: therefore m U or F is the result of the motive force of m and of its *vis inertiæ*; i. e *the force exercised by any given body, at each instant, is the result of its absolute motive force and of its* vis inertiæ.

which,

which, excepting the want of proportion in his horizontal distances and some few mistakes, into which he was led by too great a dependence on his favourite theories, are by far the best views of the structure of the crust of the earth which I have any where seen. The romantic valley in which Matlock baths are situated, was one which Mr. Whitehurst examined; and he has given a section crossing the same at the High Tor, a stupendous rock, rising almost perpendicularly from the river Derwent, which hurries along at its foot. Mr. W., as will be seen by the copy of his section in the upper part of the drawing which accompanies this (Plate II.) considered the strata under the Derwent in this place to have been broken, and those on the west side as sunk down; thereby occasioning that great difference in the height of the rock, on the east and west sides of the river, which strikes every beholder with astonishment. On extending my examination of the strata of Derbyshire into this neighbourhood, I saw abundant reasons for concluding, that the rocks facing Matlock High Tor are not materially disturbed from their original position, (except that the dip of the whole is much greater than formerly,) by the violent action from above, which has torn up, and completely carried away, the superficial strata, and *denudated* all the strata now to be seen in this part of Derbyshire, and part of Staffordshire adjoining, a fact which did not escape the sagacity of Mr. Whitehurst—(page 193 and others of his Inquiry)—had he but hit on a cause more adequate than the one he mentions, for the removal and disappearance of such vast masses of matter, as are here wanting, to complete the known order and arrangement of the British strata; which I hope in due time to be able to show to be as regular and certain, in this dislocated and broken country, as in any other part of England.

Messrs. *John* and *George Nuttall*, land-surveyors of this place, to whose extensive and minute acquaintance with the soils and circumstances of the county I have been much indebted, having furnished me with the exact horizontal distances across this extraordinary valley, in a straight line from the small clump of firs on Riber Hill, (situated about 200 yards N.W. from the hamlet of that name,) to the clump of firs on Masson Low, at the edge of the parish of Borsal, I have been at some pains to ascertain the extent and position of the strata in this line, which fortunately passes just over the High Tor, and is sufficiently near to the line which Mr. Whitehurst describes across the Tor, to admit of a fair comparison therewith. My section, in the lower part of the drawing (Plate II.) will show, that the strata preserve an exact parallelism, in rising from under Riber Hill to form Masson Hill; and that the latter would have been of a height unequalled by any hill in this part of the country, but for the denudation which it has suffered. The lime-stone shale seeming to form the point of separation between the carboniferous strata and those which some have denominated primitive, I have made this my point of comparison, for naming the principal Derbyshire strata, and have denominated the lime-stones and toad-stones, the first, second, third, &c., in order below this; and the grit-stones and coal shales the first, second, third, &c., above it, in the order in which they occur. The extent of the present section is not sufficient towards the east, for showing the first coal-shale, as the same is seen, covering the first or Mill-stone-grit Rock, on the eastern slope of Riber Hill. It will be perceived by the corresponding numbers and hatchings in Mr. Whitehurst's and my sections, that I make the second lime-stone (or dun-stone as the miners call it) to cover the eastern slope of Masson Hill in this line, except at the foot of the High Tor, where the same is torn away, so as to expose about 13 acres of the surface of the second toadstone, surrounded and covered on every side by the second lime-stone, and which in its turn is seen covered by the first toadstone, and then by the first lime-stone, in proceeding either north or south, along the turnpike-road, from off the second toadstone in front of the High Tor: a little further south, the shale also crosses the river, and covers the lime-stone for a short distance in a trough, or abrupt break-down of the measures; of which troughs numerous

instances

instances are here to be met with, covered by pieces of the upper measures, sometimes almost detached from the mass of such covering strata.

Although I differ from Mr. Whitehurst as to the fissure under the face of the High Tor, and as to valleys being generally so broken; yet I doubt not but this county furnishes numerous instances of valleys so broken, in places where the plane of the strata takes a new direction or dip, as Mr. W. supposed them to do on each side of the Tor (H) in his section.—The front of the High Tor is in the range of the Seven rakes Mine; and almost the whole of the perpendicular rocks therein are covered with spar, and other matters peculiar to the skirts of veins, or are of the nature of *riders*, which I find, not to consist of fragments of the adjoining rocks, as most authors have described them to be, but confusedly crystallized masses, occupying and filling the cavities left between the skirtings of spar and ore, which the sides of the vein had in the wider parts thereof previously received. A large portion of all the lime-stone cliffs which I have examined in this county, seem to owe their origin to rake-veins running parallel to their faces, and to have had their perpendicular façades preserved to the present time, by the facing of vein-stuff and rider, with which they are coated.

Allow me, sir, the liberty here to notice the opinions of *Mr. Hume*, on the identity of silex and oxygen, which I have read in the 29th and 30th volumes of your useful work, for the purpose of mentioning, that however far his doctrines may be repugnant to those, which chemists are at present disposed to treat as orthodox, yet that such must, I think, have to prepare themselves for still greater innovations, on their lists of supposed elementary substances, when the operations of Nature in her grand laboratory, wherein the strata of the earth were formed, and were, by their mutual action, reduced to their present state, come to be more closely and minutely examined.

The transmutation either of lime into silex, or silex into lime, can, I think, be doubted by no one, who will attentively examine and consider the surface, of either of the four lime-stone rocks (exhibited in the section Plate II.) which compose the lime-stone soils of this county. Mr. Hume (vol. xxx. page 275 and 276) would contend for the last of these changes; but I conceive the evidence here to be strongly in favour of a change of the lime-stone into rotten-stone, chert, and other siliceous substances, and even into vegetable mould containing a large portion of silex; for here the fragments of *lime-stone*, the fourth in particular, assume that blunted nodular shape, when exposed on the surface (often surrounded by a coating of rotten-stone), which Mr. Hume (page 276) considers as evidence of "loss in the primitive mass." The lower beds of the first lime-stone rock, which are so much admired for the beautiful assemblage of entrochi which they contain, when exposed on the surface by the oblique fracture of the strata in particular places, as on the N.E. skirt of Masson Hill, near to Salter's Way in this parish, are found among the vegetable soil converted into masses of chert, with the shells also changed to that substance: how much more probable is it, that these chert blocks on the surface are changed from lime, than that the whole mass of lime-stone (in which state these entrochi beds are always, I believe, found, except near to the surface) has been changed from silex to lime? May not silex, lime, oxygen, and others of our supposed elements, all be compounds, or modifications of some, perhaps, unknown substances? and how otherwise can we account for the same stratum (or rather assemblage of strata) producing concoctions or nodules, upon an immense scale, of rock-salt, of gypsum, of sienite, of slate, and perhaps of other substances, equally distant in the chemist's list of mineral relations? I allude here to the strata called by *Mr. Smith*, and the Somerset colliers, the *red ground*, or red earth, from that being its prevailing colour; in which salt will be found imbedded in Cheshire and other places, gypsum in this and various other counties, sienite and slate in Charnwood Forest in Leicestershire, and in other places, perhaps wherever any such are met with in England. Hoping that I shall, ere long, see the attention of practical chemists and mineralogists turned, in right earnest,

earnest, to the examination of the British strata, before the subject is forestalled by the researches of our industrious neighbours on the Continent, I remain, sir,

your obedient servant, JOHN FAREY.

Matlock, Derbyshire,
May 18, 1808.

VII. *On Malting.* *By* JOHN CARR, *Esq.**

Theory of Malting.

THE interior of a barley grain consists of two distinct parts, a minute germ, destined to elongate into the future plant, and a portion of farinaceous and mucilaginous matter, stored up expressly for its future conversion into saccharine, as the pabulum of the germ in the earliest stage of its vegetative existence.

The germ itself consists of two very different parts, the plumula (acrospire in malting) and the radicle or root: both are united at the same end of the grain, but in germinating, the radicle very soon pierces the husk, and separating into several fibres elongates downwards, while the acrospire, but much more slowly, advances through the body of the grain, and piercing the opposite end, soon shoots up into a green blade, leaving the husk of the corn empty, and perfectly exhausted of its former contents.

The radicle is much more rapid in its formation and growth than the acrospire, because, as it is destined to prepare and transmit to the stem nearly all its pabula, it is necessary that it should be sufficiently matured to perform this office by the time the acrospire has consumed the store which provident Nature had laid up for it in the grain.

There is no difficulty in comprehending the first dawnings of vegetative life in the germination of barley; the grain placed under favourable circumstances of moisture and warmth imbibes both, and swells much; the radicle, lying nearest to the exterior, is the most susceptible of these, it swells

* From *Papers presented to the House of Commons relating to the Sprinkling of Malt on the Floor.* Ordered to be printed 10th of August, 1807.

most

most and first, and under its new combination of moisture acquires an attraction for the oxygen of the atmosphere. The oxygen, as it becomes fixed, produces two powerful effects, it gives up that portion of latent heat which held it in a gaseous state, and by its fixation enters into a new combination with the farina of the grain, converting it into an oxide, or in other words into a saccharine.

The stem part of the germ, previously swelled by the moisture, and now invigorated by the heat produced from the fixation of the oxygen, acquires an attraction for the newly-formed saccharine, assimilates it to itself, and in the chemical action of union which ensues, vegetative life is developed.

Such simply is the natural process of germination in every species of seed, though here restricted to barley; and it is important to remark, that the heat arising from the fixation of the oxygen is the same which first becomes sensible in the couch, and afterwards continues to show itself in different degrees amongst the corn on the working-floors, and in the nice adjustment and due regulation of this heat consists the most important part of the manipulations of malting.

The formation of the saccharine in the grain is slow and progressive as the acrospire requires it, and hence it may easily be conceived that between its first formation and final consumption, there must be a period of time when the largest proportion abounds in the grain, and this is the proper time for throwing the corn upon the kiln.

Mr. Reynoldson, in his evidence, states that the saccharine previously exists in the barley, and that the process of malting only develops a substance which was already present in the grain; but this, like several other of his philosophical assertions, is so contrary to the natural fact, as obviously to refute itself. The chemical and natural characters of malt differ so essentially from those of barley as clearly to prove that there has been not a mere development of a thing present, but an entire change of the original substance into another.

Practice of Malting.

Malting then is nothing more than the promotion of a healthy

healthy germination of the barley up to that period when the largest proportion of saccharine has been formed; nor can any thing be more obvious than that in a variety of modes to accomplish this, one must be superior to all the rest, and that not locally, but every where, because nature is every where the same. In every natural process, a varying of the means will necessarily produce a difference in the end; and in the two modes of malting, by watering on the floors, or omitting to do so, there is so material a difference, not merely in the use or disuse of the water, but in the time, management, and other circumstances, that the one cannot but be superior to the other in the quality of its respective commodity.

A single instance, I believe, cannot be produced of any natural process whatsoever, wherein Nature permits the employment of two different means to produce precisely the same end. The application of this to the question of malting will, I humbly presume, be sufficiently obvious, by separately considering the different branches of the case.

The Radicle.

This is by much the most important organ in malting: without a root the grain will never germinate, and with too much, the substance of the corn will be exhausted, and the malt on that account will be light and unproductive. This has hitherto, I believe, either not been sufficiently known or attended to;—in this, as in every other natural process, Nature herself affords the best explanation.

On the richest and best lands the roots of barley are short, and the plant large and strong; but on loose and poor soils the roots are long, and the stem small and weak. In the one case the root, having readily found what it was in search of, stops; but in the other, Nature is compelled to expend much of the pabulum on the more ignoble part of her production. On the floor of a malt-house the grain is worse situated than on the loosest and poorest land; for it contains no soil at all, and if permitted, the root there would run out to some inches in length, and almost wholly ex-

haust

haust the substance of the corn. To prevent this is one of the principal objects in the manufacture of malt, and hence too a just criterion is afforded for estimating the merit of different methods of working; for that method which will accomplish the full malting of the barley with the least possible root is so far unequivocally the best, because such malt will have expended the least portion of itself on an object entirely unproductive. Now there is perhaps no one circumstance wherein the Hertfordshire method of malting differs so distinctly from the watering system, as in its short and comparatively small radicle. This may be very clearly collected from many parts of the evidence, for the watering party even seem to have made a merit of it, by endeavouring to show that their own steepings, from the larger quantity of root which they contained, approached and even ran into floor charges far beyond the Hertfordshire steepings; and they thence endeavoured to infer that a larger opening was left in the latter for fraud, by the introduction and mixing of corn privately steeped. It is indeed certainly true that the Hertfordshire mode of working gives the floor gauges low, and the other high; but with this the question of fraud has very little to do, for mixing is seldom if ever practised in whole floors; but the short and small radicle of the one, and long bushy root of the other, are decisive characteristics which are admitted by themselves, and which would, in my humble judgment, stamp a decided superiority on the Hertfordshire malt.

That the radicle is actually formed from the body of the barley is too obvious to require any proof, and indeed it is universally admitted to be so; and as it is afterwards burnt off on the kiln, and becomes mere waste, every particle of matter which it unnecessarily takes from the substance of the corn is just so much loss; and though this has not been at all adverted to in the inquiry before the committee, it does in fact constitute one of the most important portions of the subject, for it actually is the expenditure of the substance of the barley on the root, by working it too much out, which is the chief cause why malt manufactured under the forcing

forcing system of watering the floors is lighter and less productive than the malt made by the Hertfordshire mode, without watering.

The Acrospire.

In the malting trade a great diversity of opinion prevails as to how far the vegetation of the acrospire should be carried. This arises from a notion, very general among maltsters, that just so far as the acrospire penetrates the grain, it becomes malted, and that the impenetrated part remains unchanged barley. I trust, however, that I shall soon show there is nothing either of truth or nature in this notion. The evidence of Messrs. King and Clough sufficiently establishes that the best malt is made when the acrospire proceeds only two thirds through the grain, and it is my present purpose to prove that their opinion and practice are supported by the natural reason of the case.

I have already stated that it is the radicle which first acquires an attraction for the oxygen of the atmosphere, communicating it progressively to the interior substance of the barley, and forming by its fixation and union with the farina the first saccharine; and that afterwards the plumula, or infant stem, requires an attraction for the newly formed saccharine, and by its chemical action is pushed into vegetable life.

In this statement a solution is given of the question of the acrospire, and the truth really is, that the radicle is the only natural organ which malts the barley, or, in other words, oxidites the interior substance, and forms the whole of the saccharine, while the acrospire is simply employed in feeding upon it, and from thence acquiring its growth and bulk.

This obvious, and I trust just and natural distinction in the offices which Nature assigns to each of those different members of the plant, sufficiently explains why the barley may be, and actually is perfectly malted by the Hertfordshire method, though the acrospire has proceeded only two thirds through the grain, because in the more slow and natural growth of the acrospire, the root has had time to malt the interior substance beyond it, and even to the extreme

end

end of the corn, whereas in the more unnatural forcing of the watering mode, the acrospire is driven forward as rapidly, though without having any immediate connection with the oxidation; and thus an accidental occurrence has been erroneously mounted up into a cause. It is material to remark, that in brewing, the acrospire is insoluble, and always appears so among the spent grains; hence the larger it grows the more it contributes to waste.

The preceding account of the radicle and acrospire so far simplifies the question of malting as to concentrate it to this limited rule, that that mode of working will necessarily be the best which can accomplish the full malting of the barley with the smallest radicle and acrospire; for both, as I have already shown, are supported from the interior substance, and just in proportion as they are advanced in bulk, that portion of the malt which yields the fermentative extract will be diminished.

On page 40 of the printed evidence Mr. Delafield states, that he has found malt, made by sprinkling, to yield from 15 to 20 pounds weight in four bushels less than an equal quantity of malt which had not been watered; and on page 43 Mr. Martirrena declares, that sprinkled malt affords only 64 pounds of extract, when a like quantity of unwatered malt gave as high as 84 pounds: other passages of the evidence also prove, that watered malt is lighter, and on that account less productive, than the Hertfordshire malt; but no explanation of the immediate cause of so material a difference is any where attempted here: however, I would humbly submit the true cause to lie in the comparative smallness both of the root and acrospire in the Hertfordshire malt, whereby less of the substance of the grain is consumed, and that it is the long and bunchy root and large acrospire of watered malt that render it so light and unproductive.

Temperature of the Floors in Malting.

There is no one circumstance in the manufacturing of good malt that merits so constant and careful an attention to the working floors as this temperature. There is a certain maximum of heat that is the best adapted to malting, and with

with which the vegetation will proceed in the safest and most natural order; either above or below this temperature is a disadvantage, but an excess and fluctuation of heat are highly injurious in a malt-house. In whatever way the floors are worked the temperature will continue to rise in proportion to the time they lie undisturbed, and the only method of checking the rise is by turning them.

Moisture is the remote cause of all heat in vegetable substances, heaped together, and containing a farinaceous or starchy matter. This matter passes into a state of fermentation, attracts oxygen from the atmosphere, which in its fixation parts with the latent heat it was before combined with, and this accumulating in the heap will frequently rise to inflammation. The heat of a dunghill, moist hay-rick, wet barley, and all other similar heaps of wet vegetable matter, originates in one and the same natural cause. In floors of malt the heat is always in proportion to the quantum of moisture and repose of the floor.

The chief object in a well regulated malt-house is not only to preserve the floors in one equable state of temperature from the cistern to the kiln, but more especially to preserve every part of the same floor in an equal warmth. A departure from this produces an unequal vegetation. In the Hertfordshire method of working, as there never is any increase of moisture after the corn leaves the cistern, an equable and steady temperature in both of the preceding cases can be preserved with much certainty; but under the practice of watering the floors it is not practicable to maintain the same equal degree of temperature either in the progress of the floors to the kiln, or in the different parts of the same floor; and the consequence is, that a forced, a fluctuating, and an unequal vegetation is induced in the same steeping, and the malt thereby becomes greatly injured. It is heat in the first instance that dissipates the water which the grain had imbibed in the cistern, and renders subsequent watering necessary. The floors cannot be heated without an expenditure of moisture, for the warmth sweats the water out of the corn, and when the floor is turned, the moisture on the husk flies off by evaporation: hence, though the

the water is at first the cause of the heat, the heat again renders more water indispensable. The floors in Hertfordshire are never watered, simply because they are never heated; and it is the cool state in which they are kept in the early stage of malting that preserves the original moisture, and induces that slow and natural vegetation so necessary to prevent the substance of the grain from being run out.

Mr. Reynoldson, in his evidence, states that the water imbibed in the cistern is employed in forming the root, and that the root afterwards is employed in supplying the grain, and hence he infers that fresh water is necessary on the floors. This description is tolerably just when applied to the watering practice, but by no means so in that of the Hertfordshire. In the former the cistern water, as I have already stated, is nearly all expended in the first five or six days by the employment of heat to drive out a rapid vegetation of the root, but in the latter, seven or eight days are employed to vegetate a less root. It is in this that the two practices differ from each other.

Mr. Reynoldson also states that the water received into the grain becomes decomposed, and after such decomposition exudes from the grain in a state unfit for vegetation, and hence he again infers the necessity of fresh water by sprinkling. This is another of that gentleman's unphilosophical assertions which is without foundation: in the chemical analysis of water only two products are obtained, viz. hydrogen and oxygen; and these, when separated, have never yet appeared in any other form than that of gases. The decomposed water of Mr. Reynoldson is nothing more than the pure water imbibed in the cistern, and injudiciously sweated out on the surface of the grain.

Flinty Malt.

Much is said in the evidence about flinty malt, and the agents of the watering party insinuate that watering the corn on the floors will best prevent it; I have however much reason for believing the contrary. Flint is allowed to differ essentially from the original substance of the barley, and its formation in the malt is therefore unquestionable. It consists

sists of little hard knobs or ends in the grain, which are insoluble, and so far impoverish the malt. Its natural cause, I am well convinced, resides in the heat improperly given to young floors, more especially of watered malt. This heat occasions the glutinous mucilage of the barley to run into a clammy substance, somewhat like birdlime, enveloping part of the farina, and inspissating first on the working floors, and afterwards on the kiln, hardening into that substance called in the trade flint; and as heating the young floors is a common practice with the watering party, and can only happen in Hertfordshire from the neglect of the workmen, it is surely reasonable to conclude that the watering system, amongst its other evils, will be the principal source of flinty malt.

Flavour of Malt.

A great deal is said by the agents for watering, on the subject of their being enabled to make their malt of a superior flavour by sprinkling; but the question of flavour, when applied to pale or common malt, resolves itself into this simple fact, that that malt which is worked in the most pure, clean, and natural manner, will be the most free from all adventitious and improper flavour.

While pale malt is working on the floors, all that can be done is not to give, but to guard it from any peculiar flavour. On the kiln the case is widely different; there, just in proportion as the fire is urged, slowly or rapidly, less or more of flavour and colour will be given to the malt: it is in this way only that all malt, expressly intended for the brewing of porter, has its peculiar flavour and colour given to it: but the flavour of ale, generally speaking, is derived from a different source; this latter arises from the union of a peculiar oil of a greenish colour, naturally abounding in hops, with a portion of the unfermented wort, and the mucilage and alcohol of the fermented part; these, judiciously blended together in a due proportion, give to ale all its agreeable taste; but the palate being an arbitrary organ, and differing widely in different places, no established rule can be laid down for adjusting the flavouring of ale: in some places the sweet taste of the malt is required to be pretty full in the mouth, by leaving a larger proportion of the unfermented wort; while in others it is required to be almost entirely dissipated by a more complete fermentation, and between these a variety of flavour may easily be imagined.

What has been said will be sufficient to explain the case as far as regards that flavour which it is desirable to obtain: but there is another point of view in which it is to be considered, and that is, those bad flavours which malt acquires in its progress through a manufacturing state, and which greatly depreciate its value. The principal of these, and indeed the only one with which the present inquiry is immediately connected, is that of mouldy malt, arising from the vegetation ceasing after having made some progress; most of the grains which are bruised by being trodden under the feet of workmen or others while in a state of malting, pass into a mouldy or putrid state; but the principal source of mouldy malt is in wet grain buried under other corn, and too long excluded from the influence of the atmosphere: a simple experiment will sufficiently illustrate this; if a sample of half malted barley be placed under a bell-glass, air-tight at the bottom, the corn will vegetate freely until the inclosed oxygen is all consumed, when the vegetation will cease, and the grain will pass into a state of decay similar to mouldy malt, and the more moist the grain was when inclosed under the glass, the sooner it will become mouldy.

In watering on the floors it is invariably the practice to turn over the grain immediately after it has been sprinkled, hence the wet corn is placed at the bottom, and it will necessarily happen that some of this will again be thrown undermost in the subsequent turnings, and this cannot fail to destroy the vegetation and render such grain mouldy, and not only the grains individually dead, but all others with which they happen to come in contact will acquire a disgusting taint, which will afterwards materially affect the flavour of the liquor drawn from the malt.

[To be continued.]

VIII. *Chemical*

VIII. *Chemical Examination of the Pollen or the fecundating Dust of the Date Tree of Egypt*—Phœnix dactylifera. *By* A. F. Fourcroy*.

§ I. *Introduction.*

M. Delille, one of the learned men who accompanied Bonaparte in his expedition to Egypt, sent me a quantity of pollen or the fecundating dust of the date tree (*phœnix dactylifera* Lin.). This dust escapes from the antheræ, or small sacs, which contain, it so easily, and in so large a quantity, that whenever seen at sun-rise, at a distance it resembles a mist which surrounds the date trees. M. Delille collected it by causing some branches of male date trees to be shaken in a room hung round with napkins, to which the pollen adhered.

I ought here to mention a very remarkable fact published by M. Michaux, on the subject of the fecundating principle of the palm date tree. This naturalist travelled in Persia, when several usurpers were in arms contending for portions of that vast empire. The different parties, alternately victorious, penetrated into the provinces; and in order to reduce the inhabitants more speedily, they burned all the male individuals of the date tree. The most dreadful famine would have desolated these unhappy countries, if the Persians had not taken the precaution to keep in reserve the pollen of the antheræ, and to use it for fecundating the female individuals. This observation proves that the dust of the *phœnix dactylifera* preserves its fecundating property for a long time. It seems they kept it eighteen years without its having lost this virtue. I am therefore of opinion that the pollen of the date tree, brought by M. Delille, and contained in thick paper parcels, has undergone no alteration.

Upon opening the packets, I found the fecundating dust dry, of a sulphur yellow, sufficiently compressed to have been neither moistened nor heated, and well enough defended from the external air to prevent all bad influence.

* From *Annales du Muséum d'Histoire Naturelle,* tome i. p. 417.

There

There was a sufficient quantity of it (nearly 10 ounces) to make a very extensive chemical examination; and it was the first time that a similar occasion in modern chemistry had occurred of analysing this interesting substance. It brought to my recollection what I had seen sixteen years ago, in consequence of the kindness of M. Tessier, who then sent me a small quantity of the pollen of flax. I remember that the experiments made in my laboratory at this period, when the means of analysis were not so perfect as they are now, had been so unsatisfactory that I did not think it worth while to publish them. On the present occasion every circumstance concurred to induce me to profit by the opportunity :—the zeal and attention of M. Delille, who had furnished me with a rare and well-preserved production, and which had never been analysed ; the hope of discovering, with the help of well-known reagents, properties entirely unknown hitherto in a substance so important in its effects ; the abundance of the quantity, which admitted of my multiplying and varying the experiments in order to ascertain its chemical nature ; and, lastly, the perfection which we have attained in the analysis of organic compounds.

I could not be guided in my experiments by any preceding analysis, because from what we formerly knew of the pollen of the antheræ we were forced to consider it, according to some ideas of Reaumur, as a kind of concrete oily substance like the first matter of beeswax. I associated in these researches my friend M. Vauquelin, to whom I have been allied by a similarity of pursuits for a great number of years. Our readers will find that our experiments afforded us results which nothing could induce us to foresee or suspect.

§ II. *Preliminary Experiments.*

Before proceeding to the exact analysis of this dust, we thought it necessary to try some preliminary experiments, in order to ascertain the general nature of it, and to direct more certainly our progress in the details of the analysis. The following are the first general properties which presented themselves :

1. The

1. The pollen of the date tree has an acidulated and disagreeable taste.

2. When mixed with the tincture of turnsole it reddens it perceptibly.

3. When washed with warm water, it communicates to it a yellowish colour, and a very sensible acidity.

4. This infusion is precipitated in a canary yellow by lime-water and ammonia; the liquor which swims above the precipitate is of a golden yellow.

5. Solution of acetate of lead, of nitrate of mercury, and of silver, is precipitated in yellowish white by the same liquor.

6. Alcohol forms a white deposit, which is flaky and very light.

7. Heat renders the solution turbid, and occasions a separation of white concrete flakes.

8. The solution of sulphate of lime undergoes no change from the infusion of pollen.

9. The oxalate of ammonia instantly produces a pulverulent precipitate, which has all the properties of the oxalate of lime.

These experiments show that the pollen of the date tree contains a free acid; that this acid, very soluble in water, is accompanied by a calcareous salt, which, being insoluble of itself, is only dissolved by the intermedium in question, and that this calcareous salt is the cause of the precipitation of the solution of the nitrates of mercury and silver, by the infusion of the fecundating dust.

§ III. *Washing of the Pollen with cold Water.*

The most sensible and the most remarkable matter in the pollen being the acid exhibited upon the first experiments, we endeavoured to obtain it separately, in order to ascertain the nature of it. For this purpose, we washed 124 grammes of pollen (about four ounces) with a sufficient quantity of cold distilled water. The washings had a reddish colour, and an acidulated taste and smell similar to that of beer.

By evaporation, this liquor gave a matter of a reddish brown colour, the consistence and smell of which were like molasses;

molasses; its taste was sourer, and at the same time nauseous.

The matter produced from the evaporation of the washing of the pollen, agitated with alcohol, did not communicate any colour to it in the cold, although left a long time in contact with this liquid : but on the addition of heat, a part of this substance was combined with the alcohol, and gave it a very deep colour.

The part of the residue insoluble in alcohol then appeared less coloured, and was thicker than before; it was easily dissolved in water, and at the same time deposited a grayish matter in abundance; its taste was much less acid, and had a kind of putridity and mucilaginous viscosity. The produce of the aqueous ley of the evaporated pollen was therefore separated by the alcohol and water, applied successively in three substances; the one soluble in alcohol, the other soluble in water, and the third not soluble in either. We shall resume the examination of these substances, in order to determine their nature.

The alcoholic solution evaporated to the consistence of a soft extract, had in this state a fine red colour, a smell of boiled apples, a taste strongly acid, but sensibly disagreeable latterly.

It was easily and abundantly dissolved in water; it reddened turnsole tincture, made an effervescence with solutions of the alkaline carbonates, slightly precipitated lime-water in yellowish white flakes, which were dissolved in a new quantity of the acid liquor. It must be observed that this matter thus separated by the alcohol, precipitated lime much less than the first aqueous ley of the pollen; but united to lime-water to the point of saturation, the liquor presented in a few days at its surface a considerable quantity of insipid prismatic crystals soluble without effervescence in the muriatic acid.

The solution of the alcoholic residue in water precipitated also the acetite of lead in yellowish flakes which are dissolved in the acetic acid; nitrate of mercury a little oxygenated experienced the same effect.

Although the preceding experiments seem to prove that the

the acid contained in the pollen of the date tree was malic acid, in order to obtain a more rigorous demonstration of it we submitted it to the following test.

A portion of the solution of this acid, mixed with nitric acid, produced a great deal of nitric gas, and furnished upon cooling crystals of oxalic acid floating in a mother-water of a yellowish red colour and of a bitter taste. This experiment, as we see, confirms what the rest had announced, viz. that the acid of the pollen of the date tree is undoubtedly malic acid; for no other vegetable acid is changed so easily into oxalic acid by the nitric acid. It also resolves the question whether this acid existed naturally in the pollen, or if it be the result of a fermentation occasioned by the humidity on the voyage from Egypt. We know that in fact the malic acid never proceeds from a similar operation, and on the contrary, it is itself destroyed, in order to give rise to the acetic acid.

A portion of the matter soluble in alcohol having been dissolved in a small quantity of water, we mixed carbonate of soda with it; a very brisk and frothy effervescence was produced; and when the saturation appeared complete, we concentrated the liquor by evaporation to the consistence of a clear syrup: in this state it furnished in seven or eight days a quantity of small transparent crystals: there still, however, remained a great deal of matter which had not crystallized. The crystallized salt, mixed with lime-water, precipitated it but feebly; but some time afterwards new crystals were formed in the liquor.

§ IV. *Examination of the Portion of the Extract of the Pollen which was insoluble in Water and in Alcohol.*

We have said that the extract of the pollen obtained by the evaporation of the water with which this pollen had been washed, was not entirely dissolved in the alcohol, even with the assistance of heat; and that this residue had a brown colour, and a taste less acid than formerly, but nauseous. This portion insoluble in the alcohol was subjected to the following experiments, in order to ascertain its nature.

Upon dissolving in water it precipitated a matter of a yellowish

lowish white, which weighed when dried two grammes and a quarter, and which was reduced to one gramme and a quarter by calcination; it was then black like charcoal dust. This substance exhaled while on the fire the smell of burnt horns mixed with that of ammonia, but without softening or melting like horn. When exposed to the blow-pipe it first became black, afterwards white, and melted at last into a brilliant white globule, of a very lively phosphoric lustre.

This same matter not soluble in water was dissolved in the nitric and muriatic acids without effervescence; lime-water and ammonia gave precipitates from these acids in white gelatinous-like flakes. Oxalate of ammonia produced in the acid solutions a pulverulent and granulous precipitate. Sulphuric acid decomposed the same matter without dissolving it: after having boiled it for some time with this acid diluted in water we filtered the liquor, and washed the solid mass with cold water; we afterwards boiled it with a great quantity of water, which produced the complete solution of it; oxalate of ammonia formed oxalate of lime with it, and muriate of barytes formed sulphate of barytes.

Thus one of the elements of this substance treated with sulphuric acid was in reality lime. The acid to which this earth was united was ascertained by the following experiments: ammonia formed in it a gelatinous precipitate in abundance; and lime-water, when poured into the liquor decanted from off this precipitate, produced a new one in every respect resembling phosphate of lime. It is therefore certain that the lime found in this substance by the preceding experiments was united to phosphoric acid. The pollen of the date tree, therefore, contains phosphate of lime, which was dissolved in water. We shall presently see that it contains even more than the quantity mentioned, and that it is accompanied by another phosphoric salt.

§ V. *Examination of the Portion of the Extract of Pollen not soluble in Alcohol and soluble in Water.*

It has been remarked, that the portion of the extract of pollen not soluble in alcohol was separated into two by the water,

water, that the portion not dissolved in this liquid was phosphate of lime. It became necessary to know the real nature of the portion dissolved by the water in the experiment last described. This aqueous solution, mixed with ammonia, gave a very abundant precipitate of a yellowish white colour, like gelatine, which, when well washed and dried, weighed one gramme and one-fifth, or twelve decigrammes.

This precipitate was melted into a transparent pearl by the blow-pipe; it exhaled a strong smell of ammonia, and sparkled during its fusion with a very distinct phosphoric light. A boiling ley of caustic potash liberated from it the smell of ammonia, diminished it in volume, and gave it the form of a light flaky substance: the filtered alkaline liquor, saturated with nitric acid and boiled for a few minutes, gave by means of lime-water a very abundant precipitate, which was recognised to be calcareous phosphate. Thus the precipitate formed in the aqueous solution by ammonia contained phosphoric acid; we afterwards ascertained the base to which this acid was united, by the following experiments:

The light flakes, separated by the potash which had taken up the phosphoric acid, were of a yellow colour, of the consistence of paste, and became hard when dried. Sulphuric acid dissolved them almost entirely, excepting a little sulphate of lime which was formed; and this solution filtered, and left to evaporate, spontaneously presented, in a few days, prismatic crystals, the taste, solubility, and properties of which were perfectly similar to those of the sulphate of magnesia. The pollen of the date tree therefore contains magnesian phosphate, like several other animal substances.

§ VI. *Examination of the Matter from which the Phosphate of Magnesia was separated by Ammonia.*

The aqueous solution of the extract of pollen treated at first by alcohol, deprived by the addition of ammonia of the magnesian phosphate which it contained, having been evaporated to the consistence of a clear syrup, furnished, upon cooling, a granulous mass filled with small transparent and prismatic crystals. This salt was a combination of malic

acid

acid with ammonia, since lime and a caustic alkali extricated from it extremely sharp ammoniacal vapours. In truth it precipitated but very slightly by means of lime-water, because it no longer contained phosphate, which formerly thickened the volume of the precipitates; but after having added a certain quantity of lime-water, there were formed in a few days large crystals of true malate of lime.

But the liquor now under consideration was not entirely formed of malate of ammonia; for upon exposing it to the fire it exhaled an odour of burnt animal matter, in place of a smell of caramel like pure malic acid; besides, the infusion of gallnuts formed in its solution an abundant brown and viscous precipitate. Thus water applied to the pollen of the date tree dissolved this animal matter by the intermedium of the malic acid; and what proves this is, that when once the greatest part of the malic acid was taken up by the alcohol, the phosphate of lime by being precipitated took a great quantity along with it, which put this salt nearly in the same state with that which forms the saline earthy calculi of the bladder, or the matter of the bones.

§ VII. *Remarks upon the Presence of the Phosphates of Lime and Magnesia in the Pollen of the Date Tree, and upon their Solution in the Aqueous Ley of this Pollen.*

The preceding experiments prove that phosphates of lime and of magnesia were held in solution in the water with which we had washed the pollen of the date tree; nevertheless we know that these salts, and particularly that of lime, are not soluble in water solely and by themselves; but as they are accompanied by malic acid, it appears certain, that it is to this acid they owe their solubility. Thus, when we wash with alcohol these matters, separated from water and thickened into an extract by evaporation, this liquid takes up a great quantity of the malic acid, and the residue deposits as we have seen, on being dissolved in water, a portion of these salts, and particularly phosphate of lime, which no longer finds a sufficient quantity of acid for being soluble. Nevertheless it seems that a portion of malic acid is combined intimately enough with the phosphates, and

particularly

particularly with that of magnesia, to prevent the alcohol from separating it. Hence it follows that the phosphate of magnesia seems to have more affinity for the malic acid than the phosphate of lime; for there is no reason to doubt that these salts are rendered soluble in water by their combination with the malic acid, as we have observed. We now see therefore why the alcohol takes up a portion of malic acid from the mixture of the substances of which the extract of pollen is composed; also the reason why the residue deposits phosphate of lime when we dissolve it in water; and, lastly, why the phosphate of magnesia remains in solution in the water, and requires, in order to be separated from it, the addition of ammonia, or of any other alkali.

§ VIII. *Examination of the Pollen washed and exposed to the Air.*

After having found that water takes up malic acid from the date tree, besides phosphates of lime and magnesia, and a matter analogous to that furnished by animals, we proceeded to examine that part of the pollen which is completely insoluble in water. The pollen, well washed, was placed to drip upon blotting paper: having been eight days upon a shelf in the laboratory, in place of being dried, and resuming its natural form of powder, its parts were softened, glued together, and formed a kind of paste, in which a fermentation took place which made it contract a smell extremely fetid, analogous to that of old cheese. This smell had attracted the flies; for we found plenty of larvæ of these insects which are nourished there.

This matter thus altered, assumed when completely dried a semitransparence, and a hardness which approached those of strong glue. Before being entirely dried it was easily diluted in water, where it remained suspended for a long time and gave it the property of frothing like soap. The water in which we had thus diluted the mashed pollen was coagulated by the acids and the calcareous salts, which proves that there was formed a kind of soap during the fermentation which the pollen had undergone; the fixed alkalis liberated

rated a strong smell of ammonia from it; this soap was therefore of an ammoniacal nature.

Thirty-two grammes of pollen, which had fermented as above described, submitted to distillation, furnished at first a white liquid which gradually became coloured; some time afterwards there passed over a red fetid oil, and some carbonate of ammonia, one part of which was crystallized upon the sides of the receiver, and another remained in solution in the liquor. A portion of the oil was in the state of ammoniacal soap; for the acids separated a great quantity of this oil from the filtered liquor.

There remained in the retort a voluminous charcoal shining and difficult to burn: after some time, however, and with a sufficient heat, we reduced it entirely to a white cinder, which was dissolved completely, and without effervescence, in the nitric acid, from which it was afterwards precipitated by ammonia. This precipitate, washed and dried, weighed 0·36 parts of a gramme; it was phosphate of lime. We must conclude from this latter fact, that the quantity of malic acid existing in the pollen of the date tree is not sufficient to render soluble the whole of the phosphate of lime contained in it, and that in spite of the manifold washings which this pollen had undergone, there remained a portion of the calcareous salt which the incineration had developed. Thus the pollen contains a greater quantity of phosphate of lime than that which has been announced above.

§ IX. *Treatment of the unwashed Pollen with Acids.*

A gramme of unwashed pollen put into muriatic acid cold, seemed at first as if combined with it and dissolved: eight days afterwards the filtered liquor had a greenish yellow colour, as well as the undissolved pollen. This liquor became very yellow with ammonia, and deposited a powder of the same colour. This experiment proves that the pollen takes with muriatic acid a deeper yellow colour than it has naturally, and that a portion of this substance is dissolved in the muriatic acid, since ammonia separates a coloured

loured matter from it, mixed, or perhaps combined with a small portion of phosphate.

A gramme of the same substance put into nitric acid immediately assumed a yellow colour, and seemed to be dissolved; but in a few days the dust was separated and occupied the upper part of the liquor. The latter had a fine citron yellow colour; it was precipitated abundantly by lime-water, and this precipitate was of a very deep yellow: its nature was the same with that of the precipitate produced by the ammonia in the preceding experiment. The pollen thus treated, when washed with distilled water assumed upon drying a very intense yellow colour, and the form of soup, to which desiccation gave semitransparency and hardness. Placed upon burning charcoal, it softened, and an oily substance exuded from every part of it: it soon left a light charcoal behind it. The pollen had therefore undergone a commencement of alteration on account of the nitric acid, since it presented after being subjected to its action properties which it had not previously; it seems to have acquired a greasy character, like the animal substances treated by the nitric acid.

This alteration indicated by the preceding experiment, having appeared deserving of being better known, we repeated the experiment in the following manner: Sixteen grammes of unwashed pollen were put into a glass retort with nitric acid diluted to 30 degrees of the aräometer. An action between the substances was manifested upon the first contact, and without the assistance of fire. The pollen appeared to be softened and dissolved in the nitric acid; its dust formed a homogeneous mass, semitransparent, and presenting the consistence of soup. Soon afterwards, and always in the cold, a gas was developed, which, slowly extricating itself in the midst of a thick matter, lifted it up like beer-yeast when the process of fermentation is going on. This gas was in a great measure azotic gas, mixed only with a small quantity of nitrous gas.

This mixture subjected to the action of a slight heat soon boiled, it produced a large volume of gas, which was, from the beginning to the end of the operation, a mixture of nitrous and carbonic acid gas. Some time after boiling, an oily substance was formed of a yellow colour, which swam on the surface of the liquor. The quantity of this fatty matter seemed to increase as the ebullition went on, but it seemed to decrease latterly; we then removed the mixture from the fire. When it was cool the fatty substance became fixed, forming a thick coat on the liquor, which was of a very deep yellow, similar to the colour communicated by the nitric acid to all animal substances treated in the same manner.

This liquor had a very bitter taste, and a smell like that of prussic acid, although it was impossible to ascertain the presence of this acid.

The colouring matter thus formed by the nitric acid adhered strongly to pieces of cloth, and particularly to fabrics of an animal nature, and was extremely fixed.

The nitric solution mixed with the alkalis until the excess of acid was saturated, assumed an orange yellow colour, much deeper, and precipitated earthy phosphates and oxalates, charged with a portion of the colouring matter; an excess of alkali makes the orange colour change to a blood red.

This same liquor left, upon being properly evaporated, a reddish yellow substance, very bitter, tenacious, and gluey, perfectly soluble in water, to which it communicated a citron shade, giving a precipitate of oxalate of lime upon the addition of ammonia, and ammonia by its mixture with the caustic alkalis.

The action of the nitric acid upon the pollen of the date tree had therefore formed, 1st, ammonia; 2d, carbonic acid; 3d, oxalic acid; 4th, a yellow matter, bitter, and soluble in water; 5th, a kind of suet or fat matter. This last, when washed several times with warm water, was of a greenish yellow colour, a bitter taste, weaker, however, than that of the liquor from which it had been separated: it became white upon being dried in the air.

It became soft in the fingers, to which it stuck like liquid and tenacious resins. By heat it was melted into a yellow liquor, at the bottom of which there were some solid bodies

bodies which must have escaped the effects of the nitric acid. When put upon burning coals it was dissipated, after being fused, into a pungent smoke like that of fat; but it left a more voluminous charcoal than the latter. When retained some time in the mouth it produced at first a sensation of bitterness, and then of rancidity, like common fat, when treated in the same way. It no longer gave ammonia in any perceptible quantity upon distillation, which seems to prove that all the azot had been separated; cold alcohol did not dissolve it, but only took up a small portion of it by means of heat. Thus it cannot be doubted that this substance is a kind of oxygenated fat, or of artificial *adipocire* nearly similar to that prepared with hog's lard and the nitric acid. This fat was not pure; it contained, as has been just mentioned, a yellowish dust, which was not pollen, neither was it an adipose substance, but it must have become so by a longer continued action of the nitric acid.

§ X. *Examination of the Pollen by the Alkalis, and after Putrefaction.*

The caustic alkalis acted upon the produce of the date tree in the same way as upon some dry, pulverulent, or animal matters. This pollen when shaken with a ley of very caustic potash, seemed to be dissolved even in the cold; and it became soft, assuming a kind of transparency. This mixture, when heated, bubbled up and was covered with froth; it exhaled a distinct ammoniacal smell; when filtered after a few minutes ebullition, the liquor was of a brownish yellow colour; it gave a slight precipitate by the acids, and presented the characters of a soap.

Thirty-two grammes of the seminal powder of the date tree, not washed, were put into a flask with an equal quantity of distilled water; after having agitated the mixture in order to form a paste, the vessel was closed, and the soft matter was abandoned for about two months in summer, exposed to all the variations of heat which the atmosphere underwent during this period.

The substance was at first covered with white mould, which

which communicated its peculiar smell to the whole mass: we could distinguish, however, through this mouldy smell that of new cheese, or the disagreeable kind of acid which we meet with in dairies.

When we proceeded to take the matter out of the bottle, we found that it had formed a homogeneous mass, tenacious and gluey. It had a very pungent taste, like that of old cheese, but by no means acid, as it was before undergoing fermentation.

It had not contracted any fetid or ammoniacal smell, as happens with animal matters in putrefaction; we shall soon see that this difference may be easily explained. Its colour was a whitish gray; but when we diluted it in a solution of caustic alkali, it immediately assumed a very fine yellow colour, and exhaled a sharp ammoniacal smell.

It is evident that a good deal of ammonia was formed during the putrefaction undergone by the pollen, and that this ammonia proceeds from the peculiar combination of azot with hydrogen, both contained in the fecundating dust. But how does it happen that the matter thus altered exhales no fetid smell, and does not give out an ammoniacal odour? The cause of these phænomena exists in the presence of the malic acid in the pollen of the palm tree. This acid is combined with ammonia, at least partly so, in proportion as it is formed; while the other part of the ammonia which the malic acid cannot saturate is united to the oily matter, the formation of which is the necessary consequence of that of ammonia. Thus there result from this putrid decomposition, malate of ammonia, and a kind of ammoniacal soap. Nevertheless the vegetable matter was not entirely transformed into soap, for it was not totally dissolved in water; but the portion which was dissolved, formed instantly with nitric acid a coagulation like that which takes place with a weak aqueous solution of soap.

§ XI. *General Result of the preceding Analysis, and Conclusion upon the Nature of the Pollen of the Date Tree.*

The experiments which have been described, prove very evidently,

evidently, that the pollen or the fecundating dust of the date tree contains:

1st, A great quantity of malic acid completely formed, and which may be separated from it by cold water.

2d, Phosphates of lime and of magnesia, the greatest part of which is taken up by the washings at the same time with the malic acid, which renders them soluble.

3d, An animal matter which is dissolved in water with the assistance of the acid, and which, being precipitated by the infusion of gall-nuts, shows itself as a kind of gelatine.

Lastly, a pulverulent substance which the preceding bodies seem to cover, which is insoluble in water, susceptible of giving ammonia, of being converted into an ammoniacal soap by putrefaction, by the fixed alkalis; and which, on account of its properties, seems to be analogous to a dry albuminous or glutinous matter. This singular composition, which presents a very remarkable resemblance between the pollen of the date tree and animal substances, is still more singular on account of its resemblance to the seminal fluid. We are already acquainted with the striking analogy between the smell in particular of the seminal fluid and the fecundating dust of the chesnut, poplar, &c. The relations which a simple sensation had permitted us to discover between two substances of different kingdoms in nature, are found stronger and more intimate, after analysing both the one and the other of these substances. It seems that in destining them to the same uses, Nature had wished to constitute them of the same elements; or rather, that, in order to make them fulfil the same functions, it was necessary to infuse into them the same principles. It is true, that in spite of the discoveries in chemistry, in spite of the precise knowledge which it furnishes upon the comparative composition of the fecundating substance in both kingdoms of organized bodies, we are scarcely further advanced as to the mysterious property which distinguishes this matter; and we have not thrown any better light upon the relation which exists between its composition and its fecundating quality.

IX. *On Chemical Nomenclature.*

To Mr. Tilloch.

SIR,

In your Magazine of last month, I observed a very ingenious suggestion for an improvement in the nomenclature of metallic salts, signed E. B.

Following the modern system of nomenclature, the name of the metallic salt should show in the most concise manner, the acid, the oxide, and whether it is neutral, or contains excess of acid or excess of base; as the same oxide sometimes forms three salts with the same acid.

A little reflection will show that this is not effected by the present nomenclature; and E. B.'s may, I think, be shortened and improved.

The simplest mode of displaying my plan, is, I think, to write in succession the existing nomenclature, E. B.'s, and my own; and afterwards say a few words on the last.

Present Nomenclature.	*E. B.'s Plan.*	*A. J.'s Plan.*	
Sulphate	Sulphated protoxide	Prosulphat	of mercury.
Supersulphate	Supersulphated protoxide	Superprosulphat	of mercury.
Subsulphate	Subsulphated protoxide	Subprosulphat	of mercury.
Oxysulphate	Sulphated peroxide	Persulphat	of mercury.
Superoxysulphate	Supersulphated peroxide	Superpersulphat	of mercury.
Suboxysulphate	Subsulphated peroxide	Subpersulphat	of mercury.
Hyperoxymuriate	Oxymuriated peroxide	Peroxymuriat	of mercury.
Muriate of mercury	Muriated protoxide	Promuriat	of mercury.
Oxymuriate	Muriated peroxide	Permuriat	of mercury.
Nitrate of lead	Nitrated protoxide of lead	Pronitrat of lead	
Oxynitrate of lead	Nitrated deutoxide of lead	Deunitrat of lead.	

Bare inspection is almost sufficient to understand my plan. To the metal prefix the acid, to which prefix the words *pro, deu,* &c., to denote the oxide; and to denote the salt with excess of acid or of base, place the words *super* or *sub* before the *pro, deu,* &c.—thus considering the *pros, deus,* &c., as neutral salts, and the *superpros, subpros,* as the salt with excess or diminution of acid. The word *oxide* is understood; and its omission, I think, perfectly

fectly warrantable, as the words *pro, deu,* alone answer every purpose.

In the terminations of the acids I have adopted Desmond's orthography. See his Translation of Fourcroy's Chemical Philosophy.

Most of the absurdities of the present nomenclature will be evident on inspecting the above plan; which I have given in this detailed way, that the three modes may be better contrasted.

To Dr. Thomson we are indebted for the nomenclature of the oxides; and E. B.'s ingenious nomenclature of the salts suggested the plan, which, with the utmost deference, I now submit. Your most obedient servant,

London, June 23. A. J.

X. *On the Light emitted by Silver in a State of Combustion.*

3, Princes-street, Cavendish-square,
June 25.

To Mr. Tilloch.

SIR,

THE singularity of the following circumstance (observed when preparing for a public lecture) induces me to believe that its communication will be acceptable to many readers of your valuable publication. Should you entertain the same opinion, its insertion in the Philosophical Magazine will much oblige yours respectfully,

G. J. SINGER.

When the brilliant experiments of the deflagration of metals by the Voltaic battery were first published, it was observed, that silver burned with a bright emerald green light; and this observation has been repeated by most subsequent writers and experimentalists. In the lectures recently delivered at the Royal Institution, when this experiment was repeated, the green flame did not appear, the deflagration of silver leaf being attended by the emission of a brilliant white light. Mr. Davy attributed this to the great purity of the silver employed; and conjectured, that the green flame usually observed, arose from the admixture of copper with the silver, as usually practised in the manufacture of that metal. Having, however, uniformly observed the green light, from the purest silver leaf I could obtain, when deflagrated either by an electrical or Voltaic battery, I did not feel inclined to assent to this conclusion without further trial; and was rather disposed to attribute the phænomena then observed to some other cause. The construction of a large Voltaic apparatus for the Lectures at the Scientific Institution, soon afforded me an opportunity of verifying the opinion I had form d. Having observed that Mr. Davy's conducting wires were terminated by charcoal, I employed a similar arrangement; and applying the charcoal to pure silver leaf, it immediately burned with a beautiful white light. Some of the same portion of silver having been before employed, when the green flame was produced, it became evident that the white light in this and in Mr. Davy's experiment proceeded from the charcoal: and that this was really the case, appeared from the immediate evolution of green light when the contact was made by a metallic wire. By the application of charcoal to the extremity of a wire, so bent that either the wire or charcoal may touch the silver at pleasure, the white and the green flame may be alternately produced; and a conclusive demonstration of the fact, with a pleasing variation of a brilliant experiment, will be thus at once afforded.

XI. *On the Union of Gases.*

To Mr. Tilloch.

SIR,

I HAVE sent you the inclosed for a place in your work, if you think fit. An idea has struck me of a mechanical union of gas, which will not be liable to any of the objections raised against Mr. Dalton's, and which, I believe, will apply to every phænomenon. The principle is this, that from the laws of elastic fluids, it will be found to follow, that if the particles of one be larger than the particles of another; or rather, if the repulsive sphere of one be greater than the repulsive

pulsive sphere of another, the particles of any two (or more) elastic fluids will arrange themselves at the greatest possible distance from each other. This, I think, would bear issue with mathematical demonstration, which is what Mr. Dalton evidently shrinks from:—but I am almost satiated with hypotheses, there are such shallow ones, and in vogue too:—we need no more of them, till those we already have be more justly appreciated.

I remain your obedient humble servant,

James Scholes.

Manchester,
June 24, 1808.

In Mr. Dalton's new Treatise on Chemical Philosophy just published, it appears to me, he assumes this principle, That two gases, each pressing on the containing vessel, with a force as 1· from every particle, and having no repulsive action on each other, the joint effect of this pressure will be equal to the individual effect of a single gas with a similar pressure of 1·26; which cannot be the case. For suppose *a*, a repulsive force that has the power of extending a certain quantity of gas A, under a given pressure, a certain space *s*; and suppose *b* another repulsive force that has the power of extending another quantity of another gas B, under the same pressure, the same space *s*;—neither of these two forces can extend these gases to greater space than *s* (the contrary is absurd). And these two gases will conjointly, if put together on these principles, only occupy the same space *s*, that each would individually. But the repulsive power of gases under the same circumstances is as the space occupied: consequently, the powers of expansion in two gases with no repulsive action on each other, cannot act conjointly, but must be equal only to the expansion of a single gas whose power is as great as either of these supposed conjoined forces; and, as it has been generally inferred, two measures of gas combined on this theory ought only to occupy the space of one before admixture. Mr. Dalton admits, that if an equal quantity of two gases be combined according to his principles, in one vessel, the repulsion of their particles from each other, being 1·26 before admixture, will afterwards become only 1· : but, says

he,

he, the pressure upon the vessel will still be the same as before. But I have endeavoured to show that nothing can be derived from a supposed conjoint action of the repulsion of the gases. From whence, therefore, must half the pressure proceed? The number of particles is the same before and after admixture: there is in one case n particles pressing upon the vessel with a force $= 1\cdot26$; and in the other n particles pressing with a force $= 1\cdot$ only:—How can the aggregate of these forces be equal? And again, for every action there must be a corresponding reaction: the particles of a gas, therefore, cannot press upon a vessel in a greater degree than they react upon themselves. And as Mr. Dalton supposes that gases under this combination have nothing to react upon but particles of their own species, How can he reconcile the pressure upon the vessel as being 1·26 for each particle of gas, whilst he himself supposes the utmost reaction of each particle as 1· only?

XII. *Report of Surgical Cases in the City and Finsbury Dispensaries, for December* 1807. *By* JOHN TAUNTON, *Esq.*

In the month of December there were admitted on the books of the City and Finsbury Dispensaries 228 surgical patients.

Cured or relieved	—	192
Died —	—	5
Under cure	—	31
		228

Since which time there have been admitted 1283.

Miss R., æt. 26, of a spare habit of body, delicate constitution, general health much impaired, suffers greatly during the discharge of the catamenia, which returns at intervals of about six or seven weeks.

About six years since she received a blow on the right breast, which produced a general swelling of the gland, attended with much pain: these were relieved by fomentations and

and lotions; but the breast remained somewhat enlarged, apparently from a tumour, which was entirely neglected, as it did not produce much inconvenience, only occasionally some darting through the part.

In October, 1806, she received a second blow while playing with a child, who threw its head back with great force on the same breast, which was then exposed:—this produced exquisite pain at the instant. The tumour was now more evident, and excited greater attention from the darting pain, which was become severe, returned at short intervals, and was accompanied with a sensation of heat.

She was now placed under the care of a physician, who directed that from eight to twelve leeches should be applied to the breast; and, after the bleeding had subsided, that the whole be covered with the emplastrum thuris compositum, and that the most abstemious regimen be enjoined. More leeches and another plaster were applied at about the end of eight days.

This mode of treatment was persevered in till April 1807, when I first saw her. The tumour was large and irregular on its surface, exceedingly painful; the dartings, always accompanied with a sensation of heat, extended through the nipple, which was retracted, and the integuments somewhat puckered: a considerable enlargement had also taken place in one of the lymphatic glands on the lower edge of the pectoral muscle, towards the axilla.

During the above plan of treatment by *depletion*, the periods of the catamenia were protracted, and became more painful; the general health and strength of the body were much reduced, and little calculated to bear up against the increasing degree of pain produced by each application of the leeches; the disease assumed its true character, and was now making rapid advances.

A generous regimen was immediately ordered, and the breast covered with the emplastrum ammoniaci cum hydrargyro. At the end of the first week it was evident that she had experienced great benefit from the change in the plan of treatment: the diet was now directed to be of the most nutritious kind; some alterative medicines were prescribed, and the plaster continued.

At the end of three weeks the tumour was greatly diminished in size, had a smooth surface; the enlargement of the lymphatic gland had nearly subsided; the pains returned at longer intervals, and were less severe: the general health and strength appeared to be greatly improved.

Some tonic medicines were now taken, particularly the ferri rubigo; a generous diet was persevered in, and a glass or two of wine taken after dinner. The emplastrum saponis was now applied to the breast, and renewed once a week.

May 26. Six weeks from the time I first saw her the pain was reduced so as to give but little uneasiness; the tumour nearly absorbed; the constitution appeared to be in a state of renovation: the alterative medicines were given for about a fortnight; then the tonic plan was again resorted to, the nutritious regimen continued, the emplastrum ammoniaci cum hydrargyro was continued for about 14 days; then the emplastrum saponis, which was applied twice in that time.

July 27. Every symptom of disease appears to have subsided; the catamenia is more regular, the pain at which period is greatly diminished by taking some diaphoretic draughts.

The treatment as recommended on the 26th of May to be continued.

On the 17th of September she received a considerable blow on the upper part of the same breast, which produced inflammation and swelling of the part: to this the following lotion was applied with the desired success:

℞. Sal. ammon. cr. ʒj. Sp^t^. vin. rec. ℥ij. aut dict. ℥vj.

This accident did not produce the least appearance of a return of the original disease. The former plan of treatment was persevered in, with occasional intermissions of the medicines for a fortnight at a time, till the beginning of March 1808, when she appeared to enjoy the highest state of health, and has continued so to do to the present time.

JOHN TAUNTON,
Surgeon to the City and Finsbury Dispensaries, Lecturer on Anatomy, Surgery, Physiology, &c.

Greville street, Hatton Garden,
June 20, 1808.

P. S. It

P. S. It is my intention to make some observations on this case in a subsequent Report.

In the last Report, p. 363, for 1007 read 1264.

XIII. *Notices respecting New Books.*

Part I. of the Philosophical Transactions for 1808 has made its appearance. The following are its contents:

1. The Bakerian Lecture, on some new Phænomena of chemical Changes produced by Electricity, particularly the Decomposition of the fixed Alkalis, and the Exhibition of the new Substances which constitute their Bases; and on the general Nature of alkaline Bodies. By Humphry Davy, Esq. Sec. R.S. M.R.I.A.—2. On the Structure and Uses of the Spleen. By Everard Home, Esq. F.R.S.—3. On the Composition of the Compound Sulphuret from Huel Boys, and an Account of its Crystals. By James Smithson, Esq. F.R.S. —4. On Oxalic Acid. By Thomas Thomson, M.D.F.R.S. Ed. Communicated by Charles Hatchett, Esq. F.R.S.— 5. On Super-acid and Sub-acid Salts. By William Hyde Wollaston, M.D. Sec. R.S.—6. On the Inconvertibility of Bark into Alburnum. By Thomas Andrew Knight, Esq. F.R.S. In a Letter to the Right Hon. Sir Joseph Banks, Bart. K.B.P.R.S.—7. Some Account of Cretinism. By Henry Reeve, M.D. of Norwich. Communicated by William Hyde Wollaston, M.D. Sec. R.S.—8. On a new Property of the Tangents of the three Angles of a Plane Triangle. By Mr. William Garrard, Quarter Master of Instruction at the Royal Naval Asylum at Greenwich. Communicated by the Astronomer Royal.—9. On a new Property of the Tangents of three Arches trisecting the Circumference of a Circle. By Nevil Maskeline, D.D. F.R.S. and Astronomer Royal.—10. An Account of the Application of the Gas from Coal to œconomical Purposes. By Mr. William Murdoch. Communicated by the Right Hon. Sir Joseph Banks, Bart. K.B.P.R.S—11. Further Experiments on the Spleen. By Everard Home, Esq. F.R.S.

Appendix.

APPENDIX.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

A new System of Chemical Philosophy. Part I. *By* John Dalton, *8vo. pp.* 220.

The intention of this small but interesting volume is to exhibit and elucidate the author's ideas relative to those primary laws which seem to obtain in regard to heat, and to chemical combinations. Some of the doctrines which he maintains will occasion discussion and investigation, but they are of so interesting a nature as to promise an ample recompense in the elucidation of chemical truths, which may be expected to be the result.—The author expects to publish Part II. in about a year hence.

In the course of next month will be published, a supplementary volume of Birds, to Barr's Edition of Buffon.—The proprietors of that work have engaged a literary gentleman to collect all that has been discovered in ornithology of an interesting nature since the death of the illustrious Buffon; and for that purpose procured the splendid edition of his works lately published by Sonnini, in 114 volumes. From this has been selected every article of importance, or of curiosity, from the additions of Sonnini and J. J. Virey.

Several new plates will accompany the volume; the contents of which will bring down the æra of discovery in this interesting branch of natural history to the present day.

Mr. Accum, lecturer on operative chemistry and mineralogy, &c., has in the press A System of Mineralogy and Mineralogical Chemistry, with applications to the Arts. The work will be formed chiefly after Haüy and Brongniart, and will be published in three octavo volumes, with fifteen copper plates.

XIV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

JUNE 2 and 16. The president in the chair.—The continuation of Messrs. Allen and Pepys's paper on Respiration, occupied

occupied the Society. The general result of the numerous and accurate experiments performed by these philosophers prove, that the quantity of carbonic acid produced in respiration is always equal to the quantity of oxygen consumed, and *vice versâ;* that a healthy man, whose pulse is 70 in a minute, will consume 3400 cubic inches of oxygen gas in eleven minutes; that the same man will emit in the course of 24 hours, calculating the quantity of gas which always remains in the lungs after every respiration, 18000 cubic inches of carbonic acid, which yield 10 oz. 2 grs. of solid carbon. It also appeared that no combination takes place between oxygen and hydrogen in the lungs, and that they do not form water in the process of respiration. The authors were assisted in the accuracy of these results by the great perfection to which they have brought their eudiometer.

June 23. The president in the chair.—A paper by Dr. Henry of Manchester was read, On the instruments of analysis of carbonic acid, and the gases emitted by coal in destructive distillation. This paper chiefly consisted of tables of the relative quantities of gas contained in coals, and of the tests and means of measuring their qualities and quantities.

Mr. Home furnished the society with a sketch of the natural history of the trombac and caudivolva of New South Wales and Bass's Straits. The trombac was domesticated by him two years, is about two feet long and one thick, with round ears and a head resembling a pig, and without a tail. It burrows in the earth and climbs trees; it suffered itself to be nursed, and when it bit any thing it was without ill-nature. On dissection it was discovered to have two *uteri*. Mr. Bell, a surgeon in New Holland, dissected one in a pregnant state, and found the uteri containing a gelatinous substance conveyed in two tubes, instead of a placenta. It is of the same genus (Didelphis) as the American opossum and the kangaroo.

WERNERIAN NATURAL HISTORY SOCIETY.

At the last meeting of the Wernerian Natural History Society, (June 11,) Dr. Thomas Thomson, one of the vice-presidents, read a very interesting and valuable paper on the chemical

chemical nature of fluor-spar.—Captain Lasky also read a paper on the Pinna ingens of Pennant. From his observations it appears, that the Pinna ingens of Montagu, Pinna borealis of Stewart, and Pinna ingens of the Linnæan Transactions, are the same species, and identical with the Pinna ingens of Pennant.—At the same meeting, Charles Anderson, esq. read some observations on the geognosy of the island of Inchkeith, in the Frith of Forth. It appears from the interesting details which he communicated, that the whole island is composed of rocks belonging to the independent coal formation; and that the green-stone which there occurs, is traversed by true veins filled with quartz, chalcedony, calcspar, &c.; and also contains numerous contemporaneous veins of different kinds. Mr. Anderson intimated his intention of laying before the Society, at a future meeting, a more particular description of the island, illustrated by drawings and a series of specimens.

XV. *Intelligence and Miscellaneous Articles.*

CALCULUS IN THE BLADDER.

M. Vurzer, a French chemist, has published the following analysis in support of Messrs. Fourcroy and Vauquelin's discovery of silex in urinary concretions *:

"I received the calculus, of which the following is the analysis, from M. Michaelis, who extracted it by an operation from a patient.

"*Physical Properties.*—It was nearly oval, but a little compressed; brown externally, and of a yellowish white internally. It weighed exactly 870 grains; its specific gravity was 1·572; its surface was irregular and uneven. It was of the consistence of hard chalk, was entirely without a nucleus, and was composed of layers.

"*Chemical Examination.*—1. I macerated 300 grains of this concretion (after having pulverised them) for two days in distilled water, at a temperature of 12° (Reaumur). I then filtered. The colourless liquor presented by the reagents the

* From *Annales de Chimie*, tom. lx. p. 310.

the following phænomena: the nitrates of mercury and of silver.—The muriate of barytes—the water of barytes—lime-water—oxalic acid—potash and ammonia produced no precipitate nor any sensible change. It is clear, therefore, that the distilled water employed contained none of the constituent particles of this urinary concretion.

"The dried powder was of the same weight as before.

"2. I next treated this powder with muriatic acid, (the specific gravity of which was 1·181,) keeping the mixture for two days at the temperature of 15° of Reaumur. I afterwards added distilled water. After having filtered the residue, when well dried it still weighed 248 grains, and was of a reddish-brown colour.

"3. The filtered liquor precipitated by lime-water gave a deposit which, when collected and examined, was found to be *phosphate of lime:* it weighed 52 grains.

"4. The 248 grains which remained after the second experiment were put into a solution of potash a little diluted, and left for two days at a temperature of 18° of Reaumur. I afterwards filtered; and the liquor decomposed by the acetous acid furnished a precipitate weighing 230 grains, which, when examined with care, consisted of 226 grains of *uric acid* distinctly characterized, and four grains of animal matter.

"5. The weight of what remained upon the filter was 18 grains; I heated it in a silver crucible until red-hot. During this operation, there was a very disagreeable fetid odour disengaged, like that of burnt horns or hair. The residue weighed scarcely three grains.

"6. These three grains were not dissolved in the sulphuric, the nitric, or muriatic acids, even when heated successively with these acids to ebullition.

"7. I then mixed it with four parts of potash, and melted it in a suitable fire. The whole was dissolved in water, and I precipitated, by an excess of acid, *pure silex.*

"This substance has only been found twice in the urinary calculi by Messrs. Fourcroy and Vauquelin, although they have analysed an immense number of them. This induced me to recommence my labours with the 570 grains which I had

laid

laid aside. Having again found silex, I was convinced that no mistake had crept into my former analysis.

" From the above experiments it results that 300 grains of the above calculus contained

	Grains.
Phosphate of lime -	52
Uric acid - - -	226
Animal matter - -	19
Silex - - -	3
Phosphate of lime -	17·35
Uric acid - - -	65·33
Animal matter - -	6·32
Silex - - -	1·00

The above table gives per cent.

Phosphate of lime -	17·35
Nitric acid - -	75·33
Animal matter -	6·32
Silex - - -	1·00
	100·00

SOCIETY FOR THE RELIEF OF THE RUPTURED POOR.

The election of Surgeon for this institution, vacant by the death of Mr. William Turnbull, took place on Tuesday the 28th of June; when 48 old subscribers to the charity balloted in person, as follows:

For Mr. Taunton . .	37
Mr. Rees Price .	6
Mr. Field . .	3
Mr. Berkley . .	2
	48

After the ballot had taken place, it appeared that Mr. Price had previously paid into the hands of the treasurer 34 guineas, which, together with the six votes above stated, gave him a majority, and he was declared duly elected.

MONUMENT TO LOCKE.

The admirers of the writings of Locke will rejoice to hear that a subscription has been begun for the purpose of erecting a monument to his memory. Subscriptions are received at the office of the Literary Fund, where a model of the intended erection may be inspected.

LIST

LIST OF PATENTS FOR NEW INVENTIONS.

To Rebecca Ching, of Rush Common, Lambeth, Surry, widow of John Ching, late of Cheapside, apothecary, for certain improvements in a medicine now called Ching's worm-destroying lozenges, for which her late husband obtained letters patent bearing date the 28th of June 1796. May 7.

To John Harriot, of Wapping, in the county of Middlesex, esq., for a new fire-escape, or machinery to be used in cases of fire. May 10.

To William Hunt, of the Brades, in the parish of Rowley Regis, in the county of Stafford, iron-master, for a method of rolling moulds, or plates of trowels, from pieces of either blister, sheer or cast steel, of a square, or nearly square, or oblong form. May 10.

To John Watson, late of Bury-Place, Bloomsbury, gent. for certain improvements in the art of soap-making, by which the article is in several respects ameliorated. May 10.

To Chester Gould, of Old-Street, gent., for certain improvements in the construction of a machine for washing or cleansing linen and various other articles. May 17.

To William Congreve, of Garden-Court, Temple, esq., for a gun-carriage of the simplest construction, either for land or sea service, calculated to reduce very considerably the labour of working the guns, to produce a smooth and even recoil, and to prevent the violent action that takes place in common carriages when the gun is fired. At the same time, the carriage is of much lighter and less expensive construction, and less liable to be struck and splintered by the enemy's shot, as presenting much less surface when applied to the sea service: it allows moreover of a very considerable reduction in the size of the port. May 24.

To John Stedman, of Horton Kirby, in the county of Kent, farmer, for a patten and clog, of infinite utility and ease to such persons who may wear them. May 24.

ERRATUM.

Vol. xxx. p. 351, line 7, read 351^d 8^h 48^m $31''2051$.

METEORO-

METEOROLOGICAL TABLE,
By Mr. Carey, of the Strand,
For June 1808.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Thermometer. Noon.	Thermometer. 11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
May 27	54°	62°	56°	29·87	10	Rain
28	57	63	51	30·12	47	Fair
29	54	66	50	·20	29	Cloudy
30	56	72	60	·18	47	Fair
31	60	74	55	29·88	46	Fair
June 1	55	61	50	·89	38	Cloudy
2	50	67	49	30·02	47	Fair
3	55	68	52	29·81	41	Fair
4	56	67	51	·66	27	Showery
5	53	67	50	·69	52	Showery
6	49	58	50	·75	46	Cloudy
7	51	63	49	·85	35	Showery
8	54	64	51	·77	82	Fair
9	54	56	50	·68	0	Rain
10	52	59	52	·96	47	Cloudy
11	54	68	53	30·03	77	Fair
12	56	62	55	·20	52	Cloudy
13	56	70	61	·12	71	Fair
14	62	66	54	29·95	65	Fair
15	60	67	56	30·01	61	Fair
16	59	66	53	·12	62	Fair
17	56	63	60	·05	49	Cloudy
18	63	75	68	30·08	66	Fair
19	67	76	66	·12	65	Fair
20	65	72	61	·06	65	Fair
21	63	72	60	29·99	47	Fair
22	62	71	56	·76	51	Fair
23	58	67	54	·78	62	Fair
24	58	68	58	·92	72	Fair
25	59	69	55	30·05	61	Fair
26	56	72	57	·10	79	Fair

N. B. The Barometer's height is taken at one o'clock.

XVI. *Analysis of the lately discovered Mineral Waters at Cheltenham; and also of other Medicinal Springs in its Neighbourhood.* By FREDERICK ACCUM, *M.R.I.A. Operative Chemist, Lecturer on Practical Chemistry and on Mineralogy and Pharmacy, &c.*

[Continued from p. 28.]

ANALYSIS OF THE SPRING CALLED THE CHALYBEATE WEAK SALINE WELL.

I. PHYSICAL CHARACTERS OF THE WATER.

THE taste of this water is slightly saline and soft. It is perfectly limpid, and destitute of smell. It sends forth a few air-bubbles, but not in any remarkable quantity. Its temperature was 54° Fahr.; the surrounding air being 80°, and the barometrical pressure 29·7. Its specific weight at that temperature was as 289·4 to 289. The spring which furnishes this water rises in the area on the east side of Hygeia House. Its bed is a stiff blue clay, abounding with extraneous fossils, chiefly of the bivalve kind, wholly converted into clay. The depth of this well is 36 feet. It yields 150 gallons of water in 24 hours.

II. EXAMINATION BY RE-AGENTS.

Experiment I.—*Tincture of cabbage* is reddened by this water.

Experiment II.—*Tincture of galls* produced no effect. A slice of a nut-gall suspended in the water highly concentrated and previously mingled with a few drops of nitric acid, occasioned a purplish hue.

Experiment III.—*Succinate of ammonia* and *prussiate of potash* when applied in a similar manner occasioned a precipitate. Water that had been boiled and suffered to stand undisturbed and then decanted, when treated with the same tests remained unaltered.

Experiment IV.—*Lime-water* mingled with this water in equal quantities became cloudy: muriatic acid rendered the mixture transparent.

Experiment V.—*Sulphate, acetate* and *nitrate of barytes* occasioned a milky precipitate both in the fresh and in the boiled water.

Experiment VI.—*A crystal of muriate of barytes,* or *nitrate of strontia,* rendered the water cloudy. The admixture of muriatic acid had no effect.

Experiment VII.—*Acetate* and *nitrate of lead* produced a cloudiness.

Experiment VIII.—*Sulphate, nitrate* and *acetate of silver* effected a white precipitate. The same effect ensued, although a few drops of sulphuric, nitric, or acetic acid had been added.

Experiment IX.—*Phosphate of soda* assisted by *carbonate of ammonia* when added to a portion of the water highly concentrated, did not occasion a precipitate.

Experiment X.—231 cubic inches of the water of the Weak Chalybeate Saline Well boiled down to five cubic inches after being mingled with muriatic acid, yielded a brown flocculent precipitate when poured into liquid ammonia.

Experiment XI.—*Solution of soap in water* becomes decomposed by this water.

Experiment XII.—*Oxalate of ammonia* and *fluate of soda* occasioned an abundant precipitate.

Reasoning on these preliminary experiments, which were undertaken at the fountain head, we are led to believe that this medicinal water contains carbonate of iron, salts with earthy bases and with muriatic and sulphuric acids.

The gaseous contents of the water of this spring collected and separated in the usual manner, amounted in one gallon to

$7\frac{3}{4}$ cubic inches carbonic acid gas, and
$4\frac{1}{2}$ ———— atmospheric air.

ANALYSIS.

Experiment I.—One thousand eight hundred and forty-eight cubic inches of the water of the Chalybeate Weak Saline Well evaporated to one half were suffered to cool, filtered, and the insoluble part collected.

Experiment

Experiment II.—The powder thus separated by evaporation was dissolved in muriatic acid. The usual tests, viz. fluate of soda, oxalate of potash, and succinate of ammonia, showed that it contained lime and iron. Phosphate of soda with carbonate of ammonia proved that it was free from magnesia. The solution was therefore evaporated to dryness, and the residue redissolved in dilute nitric acid.

Experiment III.—Into the nitric solution previously highly concentrated by evaporation, liquid ammonia was poured. The precipitate being collected was redissolved in muriatic acid, and the obtained solution decomposed by succinate of soda. The succinate of iron being redissolved in muriatic acid, the solution was decomposed by carbonate of potash. The obtained carbonate of iron weighed four grains; which gives half a grain of carbonate of iron to each gallon of the water.

Experiment IV.—Into the muriatic solution, highly concentrated, sulphuric acid was dropt, and the whole evaporated nearly to dryness; the mass being softened with water and the sulphate of lime collected. The product, taking 100 grains to be equal to 70 of carbonate of lime, proved that 1848 cubic inches of this water contained $24\frac{1}{2}$ grains of carbonate of lime; which gives to each gallon of the water $3\frac{1}{16}$ of a grain of that salt.

Experiment V.—The fluid from which these salts had been obtained (Exper. I.) was evaporated to perfect dryness, reduced to an impalpable powder in a warm mortar, and digested repeatedly in alcohol.

Experiment VI.—The alcoholic solution diluted with a small portion of water became turbid by sulphate of silver and oxalate of ammonia; but phosphate of soda with carbonate of ammonia effected no change when added to it. It was therefore evaporated to dryness, and yielded four grains of muriate of lime; which gives half a grain of this salt to each gallon of water.

Experiment VII.—The mass left from the alcoholic solution (Exper. V.) was repeatedly digested in small quantities of cold water, till the fluid that had been suffered to be in contact with it for six hours did not disturb the solutions of sulphate of silver, nitrate of barytes, and other tests. On evaporating this fluid, muriate of soda was obtained, which gave 16¾ grains to each gallon of the water.

Experiment VIII.—The fluid freed from muriate of soda became turbid by phosphate of soda and carbonate of ammonia, by muriate of barytes, but not by muriate of platina. It was concentrated and decomposed by sub-carbonate of soda; the carbonate of magnesia was dissolved in sulphuric acid, and the sulphuric solution, when highly concentrated, was mingled with alcohol. The sulphate of magnesia thus obtained weighed 40 grains.

Experiment IX.—On examining the solution it was found that sulphate of silver occasioned a precipitate. This salt was therefore added. The precipitate produced by means of it weighed 15¾ grains, which are equal to six grains of muriate of soda, that must have escaped the process of crystallization before mentioned. This portion of salt added to that obtained already gives 16¾ to each gallon of the water.

To facilitate the conclusion of the analysis, the residue of 231 cubic inches of water of the Chalybeate Weak Saline Well obtained by evaporation, being previously digested in alcohol, was repeatedly digested in small quantities of cold water till this fluid dissolved no more. Into this solution muriate of barytes was dropt, till it produced no further cloudiness. The precipitate being collected and weighed, and the sulphuric acid deducted which belonged to the sulphate of magnesia, taking 100 to be equal to 52·11 of sulphate of magnesia, there remained eight grains of sulphate of barytes originating from the decomposed sulphate of soda; which are equal to 5¾ of that salt.

Over the insoluble residue left a large quantity of boiling water being poured which dissolved the whole—Muriate of barytes produced 105 grains of sulphate of barytes, indicating 72 of sulphate of lime; which indicate nine grains of this salt in each gallon of the water.

Contents

Contents of the Water.

	Contents in one Gallon. Grains.	*In one Pint.* Grains.
Muriate of soda - -	16·75	2·09375
Carbonate of lime -	3·0625	0·3828
Muriate of lime - -	0·5	0·0625
Sulphate of magnesia	5·	0·625
Sulphate of soda - -	5·75	0·7185
Carbonate of iron -	5·	0·625
Sulphate of lime - -	9·5	0·71875
	40·5625	5·0703
	Cubic inches.	Cubic inches.
Carbonic acid gas - -	7·75	0·96875
Atmospheric air - -	4·5	0·5625
	12·25	1·53125

ANALYSIS OF THE STRONG SULPHURETTED SALINE WELL.

Situation of the Spring, and Physical Properties of the Water.

The spring called the Strong Sulphuretted Saline Well is situated about 90 feet distance from the last described spring. The water of this well has a strong odour, resembling sulphuretted hydrogen gas. Its taste is saline. It is as transparent as rock crystal, and perfectly colourless. Its temperature was 51°·7 at 29 barometrical pressure; the temperature of the room in which the pump for delivering the water is placed being 64 Fahr. The specific gravity of this water is as 279·7 to 277. It strongly tarnishes all metallic substances over which it is suffered to flow. Fishes and frogs, when suffered to traverse the water of this well, soon die in it. This spring affords upwards of 2000 gallons of water in 24 hours.

Examination by Re-agents.

Experiment I.—*Tincture of cabbage* becomes sensibly

reddened

reddened from the fresh, but not from the boiled sulphuretted water.

Experiment II.—*Tincture of turmeric* suffers no change.

Experiment I I.—*Silver leaf* acquired a slight iridescent tarnish, after having been immersed in this water for three days; the boiled sulphuretted water did not affect the lustre of this metal.

Experiment IV.—*Quicksilver* exposed to the action of this water retained its brilliancy, but being suspended in a muslin bag in the covered reservoir of the well, it acquired a tarnish within 24 hours.

Experiment V.—*Bismuth*, disposed in a like manner, lost its lustre, and became brown.

Experiment VI.—*White oxide of bismuth*, fresh prepared, and still moist, diffused through the sulphuretted water became black in 12 hours.

Experiment VII.—*Arsenious acid and muriate of arsenic* suffered no change.

Experiment VIII.—*Acetate of silver*, of the usual strength, yielded a white precipitate, but when diluted it produced an orange-coloured cloud.

Experiment IX.—*Crystals of acetate of copper* became black, after having been covered by the water for a few minutes.

Experiment X.—*Paper moistened with nitrate of mercury* acquired a brown colour when kept immersed for three hours in the water.

Experiment XI.—*Succinate of ammonia, prussiate of potash*, *gallic acid*, and *tincture of galls*. Neither of these re-agents produced a change in the fresh water, or in such as had been concentrated by evaporation.

Experiment XII.—*Lime water* produced a cloudiness.

Experiment XIII.—*Crystallized hydrate of barytes* and *hydrate of strontia* occasioned much precipitate, both in the water at the fountain head, and in such as had been concentrated by evaporation.

Experiment XIV.—*Muriate*, *acetate* and *nitrate of barytes* effected a copious precipitate.

Experiment XV.—*Oxalate of ammonia, oxalic acid,* and *fluate*

fluate of soda, rendered both the fresh and the boiled sulphuretted water turbid.

Experiment XVI.—*Acetate* and *nitrate of lead* produced the same effect.

Experiment XVII.—*Concentrated sulphuric* and *nitrous acid,* added in large quantities to the water taken fresh from the pump, caused a copious disengagement of air-bubbles. The same acids mingled with water highly concentrated by boiling, occasioned the development of a sulphureous odour.

Experiment XVIII.—*Sulphureous acid gas* passed into the sulphuretted water at the fountain head effected no sensible change.

Experiment XIX.—*Oxygenized muriatic acid gas,* kept in contact with the sulphuretted water, rendered it slightly turbid: the colour of the fluid in contact with a measured quantity of the gas was more intensely yellow than a like bulk of distilled water, kept in contact with an equal bulk of the gas, under equal circumstances.

Experiment XX.—*Sulphate of magnesia* effected no change when mingled with water highly concentrated by evaporation.

Experiment XXI.—*Muriate of lime* rendered the sulphuretted water cloudy.

Chemical Examination of the Gaseous Contents of the Water.

Experiment XXII.—1848 cubic inches of the sulphuretted saline water, on being evaporated in a glass retort to 150 cubic inches, deposited a gray-coloured precipitate: the super-natant fluid being decanted, the powder separated by the filter, and washed by the affusion of small portions of distilled water, was suffered to dry spontaneously.

Experiment XXIII.—The decanted fluid, together with the water employed for washing the powder, being again concentrated to 50 cubic inches, a pulverulent precipitate ensued; it was made to subside by the admixture of alcohol collected, dried, and added to that obtained in Experiment XXII.

Experiment XXIV.—The pulverulent substance thus collected,

lected, strongly effervesced with muriatic acid, but no complete solution could be effected by that agent. The insoluble part, separated by the filter, had a crystalline appearance. The muriatic solution became turbid by the admixture of fluate of soda, by oxalate of ammonia, and by other tests, indicating the presence of lime.

Experiment XXV.—The substance which resisted the action of muriatic acid in the preceding process, was completely soluble by ebullition in 600 times its quantity of water, the solution was decomposable by oxalate of ammonia, by fluate of soda, and by barytic water.

Experiment XXVI.—To learn whether the lime detected, was present in the water in combination with carbonic acid, or with sulphuretted hydrogen, a narrow-mouthed jar containing a determinate bulk of the sulphuretted saline water, and furnished with a crooked glass tube, terminating under a cylinder filled with lime water, was gradually made to boil, the lime-water became turbid, and a copious precipitate appeared. The obtained precipitate effervesced with muriatic acid, emitting at the same time a strong odour of sulphuretted hydrogen gas. The solution diluted with water occasioned a brown precipitate when mingled with nitrate of bismuth or nitrate of silver.

Experiment XXVII.—The lime water from which the before-obtained precipitate has been separated was void of odour, it possessed a pungent bitter taste. White oxide of bismuth diffused through it, became instantly black. It changed the colour of yellow sulphate of mercury to brown; red oxide of lead acquired by it a purple colour, and paper impregnated with a solution of nitrate of silver immersed in this fluid became gray. Concentrated nitrous acid rendered it turbid. From these preliminary inquiries it became evident, that both carbonate and hydro-sulphuret of lime exist in the water, the first and part of the latter being precipitated by the action of lime water, though a considerable portion of the hydro-sulphuret remained in solution: hence lime water could not be employed to separate the carbonic acid from the sulphuretted hydrogen gas contained in the sulphuretted saline water of Cheltenham.

Experiment

Experiment XXVIII.—To ascertain the respective proportions of these gases contained in a given bulk of water, 924 cubic inches of the sulphuretted water taken fresh from the spring head, were introduced in a jar, connected with a Woulf's apparatus in the ordinary manner; the first of the three-necked bottles of the apparatus was filled with a solution of acetate of lead; rendered acidulous by the addition of acetic acid; the second contained lime water. On applying heat to the water in the jar, a precipitate was soon deposited in both the bottles: the solution of acetate of lead acquired a velvet black colour; and the lime water in the second bottle became milky. The sulphuretted hydrogen gas was thus made to combine with the oxide of lead; and the carbonic acid being prevented from forming a carbonate of lead on account of the excess of acetic acid, it passed through the metallic solution unaltered, and united with the dissolved lime in the second bottle. Thus both gases were distinctly arrested by different agents, and in different vessels. To render this experiment as conclusive as possible, like quantities of sulphuretted water were treated in the same manner, with the exception of substituting only one Woulf's bottle instead of two in the arrangement of the apparatus, the bottle containing acetite of lead with excess of acid, and lime water alternately. The production of hydro-sulphuret of lead, and carbonate of lime was uniformly the same with variations not amounting to the $\frac{1}{100}$dth part of a grain. 924 cubic inches of the sulphuretted water treated in this manner, yielded 78 grains of hydro-sulphuret of lead, which are equal (according to Westrumb) to 40 cubic inches of sulphuretted hydrogen gas*. The carbonate of lime obtained from 231 cubic inches of water, calculated in the usual manner, indicated 7 $\frac{9}{10}$ cubic inches of carbonic acid gas. One gallon of the sulphuretted saline water therefore contains

	Cubic inches.
Sulphuretted hydrogen gas .	11·0
Carbonic acid gas - -	7·9
	18·9

* Westrumbs Beschreibung der Gesund Brunnen, 1805, p. 150.

ANALYSIS.

Experiment XXIX.—1848 cubic inches of sulphuretted saline water having been slowly evaporated, yielded a grayish white powder, which, when dried over a lamp in a sand bath, at a heat of 225° Fahr., exhaled a peculiar fetid sulphureous odour.

Experiment XXX.—This powder was levigated with alcohol, and digested in that fluid for four days. The alcoholic solution, when filtered, was of a pale amber colour: on being evaporated to dryness, and redissolved in water, it deposited a pearl-coloured powder, which effervesced with muriatic acid, and diffused a smell of sulphuretted hydrogen gas. The quantity of this powder obtained not being accurately appreciable, on account of portions of it having been employed for various experiments, 1848 cubic inches of water were again evaporated to dryness; the residue obtained was treated with alcohol as before, and the insoluble part put aside. The product weighed 262 grains. The repeated application and abstraction of nitric acid converted it into sulphate of lime, which, together with the development of the sulphuretted hydrogen gas, which it emitted on the affusion of acids as stated before, proved it to be hydro-sulphuret of lime, of which 32¾ grains are contained in 231 cubic inches, or one gallon of this water.

Experiment XXXI.—Into the fluid freed from the hydro-sulphuret of lime, fresh prepared lime water was suffered to fall till no more cloudiness ensued: muriate of magnesia had therefore been dissolved by the alcohol. The obtained magnesia weighed 58 grains after having been slightly heated; which gives 29 grains of muriate of magnesia to 231 cubic inches of the sulphuretted saline water.

Experiment XXXII.—The liquid left in the last process was concentrated to dryness in a glass capsule, and redissolved in as little water as possible. On pouring into this concentrated fluid a solution of neutral carbonate of ammonia, a precipitate ensued, which being dried, weighed 189 grains. Hence 24⅛ grains of muriate of lime are contained in 231 cubic inches of the water, deducting the lime which

which belonged to the lime water employed in the former experiment.

Experiment XXXIII.—The residue which had resisted the action of highly rectified alcohol (Experiment XXX.) was transferred into a flask, containing a mixture composed of one part of alcohol and three of water, digested for six hours, filtered, and evaporated to dryness.

Experiment XXXIV.—Upon the dry mass four parts of cold water were affused, and suffered to stand for two days; which dissolved the whole, except four grains which were found to be sulphate of lime; this was added to the insoluble residue left in Experiment XXXIII.

Experiment XXXV.—The watery solution obtained in the preceding experiment became milky by lime water: it was therefore concentrated by evaporation as much as possibie, and then decomposed whilst boiling hot, by a solution of carbonate of ammonia. The precipitated magnesia weighed 764 grains, which are equal to 3172 grains of sulphate of magnesia; of which salt 48$\frac{1}{8}$ grains exist therefore in 231 cubic inches of the sulphuretted water.

Experiment XXXVI.—The fluid left in the last process having been again concentrated, was mingled with nitric acid in excess, and then decomposed by a solution of nitrate of barytes: the precipitate (taking 170 grains of sulphate of barytes to be equal to 100 of sulphate of soda,) proved that 53 grains of sulphate of soda were present in 231 cubic inches of the sulphuretted water; allowance being made for that portion of sulphuric acid which belonged to the sulphate of magnesia decomposed in Experiment XXXV.

Experiment XXXVII.—Into the fluid freed thus from all the salts, with a base of sulphuric acid, sulphate of silver was dropped, till no further cloudiness ensued: the obtained precipitate being weighed, indicated the presence of 183$\frac{1}{4}$ grains of muriate of soda in 231 cubic inches of the water; taking 235 of muriate of silver to be equal to 100 of muriate of soda.

Experiment XXXVIII.—The insoluble residue of Experiment XXXIII was repeatedly boiled in large quantities of distilled water, until this fluid ceased to become turbid by hydrate

hydrate of barytes: the solution being evaporated to dryness, indicated (with that obtained in Experiment XXXIV.) 66·5 grains of sulphate of lime in 231 cubic inches of the water.

Experiment XXXIX.—The residue left in the preceding process was lastly digested in nitro-muriatic acid, composed of equal parts of nitric and muriatic acids evaporated nearly to dryness, and re-dissolved in the least possible quantity of water: the fluid did not yield a precipitate by liquid ammonia, nor by succinate of soda, or tincture of galls; lime water rendered it turbid, and fluate of soda produced much cloudiness.

Experiment XL.—To effect the decomposition of this solution, it was evaporated to dryness, and the dry mass redissolved in the least possible quantity of water previously mingled with one part of alcohol. Into this fluid, when heated, a mixture of equal parts by bulk, of sulphuric acid and alcohol, was poured, till it produced no further cloudiness. The sulphate of lime obtained proved that 18 grains of carbonate of lime were present in 231 cubic inches of water; taking 100 grains of the precipitate to be equal to 64 of carbonate of lime.

Experiment XLI.—The fluid separated by the filter, being again evaporated to dryness and redissolved in distilled water, was made boiling hot, and then mingled with a solution of sub-carbonate of potash. The sub-carbonate of magnesia produced, indicated 5·75 grains of this substance to be present in 231 cubic inches of water.

The analysis being now completed, we are led to believe that the contents of the sulphuretted saline water are the following:

	Contents in one Gallon. Grains.	*In one Pint.* Grains.
Muriate of soda -	183·25	29·90625
Sulphate of magnesia	48·125	6·015625
Hydro-sulphuret of lime	32·75	4·09375
Muriate of magnesia -	29·0	8·3125
Sulphate of lime -	66·5	3·625
Muriate of lime -	24·125	3·015625
Sulphate of soda -	53·0	6·625
Carbonate of lime -	18·0	2·25
Carbonate of magnesia	5·75	0·71875
	460·5	57·5625

Carbonic

	Contents in one Gallon. Cubic inches.	*In one Pint.* Cubic inches.
Carbonic acid gas -	7·9	0·9875
Sulphuretted hydrogen gas	11·	1·375
	18·9	2·3625

[To be continued.]

XVII. *On Malting.* *By* JOHN CARR, *Esq.*

[Continued from p. 50.]

Weight of Malt.

SEVERAL erroneous opinions are delivered in the evidence given before the committee respecting the goodness of malt being determined by its weight. Abstractedly considered, weight indeed does not afford any certain data for estimating the worth of malt, because bad malt may be either heavier or lighter than that which is good. If the vegetation of the grain has been imperfect, or not carried sufficiently far, the product will be part malt and part barley, and of course heavier than good malt: but if on the other hand the vegetation has been carried too far, too much of the substance, and of course weight, of the grain will have been driven out, and the malt will be light in proportion as the injuring cause has been allowed to operate: in this way malt may be rendered light and unproductive to any extent at the discretion of the maltster.

But notwithstanding all this, in every instance where the grain has been perfectly malted, weight is the only certain standard now known for determining the value of malt; and this is now so well understood in the markets, that it is not unusual for the buyer of malt to be provided with a pair of scales and a small measure, and to govern his opinion of the price by the weight which his measure of the sample yields. In all malt, therefore, which has been perfectly malted, there can be no question of the heaviest being the best,

best, and in this respect the Hertfordshire malt preserves a distinguished superiority over all watered malt.

Varieties of Malt.

Strictly speaking, there are only three varieties of malt, viz. brown, amber, and pale malt. The first two are peculiar to porter, and have special reference to its flavour and colour; the third is the general basis as well of all porter as of every other species of malt liquor; and it is the only one which merits any consideration in the general question of malting. Brown malt receives all its peculiar qualities in the kiln, by an operation called blowing: it is spread there very thin, and a very quick and active heat is passed through it from flaming faggots: the sudden application of the heat converts the moisture in the grain into vapour, which blows up the husk, and the heat catching it in its distended state hardens and prevents it from collapsing; hence the grains of such malt are large and hollow, and increase the measure from one to two bushels in a quarter. The saccharine of this malt is nearly all destroyed by the operation of the fire, and its sole object in porter is to communicate flavour and colour; but as these qualities are probably to be obtained from other materials than malt, some porter-brewers are not using it at all, and the making of it is very rapidly declining. Amber malt is a species between brown and pale, and is also made on the kiln by giving it less fire than the former, and more than the latter; it is still generally used in porter along with pale malt, but the quantity made is inconsiderable.

As bad flavour in malt subtracts from its value, and the charge of producing was strongly shifted by the watering party from themselves to the Hertfordshire maltsters, the present portion of the subject is material in the inquiry; and from what has been said it may be readily understood that flavouring, when applied to the working floors, can only mean manufacturing the different steepings there as sweet and clean as possible, and thereby not giving but guarding against any peculiar flavour.

Varieties of Barley.

In the evidence given before the committee, the agents of the

the watering party have set up a very material distinction between what they call heavy and light land barleys, and they appear to have laid much stress on this distinction, and to have considered it as one of the chief supports of their case: to me, however, it seems no other than one of those artful subterfuges so commonly resorted to by artful and interested traders in revenue questions, merely to obscure and disguise the true state of the matter at issue.

On all the numerous gradations of soil, from the lightest down to clay itself, barleys are produced, varying in every degree, chiefly as to colour and thickness of skin; but this variety is not, as is attempted to be set up, a local circumstance. It abounds every where, because light and heavy soils do every where abound; and it is only to the extremes, and not to the multitude of intermediate gradations, that any thing advanced before the committee can fairly be referred. Certainly to mix the very coarsest with the very finest barleys in the same cistern would be improper; but each sort can be well malted separately without any aid from watering on the floors, which is in no respect more necessary for what is called the heavy than it is for the light land corn.

The several witnesses who have spoken to the case have advanced that more water is required for the coarse than the fine skinned grain, but the fact is probably the contrary. The thin skinned barley, being the largest and plumpest corn, will certainly require the most water for its vegetation, but on account of its more pervious husk, it will sooner imbibe its proportion of the fluid. Hence it is that thick skinned grain does not actually require a larger proportion of water but only of time in the cistern to absorb its proportion; and having accomplished that, it is equally, and perhaps better, fitted for going through the subsequent process of malting without a further supply, as its thick husk is more likely to retain the moisture which it has got.

If, however, the reason of the thing did not sufficiently prove it, the testimony of Messrs. Clough and King fully establishes that better malt can be made from coarse barleys without than with watering upon the floors; and in every

place

place where I have been, except giving the thick skinned corn a few hours more of time in the cistern, no further attention is paid as to treating them differently from others.

It has long been a pretty generally received opinion amongst farmers and others, that barleys grown on heavy lands contain a larger proportion of earthy matter than those produced from light lands; but from the chemical analysis of both kinds it has been found that there is no truth in this opinion, and that the proportion of calcareous and other earths is the same in light as in heavy land barley, and that the real difference between the two lies merely in the husk: all therefore that we are authorised to conclude on the subject is, that in equal weights or measures, the coarser skinned grain contains a large proportion of waste, and on that account only is less proper for the purpose of malting.

There is another distinction of barleys which the agents of the watering party have advanced in support of their case, and that is, that though the large fine barleys of Hertfordshire and in the southern parts of the kingdom are malted without watering upon the floors, yet that the inferior corn more northwards does require and cannot be malted without sprinkling: now I am well convinced the case is directly contrary to their statement. It is a well-known fact that the thinner, lighter, and more inferior the barleys are, the more apt are they to run themselves out in a too quick vegetation; and having of themselves but little substance, the less of it can be parted with in the process of malting; whereas the large fine plump barleys of Hertfordshire both require more water to malt them, and could much better admit a portion of their substance to be wasted in the process; and such barleys actually having a less aptitude to run out in vegetating, they would require and would stand watering much better than the others: the conclusion therefore is just, and the fact really is, that as the finest barleys in the kingdom are actually best malted by not being watered on the floors, so the inferior kinds would be benefited in a higher proportion by being restricted to the same process, for which they are naturally better adapted.

Frauds

Frauds of Watering on the Floors.

There are no frauds of any extent practicable at a malt-house except those which are immediately connected with and entirely depend on the practice of watering on the floors. These last are three in number, viz. draining the cistern before the time prescribed by law, in order to keep down the gauges in the couch; wholly emptying the cistern to be fraudulently worked as a distinct floor; and privately plundering the cistern of parts of the corn in order to be mixed with the youngest floor; as the grain in each of these frauds is short wet in the cistern, it would be impracticable to carry it forward in a sufficiently malted state to the kiln without watering it upon the floors. Of the first I shall say nothing, as it explains itself. Instances of both the others I have myself detected; and what is more, an instance of the second was in a foot walk, and had been practised to a great extent. But it is in rides where it can be pursued almost with impunity, from the officer's visits at the malt-house being only two or three times a week, and I am inclined to believe that it is followed in such situations to a degree much beyond what has yet been discovered or even suspected. It requires indeed the use of a large kiln; and where that has been provided it is only necessary to get the oldest floor there immediately before the cistern is fraudulently emptied: and though it must, like every other fraud, at particular stages of its practice, afford indication of what is doing to a vigilant and intelligent officer; yet, for the most part, an officer may survey in the usual manner for a length of time without observing any thing to call forth his suspicions. I can even readily believe that a cautious and artful maltster may defraud the revenue of half the duty which he ought to pay, by means of this fraud, and yet incur in the practice of it but very little risk, provided he is indulged with watering the short wet corn on the floors.

The third fraud of robbing (or as it is called in trade gelding) the cistern, and mixing the plundered corn with the youngest floor, certainly has been, and there is reason to fear it is yet, practised to a most injurious degree, as the present restriction against watering on the floors does not extend to a period sufficiently late to exclude its practicability, and which indeed may be equally said of the preceding fraud. The one, however, of which I am now speaking is too well known at the board, from the numerous detections which have been made of it, to require any particular description or comment from me.

Present Restriction against Sprinkling.

When the present restriction against watering on the floors was established, a very material circumstance, intimately connected with it, was probably in some degree overlooked, or at least not sufficiently adverted to. This circumstance is, that in every instance where short wet corn is fraudulently laid upon the floors, it does not take the true age when it was actually removed out of the cistern, but a false age of the same date of the preceding steeping. This arises from its being either mixed with and of course becoming part of the youngest floor, or taking its place in the officer's account, and passing for it through all the subsequent stages of malting. The regulation of this false age is very much within the power of the fraudulent maltster; for, as he steeps when he pleases, he can determine the day and hour when he will empty privately the cistern, and he can keep back the youngest floor from growing by spreading it very thin. In this way three days of false age can be readily gained, and such corn will come in course to be watered on the seventh, instead of the tenth day, as intended by the restriction: but had the maltster a discretional power of watering, he would not do it sooner than about the sixth day: hence the present restriction against watering, as far as regards fraud, cannot be considered as operating to any very useful purpose; and even in cases where no fraud is practised its operation is very feeble indeed, and the great extent to which watering upon the floors is still followed, sufficiently proves the inutility of the present restricted period.

The former restriction of twelve days was much more effectual, as short wet corn could not be worked up to that period, even with the false age already spoken of, without watering it; and by watering it illegally, the penalty for doing so was

not

not only risked, but, what is much more, great hazard was incurred of disclosing the fraud itself, the very circumstance of watering being matter of suspicion sufficient to direct specially the officer's attention to the state and condition of the particular steeping which he found illegally watered.

The restriction of twelve days also took away from the interested maltster the mischievous means of wasting the substance of the corn, by throwing out too much vegetation, and making that light unproductive malt which actually is at this time so abundant in the market. I would therefore humbly submit it as a matter of much importance, and as a case resting upon grounds which cannot fairly be controverted, that the revenue on malt can only be protected from very extensive depredation, and the quality of the commodity manufactured in the greater part of the kingdom preserved from a most improvident waste, by the restriction against watering the grain upon the floors being extended from its present period of nine to its former of twelve days.

What has hitherto been stated in this report is the result of my own previous experience and knowledge in the survey and manufacture of malt; but I have now to detail the various practical facts and circumstances collected on my journey through many of the most considerable malting places, and from which I am but just returned.

My first progress was into Hertfordshire, and into the north-eastern and western directions from London, where the practice of malting prevails without watering upon the floors. I visited 115 different malt-houses of this description, all in full work. The periods of steeping were generally twice a week, and the time of keeping the corn under water varied from 48 to 56 hours. This period was shorter than had usually been employed, owing to the barleys of the last year being lighter and thinner than in former years, from a want of rain at a particular period of the crop. As the barleys, however, were hardening by longer keeping, they would take more water in the cistern.

In my inspection of the numerous maltings, I paid every attention to the state of the corn in its progress through every stage. The same process uniformly prevailed at all, and the only discoverable difference was readily to be traced in the conduct of the workmen; for where the most industrious and steady men were employed, the corn was in the best condition; but the management and object of the process were at every individual house the same.

The system of malting pursued through this part of the country is simple and obvious, and contains nothing of secrecy or difficulty that can form an obstacle to its adoption in any other part of the kingdom. It consists, in the first instance, in giving the corn a due proportion of water in the cistern, according to its condition. The thinner and lighter the grain is, the shorter is its period of steeping; and the larger, drier, and bolder the barley is, the longer it is continued under water. When thrown out of the cistern it remains in the couch from 26 to 30 hours, and it is kept a day longer at a depth of from 10 to 16 inches, varying with the state of the weather. In this situation a very moderate rise of temperature comes on, which is carefully watched, and checked by turning the grain. By the fourth day the root has come freely out, and the corn is spread abroad in the floor very thin. At this time its temperature is very little above that of the air in the malt-house, and the steeping is continued to be worked in this cool state up to the eighth or ninth day, and during this cool part of the process, the root, which at first shot out straight from the corn, curls back upon it, forming a little bushy knot of curled fibres, which does not afterwards grow any longer, and rarely exceeds half an inch in length. By the eighth day the acrospire has advanced about one-third up the grain, and to promote its further progress, the grain after this period is laid a little deeper, and so gradually increased up to the kiln. The completion of the process is judged of by the acrospire having reached two-thirds, or at most three-fourths up the grain. The circumstance therefore which chiefly distinguishes this process of malting, is that of working the steepings as cool as possible during the first half of the period of operation, and gradually increasing the heat during the other half up to the kiln.

The numerous floors which I examined in every stage of operation,

operation, bore the most unequivocal appearance of no water having been employed in working them, and yet the vegetation was regularly and steadily kept up to the kiln. I examined specially all the old floors in the last stages of the process, and even on the kiln, and found them fresh, sweet, and in an evident state of healthy vegetation; and in some instances where the grain had been some time on the kiln, the quantity of moisture, which was flying off in a thick dense vapour, afforded satisfactory testimony, that barley, when properly treated through the working process, can carry along with it a sufficiency of the cistern water for all the necessary purposes of malting.

So very evident indeed was this, that it would only have been requisite to allow the oldest floors to have lain for a proper time undisturbed, in order to their springing up into a thick green bed of living plants. I was especially attentive to this circumstance, and can now confidently declare, that the statement of Mr. Reynoldson before the committee, wherein he affirms, in such express terms, that the putrefactive fermentation formed a part of the Ware process of malting, has, in fact, no foundation whatsoever.

I conversed with a gentleman who examined the same three floors on the following day after Mr. Reynoldson's inspection of them, and who declared, that though the corn was not in good condition, owing to the warm state of the weather, and advanced season, (they were the last steepings,) yet that the vegetation was completely alive on all of the floors, and that there did not exist a single fact or circumstance in the case, which could authorise the strange account given of them. All the maltsters also with whom I conversed on the subject, ridiculed the notion that putrescence could have any share in their process, and expressed their surprise, that so wild an opinion could have been advanced or encouraged by any one.

Most of the malt-houses consist of a range of building three stories in height, of which the two uppermost are commonly boarded, and the lower one plaster. Each steeping is divided into three parts, and worked on a separate floor. The boards are warmer than the plaster, but being

 higher,

higher, the grain is situated cooler on them. This, however, contrary to what is stated against it in the evidence by the watering party, produced no irregularity in the vegetation, for the corn situated the coolest is worked the deepest; and in this way, the workmen, from practice, can keep the pieces very nearly at the same temperature. I paid particular regard to this fact, and being provided with a thermometer, it enabled me to determine it very exactly.

The malting rooms were kept remarkably open and airy, by throwing all the doors and windows open, and allowing the wind freely to blow over the corn. In several houses even flocks of sparrows were feeding upon the floors, and so tamely as to show that they were familiar with the place, and visited it without interruption. I was already well aware of the great importance of fresh air in malting, but did not imagine that it could be so freely admitted in the process where watering upon the floors was not practised, without inducing a too great expenditure of the cistern water by evaporation.

[To be continued.]

XVIII. *On Oxalic Acid. By* THOMAS THOMSON, *M.D. F.R.S. Ed. Communicated by* CHARLES HATCHETT, *Esq., F.R.S.**

OXALIC acid, from the united testimony of Ehrhart, Hermbstadt, and Westrumb, appears to have been discovered by Scheele; but it is to Bergman that we are indebted for the first account of its properties. He published his dissertation on it in 1776, and since that time very little has been added to the facts contained in his valuable treatise. Chemists have chiefly directed their attention to the formation of that acid, and much curious and important information has resulted from the experiments of Hermbstadt, Westrumb, Berthollet, Fourcroy, and Vauquelin, &c.; but the properties of the acid itself have been rather neglected. My object in the following pages is not to give a complete history

* From Philosophical Transactions for 1808, Part I.

history of the properties of oxalic acid, but merely to state the result of a set of experiments, undertaken with the view of ascertaining different particulars respecting it, which I conceived to be of importance.

I. *Water of Crystallization.*

Oxalic acid is usually obtained in transparent prismatic crystals more or less regular; these crystals contain a portion of water, for when moderately heated they effloresce and lose a part of their weight, which they afterwards recover when left exposed in a moist place. When cautiously heated on a sand bath they fall to powder, and lose about a third of their weight. But as the acid is itself volatile, it is not probable that the whole of this loss is water. To ascertain the quantity of water contained in these crystals I had recourse to the following method:

1. Seventy grains of crystallized oxalic acid were dissolved in 600 grains of water, constituting a solution which weighed 670 grains.

Fifty grains of pure carbonate of lime, in the state of calcareous spar, were dissolved in muriatic acid; this solution was evaporated to dryness to get rid of the excess of acid, and the residue redissolved in water.

Into this muriate of lime the solution of oxalic acid was dropt by little and little as long as any precipitate fell, and the oxalate of lime thus formed was separated by the filter. Pure oxalic acid is not capable of precipitating the whole lime from solution of muriate of lime, the muriatic acid evolved being always sufficient to retain the last portions in solution.

It was necessary to get rid of this excess of acid; the method which appeared the least exceptionable was to saturate the muriatic acid with ammonia: accordingly, when the oxalic acid ceased to occasion any further precipitate, I cautiously added pure ammonia, till the liquid ceased to produce any effect upon vegetable blues. A copious additional precipitate of oxalate of lime was thus obtained. Oxalic acid was now added again as long as it rendered the liquid muddy. By thus alternately having recourse to the

 acid

acid solution, and to ammonia, and by adding both with great caution to avoid any excess, I succeeded in separating the whole of the lime without using any sensible excess of oxalic acid.

558 grains of the acid solution were employed, a quantity which is equivalent to 58·3 grains of the crystallized acid.

2. The oxalate of lime, after being well washed and drained, and exposed for a week to the open air, at a temperature of about 60°, weighed 76 grains; but upon being left on the sand bath for some hours in a temperature between 200° and 300°, its weight was reduced to 72 grains.

3. These 72 grains of dry oxalate of lime were put into an open platinum crucible, and gradually heated to redness. By these means they were reduced to 49·5 grains, which proved to be carbonate of lime. The crucible was now exposed to a violent heat in a forge. Nothing remained but a quantity of pure lime weighing 27 grains.

4. From this experiment we learn, that 72 grains of dry oxalate of lime contain 27 grains of lime. Of consequence, the oxalic acid in this compound must be 45 grains. But the weight of crystallized oxalic acid actually used was 58·3 grains, a quantity which exceeds the whole acid in the oxalate by 13·3 grains. These 13·3 grains are the amount of the water of crystallization, which either did not unite with the salt, or was driven off by the subsequent exposure to heat. Hence crystallized oxalic acid is composed of

Real acid - -	45·
Water - -	13·3
	58·3

Now this is equivalent to

Real acid - -	77
Water - -	23
	100

So that the crystals of oxalic acid contain very nearly the fourth part of their weight of water*.

II. *Alkaline*

* Vauquelin in a late dissertation on cinchona, marked with that profound skill which characterizes all the productions of this illustrious chemist, has mentioned

II. *Alkaline and Earthy Oxalates.*

1. The preceding experiment gives us likewise the composition of oxalate of lime. This salt, when merely dried in the open air, still retains a portion of water which may be driven off by artificial heat. It is necessary to know that it parts with this water with considerable difficulty, so that a long exposure on the sand or steam bath is necessary to get it thoroughly dry. It afterwards imbibes a little water if it be left in a moist place. Well dried oxalate, we have seen, is a compound of

Acid	45	or per cent,	62·5 acid.
Base	27	- -	37·5 base.
	72		100

Though the oxalate of lime dried spontaneously can scarcely be considered as always in the same state, yet as the difference in the portion of water which it retains is not great, provided it be dried slowly in the temperature of 60°, and in a dry place, it may be worth while to state its composition. It is as follows:

Acid	45	or per cent,	59·2 acid.
Base	27	- -	35·5 base.
Water	4	- -	5·3 water.
	76		100·0

When rapidly dried, as by pressing it between the folds of filtering paper, it is apt to concrete into hard lumps, which retain more moisture. In this state I have sometimes seen it retain 10 per cent. of water after it appeared dry.

mentioned incidentally, that the crystals of oxalic acid contain about half their weight of water. He dissolved 100 parts of cinchonate of lime in water, and precipitated by means of oxalic acid; 22 parts of crystallized oxalic acid were necessary; and the oxalate of lime formed weighed 27 grains. From this experiment he draws the conclusion which I have stated, (see *Ann. de Chimie*, lix. 164) But this ingenious chemist does not seem to have been aware of the real composition of oxalate of lime. 27 grains of that salt are composed very nearly of 10 grains of lime and 17 grains of acid. But the weight of the crystals used by Vauquelin was 22; the difference, five, is obviously the water of crystallization in 22 grains of the crystals. But if 22 grains contain five of water, it is obvious, that 100 contain very nearly 23. So that his experiment in reality coincides with mine.

Bergmann

Bergmann states the composition of oxalate of lime as follows:

Acid	- -	48
Lime	- -	46
Water	- -	6
		100*

His method was to dissolve a determinate quantity of calcareous spar in nitric acid, and then to precipitate the lime by oxalic acid. 100 parts of calcareous spar thus dissolved, require, according to him, 82 parts of crystallized acid to precipitate them. But there must have been some mistake in this experiment; for, according to my trials, (provided the nitric acid be carefully neutralized by ammonia as it is evolved,) no less than 117 grains of oxalic acid would have been required, and at least 145 grains of oxalate of lime would have been obtained instead of the 119, which was the result of Bergmann's experiment. It is obvious that Bergmann did not precipitate all the lime. He added oxalic acid till it ceased to produce any effect on the solution from the great excess of nitric acid evolved; and then took it for granted that all the lime was separated. But had he added ammonia, he would have got an additional quantity of oxalate of lime, and the precipitation would have recommenced upon adding more oxalic acid. This explanation accounts in a satisfactory manner for the difference between Bergmann's statement of the composition of oxalate of lime, and mine.

2. Though the preceding experiment was made with care, yet as some of the most important of the following observations in some measure rest upon the analysis of oxalate of lime, I thought it worth while to verify that analysis in the following manner:

100 grains of crystallized oxalic acid were dissolved in 1000 grains of water, making a solution which weighed 1100 grains.

It is obvious that every 100 grains of the above solution contained 9·09 grains of crystal of oxalic acid, equivalent,

* Opusc. i. 262.

according

according to the preceding analysis, to seven grains of real acid.

100 grains of this solution were gradually mixed with lime water till the liquid ceased to produce any change on vegetable blues. The oxalate of lime thus formed being well dried, weighed 11·2 grains. Exposed to a violent heat in a platinum crucible, this salt left 4·2 grains of pure lime. Hence it was composed of

7 acid, or per cent.		62·5	acid.
4·2 lime	-	37·5	base.
11·2		100·0	

Thus we have obtained exactly the same result as in the former experiment, both as far as relates to the composition of oxalate of lime, and likewise to the proportion of water of crystallization in crystallized oxalic acid.

The lime water necessary to saturate the acid amounted to 3186 grains. Hence, it contained only $\frac{1}{758}$th of its weight of lime.

3. The oxalates of barytes and strontian are white, tasteless powders, which may be obtained by mixing oxalate of ammonia with the muriates of these alkaline earths. It is said that these earths are capable of forming soluble superoxalates with this acid; but I have not tried the experiment. These oxalates, as well as oxalate of lime, are partially soluble in the strong acids.

4. Oxalate of magnesia is a soft white powder, bearing a considerable resemblance to oxalate of lime. It is tasteless, and not sensibly soluble in water; yet when oxalate of ammonia is mixed with sulphate of magnesia, no precipitate falls; but if the solution be heated and concentrated sufficiently, or if it be evaporated to dryness, and redissolved in water, in both cases the oxalate of magnesia separates in the state of an insoluble powder.

5. Oxalate of potash readily crystallizes in flat rhomboids, commonly terminated by dihedral summits. The lateral edges of the prism are usually bevelled. The taste of this salt is cooling and bitter. At the temperature of 60° it dissolves in thrice its weight of water. When dried on the sand bath, and afterwards exposed in a damp place, it absorbs a little moisture from the atmosphere.

This

This salt combines with an excess of acid, and forms a superoxalate, long known by the name of *salt of sorrel*. It is very sparingly soluble in water, though more so than tartar. It occurs in commerce in beautiful 4-sided prisms attached to each other. The acid contained in this salt is very nearly double of what is contained in oxalate of potash. Suppose 100 parts of potash; if the weight of acid necessary to convert this quantity into oxalate be x, then $2x$ will convert it into superoxalate.

6. Oxalate of soda readily crystallizes. Its taste is nearly the same as that of oxalate of potash. When heated, it falls to powder, and loses the whole of its water of crystallization. Soda is said to be capable of combining with an excess of acid, and of forming a superoxalate. I have not tried the experiment.

7. Oxalate of ammonia is the most important of all the oxalates, being very much employed by chemists to detect the presence of lime, and to separate it from solutions. It crystallizes in long transparent prisms, rhomboidal, and terminated by dihedral summits. The lateral edges are often truncated, so as to make the prism 6- or 8-sided. Sometimes the original faces of the prism are nearly effaced.

The taste of this salt is bitter and unpleasant, somewhat like that of sal ammoniac. At the temperature of 60°, 1000 grains of water dissolve only 45 grains of this salt. Hence, 1000 grains of saturated solution of oxalate of ammonia contain only 43·2 grains of this salt. The specific gravity of this solution is 1·0186. As it may be useful to know the weight of this salt contained in solutions of different specific gravities, I have thought it worth while to construct the following table:

Weight of Oxalate of Ammonia in 100 parts of the Solution.	Specific gravity of the Solution at 60°.	Weight of Oxalate of Ammonia in 100 parts of the Solution.	Specific gravity of the Solution at 60°.
4·32	1·0186	1·5	1·0075
4·	1·0179	1·	1·0054
3·5	1·0160	0·5	1·0030
3·	1·0142	0·4	1·0024
2·5	1·0120	0·3	1·0018
2·	0·0095	0·2	1·0012
		0·1	1·0006

8. To

8. To determine the composition of these salts, I took seven different portions of a diluted oxalic acid solution, each weighing 100 grains, and containing seven grains of real oxalic acid. To each of these portions I added respectively potash, soda, ammonia, barytes water, strontian water, and lime water, till it ceased to produce any change. The liquid was then evaporated to dryness, and the residue, after being well dried on the steam bath, was weighed. Each of these salts contained seven grains of acid; the additional weight I ascribed to the base. Hence I had the following table, which exhibits the weight of each salt obtained, and its composition deduced from that weight.

Salts.	Weight obtained.	Composition.	
		Acid.	Base.
Oxalate of Ammonia	9·4	7	2·4
——— Magnesia*	9·5	7	2·5
——— Soda -	11·0	7	4·0
——— Lime -	11·2	7	4·2
——— Potash	15·6	7	8·6
——— Strontian	17·6	7	10·6
——— Barytes	17·0	7	10·0

The composition of these salts reduced to 100 parts, is given in the following table:

	Oxalate of Ammonia.	Oxalate of Magnesia.	Oxalate of Soda.	Oxalate of Lime.	Oxalate of Potash.	Oxalate of Strontian	Oxalate of Barytes.
Acid	74·45	73·68	63·63	62·50	44·87	39·77	41·16
Base	25·53	26·32	36·37	37·50	55·13	60·23	58·84
Total	100·	100·	100·	100·	100·	100·	100·

* The oxalate of magnesia was obtained by neutralizing the oxalic acid solution with ammonia, then mixing it with sulphate of magnesia, evaporating the solution to dryness, and washing the insoluble oxalate of magnesia with a sufficient quantity of water.

But

But for practical purposes, it is more convenient to consider the acid as a constant quantity. The following table is constructed upon that plan:

	Acid.	Base.	Weight of Salt.
Oxalate of Ammonia	100	34·12	134·12
——— Magnesia	100	35·71	135·71
——— Soda	100	57·14	157·14
——— Lime	100	60·00	160·00
——— Potash	100	122·86	222·86
——— Strontian	100	151·51	251·51
——— Barytes	100	142·86	242·86

9. In the preceding statement, no account has been taken of the water of crystallization which might still remain attached to the salts, notwithstanding the heat to which they were exposed. There is reason to believe, however, that in most of them this water must be so small, that it may be overlooked without any great error. Oxalates of soda and of ammonia, I have reason to believe, lose all their water of crystallization at a moderate heat. This is the case also with oxalates of lime and barytes, and I presume that the oxalates of strontian and magnesia are not exceptions; but oxalate of potash retains its water much more obstinately. I believe that in that salt the weight of acid and of base is nearly equal, and that when dried in the temperature of 212°, it still retains nearly ten per cent. of water; but I have not been able to establish this opinion by direct experiment.

The composition of oxalate of strontian in the preceding table, was so different from what I expected, that I repeated the experiment; but the result was the same. This induced me to combine strontian and oxalic acid in the following manner: 100 grains of a solution containing 7 grains of real oxalic acid were neutralized by ammonia, and the oxalic acid precipitated by means of muriate of strontian. The salt obtained weighed 12·3 grains; of course it was composed of

Acid

Acid	7	or	56·9	or	100
Base	5·3		43·1		75·7
	12·3		100·0		175·7

Thus it appears that there are two oxalates of strontian, the first obtained by saturating oxalic acid with strontian water, the second by mixing together oxalate of ammonia and muriate of strontian. It is remarkable that the first contains just double the proportion of base contained in the second.

[To be continued.]

XIX. *Hints respecting Women's and Children's Clothes catching Fire.*

To Mr. Tilloch.

SIR,

WHEN we reflect on the many dreadful misfortunes which have of late years happened, in consequence of the clothes of women and children accidentally catching fire, it is a matter of some surprise, as well as great concern, to find so very little attention paid to the prevention of such misfortunes in future.

The following hints are offered with a sincere wish that they may meet with that serious consideration which the subject requires, and be the means of engaging the attention of the public on this subject, and of adopting the following measures recommended, or some more effectual.

There are two principal objects which offer for our consideration: the first is, *to prevent the clothes from catching fire*; and the other, *to check the progress of the flames.*

One of the most evident methods to *prevent the clothes from catching fire*, is to have wire-fenders placed before the fire-place, of a sufficient height to hinder the coals from flying into the room; such fenders are so placed in some parlours, but more it is believed for protecting the marble hearth and carpet, than for the safety of the females and children of the family. Wire screens are sometimes placed in rooms where birds are let loose, *parallel to the fire-place*; such

such as these, if more projecting ones should be objected to, might be used in common sitting-rooms. One or two strong metal bars would be some protection, if close wire-work should not be liked; these of course should come some way forward, otherwise they would not be of much use. Certainly the safest are fenders of close wire-work projecting into the room, sufficiently open to let the heat through, but not any coals which might fly from the fire. Nurseries in particular should have this sort.

The second object which offers for consideration is to *check the progress of the flames*: one of the most evident means of accomplishing this end, is to wear dresses of materials which will not readily burn: but, as it is not probable that muslins and linens will be laid aside on account of the danger they expose the persons wearing them to, perhaps some method may be adopted which may check the progress of the fire in those substances. Experiments for this purpose have been made (on a small scale) which very well answered the end, but on account of the preparations used (which were pot-ash and other alkaline substances) having the property of imbibing moisture in a great degree, it renders this exact method, it is feared, impracticable.

It has been recommended, that persons whose clothes have caught fire should immediately *roll themselves up in the carpet*: but this excellent method of extinguishing the flames is frequently quite impracticable, as it is customary to nail down carpets to the floor,—a practice which should never be suffered in rooms where there is any danger of accidents of this kind happening; nor should heavy tables or other furniture be so placed on the carpet as to hinder it from being easily rolled up.

If a woollen cloth were constantly kept in nurseries and sitting-rooms, especially when there are fires, laid *loose* upon the table or other piece of furniture, this being always at hand, might be easily resorted to in case of accident, and being wrapped tight round the flames, or strongly pressed against them, would, by excluding the air, no doubt, in many instances, soon extinguish the fire. A *green baize cloth*, which being very pliable, and likewise a neat cover

to

to furniture, is recommended for this purpose; and if such were known in the family by the name of the *Stifling-cloth*, it probably would as readily be used when there was occasion for it, as fire-engines or buckets now are. Care must be taken to procure *baize* of a close texture. Where the convenience of a *baize cloth* cannot be easily procured, as in cottages, &c. a cloth cloak, or a blanket, will answer much the same purpose.

May we not attribute many of the melancholy events which have happened of late, to the modern practice of fixing fire-grates more forward than formerly, and to the prevailing custom of wearing muslin dresses? B. F.

To Mr. Tilloch.

YOUR readiness, sir, to contribute to the welfare and happiness of our fellow creatures, by inserting a former communication on this subject in your Magazine for March, induces me to trouble you with a request that the following may be published in like manner.

The females and children in every family should be particularly told and shown, that flame always tends upwards, and consequently, that as long as they continue erect, or in an upright posture, while their clothes are burning—the fire generally beginning in the lower part of the dress—the flames meeting additional fuel as they rise, become more powerful in proportion; whereby the neck and head, being more exposed than other parts to the intense and concentrated heat, must necessarily be most injured. In a case of this kind, where the sufferer happens to be alone, and cannot extinguish the flames by instantly throwing the clothes over the head and rolling or lying upon them, as mentioned in my former letter; she may still avoid great agony, and save her life, by throwing herself at full length on the floor, and rolling herself thereon. This method may not extinguish the flame, but to a certainty will retard its progress, prevent fatal injury to the neck and head, and afford opportunity for assistance; and it may be more practicable than the other to the aged and infirm. I am, sir,

July 1, 1808. E. V.

XX. *On the Chinese Method of propagating Fruit-trees by Abscission.* *By Dr.* James Howison, *London**.

The Chinese, in place of raising fruit-trees from seeds or from grafts, as is the custom in Europe, have adopted the following method of increasing them.

They select a tree of that species which they wish to propagate, and fix upon such a branch as will least hurt or disfigure the tree by its removal.

Round this branch, and as near as they can conveniently to its junction with the trunk, they wind a rope, made of straw, besmeared with cow dung, until a ball is formed, five or six times the diameter of the branch. This is intended as a bed into which the young roots may shoot. Having performed this part of the operation, they immediately under the ball divide the bark down to the wood, for nearly two-thirds of the circumference of the branch. A cocoa-nut shell or small pot is then hung over the ball, with a hole in its bottom, so small that water put therein will only fall in drops; by this the rope is constantly kept moist, a circumstance necessary to the easy admission of the young roots, and to the supply of nourishment to the branch from this new channel.

During three succeeding weeks, nothing further is required, except supplying the vessels with water. At the expiration of that period one-third of the remaining bark is cut, and the former incision is carried considerably deeper into the wood, as by this time it is expected that some roots have struck into the rope, and are giving their assistance in support of the branch.

After a similar period the same operation is repeated, and in about two months from the commencement of the process, the roots may generally be seen intersecting each other on the surface of the ball; which is a sign that they are sufficiently advanced to admit of the separation of the branch from the tree. This is best done by sawing it off at the in-

* From Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1807.

cision,

cision, care being taken that the rope, which by this time is nearly rotten, is not shaken off by the motion. The branch is then planted as a young tree.

It appears probable, that to succeed with this operation in Europe, a longer period would be necessary, vegetation being much slower in Europe than in India, the chief field of my experiments. I am, however, of opinion, from some trials which I have lately made on cherry-trees, that an additional month would be adequate to make up for the deficiency of climate.

The advantages to be derived from this method are, that a further growth of three or four years is sufficient, when the branches are of any considerable size, to bring them to their full bearing state; whereas, even in India, eight or ten years are necessary with most kinds of fruit-trees, if raised from the seed.

When at Prince of Wales's Island, I had an opportunity of seeing this proved by experiment. Some orange trees had been raised by a gentleman, from seeds sown in 1786, which had not borne fruit in 1795, while branches taken off by the Chinese mode in 1791, had produced two plentiful crops.

Whether forest trees might be propagated in Europe in the same manner, I have not had experience sufficient to form a judgment: if it should be found practicable, the advantages from it would be great, as the infancy of trees would, by this means, be done away, a period which, from the slowness of their growth, and the accidents to which they are liable, is the most discouraging to planters.

The adoption of this method will, at all events, be of great use in multiplying such plants as are natives of warmer climates, the seeds of which do not arrive here at sufficient maturity to render them prolific.

I have frequently remarked that such branches of fruit-trees as were under the operation of abscission, during the time of bearing, were more laden with fruit than any other part of the tree. It appeared to me probable, that this arose from a plethora or fulness, occasioned by the communication between the trunk and branches, through the descending vessels being cut off by the division of the back, while that by the ligneous circles or ascending vessels, being deeper seated, remains*. The same reasoning accounts for fruit-trees producing a greater crop than usual, on being stripped of their leaves, most of the ascending juices being thrown off by them in perspiration, or expended in their nourishment, for we find that bleeding trees cease to give out their juices after they have put forth their leaves †.

I have observed that the roots from a branch under the operation of abscission were uniformly much longer in shooting into the rope when the tree was in leaf, than the contrary: hence, the spring season appears most proper for performing that operation.

It will seem singular that the Chinese entertain the same opinion that Linnæus did, respecting the pith of trees being essential to the formation of the seed. By cutting into the trunk of the guava tree before it has produced, and making a division in the pith, they have obtained fruit without seed.

Reference to the Engraving, Plate III., Fig. 1, *of the Chinese Method of propagating Fruit-trees by Abscission.*

A. The tree on which the operation is performed.

B. The straw rope wound in a ball round a branch of the tree.

C. The cocoa-nut shell or vessel, containing the water, which gradually drops from thence on the ball below it.

D. Another branch of the same tree from which the part E roosted in the straw rope or ball, and now ready for planting out, has been separated.

F. The vessel suspended from a branch above, and from which the ball had been supplied with water.

* The circumstances attending the Chinese method of propagating fruit-trees, appear a strong confirmation of Mr. Bonnet's opinion, that plants as well as animals have a regular circulation of their fluids.

† Marsden, in his History of Sumatra, page 119, says, "The natives, when they would force a tree that is backward to produce fruit, strip it of its leaves; by which means the nutritive juices are reserved for that important use, and the blossoms soon show themselves in abundance."

XXI. *De-*

XXI. *Description of a Gauge for measuring Standing Timber. By Mr.* James Broad, *of Downing Street**.

SIR,

The instrument I send herewith, is for finding the girth of standing timber, and will, I flatter myself, be found exceedingly useful to all gentlemen and others having timber to dispose of, and likewise to such purchasers as wish to pay for the true quantity. At present a gentleman having timber to dispose of, is liable to be imposed on to a very large amount; for though some surveyors may be found whose eye is pretty accurate, yet that is far from being generally the case. When an estate is sold on which the timber is to be valued, I believe there is no other way in general use of finding the girth of a tree (which being squared and multiplied by its length, gives the contents), than by actually getting up to the middle, where the girth is usually taken, with a ladder or otherwise: a method which is very troublesome and expensive where the quantity is large. The seller has, therefore, no way, but at an enormous expense, of finding the real contents of what he has to offer; and as the buyer, if a dealer, from his knowledge, is able to form a more accurate judgment, it often happens that the seller sustains much loss. *I have known it exceed* 50 *per cent.* Having some time ago a large quantity to survey, I thought it possible to invent an instrument which would obviate this inconvenience, and which might be sold at a low price, be correct in its work, quick in execution, and such as any capacity might use. I likewise thought it might be so contrived as to make such an allowance for bark as should be agreed on. The instrument I send you possesses all these qualifications, and is susceptible of several improvements, of which I was not aware when I made it, which I will point out at the end of my letter.

It is well known that the diameter and circumference of circles, are in a certain proportion to each other, and that

* From Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1807.——The silver medal of the Society was awarded to Mr. Broad for this communication.

double

double the diameter gives double the circumference. The allowance for bark is usually one inch in thirteen; that is, if the greater circumference of a tree with the bark on, is found to be thirteen inches, it is supposed it would be only 12 inches if the bark was taken off.

The instrument is composed of two straight pieces of well-seasoned deal, about thirteen feet long, joined together by a pin going through them, on which they are moveable; but neither the length nor thickness is of any particular consequence, as by following the directions hereafter given, they may be made of any size. A little way from the larger end is a brass limb I call the index, on which are engraven figures denoting the quarter-girth in feet and inches. To use this instrument, it is only necessary to take hold of the large end, and apply the other to that part of the tree where you wish to know the girth, opening it so wide as just to touch at the same time both sides of it, without straining it, keeping the graduated side of the index uppermost, on which the greater girth will be shown, after allowing for the bark, by the inner edge of the brass on the right hand leg;—an operation so easy and simple, that a person of the meanest capacity might measure a great number of trees in a day.

For taking the height of a tree, I would recommend deal rods of seven feet long, made so as to fit into ferrils at the end of each other, tapering all the way in the same manner as a fishing-rod. A set of five of them with feet marked on them, would enable a man quickly to measure a tree of more than forty feet high, as he would be able to reach himself about seven feet.

The improvements it is capable of, are, making a joint in the arch or scale, to enable it to shut up (when the legs are closed) towards the centre, which would make it easier to carry. Secondly, as it sometimes happens that standing timber is sold without any allowance for bark, and at other times with a less allowance than one inch in thirteen, two other scales on the index might be added in such cases, one without any allowance, and the other to allow as might be agreed on. I would have added these, but thought the society would rather see it in the state in which it has been tried

tried on a large survey, as any artist can with great ease add whatever scale he pleases. The present scale allows one inch in thirteen for bark, and is calculated on the following data: The diameter of a circle whose quarter circumference is 26 inches, is 33 $\frac{90}{100}$ inches. The diameter of a circle whose quarter girth is 6½ inches, is 8 $\frac{27}{100}$ inches. To graduate the scale, the instrument is opened so as to take in at the small end between the touching points 8 $\frac{27}{100}$ inches, and a mark is made on the arch to denote 6 inches quarter girth: it is then opened so as to take in 33 $\frac{96}{100}$ inches, and another mark is then made on the arch, to denote two feet quarter girth; (these marks are made close to the inner edge of the brass on the right hand limb:) the space between them is then divided into eighteen parts, which represent inches, and are again divided into half, for half inches; if any notice is to be taken of quarter inches, the eye will easily make a further decision.

I beg leave to add, that it is not my intention to make any for sale. I am, sir, your obedient servant,

JAMES BROAD.

Reference to the Engraving of Mr. James Broad's Machine for measuring Standing Timber. Plate III., Fig. 2.

Fig. 2. *a a a a* Two long pieces of well-seasoned wood, joined near the middle by a pin *b* going through them, forming an axis on which they move. *c c* Two pieces of brass screwed near their upper ends, on the sides opposite to each other, and projecting over to form the measuring points. *d* The index fastened to one of the pieces of wood at *e*, and moving freely under a small bar at *f*. *g g* Screws with nuts, placed in the middle of the long slits of the two arms, to wedge them open, whereby the vibration is destroyed, and the arms, though light, are rendered stiff. *h h h h* Screws and nuts to prevent the arms from splitting.

No. 12, Downing Street,
Dec. 8, 1806.

To CHARLES TAYLOR, M.D. Sec.

 XXII. *De-*

XXII. *Description of a Balance Level, useful for laying out Land for Irrigation, for Roads, and for other Purposes. By Mr.* RICHARD DREW, *of Great Ormond Street**.

SIR,

HEREWITH you will receive a balance level, of my invention, which I have satisfactorily used on several gentlemen's estates in Devonshire, where I have been employed to drain and carry water to irrigate meadow land. I have made several for persons in that county, whose employment is to drain and irrigate land, and they have found it to answer their purpose better than the spirit or water level, it being more portable and ready to the sight.

I have lately used it on Mr. Satterley's farm, at Hastings, to carry the water of his closes over several acres of dry ground. Dr. De Salis, who has seen it, advised me to send it to the Society of Arts, &c., that they might judge of its merits. I am, sir, your obedient servant,

RICHARD DREW.

London, Dec. 5, 1804.
To the Secretary of the Society of Arts, &c.

Explanation of the Method of using the Instrument.

Set it on a triangular staff, and point it at the object staff, which is held by another person at a distance; move the level on the joint, until the inner tube plays clear within the outer tube. Look through the sights, and observe the object staff which the person holds, let him move the slide on the staff until you see the hair cut the middle of the slide, on which there is a black line, then turn the level round, and look through the sights, you will then see if the hair cuts the middle of the slide as before, which if it does, it will be level, but if there be a difference in both ends, the person who holds the staff must set the slide to half that difference. You are then to adjust the level by turning with

* From Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1807.——Ten guineas were voted to Mr. Drew, by the Society, for this communication.

a key

a key the screw which moves the balance contained in the bottom of the inner tube.

Certificates from Mr. J. W. Gooch, Mr. Charles Layton, and Mr. Benjamin Holmes, testify that they have seen in use the level invented by Mr. Richard Drew, and that the business is done by it with accuracy and dispatch.

Reference to the Engraving of Mr. Richard Drew's Balance Level. Plate IV., Fig. 1, 2, 3, 4.

Fig. 1. The balance level, mounted on a ball and socket joint, with a tube, *a*, to fix on a stand.

Fig. 2. A section, *b b c c* two tubes of tin which slide on a short tube, *d d*, placed in the middle, and having an iron wire soldered round it to stiffen it, and to serve as a shoulder.

e e Two eye-pieces, with glass in both, one at each end, and sliding into the tubes *b* and *c*.

f f The balance level, hanging by a sort of staple *g*, on a point fixed upright on the middle of the bar *h* (shown in Fig. 3), which is fastened across the tube *d*.

i i Two eye-pieces sliding into the ends of the level *f f*, and having a narrow slit horizontally across the middle, with a hair before each, shown by the dots *h h*.

k An adjusting screw, which acts by drawing the piece *m*, (which moves in a dove-tail slide,) in one end of the tube.

n The key-hole through which the screw is turned.

Fig. 4. An end view of the case and level, showing the eye-pieces *i* and *e*, one within the other.

XXIII. *Description of a new Method of rearing Poultry to Advantage.* By Mrs. HANNAH D'OYLEY, *of Sion Hill, near Northallerton**.

SIR,

I BEG leave to communicate a most desirable method of rearing poultry, which I have proved by experience. The œconomy and facility with which it may be performed, would,

* From Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce, for 1807.——The silver medal of the Society was voted to Mrs. D'Oyley for this communication.

would, if generally adopted, lower the price of butchers' meat, and thereby be of essential benefit to the community at large. I keep a large stock of poultry, which are regularly fed in a morning upon steamed potatoes chopped small, and at noon they have barley; they are in high condition, tractable, and lay a very great quantity of eggs. In the poultry-yard is a small building, similar to a pigeon cote, for the hens to lay in, with frames covered with net to slide before each nest: the house is dry, light, and well ventilated, kept free from dirt by having the nests and walls white-washed two or three times a year, and the floor covered once a week with fresh ashes. When I wish to procure chickens, I take the opportunity of setting many hens together, confining each to her respective nest; a boy attends morning and evening to let any off that appear restless, and to see that they return to their proper places: when they hatch, the chickens are taken away, and a second lot of eggs allowed them to set again, by which means they produce as numerous a brood as before. I put the chickens into long wicker cages, placed against a hot wall at the back of the kitchen fire, and within them have artificial mothers for the chickens to run under; they are made similar to those described by Monsieur Reaumur, in his "*Art de faire éclorre et d'élever en toutes Saisons des Oiseaux domestiques de toutes Espèces,*" &c., in two volumes, printed at Paris, 1751: they are made of boards about ten inches broad, and fifteen inches long, supported by two feet in the front four inches in height, and by a board at the back two inches in height. The roof and back are lined with lambs' skins dressed with the wool upon them. The roof is thickly perforated with holes for the heated air to escape; they are formed without bottoms, and have a flannel curtain in front and at the ends for the chickens to run under, which they do apparently by instinct. The cages are kept perfectly dry and clean with sand or moss. The above is a proper size for fifty or sixty new-hatched chickens, but as they increase in size they of course require a larger mother. When they are a week old, and the weather fine, the boy carries them and their artificial mother to the grass-plot, nourishes and

keeps

keeps them warm, by placing a long narrow tin vessel filled with hot water at the back of the mother, which will retain its heat for three hours, and is then renewed fresh from the steamer. In the evening they are driven into their cages, and resume their station at the hot wall, till they are nearly three weeks old, and able to go into a small room appropriated to that purpose. The room is furnished with frames similar to the artificial mothers, placed round the floor, and with perches conveniently arranged for them to roost upon.

When I first attempted to bring up poultry in the above way, I lost immense numbers by too great heat and suffocation, owing to the roofs of the mothers not being sufficiently ventilated; and when that evil was remedied, I had another serious one to encounter: I found chickens brought up in this way did not thrive upon the food I gave them, and many of them died, till I thought of getting coarse barley-meal, and steaming it till quite soft: the boy feeds them with this and minced potatoes alternately; he is also employed rolling up pellets of dough, made of coarse wheat flour, which he throws to the chickens to excite them to eat, thereby causing them to grow surprisingly.

I was making the above experiments in the summer for about two months; and during that time my hens produced me upwards of five hundred chickens, four hundred of which I reared fit for the table or market. I used a great many made into pies for the family, and found them cheaper than butcher's meat. Were I situated in the neighbourhood of London, or any very populous place, I am confident I could make an immense profit, by rearing different kinds of poultry in the above method for the markets, and selling them on an average at the price of butchers' meat.

A young person of twelve or fourteen years of age might bring up in a season some thousands, and by adopting a fence similar to the improved sheep-fold, almost any number might be cheaply reared, and with little trouble. Hens kept as mine are, and having the same conveniences, will readily set four times in a season, and by setting twice each time, they would produce at the lowest calculation eighty chickens each, which would soon make them very plentiful.

If

If this information should be so fortunate as to merit the approbation of the Society, I shall consider myself highly honoured, and my time as having been usefully employed.

I am, sir, your most obedient servant,

HANNAH D'OYLEY.

Sion-hill, near Northallerton,
Nov. 28, 1806.

To CHARLES TAYLOR, M.D. Sec.

SIR,

ACCORDING to your request, I have sent you a model of an artificial mother. The most convenient size for forty or fifty young chickens is about fifteen inches long, ten deep, four high in front, and two at the back; it is placed in a long wicker cage against a warm wall, the heat at about eighty degrees of Fahrenheit's thermometer, till the chickens are a few days old, and used to the comfort of it, after which time they run under when they want rest, and acquire warmth by crowding together. I find it advisable to have two or three chickens among them of about a week old to teach them to peck and eat. The meat and water is given them in small troughs fixed to the outside of the cage, and a little is strewed along from the artificial mother, as a train to the main deposit. It would have given me great pleasure to have been able to send a specimen of my superior feed and management, if the season had been rather more advanced, for I think it is not possible for turkeys and chickens to weigh heavier, be whiter, or altogether better fed than mine are.

After a certain age, they are allowed their liberty, living chiefly on steamed potatoes, and being situated tolerably secure from the depredations of men and foxes, are permitted to roost in trees near the house.

I have the honour to be, sir,
your most obedient servant,

HANNAH D'OYLEY.

Sion-hill, near Northallerton,
May 11, 1807.

SIR,

ACCORDING to your request, I herewith send you a rough sketch of the apparatus I use, which probably will convey an idea of the business, and not be too complicated for persons employed in poultry-yards fully to understand. But to prevent trouble and prejudice in the first outset. I think it necessary to remark, that if the chickens do not readily run under the artificial mother for want of some educated ones to teach them, it will be proper to have the curtain in front made of rabbit or hare skin, with the fur side outwards, for the warmth and comfort to attract them; afterwards they run under the flannel ones, similar to the one I sent, which are preferable for common use, on account of cleanliness, and not being liable to get into the mouths of the chickens.

I have had great amusement in rearing poultry in the above way; and if my time was not occupied with my children and other family concerns, I should most assuredly farm very largely in poultry.

I have the honour to be, sir,
your most obedient servant,
HANNAH D'OYLEY.

Sion-hill,
May 20, 1807.

To CHARLES TAYLOR, M.D. Sec.

Reference to the Engravings of Mrs. D'Oyley's Method of breeding Poultry. Plate IV., Fig. 5, 6, 7.

Fig. 5. The apparatus called the artificial mother, with a curtain of green baize in front and ends, and holes through the top to allow the circulation of air.

Fig. 6. Another view of the artificial mother, but without the curtain, in order to show its sloping direction, and interior lining of woolly sheep-skin.

Fig. 7. A wicker basket four feet long, two feet broad, and fourteen inches high, with a lid to open, and a wooden sliding bottom similar to a bird cage: the artificial mother is shown, as placed within it.

O. A trough in front to hold food for the chickens.

XXIV. *On*

XXIV. *On Vision. By* Ez. Walker, *Esq., of Lynn, Norfolk.*

To Mr. Tilloch.

SIR,

My paper on Vision, printed in the 29th volume of the Philosophical Magazine, has been reviewed in one or two of the periodical publications.

"We," says one of these writers, "cannot help regarding it as, in some measure, derogatory to the character of a respectable journal, and at the same time discreditable to the literary reputation of the country, that papers should be brought forward, without censure, and without comment, which betray the deficiency of their authors in the first elements of science."

I believe it is now pretty well understood, that nothing is so "discreditable to the literary reputation of the country," at this time, as the concealed, ignorant critic, who passes an unjust censure upon the works of others.

"It is true," says this reviewer, "that when the surfaces of a lens are perfectly spherical, its mean focal length is altered in a very slight degree by a change in its aperture; but this change is in all practical cases absolutely insensible, and, unfortunately for Mr. Walker's opinion, is of a nature precisely opposite to that which he takes for granted."

But, whatever may be the opinion of this reviewer, it will be generally believed, that the bare assertion of an anonymous writer does not alter the truth of any proposition.

The truth of what I have advanced in my paper, respecting this property of the convex lens, may be clearly understood from the following

Experiment.—I took the same instrument mentioned in my former paper, and directed it to the moon, and drew out the inner tube until her image appeared distinct upon the unpolished glass. Then, after having contracted the aperture of the lens from two inches to $\frac{1}{5}$ of an inch, the image of a candle, which stood at the distance of 12 feet from the instrument, was distinctly painted, in an inverted position, upon the glass in the lunar focus of the lens.

The

The only difference between this experiment and those mentioned in my former paper, made with the same instrument, consists in the brightness of the object: the principle is the same.

In the next paragraph he says: "One simple argument is sufficient to set aside these opinions: it is founded on an experiment well known to all those who have properly studied the subject. If we look through two minute holes, much nearer together than the diameter of the pupil in its most contracted state, at one of two points, nearly in the same line, and within the limits of perfect vision, the other point will always appear double, whether we fix on the nearer or the more remote for the object of our attention. Here there is no change of the aperture, but a true alteration in the refractive powers of the eye."

This experiment is erroneous, and can only mislead those who may not be inclined to try it; for when we look through two minute holes, made in the manner described above, two circles of light are seen intersecting each other as represented in Fig. 9, Plate IV.

Now when a point is seen through *a* or *b* it will appear single; but if it be seen through the space *c*, it will appear double; because an image is formed of it by each hole; and if two points be viewed through *c* they will both appear double: but to see one of the points single and the other double, one must be seen through *a* or *b*, and the other through the space *c*. This experiment, which is the only one advanced "to set aside" my theory, proves nothing more than that the reviewer looked through two minute holes.

If there were any alteration in the refractive powers of the eye, we might then see one point single and the other double, when viewed through one minute hole; but this is contrary to experience, and consequently proves the absurdity of the reviewer's supposition.

As this critic does not appear to understand his own experiment, let us see, in the next place, whether he understands mine.

"It is obvious," says this writer, "that Mr. Walker's three experiments with the lens prove a great deal too much; they demonstrate that a contraction of the aperture makes a remote

remote object appear indistinct, while, in the next page, we are told, that when we view a remote object through an aperture of about one-fiftieth of an inch in diameter, if the object be seen in a proper light, it will appear as distinct as to the naked eye. What must be the confusion of that man's ideas, who could fail to discover so glaring a contradiction? The true explanation of the paradox, supposing the appearances to have been correctly described, is this: the light admitted was diminished by the contraction of the orifice, from two inches to one-fifth of an inch, in the ratio of 100 to one; consequently the pictures of all distant objects must have been rendered extremely faint: but the image of the plumb-line in the window was rendered distinct by the contraction, as it would have been by the contraction of an aperture without any lens, which would have exhibited a shadow nearly as distinct, without any trace of a picture of the remoter objects."

My experiments with the lens might appear a paradox to this reviewer in consequence of his not knowing, that distinctness and brightness are different properties. Thus, if we look through a small aperture at the moon, she will appear more distinct than to the naked eye, though less bright: if we look at a remote terrestrial object properly illuminated for the experiment, it will appear as distinct when viewed through a small aperture, as to the naked eye, but not so bright; but when the same object is seen in a faint light, through a small aperture, it will appear neither so distinct nor so bright as to the naked eye.

Now my experiments with the lens were made with terrestrial objects seen only by day-light, but the object seen through the small aperture, was strongly illuminated with the sun's rays, and appeared as distinct as to the naked eye, though not so bright: it might be (and probably was) this difference between distinctness and brightness that puzzled this gentleman so much.

It is, however, very singular that this writer should be wrong in all his observations. For in my experiment with a small aperture, the plumb-line, which hung down the middle of the window, was so clearly represented upon the unpolished

unpolished glass at the eye end of the instrument, that even its colour, a deep red, was very distinguishable. But, after the lens was taken away, the shadow of the line was so broad, faint, and indistinct, as not to be perceived by a person unacquainted with the experiment: and what might have been easily expected, this faint shadow was accompanied with a camera obscura picture of remote objects, though dark and ill defined.

The following experiments show how the eye is adjusted to distinct vision in a very satisfactory manner. These were made with a transit telescope, which has an object-glass of $2\frac{3}{4}$ inches aperture, and $3\frac{1}{2}$ feet focal distance, adjusted to observe celestial objects.

I directed this telescope to an object at the distance of 40 yards. This object consists of a circular hole $\frac{1}{10}$ of an inch in diameter made in an iron plate, with a plate of metal painted white placed at some distance behind it. With the whole aperture of the object glass, this hole in the iron plate is *invisible*; but when the aperture is contracted to $\frac{1}{5}$ of an inch, the hole appears so distinct, that it is easy to see when it is bisected by the wire in the focus of the object glass, to less than $\frac{1}{100}$ of an inch; but remote terrestrial objects viewed with the same aperture are seen very imperfectly.

Hence we see the reason of the pupil's contracting when we attentively view a near object*, and why it expands when we look at those that are remote.

That the iris is the only organ by which the eye is adjusted to distinct vision, may be clearly understood by the following experiments:

Experiment I.—Let a remote object be observed through an aperture of about $\frac{1}{50}$ of an inch in diameter, made either in a thin piece of metal or a card, and if the object be seen in a strong light it will appear as distinct as to the naked eye, though not so bright. Then introduce a small object in a line between the remote object and the eye, at the distance of six or eight inches from it, and these two objects

* This property of the eye has long been known. See Dr. Jurin's Essay on distinct and indistinct Vision, in Dr. Smith's Optics, vol. ii. p. 138.

will appear as distinct when seen together, through this small aperture, as when they are viewed separately by the naked eye.

Experiment II.—A piece of wire being placed in a line between a remote object and my eye, at the distance of two feet from it, these two objects appeared *more distinct* when seen together through an aperture of $\frac{1}{33}$ of an inch in diameter, than when they were viewed separately by the naked eye.

It is evident that no change took place in the humours of the eye, in these experiments, neither in the convexity of the crystalline lens, nor in its distance from the retina; consequently that hypothesis which is built upon a supposition that the crystalline approaches to, or recedes from, the retina, by the contraction and dilatation of the ciliary processes, must be erroneous. For it is absurd to suppose that the crystalline lens can be at different distances from the retina at the same time; and it is equally as absurd to assert, that the crystalline lens can, at the same time, have different degrees of convexity.

I am, sir, your obedient servant,

Lynn, Ez. Walker.
June 17, 1808.

XXV. *On the instantaneous Production of Fire, by the mere Compression of Atmospheric Air. By* Frederick Accum, *M.R.I.A., Operative Chemist, Lecturer on Practical Chemistry and on Mineralogy and Pharmacy, &c.*

In the xivth volume of the Philosophical Magazine, p. 363, professor Pictet communicates the accension of combustible substances by the rapid compression of atmospheric air. The discovery of this curious fact is due to Mollet, as appears from the *Journal de Physique* for Messidor, An. XII. It is there stated, that if the air be very suddenly compressed in the ball of an air-gun, the quantity of caloric liberated by the first stroke of the piston is sufficient to set fire to a piece

piece of *amadou** placed within the canal of the pump. And if the instrument be furnished by a lens firmly secured, a vivid flash of light is said to be perceived at the instant of this condensation. The evolution of light seems to have been first noticed by a workman employed in the manufacture of arms at St. Etienne, who discharged an air gun highly loaded, observed a vivid flash at the orifice of the barrel.

These curious discoveries of the foreign philosopher have lately been applied to practical utility in this country. Ingenious workmen have shown, that for the accension of combustible bodies by compressed air, the air gun is by no means necessary, but that the experiment may be performed, and even with more ease, by means of a common condensing syringe of good workmanship. The number of instruments of that kind which have been called for at my laboratory, and with which the scientific public has been supplied, gives me reason to think, that men of science deem this simple apparatus worthy of notice. The instrument I have furnished consists of a common syringe, as usually sold, about ten inches long, and not more than $\frac{5}{8}$ of internal bore. At the lower extremity it is furnished with a cap, which serves as a chamber to receive the substance intended to be fired, and which cap is attached to the instrument by a male and female screw, or instead of this cap a common stopcock may be used; the former contrivance, however, is more elegant, more durable, and less expensive.

To use this instrument the cap is unscrewed, or the stopcock turned, a small piece of *amadou* or common tinder is placed in the chamber, and the cap screwed on again. If the piston of the instrument be now depressed with as quick a motion as possible, the condensation of the air is so active as to set the amadou on fire.

From the result of a few experiments which I have made

* The name *amadou* is given to a kind of tinder which is imported from Germany. It is made of a large fungus, which grows on old trees, especially on the oak, ash, and fir. This substance, being first boiled in common water, and afterwards dried and well beaten with a mallet, is then soaked in a solution of saltpetre, and again put to dry in an oven.

with this instrument, I am induced to believe, that the accension of the combustible bodies which is effected in the manner stated, is not simply owing to the mere instantaneous condensation of the air which takes place in the syringe, and subsequent liberation of caloric, as stated by the continental philosophers; but that, on the contrary, it appears to be owing to the intense and rapid mechanical motion, vibration, or friction, produced in the particles of the body, placed in the chamber of the instrument against each other by the rapid current produced. For it was found that only such bodies as are exceedingly porous, or are made up of a multitude of minute fibres, could be set on fire by means of this instrument; and that the accension of compact combustible substances, or bodies of a different texture, when attempted, always failed. Hence phosphorus, phosphuret of sulphur, camphor, ether, naphtha, fulminating gold, fulminating mercury, and other inflammable substances, which so readily take fire, cannot be inflamed, nor can the thinnest piece of foil, made of the fusible alloy which liquefies in boiling water, be melted by the current of compressed air thus effected. The case is otherwise when a porous or fibrous inflammable body is suddenly struck upon: a piece of common tinder, a piece of amadou, very dry tow, rolled up in a coil, common touch wood, and the scrapings of dry paper, or linen rag, are instantly inflamed by a stream of condensed air. Hence it appears, that the accension of these bodies is not solely owing to the mere disengagement of caloric, of which the air is deprived when its volume is suddenly contracted. Biot has, indeed, announced in the *Magas. Encyclop.* for April 1805, that the effect of a very instantaneous compression of oxygen and hydrogen gases might be substituted for the electric spark, in the performance of the famous experiment elucidating the production of water. He states, that having introduced into an air gun a mixture of the two gases, and having given a sudden stroke to the piston, a vivid light accompanied with a violent detonation took place, indicating the combination of the bases of the two gases. This important experiment, which no doubt will be repeated by others, stands, nevertheless, unconected with what has been

advanced.

advanced. And although the performance of the instrument I have described is absolutely harmless, when applied for the purpose it is intended, the experiment of Biot requires nevertheless precaution, to prevent dangers to which those who make it are exposed.

XXVI. *Some Hints respecting the proper Mode of inuring Tender Plants to our Climate. By the Right Hon. Sir* Joseph Banks, *Bart. K.B.P.R.S. &c.**

Respectable and useful as every branch of the horticultural art certainly is, no one is more interesting to the public, or more likely to prove advantageous to those who may be so fortunate as to succeed in it, than that of inuring plants, natives of warmer climates, to bear, without covering, the ungenial springs, the chilly summers, and the rigorous winters, by which, especially for some years past, we have been perpetually visited.

Many attempts have been made in this line, and several valuable shrubs, that used to be kept in our stoves, are now to be seen in the open garden: there is, however, some reason to believe, that every one of these was originally the native of a cold climate, though introduced to us through the medium of a warm one; as the gold tree, aucuba japonica, the moutan, pæonia frutescens, and several others have been in our times.

In the case of annuals, however, it is probable that much has been done by our ancestors, and something by the present generation; but it must be remembered, that all that is required in the case of an annual, is to enable it to ripen its fruit in a comparatively cold summer, after which, we know that the hardest frost has no power to injure the seed, though exposed in the open air to its severest influence; but a perennial has to encounter frosts with its buds and annual shoots, that have sometimes been so severe with us as to rend asunder the trunks of our indigenous forest trees †.

* From Transactions of the Horticultural Society of London, vol. i. part i.

† See Miller's Dictionary, article *Frost*.

It is probable that wheat, our principal food at present, did not bring its seed to perfection in this climate, till hardened to it by repeated sowings: a few years ago some spring wheat from Guzerat was sown with barley, in a well cultivated field: it rose, eared, and blossomed, with a healthy appearance; but many ears were when ripe wholly without corn, and few brought more than three or four grains to perfection.

In the year 1791, some seeds of zizania aquatica were procured from Canada, and sown in a pond at Spring Grove, near Hounslow: it grew, and produced strong plants, which ripened their seeds: those seeds vegetated in the succeeding spring; but the plants they produced were weak, slender, not half so tall as those of the first generation, and grew in the shallowest water only; the seeds of these plants produced others the next year sensibly stronger than their parents of the second year.

In this manner the plants proceeded, springing up every year from the seeds of the preceding one, every year becoming visibly stronger and larger, and rising from deeper parts of the pond, till the last year, 1804, when several of the plants were six feet in height, and the whole pond was in every part covered with them as thick as wheat grows on a well managed field.

Here we have an experiment which proves, that an annual plant, scarce able to endure the ungenial summer of England, has become, in fourteen generations, as strong and as vigorous as our indigenous plants are, and as perfect in all its parts as in its native climate.

Some of our most common flowering shrubs have been long introduced into the gardens; the bay-tree has been cultivated more than two centuries; it is mentioned by Tusser, in the list of garden plants inserted in his book, called 500 Points of good Husbandry, printed in 1573.

The laurel was introduced by master Cole, a merchant, living at Hampstead, some years before 1629, when Parkinson published his Paradisus Terrestris, and at that time we had in our gardens, oranges, myrtles of three sorts, laurustinus, cypress, phillyrea, alaternus, arbutus; a cactus

tus brought from Bermudas, and the passion-flower, which last had flowered here, and showed a remarkable particularity, by rising from the ground near a month sooner if a seedling plant, than if it grew from roots brought from Virginia.

All these were at that time rather tender plants; master Cole cast a blanket over the top of his laurel, in frosty weather, to protect it; but though nearly two centuries have since elapsed, not one of them will yet bear with certainty our winter frosts.

Though some of these shrubs ripen their seeds in this climate, it never has been, I believe, the custom of gardeners to sow them; some are propagated by suckers and cuttings, and others by imported seeds; consequently the very identical laurel introduced by master Cole, and some others of the plants enumerated by Parkinson, are now actually growing in our gardens; no wonder then, that these original shrubs have not become hardier, though probably they would have done so, had they passed through several generations by being raised from British seeds.

Is it not then worthy a trial, as we find that plants raised from suckers or cuttings do not grow hardier by time, and as the experiment on zizania points out the road, to sow the seeds of these and such like tender shrubs as occasionally ripen them in this climate? Fourteen generations, in the case of the zizania, produced a complete habit of succeeding in this climate, but a considerable improvement in hardiness was evident much earlier.

In plants that require some years to arrive at puberty, fourteen generations is more than any man can hope to survive: but a much less number will in many cases be sufficient, and in all, though a complete habit of hardihood is not attained, a great progress may be made towards it in a much less time; even one generation may work a change of no small importance: if we could make the myrtle bear the climate of Middlesex, as well as it does that of Devonshire, or exempt our laurel hedges from the danger of being cut down by severe frosts, it would be an acquisition of no small consequence to the pleasure of the gentleman, as well as to the profit of the gardener.

Old as I am, I certainly intend this year to commence experiments on the myrtle and the laurel: I trust, therefore, it will not be thought presumptuous in me to invite those of my brethren of this most useful Society, who are younger than I am, and who of course will see the effect of more generations than I shall do, to take measures for bringing to the test of experiment the theory I have ventured to bring forward, I hope not without some prospect of success.

The settlement lately made at New Holland gives a large scope to these experiments: many plants have been brought from thence which endure our climate with very little protection; and some of these arrive at puberty at an early period; we have already three from the south point of Van Diemen's Island, where the climate cannot be wholly without frost; mimosa verticillata, eucalyptus hirsuta, and obliqua. The first of these appears to have produced flowers within eight years of its first introduction; but as a settlement is now made very near the spot where the seeds of these shrubs were collected, we may reasonably hope to receive further supplies, and, among them, the Winterana aromatica, an inhabitant of the inhospitable shore of Terra del Fuego, which Mr. Brown has discovered on the south part of Van Diemen's Island also.

XXVII. *Essay upon Machines in General. By M.* Carnot, *Member of the French Institute, &c. &c.*

[Continued from p. 36.]

Part II. [*Of Machines properly so called**.]

Definitions.

XXXI. Among the forces applied to a machine in motion, some are of such a nature that each of them forms an acute angle with the velocity of the point at which it is applied,

* Vide p. 36 of the present volume.

applied, while others form obtuse angles with their points. This being granted, I shall call the former *moving* or *soliciting forces;* and the others *resisting forces:* for instance, if a person raises a weight by means of a lever, a pulley, a screw, &c., it is clear that the weight and the velocity of the weight necessarily form by their concurrence an obtuse angle; otherwise it is evident that the weight would descend in place of ascending; but the *vis motrix* and its velocity form an acute angle: thus, according to our definition, the weight will be the *resisting force,* and the effort of the person will be the *soliciting force:* it is evident, in short, that the latter tends to favour the actual movement of the machine, while the other opposes it.

We shall observe that the soliciting forces may be directed in the same ratio with their velocities, since then the angle formed by their concurrence is null, and consequently acute, and the resisting forces may act in the direction precisely opposite to that of their velocities, since then the angle formed by their concurrence is 180°, and consequently obtuse.

It is also to be remarked, that any force which is soliciting might become resisting if the movement should change; that any force which is resisting at a certain instant, may become soliciting at another instant; and lastly, in order to judge of it at each instant, we must consider the angle which it makes with the velocity of the point where we suppose it applied: if this angle be acute, the force will be soliciting; and if it be obtuse, it will be resisting, until the angle in question changes. We see from this, that if we make any system of power assume a geometrical movement, each of them will be soliciting or resisting in respect of this geometrical movement, accordingly as the angle formed by this force and by its geometrical velocity shall be acute or obtuse.

XXXII. If a force P be moved with the velocity u, and the angle formed by the concurrence of u and P be z, the quantity P cosine $z\,u\,d\,t$, in which $d\,t$ expresses the element of time, will be named *momentum of activity,* consumed by the force P during $d\,t$; i. e. the momentum of activity consumed

consumed by a force P, in a time infinitely short, is the produce of this force estimated in the ratio of its velocity, by the path described in this infinitely short time by the point to which it is applied.

I shall call the *momentum of activity*, consumed by this force, in a given time, the sum of the *momenta of activity* consumed by it at each instant, in such a manner that s P cosine $z u d t$ is the *momentum of activity*, consumed by it in an indeterminate time: for instance, if P be a weight, the *momentum of activity* consumed in an indeterminate time t will be $P s u d t$ cosine z; let us suppose, therefore, that after the time t, the weight P has descended from the quantity H, we shall clearly have $d H = u d t$ cosine z; therefore the *momentum of activity* consumed during $d t$ will be $P s d H = PH$.

XXXIII. When we are speaking of a system of forces applied to a machine in movement, I shall call *momentum of activity*, consumed by all the forces of the system, the sum of the momenta of activity consumed at the same time by each of the forces which compose it: thus, the *momentum of activity* consumed by the soliciting forces, will be the sum of the momenta of activity consumed at the same time by each of them: and the momentum of activity consumed by the resisting forces will be the sum of the momenta of activity consumed by each of these forces: and as each resisting force makes an obtuse angle with the direction of its velocity, the cosine of this angle is negative; the momentum of activity consumed by the resisting forces is therefore also a negative quantity; and therefore the *momentum of activity* consumed by all the forces of the system, is the same thing as the difference between the *momentum of activity* consumed by the soliciting forces, and the *momentum of activity* consumed at the same time by the resisting forces considered as a positive quantity.

A force estimated in a sense directly opposite to that of its velocity, and multiplied by the path described in an infinitely short time by the point where it is applied, will be called *the momentum of activity produced* by this force in this

this infinitely short time: in such a manner *that the momentum of activity consumed*, and *the momentum of activity produced*, are two equal quantities, but of contrary signs; and there is a difference between them analogous to that which we find (XXI) between the *momenta of the quantity of movement gained and lost*, by a body, in respect of any geometrical movement.

I shall also give the name of *momentum of activity exercised by a force*, to what I have called its momentum of activity *consumed*, if it be soliciting, and to what I have called its *momentum of activity produced*, if it be resisting: thus, the *momentum of activity exercised* by any given force in an infinitely short time is in general the produce of this force, by the path which it describes in this infinitely short time, and by the cosine of the smallest of the two angles formed by the directions of this force and of its velocity; whence it clearly follows, that this *momentum of activity exercised* is always a positive quantity.

We shall make, with respect to the quantities which we call *momenta of activity produced* and *momenta of activity exercised*, the same remarks with those we have made above, upon the subject of *momentum of activity consumed* by a force or system of powers in a given time.

These definitions being admitted, I shall proceed to the general principle of equilibrium and of movement, in machines properly so called; and the inquiry into which has been the principal object of this essay.

Fundamental Theorem.

General Principle of Equilibrium and of Movement in Machines.

XXXIV. *Whatever is the state of repose or of movement in which any given system of forces applied to a machine exists, if we make it all at once assume any given geometrical movement, without changing these forces in any respect, the sum of the products of each of them, by the velocity which the point at which it is applied will have in the first instant, estimated in the direction of this force, will be equal to zero.*

That

That is to say, by calling F each of these forces *, u the velocity which the point where it is applied will have at the first instant, if we make the machine assume a geometrical movement, and z the angle comprehended between the directions of F and of u, it must prove that we shall have for the whole system $s\, F\, u$ cosine $z = 0$. Now this equation is precisely the equation (AA) found (XXX), which is nothing else in the end but the same fundamental equation (F), presented under another form.

It is easy to perceive that this general principle is, properly speaking, nothing else than that of Descartes, to which a sufficient extension is to be given, in order that it may contain not only all the conditions of the equilibrium between

* It will not perhaps be useless to anticipate an objection which might occur to those who have not paid sufficient attention to what has been said (XXX) upon the true meaning we ought to attach to the word *force*: Let us imagine, for instance, they will say, a wheel and axle to the cylinder of which weights are suspended by means of cords; if there be equilibrium, or if the movement be uniform, the weight attached to the wheel will be to that of the cylinder as the radius of the cylinder is to the radius of the wheel; which is conformable to the proposition. But the case is not the same when the machine assumes an accelerated or a retarded movement: it seems, therefore, that here the forces are not in reciprocal ratio of their velocities estimated in the direction of these forces, as would follow from the proposition. The answer to that is, that in the case where this movement is not uniform, the weights in question are not the only forces exercised in the system; for the movement of each body changing continually, it also opposes at each instant, by its *vis inertiæ*, a resistance to this change of state: we must, therefore, keep an account of this resistance. We have already said (XXX. see the note,) how this force should be estimated, and we shall see further on (XLI), how we should make it enter into the calculation. In the mean time it is sufficient to remark, that the forces applied to the machine in question are not the weights, but the quantities of movement lost by these weights (XXX), which should be estimated by the tensions of the cords to which they are suspended: now whether the machine be at rest or in motion, whether this motion be uniform or not, the tension of the cord attached to the wheel is to that of the cord attached to the cylinder, as the radius of the cylinder is to the radius of the wheel, *i. e.* these tensions are always in reciprocal ratio of the velocities of the weights they support: this agrees with the proposition. But these tensions are not equal to the weights; they are (XXX. see the note) the results of these weights and of their *vis inertiæ*, which are themselves (XXX. see the note) the results of the actual movements of these bodies, and of the movements equal and directly opposed to those which they will really assume the instant afterwards.

two forces, but also all those of equilibrium and of movement, in a system composed of any number of powers: thus the first consequence of this theorem will be the principle of Descartes, rendered complete by the conditions which we have seen were wanting in it (V).

First Corollary.

General Principle of Equilibrium between two Powers.

XXXV. *When any two agents applied to a machine form a mutual equilibrium; if we make this machine assume any arbitrary geometrical movement: 1st, The forces exercised by the agents will be in a reciprocal ratio to their velocities estimated in the direction of these forces: 2d, One of these powers will make an acute angle with the direction of its velocity, and the other an obtuse angle with its velocity.*

For if the forces exercised by the agents are named F and F′; their velocities u and u', the angles formed by these powers and their velocities z and z', we shall have by the preceding theorem, $F\,u$ cosine $z + F'\,u'$ cosine $z' = 0$: therefore $F : F' :: -u'$ cosine z' ; u cosine z, which is the proportion announced by the first part of this corollary, and by which we see at the same time that the relation of cosine z to cosine z' is negative; whence it follows that one of these angles is necessarily acute, and the other obtuse.

Second Colollary.

General Principle of Equilibrium in Weighing Machines.

XXXVI. *When several weights applied to any given machine mutually form an equilibrium, if we make this machine assume any geometrical movement, the velocity of the centre of gravity of the system, estimated in the vertical direction, will be null at the first instant.*

For if we call M the total mass of the system, m that of each of the bodies which compose it, u the absolute velocity of m, V′ the velocity of the centre of gravity estimated in the vertical ratio, g the gravity, z the angle formed by u and by the direction of the weight, we shall have, according to the theorem, $s\,m\,g\,u$ cosine $z = 0$; but by the geometrical properties of the centre of gravity we have $s\,m\,u\,d\,t$ co-

sine

sine $z = M V d t$, or $s m g u$ cosine $z = M V g$; therefore, since the first member of this equation is equal to zero, the second is so also: therefore $V = 0$. Q. E. D.

In order to have all the conditions of the equilibrium in a weighing machine, it is only necessary to make the machine successively assume different geometrical movements, and to equal in each of these cases the vertical velocity of the centre of gravity at zero.

Third Corollary.

General Principle of Equilibrium between two Weights.

XXXVII. *When two weights form a mutual equilibrium, if we make the machine assume any geometrical movement: 1st, The velocities of these bodies, estimated in the vertical ratio, will be in a reciprocal ratio to their weights: 2d, One of these bodies will necessarily ascend, while the other will descend.*

This proposition is a manifest consequence of the preceding corollary, and is still more evidently deduced from the first corollary.

We may remark by the way, how essential it is for the precision of all these propositions, that the movements impressed upon the machine should be geometrical, and not simply possible; for the slightest attention will show by some particular example, that without this condition all these propositions would be absurd.

Remark.

XXXVIII. We generally take the principle of equilibrium in weighing machines when the centre of gravity of the system is at the lowest possible point; but we know that this principle is not generally true; for besides that this point would be in certain cases at the highest point, there is an infinity of others where it is neither at the highest nor at the lowest point: for instance, if the whole system be reduced to a weighing body, and this moveable article be placed upon a curve which has a point of inflexion, the tangent of which is horizontal, it will remain visibly in equilibrium, if we place it upon this point of inflexion, which nevertheless

nevertheless is not the lowest weight, nor the highest point possible.

We may also take for the principle of equilibrium in a weighing machine the proposition which we have already given (II), and which we shall repeat, in order to give a rigorous demonstration of it.

In order to ascertain that several weights applied to any given machine should mutually form an equilibrium, it is sufficient to prove, that if we abandon this machine to itself, the centre of gravity of the system will not descend.

In order to prove it, let us name M the total mass of the system, m that of each of the weights which compose it, g the gravity; and suppose that if the machine did not remain in equilibrium, as I assert that it should, the velocity of m after the time t would be V, the height from which the centre of gravity would have descended at the end of the same time H, and that from which the body would have descended $m\,h$; we shall then have (XXIV) $s\,m\,g\,d\,h - s\,m\,V\,d\,V = 0$: therefore by integrating $M\,g\,H = \frac{1}{2}\,s\,m\,V^2$; but by hypothesis $H = 0$, therefore $s\,m\,V^2 = 0$; besides, V^2 is necessarily positive, as is evident: therefore the equation $s\,m\,V^2 = 0$ cannot take place, unless we have $V = 0$, *i. e.* unless there be equilibrium. Q. E. D.

Hence it follows, as we have said (III), that there is necessarily equilibrium in a system of weights, the centre of gravity of which is at the lowest possible point; but we have seen (XXXVIII) that the inverse is not always true, *i. e.* that every time there is equilibrium in a system of weight, it does not always follow that the centre of gravity is at the lowest point possible.

Fourth Corollary.

Particular Laws of Equilibrium in Machines.

XXXIX. *If there be equilibrium between several powers applied to a machine, and having decomposed all the forces of the system, as well those which are applied to the machine as those which are exercised by the obstacles or fixed points which form part of it; if we decompose them, I say,* each

each into three others parallel to any three axes perpendicular to each other:

1*st. The sum of the component forces, which are parallel to one and the same axis, and conspiring towards one and the same side, is equal to the sum of those which, being parallel to this same axis, conspire towards the opposite side:*

2*d. The sum of the momenta of the component forces which tend to turn around one and the same axis, and which conspire in one and the same ratio, is equal to the sum of the momenta of those which tend to turn around the same axis, but in a contrary direction.*

In order to demonstrate this proposition, let us begin by imagining, that in place of each of the forces exercised by the resistance of obstacles, we substitute an active force equal to this resistance, and directed in the same ratio: this change does not alter the state of equilibrium, and makes of the machine a system of powers perfectly free, *i. e.* freed from every obstacle. This being granted, if we make this system assume any geometrical movement, we shall have by the fundamental theorem $s \, F \, u$ cosine $z = 0$, by calling F each of these forces, u its velocity, and z the angle comprehended between F and u: thus,

1st. If we suppose that u is the same with respect to all the points of the system, and parallel to any one of the axes, the movement will be geometrical, and the equation, on account of u constant, will be reduced to s F cosine $z = 0$: *i. e.* the sum of the forces of the system estimated in the ratio of the *velocity u*, impressed parallel to this axis, will be null; which evidently reverts to the first part of the proposition.

2d. If we make the whole system turn round any one of the axes, without changing in any respect the respective position of the parts which compose it, this movement will still be geometrical; u will be proportional to the distance of each power from the axis; and therefore might be expressed by A R, R expressing this distance, and A a constant: thus the equation will be reduced to s F R cosine $z = 0$; which, as may easily be seen, reverts to the second part of the proposition.

[To be continued.]

XXVIII. *Re-*

XXVIII. *Report of Surgical Cases in the City and Finsbury Dispensaries, for January* 1808, *with some additional Remarks on a Case of Scirrhous Mamma. By* John Taunton, *Esq.*

In the month of January there were admitted on the books of the City and Finsbury Dispensaries 267 surgical patients.

Cured or relieved	—	248
Discharged for irregularity		2
Died —	—	4
Under cure	—	13
		267

Since which time there have been admitted 1291.

In the last Number of the Philosophical Magazine, p. 70, some remarks were made on the case of Miss R., who had a tumour in the right breast, which had existed for some years, and which had lately assumed the character of the true scirrhus.

It appears that this disease originated from local injury, and remained stationary for almost six years, when a second blow was received on the part:—then, and not until then, did the disease assume its true character: this took place in a constitution naturally irritable and delicate. Is it possible to suppose, that the mode of treatment by depletion, commenced in October 1806, and regularly persevered in till the following April, could fail to have produced the increase of unfavourable symptoms, and that general debility which then existed? Ought it not rather to be matter of surprise, that at this period a professional man is to be found, who should regularly and obstinately have persevered in a mode of treatment for so many months, which evidently tended to the increase of the disease, and also to the destruction of his patient?

This disease arises from very opposite causes, and takes place in constitutions which are exceedingly different; and even in many instances it occurs without any obvious or assignable cause; neither does its true nature appear to be at all understood: yet we find professional men, of no inconsiderable eminence, recommending the mode of treatment by *depletion;* from which I must confess, that so far from its doing good, (if the disease be well defined,) it can never fail, in my opinion, to increase the unfavourable symptoms, and consequently to hurry on the fatal event.

In this disease we have an extraneous substance, that is, a substance dissimilar from every part of a healthy animal body. Is it possible for this to arise from obstruction in the lymphatic system? or is it not more probable that it is produced by a peculiar action in the minute branches of the arterial system? There are certainly many facts tending to corroborate this opinion, which I have delivered in my Lectures for some years past, and mean to illustrate in a subsequent report.

JOHN TAUNTON,
Surgeon to the City and Finsbury Dispensaries, Lecturer on Anatomy, Surgery, Physiology, &c.

Greville street, Hatton Garden,
July 20, 1808.

☞ In the last Report, p. 72, seven lines from the bottom, for *aut dict.* read *acet. dist.*

XXIX. *Notices respecting New Books.*

The Edinburgh Encyclopedia conducted by DAVID BREWSTER, *LL.D. F.R.S. of Edinburgh, and of the Society of Antiquaries of Scotland.* 4to.

THOSE who can properly estimate the political and moral advantages which result, not only to individuals, but to communities, from a general diffusion of knowledge, cannot observe, but with pleasure, the various departments of science and of literature, rendered daily more familiar to every class of readers, by publications in the form of Dictionaries and Cyclopedias. Of this description the one before us seems entitled to particular attention as a valuable accession

cession to our present stock of elementary works and useful books of reference.

Part I. of this work, which is publishing in periodical portions, has made its appearance, and presents promising specimens of talent and of industry. The articles are all new written, many of them original, and exhibit a just picture of the present state of knowledge, in the various departments embraced by them—detailed with all that brevity which is consistent with perspicuity, and which is so desirable in works of this nature, to keep them within some reasonable compass—while at the same time such ample references are given to other sources, as cannot but prove of the greatest utility to those readers who may be occupied with the investigation of any particular branch of knowledge.

Among other articles which have particularly struck us as masterly compositions, exhibiting at the same time, information, genius, and intellect, are the following: *Abstraction, Accent, Ether.* As elegant well written specimens of biography we notice *Abercrombie, Abelard, Agnesi. Abyssinia* and *Africa* are good examples of concise yet perspicuous abridgement—compressing and condensing, not omitting what should be known. *Ætna* is a beautiful and interesting article. *Abstinence, Academy, Abacus, Achromatic Telescopes, Acoustics, Acids, Affinity, Agriculture,* are all excellent articles. Some of them are new in our language; and all of them present much novelty, and do credit to their respective authors.

Should this work be continued with the same spirit, and conducted with the same judgement, with which it has been commenced, it will indeed prove an acquisition to the British public. We have every reason, from the list of contributors whose names have been communicated to the public, to believe that the Edinburgh Encyclopedia will not fall off, but improve as it proceeds. The plates given with this work are superior to any before given with similar works issuing from the Scotch press, and are creditable to the artists who furnish them.

A Manual of Analytical Mineralogy, intended to facilitate the practical Analysis of Minerals. By FREDERICK ACCUM, *Honorary Member of the Royal Irish Academy, Operative Chemist, Lecturer on Experimental Chemistry and on Mineralogy and Pharmacy.* Second Edition, two Volumes, 12mo.

When we announced last month, that Mr. Accum had in the press *A System of Mineralogy and Mineralogical Chemistry,* we had no expectation of being so soon gratified with another production of this able and zealous labourer in the field of chemical science. It is not a long time since we announced the first edition of this work, and expressed our hopes that a second would soon be called for. Our wishes have been more than gratified. The present work, though presented to the public as a republication, is in many respects new, the additions that have been made being very numerous and highly interesting. All the modern improvements in analysis are detailed with brevity; but at the same time with so much perspicuity, that the student in this amusing science can be at no loss to apply them with effect. This work, though modestly entitled *A Manual,* will be found worthy of the notice of all who cultivate chemistry, whatever their acquirements may have been.

XXX. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

JULY 1.—Mr. Davy, in the Bakerian Lecture on the decomposition of the alkalies, read in November 1807 before the Royal Society, described some experiments on barytes and strontites; from which he inferred that these bodies contained inflammable matter. In a communication made this evening, he states that he has since made a number of experiments with a Voltaic battery of 36.000 square inches, on these and the other alkaline earths, and silex and alumine. All these bodies, when slightly moistened, and acted upon by iron wires, negatively electrified, undergo change at the points of contact. And the metals of the earths

earths appear to form alloys with the negatively electrified iron.

Mr. Davy has likewise metallized the earths by electrifying them when mixed with various metallic oxides, such as those of lead, silver, and mercury. In these cases, the metals of the earths, and the common metals are revived together in alloy.

Mr. Davy referred to some very recent experiments of two Swedish chemists, M. Berzelius and Pontin, who have succeeded in obtaining amalgams of the metals of barytes and lime by exposing the moistened earths to negatively electrified mercury. Their method succeeds likewise with strontites and magnesia, but not with alumine and silex.

He mentioned likewise a most interesting experiment of the same gentlemen on ammonia, which seems fully to confirm his analysis of it, and his idea of its being an oxide with a binary base.—When quicksilver is negatively electrified in contact with solution of ammonia, a soft amalgam is formed, consisting of nitrogene, hydrogene, and mercury, which absorbs oxygene, or decomposes water with the evolution of hydrogene, and re-produces ammonia.

July 8.—In a paper read this evening, Mr. Davy stated that he had procured the metal of barytes in a pure form—that it was highly combustible, and rapidly decomposed water with the production of barytes. This he effected by distilling the amalgam of the basis and mercury; and he stated that by similar methods he had succeeded in obtaining the metals of strontites and magnesia nearly pure. The earths are mixed with red precipitate which is negatively electrified, the amalgam is absorbed by fresh mercury, and when it becomes semifluid is distilled in the vapour of naphtha in a tube of plate glass.

Mr. Davy stated his intention of entering fully, at the next meeting of the Society, into the discussion of the theoretical views connected with this new subject, and of its general relations to Nature and to Art.

The detection of a metallic substance in ammonia is a singular and most interesting fact; for it has been before proved, to the satisfaction of chemists in general, that ammonia is composed of nitrogen and hydrogen—and it follows, that either nitrogen gas, or hydrogen gas, or both, are composed of the ammoniacal metal held in a gaseous form by caloric.

A paper by Mr. Knight, on the alburnum of trees, was also read; after which the Society adjourned till Thursday the 10th of November.

WERNERIAN NATURAL HISTORY SOCIETY.

At the last meeting of the Wernerian Natural History Society (July 16), the President laid before the Society three communications from Col. George Montague, F. L S. of Knowle House, Devon. Two of these communications were read at this meeting. The first part of the first communication contained an interesting view of the natural habits and more striking external appearances of the Gannet or Soland Goose, *Pelecanus Bassanus*. The second part of this communication contained an account of the internal structure of this bird, particularly of the distribution of its air-cells, which the ingenious author showed to be admirably adapted to its mode of life, especially to its continued residence on the water, even in the most turbulent seas and during the most rigorous seasons. The second communication was the description and drawing of a new genus of *insect*, which inhabits the cellular membrane of the gannet; and to which Col. Montague gives the name of *Cellularia Bassani.*—At the same meeting, Mr. P. Neill laid before the Society a list of such fishes belonging to the four Linnean orders Apodes, Jugulares, Thoracici, and Abdominales, as he had ascertained to be natives of the waters in the neighbourhood of Edinburgh, accompanied with valuable remarks, and illustrated by specimens of some of the rarer species. Of the *Apodes* he enumerated four species, belonging to three genera: 2 to Muræna; 1 Anarhichas; and 1 Ammodytes. Of the *Jugulares* he mentioned 13 species, belonging to three genera: 1 Callionymus, the gemmeous dragonet; (for, from examining many specimens, the author had concluded that the *sordid dragonet* of Mr. Pennant and Dr. Shaw is not a distinct species, but merely the female

male of the gemmeous dragonet): 9 of the genus Gadus; and 2 Blennius. Of the *Thoracici* he stated 22 species, belonging to nine genera: 1 Gobius; 2 Cottus; 2 Zeus, the doree and the opah, (a specimen of this last most resplendent fish having been taken off Cramond in the Frith of Forth, some years ago, and being still preserved in the museum of P. Walker, esq.); 7 Pleuronectes; 1 Sparus, the toothed gilt-head, (a rare fish, of which only two specimens have occurred in the Frith of Forth); 2 Perca; 3 Gasterosteus; with 1 Trigla. Of the *Abdominales* he had ascertained 14 species, belonging to seven genera: 1 Cobitis; 4 Salmo; 3 Esox, the pike, gar-pike, and the saury or *gandanook*, (which last, though rare in England, is not, it appears, uncommon at Edinburgh, but arrives in the Frith almost every autumn in large shoals); 1 Atherina; 3 Clupea. Of the genus Cyprinus, of which no fewer than ten species inhabit the rivers and ponds of England, (including the carp, tench, gudgeon, dace, roach, bream, &c.), only one insignificant species, the author remarked, is found for many miles around the Scottish metropolis, viz. the common minow. Of the genus Scomber, the mackrel is got in the entrance of the Frith of Forth. Mr. Neill reserved the notice of the *Amphibia Nantes* of Linnæus, including the Ray and Shark tribes, to a future meeting.

XXXI. *Intelligence and Miscellaneous Articles.*

RUPTURED POOR.

The City Truss Society for the relief of the Ruptured Poor, upon a plan some time ago recommended to the public through the medium of this and other Journals, has at length assumed a regular form. The right honourable the Lord Mayor for the time being is president, and the committee for managing the affairs of the charity consists of twenty-four governors, among whom are some of the first medical characters in the metropolis. The Governors of the City Dispensary have generously permitted the affairs of the above Society to be conducted at their establishment in Grocers-Hall Court, Poultry,

Poultry, and the surgical and other officers accept of no gratuity whatever for their services. By this laudable œconomy, the whole of the funds being exclusively devoted to the relief of the objects of the charity, every contributor of a guinea annually will have an opportunity of recommending three patients during the year, each of whom will receive a truss, besides medical and surgical attendance.

Subscriptions will be received by, and plans &c. of the charity may be obtained upon application to, James Amos, esq., Devonshire-Square, Bishopsgate-Street, treasurer; John Taunton, esq., Greville-Street, Hatton-Garden, surgeon to this Institution; Mr. Bartlett, at the Finsbury Dispensary; Mr. Elliot, at the City Dispensary; and Mr. A. B. Turnbull, Bolt-Court, Fleet-Street, secretary.

In our last Number we mentioned the election of a successor to the deceased Mr. William Turnbull, late surgeon to the *Society for the Relief of the Ruptured Poor*—an older institution than the *City Truss Society*, and that Mr. Rees Price was elected. We have, by some, been understood to insinuate that that gentleman's election was not so fair as it ought to have been—because we stated that 34 of his votes were by new-made voters. We meant only to state a fact, but not as prejudicial to any individual. The election was perfectly fair; for the rules of the Institution allow new members to be made as freely before elections to office as at any other period, and the friends of the unsuccessful candidates might have been admitted, had they presented themselves.

THUNDER STORM.

Hendon, by Sunderland,
July 7, 1808.

SIR, Knowing your desire of recording every striking event appertaining to the arrangement you have adopted in your very useful Journal, I have reason to suppose that the following event, which occurred to an acquaintance of mine, and was related to me very soon after, will not be unacceptable: you may make it known in any manner you please, if you think it worthy the public attention.

I am, &c.

To Mr. Tilloch. W. R. CLANNY, M.D.

Durham,

Durham, Sunday, June 5.—The morning was cloudy, and portended a thunder storm, and about mid-day distant thunder was heard in the neighbourhood, attended by very vivid lightning. The storm gradually increased till the evening was far advanced, and the lightning became remarkably vivid, approaching very close to the earth. At nine P. M., as captain W. and Mrs. W. (at present residing in Durham) were walking on the race-ground, a flash of lightning passed between them, running along the metal buttons of captain W.'s coat; he felt a sensation, as he expressed, as if a strong electrical shock had been given to the left side, which was followed by a numbness of that side for four hours after, and next morning he felt a pain of the left shoulder. He remarked also, "that though he has been much abroad, in tropical climates, he never remembers to have seen such vivid lightning; and that he is persuaded that if he had been only half a step further advanced it would have struck him lifeless!" Mrs. W. did not feel any shock, though she was on the *left* side of captain W., and close to him when it happened.

INDIAN OR HORSE CHESNUTS.

M. de la Chabaussiere, a French agriculturist, has addressed the following hints on this subject to the Editor of one of the Foreign Journals*:

"It has been stated in several Journals, that in Saxony chesnuts are advantageously employed in feeding cows. This method is also known in the environs of Montpelier, at which place they are sold in the market, although no person has as yet noticed the fact. I have long regretted that so fine and so abundant a fruit has not been turned to more advantage.

"It has been suggested, that these chesnuts might supply the place of soap and candles, or tapers may also be made of them. In Silesia, they extract the oil from the feculum

* Bibl. Phys. Econ. May 1807.

of

of chesnuts, and use the latter for making glue: this process was described in 1794, in the *Lycée des Arts*.

"In the same country they make a kind of snuff of a black colour, and also a horse medicine, from chesnuts.

"Abbé Rozier says, in his Agricultural Dictionary, that the feculum of the chesnut mixed with other fecula will make wholesome and well-tasted bread.

"We find in the *Memoirs of the Academy of Sciences*, that M. le Bon, of Montpelier, after having taken the bitterness from chesnuts by macerating them in an alkaline ley for 24 hours, and washing them every day for ten days, boiled them for three or four hours, when they made excellent food for pigeons, and kept well for some time after being dried.

"The chesnut tree (*æsculus hippocastanum* of Linn.) is indigenous in Asia, whence it was brought in 1588 to Vienna. Bachelier brought it from Constantinople to Paris in 1615 and in 1656.

"The bark of the chesnut tree is said to be an excellent substitute for Peruvian bark.

"The name of *hippocastanum* (horse chesnut) seems to be derived from its having been used in some countries as food for horses."

ELECTRICITY.

Liverpool, July 8, 1808.

Sir, Having been in the habit of amusing myself with electrical experiments in my leisure hours, I was not a little surprised on finding the difference in shocks from a Leyden phial filled from the conductor in the common way, and those filled as follows: I stood on an insulated stool, laid one finger on the prime conductor, and filled the jar from the other; when, on receiving the shocks, I found them so considerably augmented, that two taken in this manner incommoded me more than a dozen in the common method. Not having seen this fact noticed in any publication, it may perhaps prove new to many of your readers. Of the cause of the difference I have formed no opinion, but the fact is correct, the same effect having been experienced

rienced by different gentlemen with whom I repeated the experiment. I am, &c.

To Mr. Tilloch. JAMES PHŒNIX.

Mr. GEORGE SINGER is now constructing an electrical apparatus, with a cylinder of 18 inches diameter, mounted on an improved plan; which, from experiments made with cylinders of 9 and of 15 inches diameter, promises to afford at least equal intensity and regularity of action with plate machines. A series of experiments will be shortly instituted on this apparatus, and their results communicated to the public.

LIST OF PATENTS FOR NEW INVENTIONS.

To William Henry Potter, of No. 5, Pemberton-row, Gough-square, flute maker, for certain new improvements in German flutes and other wind musical instruments. May 28.

To Joseph Willmore, of Birmingham, silver-smith, and John Tonks of the same place, plater, for a new method and processes in the manufacturing of nails. May 28.

To Robert Ransome, of Ipswich, iron-founder, for certain improvements on the wheel and swing plough. May 30.

To David Thomas, of Featherstone-buildings, gent., for a perforated vessel, percolater and frame, for making or preparing portable coffee. May 30.

To Thomas Smith the younger, of Capon Field Iron Works, near Bilston, in the county of Stafford, iron-master, for certain improvements in steam engines. June 3.

To Ralph Dodd, of Change Alley, in the city of London, engineer, for improved bridge floorings, or platforms, and fire-proof floorings, and fire-proof roofings, for extensive dwelling-houses, warehouses, and mills. June 3.

To William Shotwell, of the city of New York, in North America, now residing in the parish of St. Mary Lambeth, in the county of Surrey, gent., for certain improvements in the manufacture of mustard communicated to him by a certain foreigner residing abroad. June 14.

To

To George Tennant, of Great Ormond-street, in the county of Middlesex, gent., and Alexander Galloway, of Holborn, in the same county, machinist, for a machine or machines for cutting all sorts of fustians usually denominated constitution cord, tabby cord, shaft cord, thickset, tabby velveteen, Genoa velveteen, velveret, and every other species of fustian, velveret, and velveteen, also velvet, plush, and other cloths or goods made of cotton, silk, woollen, or any mixture thereof, usually cut in the manufacture of such articles. June 14.

To George Lowe, of Cheapside, in the city of London, cotton-spinner, for an improvement in the manufacture of a fabric composed of flax and cotton, which is applicable to many useful purposes. June 23.

To Samuel Gadd, of Shadwell, in the county of Middlesex, rope-maker, for an improvement in the art of rope-making, upon the principle of composing each strand of rope with two distinct threads twisted together; and of the arrangement of the apparatus, by which that principle is carried into effect. June 25.

To John Hall, of the town and county of the town of Kingston-upon-Hull, rope-maker, for his improvements in making and manufacturing ropes and other cordage, and coiling of lines in whale boats. June 28.

To George Pocock, of the city of Bristol, schoolmaster, for geographical slates for the construction of maps. June 28.

METEOROLOGY.

For a few days about the middle of this month (July) the heat was higher than has ever been remembered. The accounts of temperature in London are so various, owing to differences of exposure and reflected heat, that they cannot be perfectly relied upon. We therefore present the following register for the two hottest days, taken from an accurate thermometer suspended in an elevated situation at Hampstead, (four miles from London,) in the shade, about a foot distant from a brick-wall facing the north, and slightly covered with the foliage of currant bushes.

Tuesday,

Tuesday, July 12.		Wednesday, July 13.	
12 o'clock, noon	86°	8 o'clock, morning	76°
1 afternoon -	88	9 - - -	82
2 - -	89	10 - - -	88
3 - -	88¼	11 - - -	90
4 - -	87	Noon - -	91½
5 - -	84¼	1 afternoon -	92½
6 - -	83½	2 - - -	93
7 - -	81½	3 - - -	92½
8 - -	75¼	4 - - -	91
9 - -	72	5 - - -	90
10 - -	70	6 - - -	87
		7 - - -	83
		8 - - -	81
		9 - - -	79
		10 - - -	77

The sun-shine this day was sometimes interrupted by thin clouds; some wind was stirring. Barometer, 29·7.

In London the heat in the shade was about one degree higher than the above.

Cheltenham, July 19.

Sir, As the subject of meteorology comes within the plan of your periodical publication, perhaps the following statement abstracted from a register I have kept of the weather at Cheltenham for two years past, may be worth inserting in the next Number of your Philosophical Magazine.

As the weather has lately been hotter than we have experienced in Britain for some years past, and I understand the mercury rose in the thermometer above 90 in London, I beg leave to state the greatest heat and cold at Cheltenham by Fahrenheit's thermometers, placed in a northern aspect, and in the shade in the open air, where they were unexposed to the influence of hot walls. It appears the heat was for two days 17 degrees higher than in the same week of the preceding year at Cheltenham.

1808.	Greatest heat. P. M.	Greatest cold of the Night.
11th of July	78°	58°
12th	86	71
13th	86	71
14th	82	72
15th	81	76

In the evening and night of the latter date much vivid and silent lightning was succeeded by heavy rain to the amount of 1·30 inch. And at the distance of a few miles from

from Cheltenham a hail-storm did considerable damage. Since then the heat has been greatly moderated, never exceeding 78° in the shade in the hottest time of the day, nor 66° in the night.

To Mr. Tilloch. THOMAS JAMESON, M.D.

Results of the Thermometer at Manchester, in the Year 1807. *By Mr.* THOMAS HANSON, *of the Lying-in Hospital, Manchester.*

1807.	MORNING.				NOON.				EVENING.				Monthly mean	Monthly range
	Mean.	Highest.	Lowest.	Range.	Mean	Highest.	Lowest.	Range.	Mean.	Highest.	Lowest.	Range.		
Jan.	37·00	48	27	21	41·50	48	31	17	38·50	48	27	21	39·00	19
Feb.	38·75	53	25	28	43·89	57	31	26	39·02	50	27	22	40·55	25
Mar.	35·51	46	24	22	40·16	54	32	22	35 67	47	25	22	37·11	22
Apr.	44·03	61	27	37	51·16	73	38	35	45·10	64	31	33	46 76	35
May	53 61	73	41	32	59 00	82	46	36	51·51	74	43	31	54 70	33
June	56·60	65	47	18	60·86	70	48	22	55·10	63	48	15	57·52	18
July	61·54	71	55	16	67·93	78	61	17	62·12	70	54	16	63 86	16
Aug.	62·00	70	54	16	69·96	76	62	14	62·64	70	54	16	64·80	15
Sept.	49·80	65	42	23	55 53	68	45	23	49·86	63	41	22	51·73	22
Oct.	52·03	60	42	18	56·93	66	48	18	52·58	60	42	18	53·84	18
Nov.	37·10	48	25	23	40·60	52	30	22	36 90	50	19	31	38·20	24
Dec.	33·74	48	18	30	37·46	50	24	26	35·67	48	22	26	35·62	27
Annual Means	46·80	59	35	23	52·05	64	41	23	47·05	58	36	22	43·64	23

The observations were made three times a day, viz. at eight o'clock in the morning, and one and eight P. M. The annual mean of the thermometer is 48·°64. The highest degree of temperature, which was 82°, took place on the 25th of May; and the lowest was 18°, which happened on the 24th of December, being 14° below the freezing point. The range of these extremes is 64°: the mean, for the six summer months, is 56·°574, and for winter, 40·°72.

N. B. The upper part of the Table having no abbreviations, is sufficiently explicit: the bottom line gives the annual mean and range, and the means upon the extremes of high and low.

Observations on the Dew-Point.

By dew-point is to be understood that degree of the thermometer

mometer at which dew begins to be formed at the time. "The higher the point is, the greater is the quantity and force of vapour in the atmosphere; and the lower it is, with respect to the actual temperature of the atmosphere, the greater is the force of evaporation."

The dew-point may easily be found by cooling a body until dew begins to form on its surface. In the hottest summer months, fresh pump water will generally answer the purpose; but, in winter, it will require to be cooled below the temperature of the air, by means of salts; equal parts of sal ammoniac and nitre answer very well. The experiment should always be made at an open window, where there is a current of air. My observations were taken at noon.

Mar.	Mean	Dew-Point, for	28 Days,	31°	Highest	47°	Lowest	15°	Range	32°
Apr.	do.	do.	28	40	do.	54	do.	25	do.	29
May	do.	do.	28	46	do.	55	do.	30	do.	25
June	do.	do.	18	48	do.	56	do.	41	do.	15
July	do.	do.	22	54	do.	64	do.	44	do.	20
Aug.	do.	do.	19	54	do.	62	do.	48	do.	14
Sept.	do.	do.	17	47	do.	58	do.	35	do.	23
Oct.	do.	do.	15	49	do.	58	do.	41	do.	17
Nov.	do.	do.	13	36	do.	46	do.	30	do.	16
Dec.	do.	do.	17	34	do.	47	do.	21	do.	26

Results of the Wind.

N.	87	S.	18
N. E.	181	S. W.	278
E.	38	W.	119
S. E.	57	N. W.	210

Total number of observations 988.

The south west, north east, and north west winds have been the most prevalent. Mr. Dalton asserts, that the two former properly belong to the northern temperate zone, arising from the two general currents of the air tending from and towards the equator.

The following will show which of the months were the most liable to high winds: the figures denote the number of days in each month on which the highest winds were observed:—

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2	5	5	5	8	3	6	2	5	2	11	10

Communications on meteorology directed to Mr. Hanson, at the above hospital, will be thankfully received.

METEORO-

METEOROLOGICAL TABLE,

By Mr. Carey, of the Strand,

For July 1808.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
June 27	57°	65°	55°	30·10	60	Fair
28	54	57	55	·11	35	Cloudy
29	56	69	59	·18	65	Fair
30	54	69	54	·25	62	Fair
July 1	59	69	53	·12	52	Fair
2	56	65	54	·09	66	Fair
3	55	69	53	·04	76	Fair
4	56	67	54	29·93	67	Fair
5	55	64	57	·99	86	Fair
6	56	66	59	30·15	54	Cloudy
7	57	75	61	·10	88	Fair
8	62	76	63	29·99	86	Fair
9	61	70	62	30·12	37	Cloudy
10	62	74	63	·10	57	Fair
11	63	76	69	·20	70	Fair
12	72	83	76	·15	98	Fair
13	76	92	76	·02	124	Fair
14	78	90	78	·04	132	Fair
15	69	79	70	·02	62	Fair
16	68	81	68	·02	71	Fair
17	69	83	69	·05	92	Fair
18	68	81	68	·06	104	Fair
19	70	83	66	29·85	86	Fair
20	66	73	64	·82	68	Cloudy
21	66	74	61	·74	82	Fair
22	62	72	66	·79	81	Fair
23	68	76	67	·85	77	Fair
24	67	76	67	·82	71	Showery
25	68	69	59	·77	32	Stormy with Thunder
26	66	72	61	·78	61	Showery

N. B. The Barometer's height is taken at one o'clock.

XXXII. *On the Identity of Silex and Oxygen.* *By Mr.* Hume, *of Long-Acre, London.*

[Concluded from vol. xxx. p. 363.]

The solution of silex in water, by means peculiar to natural agency, is not confined altogether to hot-springs, as it has been frequently detected in other mineral waters; and in no case can its presence be ascribed to an alkali acting as a medium, because this is not always to be found, and, when it is detected, it is combined with carbonic acid, which destroys effectually the solvent power of the alkali over silex. In three mineral springs, analysed by M. Stucke, the whole contained silex*; and in a sulphureous water, which was examined by the Marquis de Brezé, a considerable portion of the same inflexible and universal material was extracted †.

A great deal of the siliceous principle exists in the warm-baths of Pozzello; for, besides the 10 grains derived from every 100 pounds of the water, there was likewise a pellicle, which formed itself upon the surface of the bath; and this, when examined, consisted of silex, carbonate of lime, and carbonate of magnesia ‡.

From the experiments of M. Volta, we are informed, that all the waters of Verona contain silex in the state of carbonate of lime or *chalk*, and, agreeably to this philosopher's opinion, this is held in solution by means of *oxygen* §. Here, I think, we may perceive that graduation of silex into lime, which I mentioned in a former paragraph, and which forms another example of the prevalence of this constant association in all native carbonates. In the same warm baths of Pozzello, which I have just noticed, there is also a quantity of carbonates; thus, each hundred grains of the pellicle consisted of 86 grains of carbonate of lime, 11 grains of the carbonate of magnesia, and only three grains of silex; seemingly, as if these carbonates had derived their saturation with the oxygenating principle, from that which had originally consisted of a much larger stock of silex. If this con-

* *Crell's Journal*, 1791.

† *Mem. de l'Acad. de Turin.*

‡ *Ann. de Chimie*, tome xii.

§ *Ann. de Chimie*, tome xii. p. 147.

version take place at all, it must be effected at some depth below the surface, rather among the dry materials themselves, and in the vicinity through which the water passes; for such, doubtless, is the action of various elements in the bowels of the earth, that, as Mr. Chenevix expresses it, "the constituent principles of many stones, exercise a true chemical attraction on each other*."

Few substances are so rare as carbon, that is, in its most simple state, the diamond; and yet, in combination with other elements, especially with silex or oxygen, what can be more copiously and universally diffused through every species of matter? The alliance of carbon and silex, and the peculiar circumstances under which the combinations frequently occur, show distinctly that this coexistence is not altogether contingent, but, rather, that it proceeds from certain immutable laws to which these two elements are conformable, and of which laws the completion of the works of Providence is the sole end. The necessity of this connexion is, every where, extremely conspicuous, and most singularly so in all organized beings, in which, by the inexplicable contrivance of assimilating functions, these two associates are sure to insinuate themselves, and in such a manner as to defy human curiosity to discover their progress or trace them from the original source.

In all the matrices, beds, or mines, which envelop the diamond, and in which this singular substance is usually discovered, the same remarkable coexistence prevails; for these are composed chiefly of ferruginous sands, gravel or other siliceous materials, which serve also to conceal from man this valuable body, in order, as it were, to enhance its price, by adding to human labour and industry. Strictly speaking, the diamond is of less real value to us than any of the metals; and if we compare it with iron, its intrinsic utility vanishes entirely, it is literally of no kind of use, and cannot supply a single want.

The frequent and uniform concurrence of these two bodies might deserve a particular investigation; it is a question,

* *Ann. de Chimie*, tome xxviii.

especially

especially in all geological inquiries, that leads directly to others of the utmost importance. It might be asked—What was the primary state of carbon? Why can we not separate it from its compounds, and, as may be done with all other simple substances, exhibit carbon in its pure state or diamond, were it even in form of powder only?

However pure common charcoal may have been obtained, it always seems perfectly dissimilar to the true diamond, so much so as to lessen greatly the supposed identity of these bodies; thus, by whatever means they are reduced to the state of a powder, the diamond is always *white* and more like powdered glass, while the charcoal is intensely *black*, in proportion to its division. Whatever be the real nature of carbon, and whether it may prove to be the basis of hydrogen, which, I believe, has been suggested by some author, I shall leave to others to decide; from what I have detailed, however, respecting its alliance with silex, I am justified in this inference at least, that the coincidence is not casual, but rather the effect of design, and, consequently, that it is essential to the perfection of every thing of a material nature, in which it is present.

It has been noticed by several authors, that the peculiar smell, which is evolved when flint or any siliceous stone gives out sparks of fire, is precisely the same to our senses, as that which succeeds the electrical excitation or the strong effects of lightning from the atmosphere. Though conclusions favourable to my theory might be deduced from this singular fact, I shall not now avail myself of the opportunity; the electric fluid is imponderous, and I wish to confine these observations to material bodies only. One remark, however, may be tolerated, and not deemed an intrusion on the present occasion, it is this; that this identity of smell stamps silex with such a degree of consequence as to assimilate it, in this quality at least, with one of the most important objects in nature, the electric fluid of the atmosphere.

From numberless phænomena that admit of no other interpretation, it may be justly inferred, that Nature possesses means of converting silex into other forms, and of so interweaving it into the constitutions of her varied works that it ceases entirely to appear in its original state. Every thing connected with the progress of animal and vegetable existence; with the inscrutable secrets of the assimilating powers; or with the physiology of all organized matter, shows, that transmutation is an operation which we cannot disprove, though we may not be able to trace it through all its steps. As far as concerns the formation of chalk from silex, the next advance, if there be any such graduation, is most probably into clay; for, we may remark, in all chalky soils, particularly in such as prevail in the counties of Kent and Sussex, and other parts of England, where the superficial stratum of soil is extremely shallow, that this stratum consists chiefly of argillaceous earth, which, like all other clays, contains a considerable quantity of silex in the condition of sand. So prevalent is this mixture of sand in clay, that there never was a specimen of porcelain clay, or of any other species whatever, that did not include a portion of siliceous matter; and the most useful clays, those employed for china and pottery in general, seldom contain less than 50 per centum of silex.

The power of silex as an oxidizing, saturating and neutralizing agent, is by no means confined to rocks, mountains, and other inanimate parts of created matter, but it pervades, also as an essential element, the structure of all organized beings, and occupies a distinguished place both in the animal and vegetable œconomy. "Nothing is more astonishing," says Dr. Smith, "than the secretion of flinty earth by plants"—and this is a fact that "is well ascertained*."

That this most dense and insoluble substance is truly secreted by the peculiar assimilating faculty of the vegetable alone, and never imbibed from the soil by direct absorption, seems certainly to be the more feasible theory; indeed it is substantiated by experiments and accords with reason and general facts.

It is truly remarkable, that in those vegetables, where silex is most abundant, the chief residence is usually in the

* *Introduction to Botany.*

epidermis

epidermis and other external parts; and, hence it is that, in the common experiment of burning a piece of charcoal in oxygen gas, the scintillating appearance will be more brilliant if the charcoal be selected with the *bark* attached to it. I am assured by a friend, who resided for some years in India, that, in this experiment, he never succeeded so well as with the charcoal procured from the bamboo, and that this produced always a most splendid combustion. Now, the bamboo is known to abound with silex, for, according to Mr. Macie's experiments, the white matter, found between each knot of this reed, proved to be true silex*. In fact, the whole tribe (arundo), and also the straw of oats, wheat, barley, and, perhaps, every vegetable similarly constructed, seem to derive their necessary strength, tenacity, and some other peculiar requisites chiefly from the silex.

Straw has been very successfully used in this country for the manufacture of paper, and though the colour of this paper remained unchanged, yet in its texture and other peculiar properties, it appeared to be little inferior to that which is generally made. The bamboo, I am informed, answers likewise for this purpose, and in some parts of India it is in constant use. This circumstance is an additional proof of the efficacy of silex in the manufacture of paper. I do not recollect that common flax, of which the best paper is principally made in this country, has yet been analyzed; by analogy one would conclude this also must contain the siliceous principle. In Mr. Davy's experiments†, the straw or stems of corn, grasses, and some other vegetables yielded a notable quantity of silex, and, what must be considered as one of its most intimate associates, there was also carbonate of potash; and from the ashes of straw, a piece of fine white transparent glass was produced, perfectly soluble in water and indecomposable by acids. The culms of the grasses appeared to Mr. D. to contain more silex and a much larger proportion of potash even than the corn. In 200 grains of the culm of wheat, which, when burned, gave 31 of ashes, this gentleman obtained 13 grains of silex and 18 of potash, which was

* *Philos. Trans.* July, 1791. † *Philos. Journ.* May, 1799.

L 3 probably

probably in the state of sub-carbonate. By burning a straw with the blue flame from the blow-pipe, beginning at one end of the straw, this was converted into a fine pellucid globule of glass, almost fit for microscopic experiments. It was also suggested, that flint in these hollow bodies might be considered as analogous to the earth of bones in animals. By giving firmness and tenacity to the vegetable structure, it may assuredly serve this purpose, but I suspect it is present for other intentions, and that it contributes to the formation of certain immediate materials in the organization.

It is, probably, from the same siliceous principle that straw forms the basis of some of the richest manures, and not on account of its carbon only; for saw-dust and many other ligneous bodies, which contain more carbon, prove to be inferior or useless. The straw of oats, particularly, is burned and the ashes are employed to polish marble, and this must consequently arise from the silex, of which about one half of the ashes chiefly consist; for according to M. Vauquelin's analysis, in 100 parts, there are 55 of silex besides other matters *.

In no case whatever does it appear that silex can be considered as a fortuitous ingredient in the œconomy of vegetable life, not even when detected in the very roots, which support the whole structure, and are, it may be said, always in the immediate contact of siliceous mixtures. Though clay is comparatively a very soluble and tractable substance, and possesses every capacity for combination with native acids, yet this has never been included as one of the immediate materials of vegetable organization. Thus, among other instances, in the analysis of the roots of two polypodii, vulgare and filix mas, there were found silex, lime, and muriate of potash, but no clay. Moreover, it is known that clay attracts carbonic acid from the atmosphere, which process is supposed to be promoted by suffering lands to remain fallow, and the clay becomes then more soluble; but this cannot take place with silex, there is no such chance for

* *Ann. de Chimie*, tome xxix. † *Ibid.* tome lv.

rendering

rendering this material either soluble or miscible, and, hence, it is more difficult to account for its presence in the vegetable system, than for that of any other solid body.

I am strongly induced to establish this as a general maxim, that wherever potash is collected or, shall we say, generated in the vegetable structure, there, by necessity, there must also be silex. All the potash of commerce contains silex, and, in whatever way it is purified, it is difficult to divest it completely of this substance; for, unless it be super-saturated by carbonic acid, or some other scientific mode pursued to purify it, potash never quits entirely this substance. This being the true situation of all native potash without exception, from whatever source it is derived, and oxygen being one of the essential principles of potash, I would say, the fair induction from such premises is this; that the invariable proximity of silex and potash renders it extremely probable, if not certain, that one is subservient to the formation of the other; and that silex being avowedly an indecomposable element, it is more reasonable to say that potash is generated from this same element, than to support the converse of the argument. Indeed this singular and uniform association can, I think, scarcely be overlooked; it seems to point directly to the source from whence the alkali obtains that constituent in its nature, the oxygen or modified silex, especially when it is allowed, that the same connexion occurs in all primordial matter whatever.

Both ancient and modern experiments prove, that by means of water as the only nourishment, with free admission of solar light and heat, and exposure to the atmosphere, vegetables may be cultivated even from germination to perfect maturity, and that they produce, by analysis, precisely the same materials peculiar to each individual plant. It is a common practice, I know, particularly on board our East Indiamen, to cultivate various kinds of herbs for salad, by sowing the seeds upon a piece of woollen cloth or common flannel; where, by no other means than pure water and exposure to the atmospheric influence, the vegetation succeeds, and in this way these herbs are supplied by succession during the whole voyage.

 In

In the experiments to which I allude, the seeds were sown in a variety of the most insoluble bodies, as sulphur, glass, leaden shot, litharge, sand and such like matters, which could not assuredly yield of themselves any nourishment, but merely to serve as the supports, to which the fibres of the roots might cling. In all these instances the plants grew and generally seemed to thrive; but whether they prospered in the same degree as plants that are raised under common circumstances, I am not disposed to affirm; it is quite sufficient for my purpose to find, that they yielded the same principles by analysis as vegetables of the same species generally contain, when cultivated in the usual way or left to nature; and that potash, silex, lime, the salts and, in short, all the products peculiar to each species were obtained. There are many very pertinent remarks upon this process by M. Braconnot, who seems to have accomplished his object with great attention and ability *. Various arguments have been offered tending to invalidate the conclusions drawn from this method of experimenting; but, all those which I have seen, amount to a mere simple denial of the facts, or to captious objections built upon unfair premises.

Contrary to a very generally adopted theory, it appears, that plants, during their vegetation, do not emit oxygen or pure air; that nitrogen is not necessary to their growth, though they very frequently exhibit it to be in their composition; that "oxygen is, by the vegetative process, converted into carbonic acid *without* entering into the vegetable system;" that neither the presence nor absence of carbonic acid causes the least difference in the health and growth of plants; and that it is always, however, necessary that oxygen should be present. It is farther remarked, "that, instead of absorbing carbonic acid from the atmosphere, plants, by their vegetation, are constantly producing it;" and that, "since carbonic acid is necessarily a product and consequence of germination, it seems absurd to consider it at the same time as an exciting principle and a cause." To these observations I may add the following question, by the same intelligent

* *Ann. de Chimie,* Fev. et Mars, 1807.

philosopher,

philosopher. "Where," says Mr. Ellis, "is there an instance, in the whole circle of existence, of a living agent not only first forming its own food, but feeding on its own excretions*?

Few circumstances occur in the œconomy of vegetables more inexplicable than the circulation and accumulation in particular receptacles of insoluble salts, and, among others, particularly that of phosphate of lime, which is very abundant in most kinds of grain, though it is chiefly situated in the seed. Though the last part formed in the whole period of growth, the seed is the proper receptacle for this solid and insoluble compound. How such a salt should pass through the whole circulation to be deposited in the most distant extremity, is truly wonderful. It may be said, by way of explanation, that, by an excess of acid, this salt becomes very soluble, and that vegetables in general contain acids. This position, however, is untenable; for these vegetables, especially oats and wheat, have a great deal of carbonate of lime or chalk in their stems, leaves, and other parts; and as the super-phosphate must pass this way before it can arrive in the grain, it is evident that this phosphate of lime could not pass with impunity but must be arrested in its progress by the carbonate.

It is not only in the composition of vegetable bodies, but even in the animal organs, silex seems to have been either disregarded or considered as a mere accidental material. It is true, that it does not occur so copiously as in the vegetable constitution, nevertheless it is assuredly necessary to the animal perfection; and if we appeal to the nature and functions of some animals, we must either confess this substance to be quite essential to the life of such animals, or give some more satisfactory reasons for its presence in their organs, and as a part of their system.

According to modern experiments, the human hair, and, I should suppose, by no very forced analogy, the hair of all animals whatever, contains silex as a constituent element. This substance may probably enter also into the composition

* *Inquiry,—on vegetation, &c.*

of

of other animal coverings, such as scales, quills, feathers, wool, and a prodigious variety of such useful appendages. For the discovery of silex in human hair we are indebted to the industry and sagacity of M. Vauquelin; and from that gentleman's labours we learn, that besides a notable portion of silex in hair, there are many other ingredients; thus, he shows sulphur, iron, carbon, lime, phosphorus, manganese, oxygen, hydrogen, and nitrogen, as the associates of silex in the hair, of which he analyzed several specimens *. The manner in which this substance is assimilated and deposited, and whence it originates, are certainly important questions; for, here silex seems to have preferred the most inaccessible situation of the whole human frame, as if it would shun detection. If it is, therefore, in the constitution of hair, we must be compelled to admit that it circulates in our fluids; I believe, however, there is at least one strong objection against this conclusion, which on the present occasion it is unnecessary to mention.

Silex undoubtedly forms a part of our food, but how it is afterwards disposed of, remains still a secret; it also enters into the system as well as into the food of every animal, I believe, with no exception, and there are examples, in some animals, where it evidently performs very important offices. It is worthy of notice that the excrements of animals are generally composed with some of this substance as a principle, particularly those of horses and sheep; and, we may farther remark, these secretions are always of an acid nature. It is, possibly, on account of this property that the dung of pigeons has been found to be an excellent manure for vines, for it contains a large quantity of silex.

The stomachs of animals in general secrete an acid or gastric juice, and the elastic membrane that lines the gizzard of the domestic fowl and, indeed, of all granivorous birds, is so acid that it very effectually coagulates milk. Even when dried and powdered, if this be macerated in water till the acid is abstracted, the solution will readily turn milk and redden blue vegetable colours. Here, I should think,

* *Ann. de Chimie*, Avril, 1806.

there

there is a fair claim upon the silex as the origin of this acidified or oxygenated fluid, since this acid was created in the very cell and immediate vicinity where silex never fails to reside.

There is commonly a large quantity of siliceous stones, sand, and small gravel in the gizzards of birds; in some it is in minute grains, and in others, such as ducks, geese, turkeys, and other domestic poultry, it is considerable both in size and quantity, according to the nature and peculiar habits of each species. I have taken pieces of silex, from the gizzard of a goose, some of which weighed thirty grains, and the whole contents of the gizzard were pure siliceous matter, quite insoluble in diluted muriatic acid, and these stones exceeded one ounce in weight.

I have occasionally seen gizzards quite empty, and at other times I have met with them completely crammed. It is absurd to say these insoluble stones are for the purpose of grinding the food, and I believe no other reason has ever been advanced to account for this extraordinary accumulation.

It has been proved, that, independently of this silex in the gizzard, birds discharge more solid matter than the amount of their food; that their feathers grow very rapidly, and, whatever the species of the food be, these are always of the same nature; likewise, that the chalk or carbonate of lime of the egg-shell, together with what is found of the same chalky substance in the excrements, exceeds in weight the whole of the lime contained in the oats, with which the animal was nourished for this experiment.

As there is a considerable difficulty in accounting for some most curious phænomena respecting the physiology of birds, in which the formation of *lime* is effected, this silex of the oats or food, together with what is contained in the gizzard, must, I should think, be the only source from whence the newly created substance, the egg-shell, can be derived. It is also to be noticed, that, in these experiments, the food contained no *carbonate* of lime, it is the phosphate of lime of which oats are composed; and, respecting the egg-shell, nearly nine-tenths of its weight are carbonate of lime. "Are

we

we to conclude," says M. Vauquelin, the author of these experiments, "that it is the silex which has served to furnish this excess of lime? For this purpose it would be necessary that it should absorb nearly five times its weight of some unknown principle*."

But it is not merely carbonate of lime that is generated in this case at the expense of silex, there is also a quantity of phosphoric *acid;* for a larger quantity of the phosphate of lime is voided with the excrements than can be derived from the oats, and yet there is *less* silex.

The case is indeed so evident that, to me at least, there appears no objection to the conclusions drawn by M. Vauquelin from his experiments. These I shall endeavour to give in his own terms; and, that they may be more generally known, I shall endeavour to translate the substance of them into English.

"If the experiments are exact, if they do not include some circumstances not accounted for, we are forced to draw the following conclusions: 1st. That a portion of lime has been formed from the oats by the act of digestion and animalization; 2d, that a quantity of phosphoric acid has also been generated; 3d, that a certain quantity of carbonate of lime has likewise been created. There was less silex discharged than the oats contained, consequently some of this body had either disappeared or put on some other form."—

"Be it as it may, it is not less certain that a considerable amount of lime, as well in the state of carbonate as in that of phosphate, has formed itself in the organs of the hen, and that a quantity of silex has *disappeared.* Though these conclusions be still not very certain, the results of the experiments on which they are founded deserve, nevertheless, a high degree of credit; and if new efforts, often repeated, should be conformable to these, we must be compelled to acknowledge from them, that, during the digestion of the hen, *silex is converted into lime.*"

It were superfluous to expatiate upon every case in which

* *Ann. de Chimie,* tome xxix.

silex

silex as oxygen is concerned, either in geological inquiries or in the numerous examples that abound in the animal or vegetable œconomy; but, fearing I may have already trespassed upon the patience of your readers, I shall, for the present at least, quit this subject, with the full assurance, that the extensive influence of silex, its magnitude, ubiquity and importance, its uniform intrusion into organized bodies, where earths and more soluble matters are denied—that, from these and other considerations, this question will be indulged with an open and impartial reception by all who may peruse these remarks.

In the course of this discussion, which I have endeavoured, as much as possible, to epitomize, I have occasionally shown, that I have some reliance on *geological* proofs for support. These, however, are so intimately connected with facts and reasoning which must depend upon mineralogy, metallurgy and all other branches of chemical knowledge, that I did not deem it requisite to consider these separately; and, therefore, as I do not rest my opinion upon the merits of any solitary fact, I shall claim every latitude that the science of geology, in this acceptation of the term, can comprehend.

There are few subjects in which speculation and hypothetical reasoning have been more freely indulged, and the most opposite and even extravagant theories defended, than in geology; it must be confessed, however, that no science has a fairer claim on the most liberal and dispassionate reasoning. Indeed, while the mysteries of nature are at such an awful and inaccessible distance, human curiosity will ever be on the stretch; and, in all difficulties, the mind will surmise what is most plausible rather than abandon the pursuit, so that no phænomenon is ever rejected without some explanation.

The real history even of the present state of the globe, and "of the various relations which the different constituent masses bear to each other," is, it may be said, still in its infancy. For, alas! to what depth has the utmost industry of man been hitherto able to penetrate into this huge solidity of inorganized substance? How far has he yet advanced in exploring the contents of our sphere, whose diameter may be be called eight thousand miles? And, it may also be asked, what progress has been made in examining the more obvious and cognizable portion, the mere external shell? The bare idea of the task plunges our little efforts into pure insignificance, and compels us to confess, that, in these and all similar controversies there is ample scope for mutual and conciliating allowances among disputants; and, while we must acknowledge that no theory should be implicitly accepted, we must subscribe to the other axiom, that none should be hastily condemned or refused without a candid and reasonable investigation.

I remain, sir, with much esteem,
your obedient servant,
Jos. Hume.

Long-Acre,
July 18, 1808.

XXXIII. *Observations on the Sulphurous Acid. By M.* Planche. *Read to the Pharmaceutical Society of Paris**.

M. Berthollet, in two excellent memoirs read to the Academy of Sciences in 1782 and 1789, has detailed several remarkable properties of the sulphurous acid.

Messrs. Fourcroy and Vauquelin have presented to the Institute a much more comprehensive memoir upon the same subject, and which exhibits the most complete history of this acid, and of its different combinations. I have meditated with much attention upon the labours of these learned chemists, and have found nothing in the whole series of their experiments which had any connexion with what I am about to mention: I mean the changes which the gaseous or liquid sulphurous acid produces in the syrup of violets reddened by different acids, and *vice versâ*.

I think myself the more bound to publish this new property of the sulphurous acid, as it may furnish an interesting subject of reflection upon the theory of acids in general.

Preliminary Observations.

The sulphurous acid which I employed in my experiments

* From *Annales de Chimie*, tom. lx. p. 253.

was

was prepared by the decomposition of very pure sulphuric acid upon equally pure mercury. With respect to the manual operation, I followed that which was pointed out by M. Berthollet.

My violet syrup was a very fine blue, without mixture.

First Experiment.—Syrup of violets diluted with eight parts of distilled water, and coloured red by the nitric, muriatic, sulphuric, phosphoric, or acetic acids, resumes, upon the addition of liquid sulphurous acid, its blue colour, a little less intense, to be sure, than before its change into red; but without any mixture of this last colour.

Second Experiment.—The above acids, added gradually to the blue liquor, instantly restore its primitive red colour, the acetic acid excepted, the action of which is some minutes slower, and it must be added in a larger quantity.

Third Experiment.—Syrup of violets diluted with a similar quantity of water, and coloured red by the oxalic, citric, tartarous, and acetous acids, also becomes blue upon adding some drops of liquid sulphurous acid; but these acids present, in their subsequent employment, some peculiar properties, which I shall detail:

1st. The oxalic acid, in a small quantity, produces no change at first: we must add a considerable quantity, in order to give the liquor a violet hue, and it is some hours before it resumes its red colour.

2d. The tartarous, citric, and acetous acids, mixed in any proportion with the blue liquor, cannot make it become red again, even after being 12 hours exposed to the air.

3d. In these three experiments the blue colour gradually decreased; which shows that the sulphurous acid continues to enjoy its property of discharging colours, notwithstanding the superabundance of the other acids. All these trials were made in earthen vessels, and exposed to the air; but it became necessary to ascertain if this agent had any influence in the colouring of the different mixtures: this is the reason why I repeated the same experiments in glass bottles well closed, and operating as hastily as possible.

Fourth Experiment.—Experiments in close Bottles. I distributed in nine glass bottles, furnished with ground stoppers,

pers, some syrup of violets diluted in water, in the proportions mentioned above, and reddened by the same acids. I poured drop by drop into each flask, liquid sulphurous acid, in a sufficient quantity to restore the blue colour; but before adding a second drop of this acid, I took care to shake the mixture strongly, and to observe the change in its colour: this operation was performed upon the nine flasks successively; and the latter being corked, I allowed the whole to rest for six hours. I observed, that during this time the blue colour had become weaker, without any shade of red having altered it.

It was now necessary to examine if all the acids employed in the preceding experiments had also the faculty of reddening the syrup of violets rendered blue by the sulphurous acid. The following is the result of my experiments:

Fifth Experiment.—With the nitric, muriatic, sulphuric, and phosphoric acids, the blue liquor became a wine red.

With the acetous acid it became a clear violet colour.

With the oxalic acid, a pale red.

With the tartarous, citric, and acetous acids, mixed in a very large dose, no shade of red, nor any weakening of the blue colour.

Sixth Experiment.—Sulphurous acid gas and syrup of violets diluted in water, and coloured red by different acids.—We know that the sulphurous acid in the state of gas has much more energy than in the liquid state.

I was anxious to verify this fact, by an experiment upon syrup of violets coloured red by the acids above mentioned. For this purpose, I arranged the apparatus as if to prepare the sulphurous acid. As soon as the second flask, filled two thirds with distilled water, was saturated, I established a communication between it and a third flask filled with a mixture of water and syrup of violets, or reddened by sulphuric acid: a few bubbles of acid gas were sufficient for giving the liquor its blue colour. I replaced this flask by another, equally filled with syrup of violets diluted with water, but reddened by another acid, and so on successively until the whole mixtures reddened by the acids mentioned in the first experiment had been submitted to the action of the

the gas. I did not remark any perceptible difference between them; it appeared, however, as if the colour was less weakened with the sulphurous acid gas than with the liquid sulphurous acid.

Besides, this slight difference might perhaps be owing to the greater quantity of coloured liquor employed in the latter experiments, and to the facility of observing the effects of the gas, and to that of directing its action at pleasure.

For the present I confine myself to a simple detail of facts, and I have reason to think it correct.

The same experiments repeated with sulphurous acid, obtained either by the intermedium of charcoal or by that of sugar, furnished similar results.

XXXIV. *On Malting.* *By* JOHN CARR, *Esq.*

[Continued from p. 102.]

AT every place, and in most of the houses, I conversed with the common workmen, and endeavoured to collect from them their practice and ideas of malting. Many of them were old and intelligent men, and had worked in malt-houses all their time. They declared, they had never used themselves, or seen others use any water upon the floors; and they all believed it could not be employed there without injury. When asked, why they worked the young floors so cool? they said, to prevent the corn from sweating out the cistern water, and to keep the floors back, (meaning the vegetation.) When interrogated why it was necessary to keep back the vegetation at first? they replied, if it was allowed to go on too quick at first, it would both sweat out the moisture and drive out a long tail (root). And when questioned as to what injury would result from a long root? their reply was, it would run the inside of the corn out, and make light malt. These were the actual expressions of many, and the ideas of all; their opinions of the acrospire were also very similar. Most of them signified that they wished to get it no farther than over the back of the corn, meaning the thickest part of the barley, and none were desirous of carrying it more than three-fourths up. All of them maintained that the barley might be perfectly malted beyond the acrospire, and that driving it up to, or beyond the end of the grain would spend the inside, and make the malt less productive.

My enquiry was not limited to the common workmen, for I endeavoured to select and converse with many of the most intelligent and best informed masters; and I met with several who afforded much useful information. Some of them had worked many years themselves, and their malt was in the highest repute in the markets; their account of the process of malting was to the following effect: That the cistern water was amply sufficient when the working was properly conducted, for the malting of every variety of barleys. That they had malted barleys from every kind of light and heavy soils, and from almost every country, even as far as Scotland on the one hand, and Devonshire on the other; and they considered it as entirely groundless to imagine that there did any where exist a kind of barley which required watering on the floors more than the Hertfordshire. Their ideas were the contrary; for the more inferior the barley was, the more readily it would spend itself by running out in a quick vegetation; and the less there was of the original substance, the less of it could be spared in the process of malting it; whereas their own large plump corn would, if the thing were necessary, stand watering on the floors beyond any other kind, less bold and abundant in body. Nevertheless, though the fact really was that their own large grain would stand watering better than any other of an inferior quality, they were well convinced, that were they to practise watering, their malts would be light, and much inferior to those which they now make without watering; and they considered it as a case almost self-evident, that if their own full-sized barleys could be well and even best malted without watering, the malting of all other inferior kinds might be still easier accomplished in the same way.

They were all of opinion, that weight is the best criterion of good malt, when the grain is perfectly malted, and this was now so well known in the market, that weight and tenderness

derness were the only qualities in estimation there, and their own malts preserved their superior prices entirely from these characters. In the working process they knew that both the root and acrospire consumed the substance of the barley, and that the only mode of preserving weight in malt, was by preventing these from proceeding any farther than was consistent with the malting of the barley; and that this could not be accomplished if the floors were watered, from the too powerful vegetation which it promotes. Some of them had been down in the lower parts of Suffolk, and in other places where watering is practised, and had observed there, that the custom of watering resulted from improperly allowing the young floors to heat, in order to forward the private views of the maltsters; and the consequence was that much more root and a longer acrospire were driven out in these than in the Hertfordshire malts, and the former were, on that account, for the most part lighter than the latter, by twenty pounds in four bushels.

I also met with several intelligent common brewers, who were likewise considerable maltsters, and who declared, that their experience in brewing had confirmed to them that upwards of half a barrel of wort of equal quality could be drawn from a quarter of unwatered malt more than from malt which had been watered on the floors. They related many other interesting particulars, all directly in favour of malt made without watering; and they declared their opinions, both as brewers and maltsters, not only to be decidedly in preference of such malts, but also that every variety of barleys might be readily and best malted without any sprinkling upon the floor.

In my progress through the country I visited the breweries, and examined the ales and goods in the mash tuns, and more especially the grains, which were thin transparent husks, and more perfectly spent than I ever recollect seeing before. The usual lengths were three barrels and a half to a quarter of malt, and this I know to be upwards of half a barrel more than the brewers in Manchester draw from their malts, and the ales of the latter I also think inferior.

In the course of my journey I met with only two houses where any brown malt was making, and at one of these only two steepings were in operation. At another place a little amber malt was in process, and these were the only porter malts (except the pale) which occurred to notice in the whole enquiry. In truth there cannot prevail a more erroneous opinion than that which the agents of the watering party endeavoured to inculcate, and apparently with much success, in the committee of enquiry into malting, that the Hertfordshire malts are manufactured with an exclusive view to the brewing of porter, and are, on that account, unfit for the brewing of country ales. Very little porter indeed (I found it only at one house) is drunk in any of the places which I visited; and the ales are all brewed from the same pale malts which are sent in such abundance to the London market.

The vast mass of pale malt which I saw in operation is perfectly well adapted for the brewing of every species of the best ales that are or can be made in any part of the kingdom; and I humbly think that its superior weight, price, and quantity of wort drawn from it, all demonstrate that it really is the best and most productive malt made in the kingdom; and sure I am that all its superiority results from the mode of its manufacture.

Much the greater part of this malt is made from barleys purchased in London, and brought thither from various and distant parts of the country. I specially examined the barleys at most of the houses, and found them of all varieties and qualities. Very little regard was paid as to keeping the light and heavy land barleys apart, provided they were nearly of the same size, but small and light corn was separated from the large and stronger grain.

After returning to London from the north, I again set out into Surrey and the country west of London, where I found the practice of watering the corn upon the floors very general. I visited in all about 60 malt houses of this description. At some the steepings were made at every third, and at others every fourth day. From four to six floors were depending at each house, and the steepings were dried off a third part at a time. For the first three days after the barley is thrown out of the cistern it is kept sixteen or eighteen inches deep, and in that time sweats very much from the heat which is allowed to accumulate in it, and when the root is quite out it is thrown abroad as a floor. The root runs out straight, and I generally found it on the fourth day as long, and in many instances longer, than it was in Hertfordshire on the eighth day. After much of the cistern water had been thus sweated to the outside of the corn, and the latter had been spread out very thin, a great part of it was carried off by evaporation, insomuch that, on the ninth day, the root which was so forward on the fourth, was gone back in its vegetation, and in many instances become flaccid and brown; and it would certainly have been impracticable to carry such grain forwards to the kiln in a proper state of malting without watering it; and this accordingly was done as soon as the legal period of restriction was expired. The operation as I saw it performed was done at three separate sprinklings, turning over the corn each time, and then leaving it undisturbed from twelve to eighteen hours, according to the weather; in some cases the operation is repeated, and in others not. The water thus thrown upon the grain generally drives out a second root, not from the same aperture as the old one, but by the side of it, and this blows out the end of the corn, and makes an increase in the measure of the malt; and so very material is this considered, that the workmen, in turning the floors, tumble about the wet corn in a way purposely to beat off the old root, and in many cases I was assured they employ a besom to sweep it off.

To obtain this increase of measure is, most certainly, one of the objects of watering the floors. Before the wet corn can be brought forward to the kiln, most of the water given it on the floor must again be worked out of it, because if it is laid upon the kiln too moist it will shrink in too much, and thereby disappoint the maltster of one of the objects which he had in view, the increase of measure in the bushel; and the circumstance of being obliged again to work the water out of the grain, keeps it several days longer from the kiln than would otherwise happen, but yet it is very far from being so dry and floury when brought to the kiln as the Hertfordshire malt.

The same object, that of an increase of measure, also occasions the acrospire being driven quite up to the end of the grain, and very frequently much beyond it. The longer it is suffered to grow the more it distends the body of the corn, and of course increases the bulk of the malt. In several of the old floors which I examined I found the acrospire driven an inch out of the grain, and so unequal was the vegetation in many of the same steepings, that the acrospire was of all lengths, from upwards of an inch out down into the body of the grain. In many floors too the corn was run together in hard bunchy knots, by the fibres of the root growing and strongly matting together. This originated on the water given on the floors puddling in holes, and the corn there getting a larger proportion. All this mischievous inequality of vegetation arose entirely from the water given on the floors, and it is more or less inseparable from the practice. Nothing similar appeared on any of the Hertfordshire floors, and I also observed that many of the old watered floors were mouldy, much beyond any which I saw in Hertfordshire. It is called in the west finnery, appearing to be very common in those maltings, and it was said, by some, to be occasioned by the floors not being watered more early. But this was rather an excuse than an explanation, for it very evidently results from the wet corn heating, and being afterwards excluded too long from the influence of the atmosphere.

Exclusive of the double root which I have mentioned, and which cannot fail greatly to exhaust the corn, I paid particular attention to the quantity of root which appeared on the grain in most of the floors, and it certainly was not less than double the quantity which I had observed in the Hertfordshire floors, and this I consider as one of the chief causes of the lightness and inferiority of the malt.

In the west, as in Hertfordshire, I entered into conversation with the common workmen, and endeavoured to draw from them information on the subject of their employment. Most of them maintained that watering on the floors was beneficial,

beneficial, but when interrogated as to wherein the benefit consisted, the conclusion almost invariably was, that it was better for their masters, meaning that it produced an increase of measure. Some of them even admitted that they knew of no other purpose it answered, and others could only say that along with an increase it also improved the husk of the malt, by making it brighter. There was not one, however, who contended that watering made better malt for a brewer, and, almost every individual of them, allowed that it threw out more root, and on that account made light malt.

I also enquired of and waited upon several of the most intelligent maltsters, to learn what they had to say upon the subject of watering. Some of them said they had made malt without watering, but that when so made, it measured less than the original barley, and the trade was this season so bad, that without an increase of measure there would be no profit; they all contended for this increase of measure, and one of the principal maltsters declared he had made good malt with an increase of two bushels in twenty, but certainly the epithet can apply to such malt in no other way than good for sale. The same gentleman declared he was making his malt this season without watering, but the condition in which I found his corn on the floor evidently disproved this assertion. The reason he gave for not now watering was, that he made chiefly for a considerable brewer, who insisted on the grain not being watered; and the brewer's reason for this was said to be, that watering so late as the tenth day made the malt finnery (mouldy), and injured the flavour of his ale. It is, however, easy to imagine that the true reason of the brewer was, that watering impoverished the malt.

The maltsters all complained of being greatly undersold by what is called ship malt upon the coast, and said they had heard of many sales below the value of the barley and duty, and they acknowledged that such malt was of a wretched quality (the expression was "as light as straw"); and that the injury it received in malting, and the frauds which occasioned its being sold so low, could only originate in the abuse of watering profusely on the floors. I met with no maltsters who ventured to maintain, that watering on the floors made malt better for the brewers; but on the contrary I found brewers who were making their own malt without watering it, and precisely similar to the Hertfordshire malt. There were also a few other houses working in the Hertfordshire way without watering, though the maltsters contended for the practice, but alleged, that as they could not water so early as they wished, and watering so late as the tenth day, injured the malt, they had left it off altogether.

I found the malt-houses very large, roomy, and spacious, beyond any I had seen before, and incomparably more so than the houses in Hertfordshire; but notwithstanding their superior size, they were kept much darker and closer from the external air than the latter, and this circumstance I consider as very injudicious, and as one of the causes operating to produce their finnery or mouldy malt, several of the old floors were far more decayed than any I met with in Hertfordshire.

In the latter place the chief object in the manufacture of malt is weight; in the west it is an increase of measure, and this was said to be from one or two bushels in twenty.

The prices of malt in Hertfordshire, were from four pounds to guineas per quarter, in the west they were said to be from seventy-four to seventy-eight shillings; it is therefore evident that the profits on their light inferior malts are at least equal to those on the best made Hertfordshire malt, notwithstanding the apparent difference in the respective prices, and this without considering any advantage from fraud or otherwise. It is admitted on all hands that in unwatered malt there is a loss of measure, the malt not yielding the same quantity as the barley. I also understood that at many of the houses which I visited the frauds of short wetting had been very extensively practised, and numerous detections and prosecutions had been had thereon, and it is impossible to doubt that these frauds have been and still are looked up to as a source of very productive emolument, exclusively annexed to the watering system. In fact, notwithstanding the preference given in the market to the Hertfordshire

fordshire malts, they urge no complaint against that quarter, or appear to consider the maltsters there as at all their rivals; but they speak of being greatly injured by what they call the low country and coast maltsters; and they all admit that the inferior priced malts made there can only arise from fraud and watering, admitting, certainly, that their own frauds have been suppressed while the others are still going on.

Having thus had opportunities of personally examining the two different modes of manufacturing malt, I can now speak more confidently on the practical merits of each. In Hertfordshire they are endeavouring to preserve all the substance they possibly can in the malt for the purpose of obtaining weight, whereas in the west they are purposely driving the substance out of the grain, in order to blow up the bulk of the malt. Both objects admit of different degrees of abuse. In Hertfordshire I could observe that some of the maltsters were taking their malt too early to the kiln, and were drying it there less perfectly than it ought in both cases to promote its weight. In the west, besides wasting the corn by running out a second root, the acrospire was allowed to shoot up out of the grain, in order that it might spread over the back and increase the measure. It is also material to remark, that the lighter the malt is, the less it will press down in the bushel, and thereby measure the more. The Hertfordshire abuse has its limits, and can never extend to any mischievous length without defeating itself, but the watering abuse supports itself by the emolument rising in a nearly proportionate ratio.

Of the relative values of the respective malts it would be simple to make a question; it is even decided by the very principles upon which the two parties proceed: the one labours to preserve the substance of the malt, the other purposely to dissipate it. The emolument of the former hangs on the specific gravity of the commodity, and that of the latter on its levity.

The practice of watering upon the floors, I humbly presume, has never had or can have any other object in view than that of the individual interest of the maltster, and as the sacrifice which he makes in the light and impoverished article

cle which he manufactures, is a loss that falls wholly on the consumer, and he, very generally in the country, knows but little of the injury which has been done; all the advantage, without any share in the loss, rests with the manufacturer.

The numerous detections of the frauds of short wetting sufficiently establish their extent; and the great quantities of low priced malts that are still brought to market, prove that these frauds are yet in operation; and indeed, to any one conversant with the revenue, it is easy to imagine that this must be the case, for it is well known that excise traders, who have once shared in the large emoluments of a considerable fraud, will not, even by numerous prosecutions, be driven from the practice while they are left in possession of the same means. It is on this account that so many successive improvements are necessary in the revenue laws; as new frauds are developed, new legal regulations are become expedient, to deprive the unfair trader of his nefarious means; and this I humbly think is the only effectual mode of suppressing the gigantic frauds of short wetting at malt-houses.

That the present legal restriction against watering scarcely operates at all in protection of the revenue, and but very feebly in aid of the commodity, cannot, I humbly conceive, be doubted. That material fact, that all fraudulently short wet corn assumes a false age, viz. that of the preceding steeping, as soon as it is laid upon the floor, and that the regulation of such false age is very much within the power of the maltster, fully proves that such fraudulent corn can be timely watered under the present restriction, almost with impunity; and the general practice of watering, which is still so much pursued, also shows that the quality of the malt is not at present within the limits of legal protection.

The former restriction of twelve days was much more effectual for both purposes, and certainly afforded all the accommodation that a fair and honourable investigation of the case can discover to be necessary; and to sum up the whole: although that branch of the subject which includes fraud on the revenue be of itself of sufficient magnitude to demand

strong

strong legal interference in the process of malting, yet in my humble judgment, that most improvident waste of the commodity and mischievous injury to the community, which certainly do result from the practice of watering malt upon the floors, furnish out a case of national grievance, equally deserving the consideration of the legislature.

Excise-Office, London,
March 3, 1807.

XXXV. *An improved Method of making Muffles for Chemical Purposes.* By Mr. EDMUND TURRELL*.

MY LORDS AND GENTLEMEN,

HAVING experienced much inconvenience in the common mode of moulding muffles on wooden blocks, for the use of chemists, enamellers, &c. I beg leave to lay before your praise-worthy Society, an improved method, possessing the following advantages: namely,

First, By this new method of moulding muffles, coarser and cheaper materials may be used than can be employed in the common mode; and which also gives them the valuable property of resisting a greater degree of heat.

Secondly, That much time will be saved by this improved method of manufacturing them, must be allowed, when the two modes are compared.

Thirdly, The certainty of making them without cracks or flaws, and with coarser materials, will appear obvious, when it is considered, that by this improved method, they are *internally* moulded instead of *externally*; by which means the strength of the operator may have its full effect, in firmly compressing the composition into the mould.

Whereas, in the old mode, the workman, after having spread the composition upon a cloth, guessing at its thickness, bends it over the block in the best way he can, and by thus disturbing the composition, he must needs make many

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,* for 1807.——Ten guineas were voted for this communication.

cracks

cracks and flaws, which can be but imperfectly closed in smoothing the surface of the muffle, whilst upon the block; the evil consequence attending which is, its being subject to fly or crack when exposed to a great heat; and it will also be plainly seen, that, in the old mode, a great disadvantage is felt by the sides of the muffle, whilst in its wet state, hanging from its centre, and which also tends to crack it, as there can be nothing applied to assist it in this case, but by employing a greater proportion of cohesive clay in the composition, which, however, produces little if any advantage; whereas in the mode which I have invented, this fault is entirely obviated, and the composition, by its contraction in drying, assists the extrication of the muffle from the mould.

Fourthly, With respect to simplicity, this new mode will be found to possess a very great advantage, for a boy of twelve years of age may be taught to make them in a very short time.

The fifth advantage in this improvement, and of equal consideration, is the cheapness of the article; the price of which has been reduced nearly one-third to the consumer; and when the superior quality of them is taken into consideration, it may fairly be said to be full one-half. I mean, when regard is had to their superior quality; and that the muffles may be used over again when broken and ground, with a much less proportion of cohesive clay than in the old mode; and this I conceive to be no inconsiderable advantage; for it is well known, that when the old muffles or broken crucibles can be used without much fresh clay, they are far superior to new materials.

Sixthly, The muffles made in the old way are seldom of equal thickness; whereas those made according to the method which I have the honour to present before the Society, will be found to possess that necessary quality in perfection; for, if an hundred are made from the same mould, they will be all of the same thickness.

Description of the Moulds and Implements.

The first mould for this purpose is a tin one, Fig. 1, (Plate

(Plate V.) which may be made from a piece of tin the size of the arch, being bent so as to form such a concavity as may best suit the purpose to which it is to be applied; this being done, two square pieces of tin, *a a*, must have an arch cut out of them, of such a size that the diameter thereof may be about three-fourths of an inch less than the diameter of the concave piece before stated; these being soldered to each end of the first-mentioned piece, will form a stand for the hollow part of the mould, and the thickness of the muffle moulded in this will be exactly determined by the edge at each end. A piece of hollow tin, *b b*, may be soldered along the top edge of the mould, to form a better resistance to the great pressure within. The next part of this mould is a flat piece of tin, Fig. 2, cut exactly to fit the inside of the mould, the use of which is, to form a solid back to the muffles used for chemical purposes.

The second tool for this purpose is a piece of sheet brass, Fig. 3, about six inches long and one broad, which being bent in a semicircular form, and screwed to a piece of wood extending beyond its breadth about an inch, is used for cutting the small air holes *c* (Fig. 11), in the aforesaid muffles.

The third is the tool or frame, Fig. 4, for preventing the contraction of the muffles in drying, which is made of four pieces of beech, about three quarters of an inch broad, and half an inch thick; the length must be adjusted to the mould of the muffle; two of these being laid parallel within the inside of the mould, and being joined across by the other two, the ends of which should extend so far beyond the outer edges of the other two, that they may rest upon the edges of the muffle mould, and thereby prevent its falling into the mould.

The fourth is the tool for spreading the composition into the moulds, which is formed of iron or steel, (Fig. 5), about thirteen inches in length, one inch and a half broad, and about one-eighth thick; its face under *h* being rounded in such a manner that its curve may exactly fit the inner curve of the muffle mould (Fig. 6, is a section of it); this should likewise have a point or tongue, extending from each end,

end, long enough to be bent in the form of a bricklayer's trowel, and by the wooden handles which must be put on, hanging down, it will be found, that, as it is moved either backwards or forwards, it will always present an edge to smooth the composition, and condense it in the mould.

The fifth is a frame (*d d*), Fig. 15, of which the bottom and farthest side only are shown, and in which frame the tin mould, Fig. 1, is placed, simply constructed by joining two pieces of wood, the one as broad as the bottom of the muffle mould, and having two narrow groves (*e e*), cut in it, so that the edges of the tin mould may be confined therein; the other board being joined to this, at its edge, should come up so high as just to be under the edge of the mould.

The sixth is the tool for cutting the muffles of different lengths (Fig. 7), and is made of a piece of wood, to the end of which is fixed a thin piece of brass (*f*), which extending about one inch and one-fourth beyond the top of the wood, is bent at right angles, and made thinner at the end, that it may the more conveniently cut the muflle; under this piece of wood is used another straight piece (*g*), with two steady pins, which being shifted at the will of the workman, will cut them of any length.

The seventh is the mould for forming the bottom of the close muffle (Fig. 8), which is made of a mahogany or oak plank, about sixteen inches long, ten wide, and about three-eighths of an inch thick; upon this is fixed a ledge on each side. one inch broad, and nearly half an inch thick, and at each end a ledge of the same kind is placed, at such a distance as is best suited to the length of the bottom required. Fig. 9 and 10, are circular moulds for muffle bottoms of dial plates. Fig. 11, a complete muffle standing on its bottom. Fig. 12, a roller for rolling the composition in the first mould. Fig. 13, a tool for making small holes in the muffle.

The usual composition for making muffles is as follows: viz. two parts pipe clay and one part sand, such as is used by the bricklayers, sifted, and mixed together to a proper consistence;

consistence; this is very expensive, on account of the high price of pipe clay, which is about ten shillings the hundred weight, whereas I employ in my improved mode of making them the coarser kind of Stourbridge clay, which can be had at the glass-houses, in the ground state, for six shillings the hundred weight, and this I sift also, to separate the finer part, which I employ for making other smaller articles necessary in my business; using only the grosser or coarser part for muffles, to which I add one-eighth part only of pipe clay, mixing them well together with water, so as to form a mass of a pretty thick consistence. The tin mould being first greased, I place it in the frame Fig. 15, shown under Fig. 1, and having spread the composition in the mould, and smoothed it with the spreader, Fig. 5, till the mould is quite full, the flat piece of tin is then to be well greased, and thrust in at one end of the mould, and the back of the muffle is then formed by spreading the composition, and firmly pressing it against the part already formed. The next thing to be done is to cut the holes in the sides of the muffle, which is done by pressing the semicircular cutter, Fig. 3, into the sides thereof, while it is yet wet, and bringing the piece out entire: the tin mould must now have the frame, Fig. 4, put in to keep the sides of the muffle from contracting, and being set up end-ways, and a little inclined, it must be dried in the sun, until it has shrunk sufficiently to leave the mould, after which it must be completely dried and burned in the usual manner.

The composition of the smaller implements, or muffle bottoms for dial plates, for the mould Figs. 9 and 10, is made of the finer part of the Stourbridge clay, with a small proportion of pipe clay.

The rings are made from two parts of Dutch black lead pots, powdered, and one part of pipe clay. I have made repeated trials of English black lead, in various states, as a substitute for the Dutch black lead pots, but without finding it to answer properly.

Should any difficulty appear in any part of my process, I shall be happy in attending the committees, and performing the whole operation before them, whenever they shall

shall be pleased to appoint; when the great simplicity and advantage will appear evident.

I am, my lords and gentlemen,
your most obedient and respectful servant,
EDMUND TURRELL.

No. 40, Westmoreland Street, Goswell Road,
April 10, 1806.

To the Members of the Society of Arts, &c.

Certificates from Messrs. J. Haynes and Son, Westmoreland Buildings; John Kelly, Hooper-Street, Clerkenwell; John Foster, Author-Street, St. Luke's, and William Foster, Author-Street, St. Luke's, state, that they have been in the habit of using for upwards of twelve months, Mr. Turrell's muffles, and that they are greatly superior to any they have hitherto been able to procure, and that it is their opinion their durability may be completely attributed to his improved method of moulding them.

XXXVI. *Description of a Machine for raising Coals or other Articles from Mines. By Mr.* GILBERT GILPIN*.

SIR,

THE improvement of the machines in use for raising coal and ore from the mines, has long been a desideratum of the Society for the Encouragement of Arts, Manufactures, and Commerce, and they have repeatedly offered a premium for that purpose.

Those in general use (from the increased expense of horse labour), are worked by a steam engine, attached to a crank of twenty-one inches radius, wedged on a shaft along with a fly wheel, eleven or twelve feet in diameter, and pinion wheel, of eleven teeth, which latter works in another of sixty-four teeth, on the shaft of which is a plain cylindrical barrel, from four to six feet diameter, and nine or ten feet long;

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1807.——Twenty guineas were voted by the Society to Mr. Gilpin for this invention.

long; some have barrels formed of frustums of cones, (whose perimeters are in the proportion of about five to four), united at their bases, and of various diameters; the axes of both kinds are placed at right angles with the centre line of the pit, and at each end a rope of six inches in circumference is made fast by a staple, which ropes work (in contrary directions at the same time) over two pulleys, placed in a frame parallel to each other, and at an equal distance from the centre of the pit; to the ends of these ropes the baskets of coal and ore to be raised are hooked.

The simplicity of their general structure is such as, perhaps, not to admit of any considerable improvement; but the forms of the barrels are very defective.

On putting one of these machines in motion each rope forms a triangle, the lines thereof from the pulley to the first and last coil, and the surface of the barrel, forming its three sides. Upon the cylindrical barrel the load always tends, from gravitation, towards the nearest point of contact with the centre of motion of the barrel, and, in consequence, the ascending rope at first bends around it in receding coils from the subtending side of the triangle, diminishing their distances as they approach the nearest point of contact, (where the rope crosses the centres of the pulley and barrel at right angles,) thereby leaving a great part of the latter uncovered by the rope, and hence the necessity of such long ones; afterwards coiling hard against itself as it approaches the other side of the triangle, to its great injury in wear.

The barrels formed of frustums of cones, united at their bases, whose perimeters are in the proportion of about five to four, are equally defective, on account of the rope, for the reason before mentioned, binding hard against itself, and even sometimes (in wet weather, when its rigidity is increased by absorption of water,) folding at first in receding coils, and afterwards so hard against itself as to force those receding coils to slip suddenly towards the small perimeter of the cone, thereby making a large portion of the rope to descend the pit in an instant, breaking the rope by the sudden jerk, and frequently causing the immediate destruction of the men who may be ascending the pit at the time, or dashing to pieces the basket and its contents.

Besides the unnecessary expence arising from the use of hempen ropes, and the breakage of chains when applied in the common way, the forms of the barrels are quite erroneous in principle. Some are cylindrical; others formed of frustums of cones united at their bases, without any determinate proportion in their perimeters, or regard to the weight of the rope or chain working thereon, both of which are absolutely necessary to acquire a maximum effect.

The convex surface of a frustum of a cone, is = to the convex surface of a cylinder of the same altitude, having its circumference = to half the sum of the perimeters of the frustum: and circumferences of circles being to one another as their diameters, the surface of a barrel formed of two frustums of right cones (united at their bases), each 64 inches diameter at one end, 32 at the other, and 54 long, which is the size we have adopted here, is = to the surface of a plain cylindrical one, 48 inches diameter, and 108 long. Each will therefore bend the same length of cordage in an equal number of revolutions, and so far they are equal to each other; but they vary very considerably in the momenta required to work them.

Let a = the weight of the basket of coal, and b = that of the descending part of the chain; then, on the cylindrical barrel, when the former is hooked to the end of the latter, and eased from the bottom of the pit (the opposite chain being bent on the barrel), $a+b$ = the counterpoise required at 24 inches radius; and when it is wound up to the top (the descending part of the opposite chain hanging down the pit), $a-b$ = the counterpoise required at the same radius.

On the barrel formed of frustums of right cones, when the load is eased from the bottom of the pit, it and the chain are suspended from one of the smaller perimeters (the opposite chain being bent on the barrel), $\frac{a}{2}+\frac{b}{2}$ = the counterpoise required at 32 inches radius; and when it is wound

to

to the top of the pit, it is suspended from the larger perimeter of one frustum, whilst the descending part of the opposite chain is hanging down the pit from the smaller perimeter of the other, and in that position $a - \frac{b}{2} =$ the counterpoise required at the same radius.

Consequently, by supposing *a*, the weight of the basket of coal, to be 800lbs. and *b*, the weight of the descending part of the chain, 400lbs. (these are the weights which we have adopted here), we have the counterpoise required upon the cylindrical barrel, at 24 inches radius, 1200lbs. when the basket of coals is at the bottom of the pit, and 400lbs. when it is at the top; but upon the barrel formed of frustums of right cones, the counterpoise required at 32 inches radius is 600lbs. in each position. And as the counterpoise required is in inverse proportion to the length of the radius at which it is applied, we have 24 : 32 : : 600 : 800lbs. the counterpoise required upon the barrel formed of frustums of right cones, at 24 inches radius. Again, as the descending part of a chain + a basket of coal of double its weight, unbending out of equi-distant grooves from the base of a frustum of a right cone, towards its smaller perimeter, balances in every revolution of the barrel, a chain of equal weight + a basket of coal, of double its weight, bending into equi-distant grooves from the smaller perimeter of a similar frustum towards its base, the counterpoise required must be equal in all parts of the descent.

So that by making the weight of the basket of coal to that of the chain, and the perimeters of the frustums of cones, which form the barrel, to each other, in the proportion of two to one, *a maximum is obtained, by which a barrel of this description requires one-third less momentum, (and consequently one-third less expence,) to work it than a cylindrical one.*

The barrels are made by nailing two to three inch planks upon wooden or iron curves, as in the common way, and afterwards folded, spirally, with wrought iron tire, so as to leave a vacancy of about half an inch between each fold, for the lower part of the ellipses of those links of the chain

 which

which work vertically to move in, and keep the coils at an equal distance from each other.

The wrought iron tire is of two kinds, the one for conical, and the other for cylindrical barrels; the cross section of that for the barrel formed of frustums of cones, is nearly a parallelogram, $1\frac{1}{4}$ inch by $\frac{5}{8}$ths, out of the upper part of which about one-fourth of an ellipsis is taken, to form a horizontal bearing for those links of the chain which lie flat upon the tire; the cross section of the latter is a rectangle $1\frac{1}{4}$ inch by $\frac{1}{2}$ inch. Both are rolled into their proper form, and holes of a quarter of an inch diameter punched therein, at a foot from each other, for the purpose of nailing them to the planking of the barrels.

As the method of working chains in grooves has only been in use about three years and a half, it is impossible to give a certain idea in respect to their durability. In all that time not a single link has broke, or the least accident occurred therefrom, though Messrs. T. W. and B. Botfield have nearly three thousand feet in daily motion at this manufactory. The wear has also been so trifling, that I conceive they will sooner fail from oxydation than attrition: for although the machines for raising coal and ore from the mines are in use twelve hours in the day, the brown oxide of iron formed upon the links by exposure to the atmosphere, is seldom disturbed by the motion of the chain.

The method of folding wooden barrels with wrought iron tire, does away the necessity of cast iron ones, and may be applied to every wooden barrel now in use at a small expence, as may be seen by the estimate which is subjoined.

There are now at work in the mines of this manufactory, four machines, with wooden barrels folded with wrought iron tire, one cylindrical, and three formed of frustums of cones, raising upwards of eight hundred tons of coal and iron ore per week from pits of about eighty yards deep; and three others are in hand.

I look forward with confidence to the general substitution of chains for hempen ropes at all our mines and manufactories, a matter of importance to the British empire, as it will considerably lessen the consumption of hemp, and render it more abundant for the exigencies of the navy.

Wishing to give this method of working chains all the publicity in my power, I will obviate all apparent (for there are no real) difficulties which may occur to any person in their application, on his stating them in a letter *post paid* addressed to me here.

I am, sir, your most obedient servant,

GILBERT GILPIN.

Old Park Iron Works, near Shifnal,
Feb. 2, 1807.

To C. TAYLOR, M.D. Sec.

Expence of tarred ropes for a machine for raising coal and ore from a pit eighty yards deep, for three years and four months.

	£.	s.	d.
Ten ropes each 110 yards long, six inches in circumference, and 5lbs. per yard, 5500lbs. at 8*d*. per lb. - - - - - -	183	6	8
Deduct 10 worn out ropes 2750 lbs. at 1*d*. lb.	11	9	2
Net expence of ropes for 3 years and 4 months £.	171	17	6

Expence of chains for a machine for raising coal and ore from a pit eighty yards deep.

Two chains each 110 yards long, formed of $\frac{3}{8}$ inch iron, 28 links to the yard, and weighing 5lbs. per yard, 1100lbs. at 6*d*. per lb. - -	27	10	0
180 yards of wrought iron tire, with the holes punched therein weighing 7lbs. per yard, at 1*s*. 6*d*. per yard - - - - - -	13	10	0
540 nails for the tire, 27lbs. at 6*d*. per lb.	0	13	6
Workmanship, nailing the tire on the barrel, 180 yards at 2½*d*. per yard - - - -	1	17	6
£.	43	11	0

The above chains and tire have been at work three years and four months, and do not appear to be one-fourth worn.

SIR,

THIS is to certify, that Gilbert Gilpin has invented a method of raising coal and ore from the mines by means of chains working in grooves, formed by folding wooden barrels spirally, with wrought iron tire, so as to leave a vacancy between each fold for the lower parts of the circumferences of those links of the chains which work vertically to move in, and thereby cause uniformity and safety in motion; four of which machines we have now at work at our mines at this place, one with a cylindrical barrel, and three formed of frustums of cones, which machines are (to the best of our knowledge) superior to any hitherto known or in use, and will produce the effect at a much less expence.

(Signed) T. W. and B. BOTFIELD.

Old Park Iron Works,
March 6, 1807.

To C. TAYLOR, M.D. Sec.

SIR,

MESSRS. T. W. and B. Botfield inform me, that they sent the certificate in respect to the machine for raising coal and ore from the mines, to you yesterday.

You will please to observe, that of the four machines now in use, two only work with *two chains each*, and they are both formed of frustums of cones; the other two, the one with a cylindrical barrel, and the other a frustum of a cone, have each a chain at one end, and a patent flat rope at the other. We are induced to adopt the latter plan to do away by *degrees* the prejudices which miners and colliers have imbibed against chains, from accidents which they have been witnesses to in the common way of working. Though the causes of similar accidents are entirely done away by the new method of working, some little of the old prejudice remains; a thing not to be wondered at when we consider the uninformed state of this description of men, arising from a life spent in the dark recesses of mines; and, as it were, cut off from the rest of society.

From the uniformity and safety of the new method, their prejudices against chains are, however, rapidly wearing away, and I have no doubt that in a few years they will

even

even be preferred. It is certainly more reasonable to suppose that this will be the case from the superiority which iron holds in point of strength of materials, than that ropes even should have been known, (at least in the mines,) had the new method of working chains been in use prior to the introduction of hemp.

By excusing the liberty which I am now taking, you will oblige, Sir, your obedient servant,

GILBERT GILPIN.

Old Park Iron Works,
March 7, 1807.

To C. TAYLOR, M.D. Sec.

Reference to the Engraving of Mr. Gilbert Gilpin's improved Machine for raising Coal, Ore, &c. Plate VI. Fig. 1, 2, 3, 4.

Fig. 1. *a.* A crank to which the connecting rod is fixed to attach the machine to the steam-engine which works it.

b. A wheel of 13 teeth, wedged upon the same shaft with the crank, and which works into the wheel *d.*

c. A fly wheel 11 feet in diameter, wedged upon the same shaft as the wheel *b.*

d. A wheel of 64 teeth wedged upon the same shaft as the barrel, into which the wheel *b* works.

e. A wooden barrel, formed of two frustums of cones united base to base, and folded spirally with wrought iron tire, which keeps the links of the chains at right angles with each other, and with the grooves in the pulleys.

ff. The reeling-post and its lever, for disengaging the barrel from the steam-engine, when the men are to be let down into the pit by means of the break.

gg. A break wheel, break and lever, for regulating the velocity of the barrel when disengaged from the steam engine, and in the act of lowering the miners into the pit.

hh. The frame on which the machine is erected.

ii. Fig. 2. The pit-frame, for supporting the pulleys.

k. The pit represented by a circle, part of which is shown open, and part by dotted lines.

ll. Two grooved pulleys, over which the chains, extending a considerable length from the barrel *a,* work in parallel lines.

 m. The

m. The carriage (called a tacking in Shropshire) on which the coal and ore are landed from the chain at the pit head, moving on four small iron wheels.

nn. Baskets on which the coal and ore are raised from the pits.

o. The hook which goes into the staple of the basket to draw it forward when lowering on to the tacking.

After the basket is lowered, the tacking is drawn forward by two girls to the edge of the frame, which is laid level with the ground on its outside, and near to which the coal and ore are loaded into waggons, and afterwards drawn upon iron rail-ways to the furnaces, forges, &c.

Fig. 3. A section of a part of the barrel and tire, showing the manner the links of the chain lie on it, on a scale of three inches to the foot.

Fig. 4. A section of the pulley, with a link of the chain lying in it.

In a large machine the barrel is fixed 24 or 25 yards from the pit, which is a distance of nine feet in the model sent to the society.

Although the small chain for the model was made in Birmingham, it is remarkably full of twist, and the links in general awry where they join, in some parts as much as half the thickness of the link. It does not, therefore, keep well in the grooves, or, indeed, will it at all without a weight of five or six pounds attached to the end of it, and the barrel and frame at the proportional distance of about nine feet from each other.

XXXVII. *Remarks on an Essay on Commerce, published in the Philosophical Magazine for June* 1808, Vol. xxxi. Num. 121, p. 8.

To Mr. Tilloch.

SIR,

I HAVE perused, with much pleasure, in your Magazine for last month, a paper entitled "An Essay on Commerce," written by Mr. James Graham, of Berwick-upon-Tweed. As

As there are some points, however, contained in it, which I do not clearly comprehend, and others, on which I hold a different opinion from Mr. Graham; I shall take the liberty of troubling you with a few ideas on the subject.

The principle of commerce being nearly coëval with man, is a dogma universally admitted; it is, indeed, so evident and rational, that it would be absurd to argue against it, or even to question its probability, but, to admit it as the inference of Mr. Graham's statement, "that there is no country, however highly it may be favoured, which can produce all that is necessary for the comfort, health, protection, and security of its inhabitants," would, I conceive, be weakening instead of confirming the position, and, so far from proving the importance of commerce, would show it to be of very little use. For, if a country is naturally incapable of itself to produce all that is necessary for the health and comfort of inhabitants, I do not see how this deficiency can be supplied; because, from the nature of the soil and climate, inhabitants themselves cannot long continue there in existence. We accordingly find, that such tracts of land as are naturally barren, are also uninhabited. It is true, many countries draw the most material articles of their subsistence from others, whence they are exported for their use; but, then, this is no proof of the first being incapable to produce them, or at least, something equally, and perhaps more, adapted to the purpose; or of their not having actually produced one or other of them, previously to the connection. This, in treating of the origin of commerce, I shall explain presently more at large; but, considering Mr. Graham's statement in a general point of view, let any one examine into the various articles respectively produced by the different nations of the earth, and, if I am not very much mistaken, he will perceive how admirably they are adapted to the preeminent and, in some respects, exclusive use of the inhabitants of those countries to which they severally belong. Rice, for instance, is the chief support of the inhabitants of India, and corn may be said to answer it in Europe; an exchange, however, so as to substitute one to the exclusion of the other, would injure both people: for it it must be known that corn, instead of rice, would as ill agree with the constitution of a native Indian, as rice, substituted for corn, would with that of an European. Again, to notice an example Mr. Graham has selected as one particularly worthy of attention—I mean the difficulty of this island and the continent reciprocally obtaining wine and porter; which he condemns as a piece of cruel policy, that prevents a great bulk of people from enjoying those bounties of Providence which the earth sends forth in such abundance. Now, these articles are certainly, both of them, very useful in the countries in which they are respectively manufactured, and custom may have led some persons to suppose that they (particularly the first) are equally so in those in which they cannot be manufactured; but, taking the question generally (which is the only way to determine it correctly), let me ask, how long an English brick-maker could support himself upon French claret in lieu of porter, or what would become of a French peasant, were he to drink as plentifully of Burton ale as he does of his native wine? In the same manner, it may be argued, that the importation of tea, which, from its general use, is looked upon by many as a necessary of life, ought to be encouraged and promoted in this country; but, no one will undertake to say, that its use in this country (where, notwithstanding its prevalence, it is deprecated by the faculty) can be compared with its use in China, to which it is indigenous; it constitutes there the common drink of all descriptions of persons, from the highest to the lowest orders, and affords as much nourishment and refreshment to them as beer or wine does to the inhabitants of this country or the continent.

It is moreover to be observed, that a person passing from one country into another, where he settles as an inhabitant, no longer stands in need of those articles on which he has been in the habit of subsisting, and which can only be produced in the country he has left: these, indeed; so far from being necessary to his support, are frequently injurious and improper,—the most fit being such as are produced, or are, at least, capable of being produced, in the climate into which he has removed: which is another strong and convincing

vincing proof of the reverse of Mr. Graham's statement, and shows how Nature contributes to a change of constitution with a change of residence, so as to render the produce of each country the most proper for its inhabitants. Indeed, I am surprised that the contrary should have been stated by him to form a part of the immutable laws of the Creator; when every testimony concurs to show that it was and is his intention to gift each nation with such and such properties of soil and climate as are necessary to produce those articles the best adapted to its uses: the more especially, when we come to consider, that those commodities which are introduced into countries where they cannot be naturally produced, are, always, in such countries, articles of luxurious superfluity, and, mostly, causes of intemperance and disease. I am not prepared to defend the opinion; but, from attentively considering the different dispositions, the opposite climates, and the various languages that belong to the several nations of the earth, it should seem, that Providence had rather intended that they should be independent of one another, than that, according to Mr. Graham's representation, they should, of necessity, have recourse to mutual assistance: it cannot fail to strike, that, in proportion with the local distances between them, they differ in these particulars in a greater or less degree, which shows that the connections of society die gradually away, and that to break the natural order of its communication, by corresponding with distant parts of it, unassisted by the medium of those that intervene, is an invention of mankind, and not a law of the Creator. But this leads me to a consideration of the first principles of commerce.

When, at the beginning of these remarks, I admitted that commerce was nearly coëval with man, it is to be observed, that, not making use of the term in its fullest sense, I meant that there existed, at the first institution of society, a practice of bartering, or exchanging one commodity for another. Actuated by a principle of self-interest, men found, that, by devoting their time and talents to one particular occupation, they could obtain the necessaries of life with greater ease, in greater plenty and in greater perfection, than if each had undertaken to procure them separately for himself. Their being, however, enabled to do this, did not so much arise from natural as artificial causes; for though, most assuredly, there are particular *parts of a nation*, which may exclusively produce articles necessary to the whole, yet this is no argument in support of Mr. Graham's statement, which implies that *nations themselves* are as much dependent upon each other, as the several parts of which they are each of them composed. But, even here, it must be admitted, that such articles are more adapted to the use of the inhabitants of the parts where they are produced, than to that of those who live in different ones of the same nation; the degree of utility lessening as the local distances increase. In addition to what has been said before, that the Creator has distinguished the different nations of the earth by dissimilarity of language, habits, and dispositions, he has, to make this distinction more evident and striking, separated them by less equivocal divisions: by rocks, water, long chains of mountains, and other boundaries or marks; so that, the difficulty of defining the limits of a nation cannot be urged in opposition to the distinction which is made between that commerce which is carried on by the several parts of it, among themselves, and that which is carried on between it and other nations. But, leaving the, generally speaking, unimportant consideration of the difference between what each part of a nation is *naturally* capable of producing,—it will be found that the difference between what each part of it acually does produce, arises always, and almost totally, from that superiority of skill and judgement which is the inevitable consequence of the attention of their several inhabitants being respectively devoted to a few pursuits: physical exertion, aided by the human intellect, if confined to any particular branch of agriculture, art, or manufacture, cannot fail to arrive at a degree of perfection far beyond what it would otherwise have attained, had it been distracted by an application to all, or any considerable number of them. On this account, a piece of ground belonging to an individual, although capable of producing every thing necessary for his use, was appropriated solely to the

the cultivation of one particular article; the overplus of which, or what was more than wanted for his own consumption, he exchanged, with others in a similar situation, for such and such commodities as he required. Men were, accordingly, led to associate with one another; conscious, that the best way to accommodate themselves, was to accommodate their neighbours. Villages were established, to each particular member of which, certain functions were assigned; by which means, the whole body was combined together, and transformed, as it were, into an individual of itself.

Suppose, then, a certain number of these individual bodies to be stationed at different parts of the same country,—not so distant, however, but to be able, without difficulty, to communicate with each other; is it at all surprising, seeing the advantage which each of them has obtained by dividing their employments, that they should be induced to repeat the same experiment upon a larger scale, and appropriate to each of these bodies the principal cultivation of some one particular article or another?—Proceeding upon the same principle, we may form an idea of this extended class or province concentrating itself and communicating with others concentrated in the same way; till, at last, a whole country becomes united. During the progress, money, or something else, is introduced as a medium of exchange to facilitate the connection; civilization imperceptibly advances to refinement; and commerce, although originally directed to the necessaries of life, gradually embraces its conveniences and comforts, and ultimately includes its luxuries and superfluities.—In proof of this being the origin and rise of commerce, it is only necessary to refer to any particular country, and, even under the present complicated appearance of its arrangement, (owing to the length of time which has elapsed since the first stages were performed,) it will be seen, that separate employments are undertaken by the inhabitants of separate places, that certain manufactures are carried on in certain districts, and that the cultivation of particular articles is left to particular counties or divisions.

The commerce between nations may be accounted for in exactly

exactly the same way; every one admitting the former principle must be convinced of its applying equally in this case. Some distinction is, however, to be observed: certain principal commodities are cultivated by each nation in common, and, generally, in sufficient quantities for its own consumption; although they are alike useful to many of them, and might easily be disposed of to all. Hay and corn, for instance, two articles almost universally and absolutely necessary; the first is seldom or ever used in traffic; and the second, although frequently introduced, has always been considered as an improper object; it being the policy of each country to raise as much within itself, as is wanted for its own use. Thus, in France, at different periods, it has been found necessary to restrain the cultivation of vine-yards, (extended, by reason of their wines being a favourite article of commerce,) so as to prevent a scarcity of corn and pasture, which would render them too much dependent upon other nations for their support.

One of the principal uses of commerce between nations, appears to be not so much, as between the respective parts of them, to afford mutual accommodation to each other, as to excite amongst them a spirit of emulation; and I cannot but consider that man a greater friend to his country, who endeavours to imitate, with a view of excelling, an article manufactured in a different part of the world, than a man who employs his time and fortune in endeavouring to procure it in its most perfect state, by importing it from the place of its manufacture. The French have hitherto been justly considered to excel in the art of making lace; but, by dint of perseverance, we have greatly improved our former manufacture of it, and may, it is hoped, in the course of time, arrive at the same degree of excellence. The like may be observed of Spanish woollen cloths, Indian muslins, and a variety of other articles, too numerous to be mentioned. Our success in these particulars is another proof, that not so much is dependent upon soil and climate, in producing the raw materials, as many persons are apt to imagine; and a still further proof, that very little, if any, weight ought to be attached to the natural powers of the natives, beyond what

what uniformly results from undivided care and diligent regard to any particular object of employment. With respect to the natural resources of a country, it is impossible to say how far they may extend; because commerce, by introducing articles from abroad, applicable to useful purposes, renders the seeking of them, or substitutes for them, unnecessary at home; and prejudices people with an idea that none other will answer equally well the purposes to which they are applied: whereas, it has repeatedly been discovered, in this and other countries, when prevented from importing certain articles, that many of them are more serviceable if cultivated at home, and that several of them are less so than others indigenous to such countries, the superior use of which would never have been known, but from the circumstance of the importation being prevented.

As my only view, in troubling you with these remarks, (which, however familiar to Mr. Graham, seem to have been overlooked by him, as applicable to the question,) was to point out, what I conceive to be, an error in his fundamental statement. I should be trespassing too much upon your attention to extend them any further, although, were it necessary, I think I could assign other reasons than he has done for the decline of commerce,—a circumstance which I deplore equally with himself. Many of these reasons, detailed in a full and masterly manner, are to be found in the works of Lord Bacon and Mr. Locke, both of whom were staunch advocates for commerce, and able writers in its defence. Mr. Graham's motives, however, are laudable in the extreme; his observations are, generally, instructive; and since his abilities and experience are far superior to mine, I trust that the remarks which I have made will be indulgently received, and operate rather as an inducement to others to examine into the subject, than be considered as offered by me under an idea of their being accurate or conclusive.

I am, sir, your obedient servant,

WILLIAM LAPIS.

Cork,
July 1808.

XXXVIII. *Ana-*

XXXVIII. *Analysis of the lately discovered Mineral Waters at Cheltenham; and also of other Medicinal Springs in its Neighbourhood.* By FREDERICK ACCUM, *M. R. I. A. Operative Chemist, Lecturer on Practical Chemistry and on Mineralogy and Pharmacy, &c.*

[Continued from p. 92.]

ANALYSIS OF THE CARBONATED STEEL WELL.

SITUATION OF THE SPRING.

OF a different nature from the last described waters, is the spring called the Carbonated Steel Well. This spring is situated near Hygeia House, 600 feet from the last described well; it rises out of a black ferruginous mould. The water lines the reservoir, as well as the channels through which it flows, with a yellow brown precipitate.

PHYSICAL PROPERTIES OF THE WATER.

This water at the fountain head is perfectly colourless, and transparent. It has a slight odour, resembling that of iron when moistened, or rubbed in contact with water. It sparkles rather more than common spring water; its taste is strongly chalybeate; when suffered to be exposed to the open air for six hours, the inner side of the vessel containing it becomes studded with air bubbles; in 12 hours the water loses its chalybeate taste. The same effect ensues instantly, when it is made to boil, which renders the water turbid, and causes a brown granular precipitate to fall down. The temperature of the spring at 78 Fahr., was 53·5, the barometer indicating 29·5. The specific weight of the water was 2·39.

EXAMINATION BY RE-AGENTS.

Experiment I.—*Succinate of soda,* when added to this water, previously concentrated, by evaporation, and mingled with a few drops of nitric acid, occasioned a brown precipitate.

Experiment II.—*Prussiate of ammonia* and *prussiate of potash* tinged the water blue; boiled water did not suffer any alteration from these tests.

Experiment

Experiment III.—*Muriate, acetate,* and *nitrate of barytes* rendered both the fresh and boiled water turbid.

Experiment IV.—*Sulphate, nitrate,* and *acetate of silver* produced much cloudiness; even when a few drops of nitric, acetic, or sulphuric acid had been previously added to the water.

Experiment V.—*White prussiate of iron* underwent no change in this water.

Experiment VI.—*A plate of polished silver* and *bismuth* suffered no alteration, when kept submersed in the carbonated chalybeate water.

Experiment VII.—*Barytes* rendered the water milky.

Experiment VIII.—*Lime water* produced the same effect; the precipitate again vanished, by the admixture of muriatic acid.

Experiment IX.—*Fluate of soda* and *oxalate of ammonia* produced much cloudiness.

Experiment X.—*Sulphuric* and *nitrous acid* extricated many air bubbles.

Experiment XI.—*A slice of gall nut* suspended in the water became instantly surrounded by a purple zone, and lastly rendered the water black; boiled water remained unaltered.

Experiment XII.—*Tincture of cabbage* became reddened with the water at the fountain head, but boiled water suffered no change from this test.

ANALYSIS.

Experiment I.—Having learnt from the preceding experiments, that the water contained earthy carbonates, oxide of iron, &c., 231 cubic inches of it were slowly evaporated to five cubic inches, and when cold filtered.

Experiment II.—On the product obtained, muriatic acid was made to act, which was likewise employed to detach the earthy crust that had been formed on the vessel during the process of evaporation.

Experiment III.—To this muriatic solution, sulphuric acid was added, and heat applied until it became nearly dry;

 the

the sulphate of lime formed, being detached by ablution with alcohol, was dried and heated to redness in a platina spoon; which, taking 100 to be equal to 70 of carbonate of lime, indicated $4\frac{7}{10}$ of carbonate of lime to be contained in 231 cubic inches, or in one gallon of the water.

Experiment IV.—The solution freed from its carbonate of lime, not being decomposable by the joint action of carbonate of ammonia, and phosphate of soda, when highly concentrated, was mingled with liquid ammonia in excess, and the formed precipitate collected on the filter.

Experiment V.—The separated oxide of iron was redissolved in nitro-muriatic acid, and evaporated to dryness, for several times successively; and lastly, sulphuric acid was added, to convert it into sulphate of iron.

Experiment VI.—Having added ammonia to the sulphuric solution left in the preceding process, sufficient only to remove the excess of acid, it was decomposed boiling hot by succinate of soda, the precipitate collected by the filter.

Experiment VII.—On the succinate of iron obtained muriatic acid was poured, to effect a solution; which being accomplished, it was decomposed by sub-carbonate of potash. The carbonate of iron produced weighed $5\frac{3}{10}$ grains.

Experiment VIII.—To ascertain the saline contents of the water, 1848 cubic inches were evaporated to 100, and filtered. To free it from the substances so far detected in, and separated from it, the precipitate obtained by evaporation being again examined in the manner stated, afforded the same results, namely, carbonate of lime and carbonate of iron, besides a portion of sulphate of lime. The latter being removed, the fluid was evaporated to perfect dryness.

Experiment IX.—The dry mass being repeatedly digested in alcohol, the solution filtered, concentrated, covered with sulphuric acid, strongly heated, and lastly, the sulphate of lime separated by the filter; the fluid which passed through the paper was not decomposable by the joint action of phosphate of soda and carbonate of ammonia; muriate of magnesia could therefore not be present in this solution.

Experiment X.—The fluid which resisted the repeated application of alcohol (Experiment IX.) was covered with a small

small quantity of water, and digested in that fluid successively. It yielded seven grains of muriate of soda. These being dissolved, and added to the fluid from which they were obtained, and sulphate of silver dropt into the solution, the muriate of silver produced weighed 116 grains; indicating 50 of muriate of soda, of which 6·25 are contained in one gallon of the water.

Experiment XI.—The insoluble residue left, together with that obtained in Experiment VIII., being boiled in a Florence flask with a large quantity of water, became dissolved, and yielded by evaporation to dryness 17 grains of sulphate of lime; of which 2⅛ were therefore contained in one gallon of the water.

The aëriform products of this spring being ascertained by the usual methods, which are unnecessary to be detailed, 231 cubic inches of it yielded 14·7 of carbonic acid gas, and 3·9 atmospheric air.

From these inquiries it appears that the composition of the Carbonated Steel Well is as follows:

	Contents in one Gallon. Grains.	*In one Pint.* Grains.
Carbonate of iron -	5·3	0·6625
Carbonate of lime -	4·7	0·5875
Muriate of soda - -	6·25	0·78125
Muriate of lime - -	3·125	0·390625
Sulphate of lime - -	2·125	0·265625
	21·5	2·6875
	Cubic inches.	Cubic inches.
Carbonic acid gas -	14·7	1·8375
Atmospheric air - -	3·9	0·4875
	18·6	2·3250

ANALYSIS OF THE WEAK SULPHURETTED SALINE WELL.

The water of this well resembles that of the Strong Sulphuretted Saline Spring. It rises under Hygeia House. The odour and taste of this water indicate that it contains sulphuretted hydrogen gas. The depth of this spring is eight feet. Its circular reservoir measured three feet in diameter. The height of the water was 14 feet. The quantity of water it is capable of yielding amounts to 206 gallons in 24 hours. Its taste is slightly saline and bitter, leaving a strong impression of sulphuretted hydrogen in the mouth. It is perfectly transparent and colourless. The temperature of this spring was 52·5° Fahr., at 78° barometrical pressure. Its specific gravity was as 269·3 to 269.

The analytical investigation of this spring being conducted in the same manner as the preceding, it is unnecessary to detail the operations. The contents of the water were found to be the following:

	Contents in one Gallon.	*In one Pint.*
	Grains.	Grains.
Muriate of soda - -	123·5	15·4375
Sulphate of magnesia	39·7	4·9625
Sulphate of soda -	13·75	1·71875
Muriate of lime - -	4	0·5
Carbonate of iron -	2·75	0·34375
Sulphate of lime -	37·3	4·6625
	221	27·625
	Cubic inches.	Cubic inches.
Sulphuretted hydrogen gas	5·3	0·6625
Carbonic acid gas -	7·8	0·975
Atmospheric air - -	3·4	0·425
	16·5	2·0625

ANALYSIS OF THE SO CALLED MILK WELL.

The name of this medicinal spring is derived from its taste, which, by most people who drink the water, is found to resemble new skimmed milk.

This spring rises at the north-west corner of Montpellier Ground.

The

The constituent parts of this water are the following:

	Contents in one Gallon. Grains.	In one Pint. Grains.
Carbonate of lime -	2·5	0·3125
Muriate of soda -	9·75	1·21875
Sulphate of magnesia	3·1	0·3875
Sulphate of soda - -	8	1
Carbonate of iron -	0·25	0·03125
Sulphate of lime -	7·75	0·96875
	31·35	3·91875
	Cubic inches.	Cubic inches.
Carbonic acid gas -	7·25	0·90625
Atmospheric air - -	5	0·625
	12·25	1·53125

[To be continued.]

XXXIX. *Memoir upon the De-sulphuration of Metals.* *By M.* Gueniveau, *Engineer of Mines**.

Among the number of metallic sulphurets which nature presents to us, there are several the decomposition of which is very important in the arts: the sulphurets of iron, copper, lead, mercury, &c., give place to metallurgical processes highly deserving of the attention of chemists.

The nature and properties of these compounds are well known, since chemists have so frequently made them an object of inquiry. The facts, however, collected in laboratories have never been carefully compared with those furnished by the workshops, although it is very well known that the latter description of experiments furnish the most useful results; and the theory of various operations to which we subject the sulphurets, has not kept pace with the rela-

* From the *Journal des Mines*, vol. xxi. p. 5.– Jan. 1807.

tive progress of science. It is my intention, in this Memoir, to supply what is wanting in this respect: for this purpose, I have made various experiments, and collected several observations long known: to these I have added some reflections peculiar to myself, and have deduced from their examination, consequences which may be productive of some changes in the ideas generally entertained respecting the treatment of the metallic sulphurets.

§ I. *Of the Action of Heat upon the metallic Sulphurets.*

The action of *heat* upon the metallic sulphurets should be first examined, because it is to be met with in all the operations by which we seek to decompose these substances: in order to appreciate it in a precise manner, I have made choice of experiments and observations in which this action is entirely isolated, which is worthy of observation; for it is because we have not analysed the effects produced by several causes, that we have been led, in metallurgy, to ascribe to *caloric alone* a de-sulphurating power, which it does not seem to possess in any great degree.

The sulphurets of mercury and of arsenic are volatilized in close vessels, when they are exposed to a temperature somewhat raised. The sublimed sulphuret is frequently altered in its colour; and the experiments of Messrs. Proust and Thenard show that this change is the consequence of a variation in the proportion of the elements of this compound.

The native sulphuret of iron (pyrites of iron) undergoes a partial decomposition only from the caloric: by distilling it in a retort, we cannot extract from it the half of the sulphur which it contains *. In Saxony, the distillation of pyrites upon a large scale never yields more than from 13 to 14 per cent. of sulphur †.

These facts not being sufficient to decide my opinion upon the effects of heat, because all the experiments which have come to my knowledge were made at a tempera-

* Proust, *Journal de Physique*, tome liii.

† *Schlutter*, tome ii. p. 228, of the French translation.

ture

ture a little raised, I proceeded in the following manner: I put into a crucible, pyrites of iron pulverized; covered it with charcoal in powder, and heated it in the forge for an hour; I found a mass still preserving all the characters of pyrites; it seemed to have been completely melted, and retained two thirds of the sulphur contained in the natural pyrites. This experiment being repeated, left me in no uncertainty upon the effects of heat *by itself* upon sulphuret of iron, and I thought I might conclude, that, whatever be the temperature, these effects produce a partial decomposition.

Sulphuretted copper and pyritous copper, submitted to the action of heat, produce effects analogous to those observed with respect to iron: the distillation of the pyritous copper furnished but very little sulphur: these two kinds of minerals of copper may in short be considered as mixtures of the sulphurets of copper and of iron, and the sulphur which heat separates from it proceeds almost entirely from the sulphuret of iron.

The sulphuret of lead, or galena, is one of those minerals the treatment of which is most various: all chemists agree in regarding it as composed of sulphur and lead only, in the proportion of 15 of the former, and 85 of the latter. I was the more careful in observing the effects of caloric upon the galena, because, by trying to separate the sulphur from it by this agent, I expected to obtain lead in a metallic state, the weight and fusibility of which render the re-union very easy. It was, besides, very easy for me to operate without the contact of atmospheric air.

I put into a retort 30 grammes of galena reduced to powder, which I heated for two hours, but not so strongly as to make it agglutinate: a very little sulphuric acid only was disengaged, produced by the action of the air of the vessels, and I perceived no sulphur sublimed at the neck of the retort. I increased the fire for about two hours more, until both the galena and the vessel which contained it had undergone a kind of fusion. The sulphur volatilized in this second part of the operation was in so small a quantity that it was not possible for me to detach and weigh it: the residue was of a metallic lustre; it was agglutinated, and did not contain an atom of ductile lead *.

The heat not having been very strong in this experiment, I submitted to the fire of a forge some pulverized galena, placed in a crucible, and covered with charcoal in powder. I found a mass which had been melted, and similar to what is called *matte de plomb* by the French metallurgists; there was no lead free from sulphur, but only some parts of the button were a little ductile. Analysis convinced me that there remained about three fifths of the sulphur contained in the galena. I attributed a part of the loss of 27 per cent., which it had undergone by the action of the fire, to the volatilization of the sulphuret of lead itself; for the loss owing to the separation of the sulphur could not exceed six per cent. at most.

The galena therefore undergoes but a very incomplete decomposition from heat.

I shall not particularize the sulphurets of zinc, antimony, &c., because I do not know a sufficient number of experiments for determining, in a certain manner, the effects which heat produces upon them: analogy, however, inclines me to think that it does not completely decompose them.

All the facts I have presented seem to me to establish, that the action of caloric alone upon the metallic sulphurets, and particularly upon those of iron, copper, and lead, is confined to their taking from them a small portion of the sulphur which they contain, and afterwards in melting and volatilizing them.

§ II. *Of the simultaneous Action of Heat, and atmospheric Air, upon the metallic Sulphurets.*

The metallurgic operation which has for its object the de-sulphuration of the metals is known by the name of *roasting*. Most of the authors who have spoken of it do not seem to have recognized any other agent in the decomposition except caloric; and even those who since the new

* There are few chemists who have not made this experiment with similar results. I may here remark, that if the heat had been long enough continued, and in the open air, the *galena* would have been completely roasted.

new chemical theories have remarked the influence of the atmospheric air, have never regarded it as essential*. The experiments I have detailed having shown how the action of heat alone is insufficient for decomposing a metallic sulphuret, we must necessarily ascribe to the oxygen of the atmosphere the greatest share in the de-sulphuration of the metals by *roasting*. The affinities of sulphur and of metallic substances for this principle render this assertion very probable; it is besides proved by the chemical examination of the produce of all the roasting, as well as by the way in which the operation is conducted. In place of seeing in the roasting of the sulphurets the volatilization of the sulphur, produced *by a well managed heat*, it will be the decomposition of a sulphuret by the simultaneous action of the air and of caloric: and the well known necessity of not melting the ores does not seem to be recommended in consequence of the fear of communicating to it, together with liquidity, a force of cohesion which will oppose the separation of the sulphur; but rather because this state will confine the action of the air to a surface, which, not being capable of being renewed, will be soon covered by the metallic oxide. The combination of the oxygen with the elements of the sulphurets, gives birth to oxides and to acids, the affinities of which have great influence upon the separation of the sulphur, and the results of a roasting: the latter generally present a mixture of oxide, of sulphate, and of indecomposed sulphuret. I shall examine separately and in detail the roasting of several kinds of sulphurets, because the nature of the metal produces great modifications in their results; and shall presently show, why, and in what form, the sulphur is separated.

* Macquer, in this respect, agrees with the metallurgists. We find in his Dictionary of Chemistry the following passage: "There are several methods of separating sulphur from metallic substances: in the first place, as sulphur is volatile, and as these substances are fixed, or at least not so volatile as sulphur, the *action of heat alone is sufficient* to take the sulphur from most metals." He seems, however, to have been aware of the importance of the contact of the atmospheric air in roasting, since he says, when speaking of the sulphurets of mercury and of arsenic, "It will be possible to desulphurate them without intermedium, by a well-managed heat and *in the open air*."

Roasting

Roasting of Pyritous Copper.

We arrange pieces of pyritous copper upon faggots, in such a way as to make the combustion continue a long time. The first application of the heat separates a part of the sulphur, which is distilled in some measure, and may be collected; but afterwards it is this combustible which serves, upon burning, to continue the operation: sulphurous acid is liberated, the elasticity of which, increased by the elevation of the temperature, hinders its combination with the metallic oxides. The sulphuric acid which is formed, in spite of the care taken to slacken the combustion, is united to the oxides of copper and iron, but the sulphate of iron is partly decomposed by the hyper-oxidation of the metal.

The pyrites of iron submitted to the same operation undergoes *analogous decompositions*, the succession of which is in every respect the same.

The roasting of pyritous copper in the reverberatory furnace produces the same phænomena, and seems as if it would admit of a much more complete separation of the sulphur, than that produced in the open air. If it were not so, it would no doubt be owing to the difficulty of hindering the agglutination of the sulphuret produced by the elevation of temperature, owing to the rapid and inevitable combustion of a great quantity of sulphur.

I come now to speak of a furnace, in which we effect at the same time both the melting and the roasting (to a certain degree) of pyritous copper: this is the method practised at Falhun in Sweden*, and is done with an inner crucible,

* We find the following observations in the *Voyages Métallurgiques*, by Jars, tome iii. pages 55 & seq. "The flux of the mineral roasted *a single time*, is effected in a furnace which has an inner bason destined to contain the produce of the operation."—"When it is heated, it is charged with a good deal of scoriæ from the flux of black copper, with quartz and a little mineral."—"They do not mix the *quartz* with the mineral, but only add it when there are any fears of mischief in the inner bason."—"The fusion of the roasted pieces (*mattes*) is effected in the same kind of furnace, but smaller."—"The substances must remain a longer time in the furnace, which must not be opened until the end of twice twenty four hours. They then extract a very few *rich mattes*, but a very large pig of black copper."—"This method of melting the pyrites is certainly the only one that can

cible, which receives the produce of a flux of 24 or 48 hours, and in which a separation, or rather a combustion, of the sulphur takes place. The wind of the bellows passes over the surface with sufficient force for removing the scoriæ, and burning a part of the sulphur on the surface: the iron is thus oxidized, and quartz is added in order to vitrify it in proportion as the roasting goes on*. It is thus that we may explain the concentration of the metal, and the general result of the flux, which surprised M. Jars very much. This process is perhaps the only one in which, at the same time, the sulphur and iron are separated in any quantity.

The de-sulphuration of pyritous copper by roasting, is, in my opinion, produced, 1st, by the sublimation of a small portion of sulphur, which may be collected or burnt in the air: 2dly, by the extrication of sulphurous acid, so much the more abundant as the operation is well conducted†: 3dly, by the vaporization of a little sulphuric acid, the greatest part of which, however, remains united to the copper.

can be used, and which, in spite of the inconveniences it presents, may nevertheless be advantageous."—"Another very precious advantage is a *concentration* of the metal contained in the *fluid matter which is continually agitated by the wind of the bellows.* They extract a smaller quantity of *mattes*, but they are richer. We confess our surprise at the flux of black copper, when we see the small quantity of rich *mattes* which comes from a very inferior sort of ore, and which does *not even seem to have been roasted.*" We should be of M. Jars' opinion, that this method of melting pyritous copper is one of the best, if more copper was not volatilized than by the other processes: but if, as I think, we may substitute the *reverberatory furnace* for that used at Falhun, and in other respects following up the same series of operations, there would certainly be great advantages derived over fusion in the hand furnace.

* Swedenborg (*de cupro*) thus expresses himself: "*Plurima ejus ars* (meaning the melters) *in eo consistit, ut lapidem siliceum, justo tempore et modo, sciat offerre.*"

† Recent experiments of Messrs Clements and Desormes show, that the combustion of sulphur does not produce sulphuric acid so easily as imagined: but we know that its formation is determined by various peculiar circumstances, such as the presence of the alkalis, oxides, &c.

[To be continued.]

XL. *Essay*

XL. *Essay upon Machines in General.* By M. Carnot, *Member of the French Institute, &c. &c.*

[Continued from p. 144.]

Fifth Corollary.

Particular Law concerning Machines, the Movement of which changes by insensible Degrees.

XL. *In a machine, the movement of which changes by insensible degrees,* the momentum of activity consumed *in a given time by the soliciting forces, is equal* to the momentum of activity exercised *at the same time by the resisting forces.*

That is to say (XXXIII) that the *momentum of activity consumed* by all the forces of the system, during the time given, is equal to zero: this will be clear (XXXII) if we prove that the *momentum of activity* consumed at each instant by these forces is null: now F expressing each of these forces, V its velocity, Z the angle comprehended between F and V, and $d\,t$ the element of time, *the momentum of activity consumed* by all the forces of the system during $d\,t$, (XXXIII) $s\,F\,V$ cosine $Z\,d\,t$; we must therefore prove that we have $s\,F\,V$ cosine $Z\,d\,t = 0$; or $s\,F\,V$ cosine $z = 0$: now this is clear by the fundamental theorem: ergo &c.

The particular law here in question is certainly the most important of the whole theory of the movement of machines properly so called: we shall give some peculiar applications when we enter upon the detail of the subject, in the scholium which will succeed to the following corollary, and which will conclude this essay.

XLI. Let us suppose, therefore, for instance, that the powers applied to the machine are weights: let us call in the mass of each of these bodies, m the total mass of the system, g the gravity, V the actual velocity of the body m, K its initial velocity, t the time which has gone past since the commencement of the movement, H the height from which the centre of gravity of the system has descended during

during the time t, and lastly, W the velocity due to the height H.

This being done, we must consider that there are two sorts of forces applied to the machine, viz. those which proceed from the gravity of the bodies, and those which proceed from their *vis inertiæ*, or from the resistance which they oppose to their change of state (note to XXX): now (XXXII) the momentum of activity consumed during the time t by the first of these forces, is, with respect to the whole system, $M g H$, or $\frac{1}{2} M W^2$. Let us now see what is the momentum of activity consumed by the *vis inertiæ*: the velocity of m being V, and becoming the instant afterwards $V + dV$, it is clear (note to XXX) that its *vis inertiæ* estimated in the direction of V, is $m\,dV$, or rather $m\frac{dV}{dt}$; therefore (XXX) the momentum of activity, exercised by this force during dt, is $m\frac{dV}{dt}V dt$, or $m V dV$: therefore the momentum of activity, consumed by this *vis inertiæ* during the time t, is $s\,m V dV$, or, by integrating and completing the integral, $\frac{1}{2} m V^2 - \frac{1}{2} m K^2$: therefore the momentum of activity, consumed at the same time by the *vis inertiæ* of all the bodies of the system, will be $\frac{1}{2} s\,m V^2 - \frac{1}{2} s\,m K^2$: now this *vis inertiæ* is a resisting force, since it is by it that bodies resist their change of state: and the weight is here a soliciting force, since the centre of gravity is supposed to descend: thus, by the proposition of this corollary, we should have $M W^2 = s\,m V^2 - s\,m K^2$, or $s\,m V^2 = s\,m K^2 + M W^2$; i. e.

In a machine with weights, the movement of which changes by insensible degrees, the sum of the active forces of the system is, after any given time, equal to the sum of the initial active forces, plus the sum of active force which would take place if all the bodies of the system were animated with a common velocity, equal to that which is owing to the height from which the centre of gravity of the system has descended.

XLII. If the movement of the machine be uniform, we shall continually have $V = K$, and therefore $W^2 = 0$, or $H = 0$: this teaches us that

In

In a weight machine, the movement of which is uniform, the centre of gravity of the system remains constantly at the same height.

XLIII. Since $\frac{1}{2}$ M W² or M g H is (XXXII) the momentum of activity produced by a weight M g, which we make to ascend to the height H, it follows evidently that

Whatever method we take to raise a certain weight to a given height, the forces employed to produce this effect consume a momentum of activity equal to the produce of this weight, by the height to which we should raise it.

XLIV. In the same manner since (XLI) the momentum of activity produced in a given time by the *vis inertiæ* of any body is equal to the half of the quantity by which its active force augments during this time, we may conclude also, that

In order to make any given movement arise by insensible degrees in a system of bodies, or to change that which has arisen, it must follow that the powers destined to this effect do consume a momentum of activity equal to the half of the quantity by which the sum of the active forces of the system will have been augmented by this change.

XLV. It follows evidently from these two last propositions, that in order to elevate a weight M g to a height H, and make it assume at the same time a velocity V, it must happen, supposing this body in repose at the first instant, that the forces employed to produce this effect consume of themselves a momentum of activity equal to M g H + $\frac{1}{2}$ M V^2.

XLVI. We have supposed in all that has been said, as the title of this corollary announces, that the movement changes by insensible degrees; but if, when proceeding, any sudden shock or change happens in the system, what we have mentioned would not take place. Let us suppose, for instance, that at the moment of this shock the centre of gravity of the system has descended from the height h; that at this same instant the sum of the active forces is X immediately before the shock, and Y immediately after the shock: let us call Q the momentum of activity, which the

the moving forces will have to consume during the whole time of the movement, and g that which they will have to consume from the commencement to the epoch of the percussion: let us suppose finally, for the sake of more simplicity, that the system is at rest at the first instant, and at the last, it is clear (XLV) that we shall have $q = \mathrm{M}\,g\,h + \frac{1}{2}\mathrm{X}$; and that, by the same ratio, the momentum of activity to consume by the forces moving after the shock, *i. e.* $\mathrm{Q} - q$, will be $\mathrm{M}\,g\,(\mathrm{H} - h) - \frac{1}{2}\mathrm{Y}$; therefore $\mathrm{Q} = \mathrm{M}\,g\,\mathrm{H} + \frac{1}{2}\mathrm{X} - \frac{1}{2}\mathrm{Y}$: now (XXIII), it is clear that $\mathrm{X} > \mathrm{Y}$: thus the momentum of activity to consume in order to raise in this case M to the height H, is necessarily greater than if there had been no shock, since in this case we should have simply had $\mathrm{Q} = \mathrm{M}\,g\,\mathrm{H}$ (XLIII).

Hence it follows, that without consuming a greater momentum of activity, the moving forces may, by avoiding all shock, raise the same weight to a greater height H, for then we shall have (XLV) $\mathrm{Q} = \mathrm{M}\,g\,\mathrm{H}$, or $\mathrm{H} = \frac{\mathrm{Q}}{\mathrm{M}\,g}$, while in the present case we have $\mathrm{H} = \frac{\mathrm{Q} - \frac{1}{2}(\mathrm{X} - \mathrm{Y})}{\mathrm{M}\,g}$: whence we see, that X being greater than Y, we must necessarily have also $\mathrm{H}' > \mathrm{H}$.

Sixth Corollary.

Of Hydraulic Machines.

XLVII. We may regard a fluid as an assemblage of an infinity of solid corpuscles detached from each other; we may therefore apply to hydraulic machines all that we have said of other machines: thus, for example, from the first corollary (XXXV) we may conclude, that if a fluid mass without gravity, be enclosed completely in a vessel, and, that, having made two equal apertures in this vessel, we apply pistons to it; the forces which will act upon the fluid mass on pushing these pistons must be equal, if they mutually form an equilibrium; *i. e.* that in a fluid mass the pressure spreads equally in every direction: this is the fundamental principle of the equilibrium of fluids, which we generally regard as a truth purely experimental. We shall

even

even prove (XXV), that the conservation of the active forces takes place in incompressible fluids, the movement of which changes by insensible degrees; and in short, generally every thing which we have proved of a system of hard bodies is equally true with respect to a mass of incompressible fluid.

Scholium.

XLVIII. This scholium is destined for the development of the principle laid down in the fifth corollary: this proposition, in fact, contains the principal part of the theory of machines in a state of motion, because most of them are moved by agents which can only exercise dead forces, or those of pressure: of this description are all animals, springs, weights, &c., which is the cause why the machine generally changes its state by insensible degrees. It also most frequently happens, that this machine passes very quickly to uniformity of motion, for the following reason:

The agents which move this machine being at first a little above the resisting forces, give rise to a small movement which is afterwards gradually accelerated; but, whether as a necessary consequence of this acceleration, the soliciting force diminishes, whether the resistance increases, or, lastly, if there happens any variation in the directions, it almost always happens that the relation of the two forces is brought nearer and nearer to that in virtue of which they could mutually form equilibrium: these two forces are then destroyed, and the machine is no longer moved, except in virtue of the acquired movement, which, on account of the inertness of the matter, generally remains uniform.

XLIX. In order to understand still better how this happens, it is only necessary to attend to the motion of a ship which has the wind directly on her poop: this is a kind of machine animated by two contrary forces, which are the impulse of the wind, and the resistance of the fluid upon which it swims: if the first of these two forces, which may be regarded as soliciting, is greatest, the movement of the ship will be accelerated: but this acceleration necessarily has limits, for two reasons; because, the more the movement of the vessel is accelerated, 1st, the more is it subtracted from the

the impulse of the wind; 2d, on the other hand, the resistance of the water increases: consequently these two forces tend to equality: when they have attained this point they will be mutually destroyed; and therefore the vessel will be moved as a free body, *i. e.* its velocity will be constant. If the wind fell, the resistance of the water would surpass the soliciting force; the movement of the vessel would slacken; but, as a necessary consequence of this slackening, the wind would act more efficaciously upon the sails; and the resistance of the water would at the same time diminish: these two forces would still tend therefore to equality, and the machine would at the same time attain an uniformity of movement.

L. The same thing happens when the moving forces are men, animals, or other agents of this kind: at first the mover is a little above the resistance; thence arises a small movement, which is gradually accelerated by the repeated efforts of the moving power; but the agent itself is obliged to assume an accelerated movement, in order to remain attached to the body upon which it impresses motion. This acceleration, which it procures for itself, consumes a part of its effort, in such a manner that it acts less efficaciously upon the machine; and the movement of the latter, accelerating less and less, finishes by soon becoming uniform. For instance: a man who could make a certain effort in the case of equilibrium, would make a much less one if the body he applies his strength to should yield, and if he was obliged to follow it in order to act upon it: it is not because the absolute labour of this man is less; but it is because his effort is divided into two, one of which is employed in putting the man himself in motion, and the other is transmitted to the machine. Now it is from this last alone that the effect is manifested in the object proposed.

I shall nevertheless continue to consider machines under a more general point of view: thus, I shall place in this scholium several reflections applicable to the varied movement. I shall only suppose that this variation takes place by insensible degrees; and I shall prove that this should in

 fact

fact be the case, when we wish to employ them in the most advantageous manner possible.

LI. Let us therefore designate by Q, the momentum of activity consumed by the soliciting forces in a given time t, and by q, the momentum of activity exercised at the same time by the resisting forces: this being done, whatever be the movement of the machine, we shall always have, by the fifth corollary, $Q = q$; in such a manner, for example, that if each F of the soliciting forces be constant, its velocity V uniform, and the angle Z formed by the directions of F and V always null, we shall have at the end of the time t s F V $t = q$; and if all the soliciting forces are reduced to a single one, we shall consequently have F V $t = q$ (XXXII and XXXIII).

LII. We may in general regard the momentum of activity q, exercised by the resisting forces, as the effect produced by the soliciting forces: for instance, when it is requisite to raise a weight P to a given height H, it is very easy to regard the effect produced by the moving force as being in a compound ratio of the weight, and the height to which we have to raise it; so that P H is what we then naturally understand by the effect produced. Now, on the other hand, this quantity P H is precisely what we have called the momentum of activity exercised by the resisting force P; therefore this momentum of activity, or q, is what we naturally understand in this case by the effect produced.

Now, in the other cases, it is evident that q is always a quantity analogous to that just mentioned: this is the reason why I shall frequently, in the course of my subsequent observations, call this quantity q the *effect produced:* thus, by the terms *effect produced*, I shall mean the momentum of activity exercised by the resisting forces; in such a manner that, in virtue of the equation $Q = q$, we may establish as a general rule, that *the effect produced in a given time by any system of moving forces, is equal to the momentum of activity consumed at the same time by all these forces.*

LIII. We see by the equation F V $t = q$, found in the preceding article, that it is of no use to be acquainted with the

the figure of a machine, in order to know what effect any power applied to it can produce, when we are acquainted with that which it would produce without the machine: let us suppose, for example, that a man is capable of exercising a continual effort of 25^{tt}, by moving his own body continually with a velocity of three feet in the second: this being granted, when we apply it to a machine, the momentum of activity $F V t$, which this man will exercise, will be (XXXII) $25^{tt}\ 3\ p^{i}$ (3 feet) t, *i. e.* we shall have $F V^{t} = 25^{tt}\ 3\ p^{i}\ t$, t expressing the number of seconds: therefore, on account of $F V^{t} = q$, we shall have $q = 25^{tt}\ 3\ p^{i}\ t$, whatever be the machine: therefore the effect q is absolutely independent of the figure of this machine, and can never surpass that which the power is in a state to produce naturally, and without a machine.

Thus, for example, if this man with his effort of 25^{tt}, and his velocity of three feet in the second, is in a state with a given machine, or without a machine, to raise, in a given time, a weight p to a height H, we cannot invent any machine by which it is possible, with the same labour, (*i. e.* the same force, and the same velocity as in the first case,) to raise, in the given time, the same weight to a greater height, or a greater weight to the same height, or, finally, the same weight to the same height, in a shorter time: this is evident: since then q being (XXXII) equal to P H, we have, by the preceding article, $P H = 25^{tt}\ 3\ p^{i}\ t$.

LIV. The advantages resulting from machines do not therefore consist in producing great effects from small causes, but in affording the means of choosing, among different methods which may be called equal, that which is most convenient in the existing circumstances. In order to force a weight P to ascend to any height proposed, a spring to close together in a given quantity, a body to assume any given movement by insensible degrees, or, finally, any other given agent to produce any given momentum of activity, the moving forces employed must of themselves consume a momentum of activity equal to the first: no machine can dispense with it: but as this momentum results from several terms or factors, we may vary them at pleasure, by diminishing the force at the expense of the time, or the velocity at the expense of the force; or rather by employing two or more forces instead of one: this gives an infinity of resources for producing the momentum of activity necessary: but, whatever we do, these means must always be equal, *i. e.* the momentum of activity consumed by the soliciting forces, is equal to the effect or momentum exercised at the same time by the resisting forces.

[To be continued.]

XLI. *On the Planet Vesta. By* S. GROOMBRIDGE, *Esq. To Mr. Tilloch.*

SIR,

THE discovery of the planet Vesta, on the 29th of March 1807, having been communicated to this country by Dr. Olbers; on the 26th of April I found its place, and observed the same on the meridian. I obtained a series of observations to the 20th of May; after which, from the increase of daylight, it was no longer visible on the meridian. The observations which were afterwards made were with equatorial instruments; and these cannot be depended on, for sufficient accuracy in calculating the elements. I have, however, used some of these, from the 29th of March to the 22d of June, to determine the eccentricity; those which were made on the meridian producing nearly the same radius. I thence discovered, that the planet was decreasing in radius, and therefore conjecture that it was in aphelio about the time it was first seen. When the planet was discovered by Dr. Olbers on the 29th of March, it appears to have been about seven days past the opposition; and it is well known, not having that point of the orbit for a datum, the difficulty of calculation is increased. I was therefore anxious to observe the planet before the ensuing opposition, to obtain sufficient materials for ascertaining all the elements. For this purpose, I assumed a mean radius of the extreme observations; which, if I was right in my conjecture of the aphelium, would prove too great; and therefore the planet should be further advanced in the ecliptic. On the 30th of July, the evening being clear, and the moon not risen, I observed the difference of right ascension of several stars of the

the sixth magnitude, compared with those laid down in Bode's Catalogue; but in particular five stars, about two degrees advanced in longitude, from the computed place of the planet; not one of which was to be found in that Catalogue; the latitude being nearly the same: I therefore suspected one of these to be Vesta. On the 1st of August the same five stars being brought into the field of the telescope, it was instantly apparent that one had changed its place, southward and retrograde in right ascension: this was the object of my research. I could not obtain a meridional observation till the 11th, having been disappointed by the intervention of clouds or vapour. The following were the places as observed on the meridian; from which its course may be discovered.

1808.	Mean Time.	App. R.	Dec. S.	Long.	Lat. S.
	h. ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Aug. 11	14 24 32	356 30 2	12 0 40	351 58 35	9 37 15
14	14 11 20	356 8 51	12 23 44	351 29 56	9 50 1
19	13 48 50	355 25 57	13 3 40	350 34 51	10 9 22
21	13 39 40	355 6 14	13 20 2	350 9 42	10 16 44

From the observations in last year, I have ascertained part of the elements; which agree very well with those now made.

	°	′	″
Inclination of the orbit	7	8	20
Ascending node - -	104	38	
	Years.		
Period - - - - -	3,182		
Mean radius - - -	2,163		

The eccentricity appears to be considerable, from the increased angular motion in its orbit; but I have not at present sufficient data to determine the quantity. However, I do conjecture, that Vesta will be nearer to the Earth, about one-fifth the radius of the latter, at the ensuing than at the preceding opposition: which will enable astronomers, viewing the planet with high powers, the better to ascertain its diameter.

The opposition will happen about the 9th of September.

I am, sir, your obedient servant,

S. Groombridge.

Blackheath,
August 23, 1808.

XLII. No-

XLII. *Notices respecting New Books.*

Organic Remains of a former World. An Examination of the Mineralized Remains of the Vegetables and Animals of the Antediluvian World, generally termed Extraneous Fossils. By JAMES PARKINSON. The second Vol. 4to.

WE have much pleasure in announcing the appearance of this volume, containing the Fossil Zoöphytes, and illustrated with 20 plates. To say that there is no falling off in this volume, either in point of execution or embellishment, would not be doing sufficient justice to Mr. Parkinson. The work improves in every respect in its progress; nor could it be otherwise in the hands of a person possessing that industry and acuteness which are so discernible in the present performance; for new specimens and unabating research cannot but furnish fresh means for further investigation, and must frequently ascertain points that were before doubtful.

From a careful review of this volume, compared with the first, we think the author is justified in the conclusion he has drawn, that traces of but few of those species of organised beings which now exist can be discovered in the fossil state. Indeed we should have been inclined to conclude, that of all the varieties that have been discovered, not one of them can be identified with any living species.

Our limits do not permit our giving a longer extract than the following, which is the last letter but one in the volume, and which contains the author's "General remarks on the fossils already described," and the "Conclusions" he has drawn from the circumstances which have come under his observation.

"In the series of letters composing the former volume, various facts were adduced, in proof of the solid part of this globe having, at some very distant period, been covered by water. An unexpected circumstance was at the same time noticed:—hardly any agreement could be found between the fossil vegetable remains and those vegetables with which the earth is at present clothed; and in the present volume, an equal want of agreement has been observed between the fossil

fossil remains, and the actually existing animals, of the order of zoöphytes.

"That, in the stupendous changes which this planet has undergone, several species of beings endued with vegetable or animal life should have become extinct, is by no means inconsistent with the conclusions to which an unbiassed consideration of those grand events would lead. The discoveries, therefore, in the vestiges of a former world, of the remains of innumerable vegetables and animals, such as would constitute a prodigious number of species, and such as, according to the strict laws of arrangement, might be even disposed in new and distinct genera, although quite unexpected, is not in contradiction to what, on reflection, we should have admitted, might, from the influence of particular circumstances, have occurred. But a fact has been established in the former and in the present volume, to the expectation of which no chain of reasoning could have led. Of the numerous vegetables and animals with which the earth is at present furnished, the mineralized remains of very few species indeed can be found: of man himself, the mineral world presents not a single trace—an explanation of which I in vain attempted in the preceding volume.

"Whilst instancing this wonderful want of accordance of the mineralized organic remains of a former period, with those beings which are known now to exist, I shall here confine myself to such facts only as have been noticed whilst examining the fossil bodies which have engaged our attention in the present volume.

"The examination of fossil corals was commenced, as may be seen, with the expectation of being able to preserve somewhat of a parallelism between the corals of this and those of the former world. But it soon became necessary to abandon this attempt, it appearing that of the fossil corals, which, it may be said, have been only fortuitously discovered, many more species have existed than are known of even the recent corals, which, from their beauty and various other circumstances, have been so long and so assiduously collected. This abandonment was further authorized by its also appearing, on comparison, that scarcely any specific

 agreement

agreement could be established between the recent and the fossil corals.

"With respect to the degree of accordance of the fossil with the recent alcyonia, sponges, and other soft, and, consequently, easily altered zoöphytes, I considered myself as not authorized to speak with confidence; since it being probable, that from these bodies never having been the object of very general attention in a recent state, many may be yet withheld from our knowledge, which might, when found, considerably reduce the number of those fossil species, which we are obliged, at present, to consider as without any recent analogies.

"With respect to those zoöphytes, with the examination of which the latter part of this volume has been engaged, it must be acknowledged that they seem to point out most decidedly a considerable want of agreement between the inhabitants of the former and of the present world. It appears that of these zoöphytes, which, perhaps, should be arranged under two genera, encrinus and pentacrinus, upwards of twenty species are known in a mineralized state; but that, incalculably numerous as these animals must have been, not a single fragment of any individual, of any of the numerous species belonging to the genus encrinus, has ever yet been seen in a recent state. Two or three fragments of pentacrini have indeed been discovered, but whether exactly agreeing with any of the fossil species, I have not been able to ascertain.

"No stronger proof need be required of the sea having long covered this globe, than the various mineralized remains of zoöphytes, which have been found in different parts of the world, imbedded at considerable depths and at very great elevations, in some of the loftiest lime-stone mountains. But it may be argued, that although the marine origin of these remains be admitted, and although they are found thus imbedded, still it is not yet proved that the sea has rested on the parts where these fossil remains have been found; since they might have been brought there by floods from distant parts. But that these animals dwelt, and perished, on the identical spots where they are now found,

found, in a mineralized state, may be fairly, and, I trust, unquestionably, inferred from the circumstances of the congregation of similar animals, and of their bearing but few marks of external violence; since, had they been thus transported from distant regions, individuals of similar species would have been separated, and scarcely any individual, except of very strong fabric, would have been found, that had not suffered material injury.

"Reverting to what has been remarked of corals, that it is not very frequent that the superior external face of the coral is found in our fossil specimens, it might be thence remarked, that this was most probably the result of attrition, during the conveyance by the waves from one spot to the other. But when it is considered what prodigious masses are often formed by one species of coral, as in the recent coral reefs in the South Sea, it will naturally occur to the mind of every one, that, in cabinet specimens of fossils, which are the small fragments of such masses mineralized, by far the greater number of specimens may be expected to be found, not possessing this, the most characteristic surface of the fossil.

"Instances of the vast quantities in which these corals were accumulated, may be found in various marbles of which they form the basis, and which are in masses sufficiently large, to allow of being cut into slabs, of very considerable size, and to show that they could not have been brought by the waves to the places where they now are found. Corals, in a mineralized state, yield also ample testimony of similar species having congregated together in particular places. The Swedish islands of Gothland and Oeland, as well as many other parts of Sweden; Worcestershire, Shropshire, Perthshire, Fifeshire, and many other parts of Great Britain, possess considerable numbers of the simple turbinated madrepore*. In Wales are to be found considerable masses of the remains of the curious madrepore, distinguished by Lhwydd as *Lithostrotion, sive Basaltes minimus striatus et*

* I lately received, from some unknown friend, two of these fossils, which were found about thirty feet deep, in a mass of calcareous rock, at Lord Elgin's lime-works on the banks of the Firth of Forth, in Fifeshire.

stellatus.

stellatus. In Westmoreland, Cumberland, the bishopric of Durham, and several other parts of Great Britain, as well as of the Continent, are considerable accumulations of particular species of the aggregated and compound madrepores.

"The softer zoöphytes, such as the sponges, alcyonia, &c., evince still stronger marks of their not having been conveyed by torrents to their present residences. Many of these are of such a structure as certainly could not have borne such a conveyance, with so little injury as is discoverable in the several specimens, which have been examined in the preceding pages. But the congregation of so many of these bodies in particular districts, as has been already noticed, particularly in France, in Switzerland, and in this island, still more strongly proves these to have been the identical parts where they lived.

"But should any doubt remain of the fossil zoöphytes having inhabited the sea, in the identical places where they are now found, penetrated with and entombed in stone, those doubts must yield to the still more convincing circumstances, which attend the fossil remains of encrini and pentacrini. The marine origin of these animals, we have seen, has been determined by the discovery of the recent remains of two or three pentacrini in the Atlantic Ocean: and that the fossil species must have had their existence where they are now found, is plainly evinced, not only by the vast accumulations of distinct species in particular districts; but by several instances occurring, particularly with the lily encrinite, where, notwithstanding the extreme delicacy of their construction, even the more minute, and more easily separable parts, have been repeatedly found, in their mineralized state, preserved in almost their natural connexion.

"In concluding the present volume, it seems necessary to remark, that the circumstances observed whilst examining the several fossils hitherto noticed, have appeared to be sufficient to warrant the following conclusions:

"1st. That the water has rested for a considerable period over the general surface of the earth.

"2d. That the mineralized zoöphytes found imbedded in different parts of the earth, and even in mountains of considerable

considerable height, have lived and died on those identical spots, which in the former world constituted parts of the bottom of the ocean.

" 3d. That in a previous state of this planet, many species of organized beings existed, which are not known to us, in a recent state; their having existed being proved, only by the discovery of their fossil remains.

" 4th. That the traces of very few of those species which now exist can be discovered in the wreck of a former world.

" 5th. That even in rocks of the newest formation, and in alluvial strata, which are comparatively of but modern deposition, the remains of extinct animals are as frequently to be found, as in what are termed transition rocks, (those which are supposed to contain the first traces of organic remains.)

" 6th. That there appears to have been no line of separation between the creation of species now extinct, and of those now existing; since not only the remains of extinct species, but perhaps of extinct genera, are found, with the remains of species very similar to, if not exactly agreeing with, species known in a recent state.

" 7th. That many of the pebbles, found in gravel pits, on the shores of rivers, and on the sea beach, do not appear to have been bowldered down to the form in which they are now found; but that, on the contrary, their present forms are precisely those which they, at first, derived from the siliceous impregnation of different animals, which existed in the former ocean.

" 8th. That judging from the original delicacy of structure in these bodies, and from the little injury which they have sustained, it appears reasonable to suppose, that this solidification was effected, in several instances, previous to the removal of the waters from their former bed."

We cannot dismiss this work without speaking of the plates in terms of the highest commendation. They are executed with uncommon care, and present pictures of the various specimens coloured after nature, and so faithfully, that they may well answer the purpose of a collection of fossils to those who are fond of this pursuit—a pursuit which opens

opens a wide field for inquiry, and which, from the number of well informed men who are now devoting to it their time and talents, will, at no distant period, throw much light on every thing connected with geology.

XLIII. *Intelligence and Miscellaneous Articles.*

MEDICAL AND CHEMICAL LECTURES.

The first week of October a Course of Lectures on Physic and Chemistry will commence in George-street, Hanover-square, at the usual morning hours, viz. the Medical Lecture at Eight, and the Chemical at a quarter after Nine o'clock; by George Pearson, M.D. F.R.S., senior Physician of St. George's Hospital, of the College of Physicians, &c. &c.

A Register is kept by Dr. Pearson, of the Cases in St. George's Hospital, and an account is given of them every Saturday morning at a Clinical Lecture at Nine o'clock.

The Autumnal Course of Lectures on Anatomy, Physiology, and Surgery, will be commenced on Saturday, the first of October, at Two o'clock, by Mr. Brookes, at the Theatre of Anatomy, Blenheim-Street, Great Marlborough Street.

In these Lectures the Structure of the Human Body will be demonstrated on recent subjects, and further illustrated by preparations, and the functions of the different organs will be explained.

The Surgical operations are performed, and every part of Surgery so elucidated as may best tend to complete the operating Surgeon.

The art of Injecting, and of making Anatomical Preparations, will be taught practically.

Gentlemen zealous in the pursuit of Zoölogy will meet with uncommon opportunities of prosecuting their researches in Comparative Anatomy.

Surgeons in the Army and Navy may be assisted in renewing their Anatomical Knowledge, and every possible attention

tention will be paid to their accommodation as well as instruction.

Anatomical Converzationes will be held weekly, when the different Subjects treated of will be discussed familiarly, and the Student's views forwarded.—To these none but Pupils can be admitted.

Spacious Apartments, thoroughly ventilated, and replete with every convenience, are open all the Morning, for the purposes of Dissecting and Injecting, where Mr. Brookes attends to direct the Students, and demonstrate the various parts as they appear on Dissection.

An extensive Museum, containing preparations illustrative of every part of the Human Body, and its Diseases, appertains to this Theatre, to which Students will have occasional admittance.—Gentlemen inclined to support this School by contributing preternatural or morbid parts, subjects in Natural History, &c. (individually of little value to the possessors) may have the pleasure of seeing them preserved, arranged, and registered, with the names of the Donors.

Terms.	£.	s.
For a Course of Lectures, including the Dissections,	5	5
For a Perpetual Pupil to the Lectures and Dissections,	10	10

The Inconveniences usually attending Anatomical Investigations, are counteracted by an antiseptic Process, the result of Experiments made by Mr. Brookes on Human Subjects, at Paris, in the year 1782, the account of which was delivered to the Royal Society, and read on the 17th of June, 1784. This method has since been so far improved, that the florid colour of the muscles is preserved, and even heightened. Pupils may be accommodated in the House.—Gentlemen established in Practice, desirous of renewing their Anatomical Knowledge, may be accommodated with an Apartment to Disssect in privately.

Mr. Taunton's Autumnal Course of Lectures on Anatomy, Physiology, Pathology, and Surgery, will commence at the Theatre of Anatomy, Greville-Street, Hatton-Garden, on Saturday the first of October, at Eight in the Evening. In these Lectures Mr. Taunton purposes to take a comprehen-

sive

sive view of the Structure and Œconomy of the Living Body, with the Treatment of Surgical Diseases, describing the mode of performing Operations. Students will have an opportunity of attending the Clinical Practice of both the City and Finsbury Dispensaries.

Particulars may be had on applying to Mr. Taunton, Greville-Street, Hatton-Gardon.

Dr. Clutterbuck, Member of the Royal College of Physicians, and one of the Physicians to the General Dispensary, Aldersgate-Street, will begin his Winter Course of Lectures on the Theory and Practice of Physic, the Principles of Pharmacy, and the Materia Medica, on Tuesday the 4th of October, at Ten o'Clock in the Morning, at the Dispensary: to be continued daily (Saturdays excepted) at the same hour.

Clinical Lectures, by Dr. Clutterbuck and Dr. Birkbeck, on the most interesting Cases occurring in the practice of the same Dispensary, will be given *gratis* to the Pupils of the Class, on Saturdays throughout the season.

Further Particulars, with a Prospectus, may be had at the Dispensary, or at No. 1, Crescent, New Bridge Street.

The Autumnal Course of Lectures at St. Thomas's and Guy's Hospitals, will commence the beginning of October, viz.

At St. Thomas's.—Anatomy and Operations of Surgery, by Mr. Cline and Mr. Cooper.—Principles and Practice of Surgery, by Mr. Cooper.

At Guy's Hospital.—Practice of Medicine, by Dr. Babington and Dr. Curry.—Chemistry, by Dr. Babington, Dr. Marcet, and Mr. Allen.—Experimental Philosophy, by Mr. Allen.—Theory of Medicine, and Materia Medica, by Dr. Curry and Dr. Cholmeley.—Midwifery, and Diseases of Women and Children, by Dr. Haighton.—Physiology, or Laws of the Animal Œconomy, by Dr. Haighton.—Occasional Clinical Lectures on Select Medical Cases, by Dr. Babington, Dr. Curry, and Dr. Marcet.—Structure and Diseases of the Teeth, by Mr. Fox.

N.B. These Lectures are so arranged, that no two of them interfere in the hours of attendance. Terms and other Particulars may be learnt at the respective Hospitals.

LIST OF PATENTS FOR NEW INVENTIONS.

To Richard Trevithick, of Rotherhithe, in the county of Surry, engineer, and Robert Dickinson, of Great Queen-Street, in the county of Middlesex, esq., for certain machinery for towing, driving, or forcing, and discharging ships and other vessels of their cargoes.—July 5.

To William Proctor, of Sheffield, in the county of York, optician, for his improved methods of melting and using malleable wrought iron or steel. July 6.

To James Browell, of Cornhill, in the city of London, tailor and draper; James Jacks, of Cornhill aforesaid, tailor and draper; and Thomas Leunitte, of Aldgate in the said city of London, man's mercer, for a new chemical preparation for the purpose of preserving from destruction by mildew, rot, or fermentation, all kinds of woollen and vegetable substances, from which woollen, cotton, and linen cloths, canvas, paper, and other manufactures are made; and also for rendering all sorts of woollen, cotton, and linen cloths, canvas, silk, leather hats, and paper impervious to rain, by an improved method. July 11.

To John Heathcoat, of Loughborough, in the county of Leicester, lace manufacturer, for his machine for the making or manufacturing of bobbin lace, or lace near resembling French lace. July 14.

To James Linaker, of the Dock-yard, Portsmouth, millwright, for his method or methods of towing, driving, or forcing ships and other vessels. July 14.

To Benjamin Crosby, of the parish of St. Martin Ludgate, in the city of London, bookseller, for his new invented stand for books, which may be made either circular, square, or any other convenient shape, and which may be turned or moved at pleasure, with cases to receive books as well as various other articles and things. July 25.

To William Hawkes, of Newport, in the county of Salop, esq., for his improvements on musical keyed instruments of 12 fixed tones. July 25.

To George Richards, of Truro, in the county of Cornwall, architect, for his single and double cannonades or ordnance musquets, and all other kind of fire arms, on a new principle; and a new method of charging or loading the same, and of fixing or placing bayonets on fire arms. July 30.

METEORO-

METEOROLOGICAL TABLE,
BY MR. CAREY, OF THE STRAND,
For August 1808.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather.
July 27	66°	74°	60°	29·75	58	Cloudy, with Rain at night
28	61	64	61	·52	10	Rain
29	63	73	63	·70	51	Fair
30	66	76	64	·80	65	Fair
31	68	78	66	·80	62	Fair. Rain in the evening with Thunder
August 1	67	68	64	·60	31	Showery
2	66	76	61	·90	65	Fair
3	66	71	62	30·14	62	Cloudy
4	67	77	64	29·99	84	Fair
5	66	77	66	·85	78	Fair
6	69	75	65	·75	61	Fair
7	68	72	63	·80	52	Showery
8	68	74	62	·80	60	Fair
9	62	70	61	·61	55	Stormy
10	61	71	63	·80	50	Cloudy
11	62	71	61	·72	61	Fair
12	60	74	63	·85	71	Fair
13	62	68	63	·70	10	Rain
14	64	72	63	·70	61	Fair
15	64	69	59	·81	49	Showery
16	60	71	63	·85	82	Fair
17	60	69	61	·96	72	Fair
18	61	68	59	30·08	65	Fair
19	60	71	58	·14	70	Cloudy
20	58	71	61	·20	71	Fair
21	63	73	63	·22	45	Cloudy
22	60	69	59	·16	65	Cloudy
23	59	69	58	·15	62	Fair
24	59	68	57	·15	61	Fair
25	57	69	59	·05	69	Fair
26	58	72	58	29·75	78	Fair

N. B. The Barometer's height is taken at one o'clock.

XLIV. *Description of the Apparatus invented by* W. H. Pepys, *Esq., for the Decomposition of the Alkalis under Naphtha, by Galvanism.*

The celebrated discovery of the compound nature of the alkalis by professor Davy excited the attention of all classes of philosophers. Numerous experiments and apparatus for the more easily and permanently securing these volatile and decomposable metals were invented.—Of the several apparatus for decomposing the alkalis under naphtha, the most simple is that invented by Mr. Pepys.

Mr. Knight, of Foster-lane, who has made several, favoured us with the instrument from which the present Plate is taken:

C. A cylinder of glass with a pedestal ground glass stopper P, perforated through to allow a communication to take place, by means of a wire, between two metallic plates cemented to the top and bottom of the stopper. The lower plate is of copper: the upper of platina.

W. A wooden cover, through which a platina wire (with a plate of the same metal riveted to the inferior end) is allowed to slide.

Use.—The copper base of the pedestal is brought in contact with the positive end of the trough: the potash, slightly moistened, is laid on the platina plate *p*. The cylinder is then filled with naphtha, the wooden cover put on, and the platina wire N, previously communicating with the negative end of the trough, is suffered to come into contact with the potash or soda. Decomposition is immediately effected. Part of the metal sometimes floats, but the larger portion will be found imbedded in the alkali. A considerable portion of gas is evolved from the decomposition of both the naphtha and the alkali.

By a simple modification of the above apparatus, we understand Mr. Pepys has collected the whole of the gases during decomposition.

XLV. *On the Crossing Spider.* By R. Teed, *Esq.*

To Mr. Tilloch.

SIR, Lancaster Court, Strand.

Your ingenious correspondent, signed Lehmann, (Phil. Mag. vol. ii. p. 320,) having given an interesting, and in my opinion the best account of the crossing spider (Aranea Diadema), induced me not long ago to examine more minutely the wonderful sagacity and contrivance of that curious insect: and as the experiment I made is simple, and can be repeated by any person inclined to ascertain the fact, (to whom I will promise much pleasure from the result,) I shall describe as briefly as possible the method I pursued to obtain the most ample satisfaction. In the month of September last as I was one evening amusing myself in my garden at Kentish-Town, just as the sun was setting, I observed a large crossing spider in the centre of his web, watching for the unwary fly who should chance to be entangled in it. I took him from his post on a small stick, and, suspending the insect between myself and that bright luminary, I observed that he let himself down to the distance of about one yard; which was no sooner done, than I saw the thread by which he was suspended, in a moment divide or split into five or six lengths of a smaller size, and nearly half a yard long. A gentle breeze at that instant blowing towards the setting sun, and consequently from me, I was enabled to see more distinctly the very wonderful and surprising operation; for the end of one of the threads nearest the stick, being at liberty, was blown by the wind until they were all unfolded to some distance; and being stopped by a tree, the spider, who appeared perfectly acquainted with the busines, felt with one of his hinder legs that it had laid hold of something. I soon perceived his object; I extended the stick, and thereby tightened the thread: this being known to the spider, he crossed from the stick to the tree with the greatest alacrity. I was then convinced how easy it is for these insects to transport themselves

selves from one side of a garden to the other, or to cross lanes, rivers, &c. But it may be asked, How the spider, who has an inclination to cross a garden, knows when the line or thread is long enough to answer his purpose?—A second experiment with another of these curious creatures most fully satisfied me. Repeating what I have already stated, I so managed the floating web that it should not presently fix on the tree; but as the air wafted it to a distance, I was much gratified by observing the line to lengthen, not from any more folds, but from the spider's body, the wind drawing it out, and no doubt aided by some internal force which he had the power to exert, thereby lengthening it at least ten yards:—it was then suffered to light on a wall, when the spider in a moment ran along the thread with the greatest ease. Now, sir, these experiments I have many times made, and advise others who are fond of exploring Nature in all her wonderful works to do the same; but it is best to have a strong light, in order to observe the curious foldings of the web, which appears (when viewed with a glass of one inch focus) to be fastened with something like a slip knot*.

The observations which I shall make are as follows:—First, it appears to me that Nature has furnished these little creatures (which we from habits of education too much despise) with a most curious method of ejecting at pleasure a glutinous thread many times double; and although moist, the spider can contrive to separate or spin singly, by which means they not only weave their beautiful nets, but make a thread which has excited the wonder of thousands, to know by what means they have crossed roads, &c. And secondly, that by the power they have of lengthening those threads they can cross to any distance. It is indeed probable that instinct informs them when the wind is fair for their purpose; and it is remarkable that these powers are confined to the crossing spider, as no other which I have ever met with possesses them. The largest spiders have the strongest webs, and are best for the experiment; but the

* You will remark that M. C. G. Lehmann has not noticed this: and I am persuaded that each folding is fastened by a knot leaving one end loose.

smallest have the same properties, and the thread may be seen to unfold with a good glass. By what means these threads are separated at the instant they are drawn from the spider's body, I am at a loss to determine, and by what kind of construction the aperture from whence they are drawn is contrived to spin a thread of a gummy consistence, either single or double, at the pleasure of the spider, is equally mysterious.

The spider, for some reason or other, is generally looked upon with abhorrence, and some have declared them to be poisonous, but the fact is otherwise; they are perfectly innocent, which could be easily proved, and they are a very ingenious and wonderful little insect, highly deserving the attention of the curious. When I say they are not venomous, I speak only of our English spiders; for notwithstanding their dexterity in killing a fly, there is, I believe, no doubt as to the means they use for that purpose, being commonly done by incisions made with their formidable forceps, and then sucking their blood.

There are many other very curious observations which might be made, peculiar to the spider, and which I may at a future period trouble you to insert in your valuable Magazine. I am, sir, yours, &c.

R. Teed.

XLVI. *On Oxalic Acid. By* Thomas Thomson, *M.D. F.R.S. Ed. Communicated by* Charles Hatchett, *Esq., F.R.S.*

[Continued from p. 111.]

III. *Decomposition of the Oxalates.*

1. When oxalic acid, in the state of crystals, is exposed to heat, it is only partially acted upon, a considerable portion escaping without alteration; but when an alkaline or earthy oxalate is heated, the acid remains fixed till it undergoes complete decomposition. The new substances into which the acid is converted, as far as my experience goes, are always the same, what oxalate soever we employ. They are

are five in number; namely, *water, carbonic acid, carbonic oxide, carbureted hydrogen,* and *charcoal.*

2. The water is never quite pure. Though no sensible portion of oil can be perceived in it, yet it has always the peculiar smell of the water obtained during the distillation of wood; a smell which is usually ascribed to oil. It commonly shows traces of the presence of ammonia, changing vegetable blues to green, and smoking when brought near muriatic acid; but this minute portion of ammonia is probably only accidentally present. All the oxalates which I decomposed by distillation, were obtained by double decomposition from oxalate of ammonia; and though they were washed with sufficient care, yet I think it not unlikely that a minute portion of oxalate of ammonia might continue to adhere. Practical chemists know the extreme difficulty of removing every trace of a salt with which another has been mixed.

The carbonic acid remains partly combined with the base, which always becomes a carbonate, and partly makes its escape in the form of gas.

The carbonic oxide and carbureted hydrogen make their escape in the form of gas: the charcoal remains in the retort mixed with the base, to which it communicates a gray colour: the quantity of it depends in some measure upon the heat. If the oxalate was exposed to a very violent heat, no charcoal at all remains. Hence it probably acts upon the carbonic acid united to the base, converting it into carbonic oxide, as happens when a mixture of a carbonate and charcoal is heated.

3. I was induced to examine this decomposition with considerable attention, because I conceived that it would furnish the means of estimating the composition of oxalic acid; and I pitched upon oxalate of lime, as the salt best adapted for the purpose I had in view. A determinate quantity of this salt was put into a small retort, and gradually heated to redness. This retort was connected with a pneumatic trough by means of a long glass tube, having a valve at its extremity which allowed gas to issue out, but

 prevented

prevented any water from entering the tube. The experiment was repeated three times.

4. A hundred grains of oxalate of lime, when thus heated, yield above sixty cubic inches of a gas, which is always a mixture of carbonic acid and inflammable air, nearly in the proportion of one part of the former to three and a half of the latter, reckoning by bulk. The specific gravity of the inflammable gas was 0·908, common air being 1·000; it burns with a blue flame, and when mixed with oxygen may be kindled by the electric spark. The loudness of the report depends upon the proportion of oxygen.

The smallest quantity of oxygen, with which it can be mixed, so as to burn by the electric spark, is 1-9th; the combustion is very feeble, and is attended with no perceptible report. If the residue be washed in lime-water and mixed with 1 9th of its bulk of oxygen, it may be kindled a second time: this may be repeated five times, after which the residue cannot be made to burn.

The combustion becomes more violent, and the report louder, as we increase the proportion of oxygen, and both are greatest when the oxygen is double the bulk of the gas. As we increase the dose of oxygen, the combustion becomes more and more feeble; and five parts of oxygen and one of gas is the limit of combustion on this side: for a mixture of six parts of oxygen and one of the inflammable air will not burn.

In these experiments the results differ materially from each other, when the proportion of oxygen used is small and when it is great. I am not able at present to account for this difference, which holds not only with respect to this gas, but every compound inflammable gas which I have examined. This difference makes it impossible to use both extremes of the series: I make choice of that in which the proportion of oxygen is considerable, as upon the whole more satisfactory. The best proportion is one part of the gas and two parts of oxygen. The oxygen ought not to be pure, but diluted with at least the third of its bulk of azote, unless the gas be much contaminated with common air.

I have

I have elsewhere detailed the method which I follow in analysing gases of this nature*. The following table exhibits the mean of a considerable number of trials of this gas with oxygen.

Measures of inflammable Air consumed.	Measures of Oxygen consumed.	Carbonic Acid formed.	Diminution of Bulk.
100	91	93	98

that is to say, 100 cubic inches of the gas when burnt, combine with 91 cubic inches of oxygen; there are produced 93 inches of carbonic acid; and after the combustion these 93 inches alone remain, the rest being condensed. Hence we conclude that the other substance produced was water.

This result corresponds almost exactly with what would have been obtained, if we had made the same experiment upon a mixture of 70 measures of carbonic oxide, and 30 measures of carbureted hydrogen, as will appear from the following table.

	Measures of inflammable Gas consumed	Measures of Oxygen consumed.	Measures of carbonic Acid formed	Diminution of Bulk.
Carbonic oxide	70	31·5	63	38·5
Carbureted hydrogen	30	60·0	30	60·0
Total	100	91·5	93	98·5

This coincidence is so exact, that I do not hesitate to conclude that the inflammable gas, which was the subject of experiment, was in reality a mixture of 70 parts of carbonic oxide, and 30 of carbureted hydrogen. The specific gravity indeed, which was 0·908, does not exactly agree with the specific gravity of such a mixture; for $2\frac{1}{3}$ measures of carbonic oxide, and one measure of carbureted hydrogen, ought

* See Nicholson's Journal, xvi. 247.

to form a mixture of the specific gravity 0·849, provided the specific gravity of carbonic oxide be 0·956, and that of carbureted hydrogen 0·600; but this objection cannot be admitted to be of much weight, till the specific gravity of pure carbureted hydrogen be ascertained with more accuracy than has hitherto been done.

The results contained in the preceding table enable us to determine the composition of this inflammable air with considerable precision; for 100 cubic inches of it require 91 inches of oxygen, and form 93 cubic inches of carbonic acid. But it is known that carbonic acid gas requires for its formation a quantity of oxygen gas equal to its own bulk: therefore to form 93 inches of it, 93 inches of oxygen gas must have been employed; but only 91 were mixed with the gas: therefore the gas itself must have furnished a quantity of oxygen, equivalent to the bulk of two cubic inches, besides all the carbon contained in 93 inches of carbonic acid.

This carbon amounts in weight to	12·09 grains.
Two cubic inches of oxygen weigh	·68
Total	12·77

But as 100 cubic inches of the gas weigh 28·15 grains, it is obvious that besides the 12·77 grains which it furnished to the carbonic acid, it must have contained 15·38 grains of additional matter; but as the only two products were carbonic acid and water, it is plain that the whole of this additional matter must, by the explosion, have been converted into water. Its constituents of course must have been

13·19	oxygen
2·19	hydrogen
15·38	

Adding this to the 12·77 grains formerly obtained, we get the composition of the gas as follows:

Oxygen	13·87
Carbon	12·09
Hydrogen	2·19
	28·15

which

which reduced to 100 parts, becomes

Oxygen	49·27
Carbon	42·95
Hydrogen	7·78
	100·00

5. The residue which remained in the retort, after the distillation was over, was a gray powder, not unlike pounded clay slate. To ascertain its constituents, it was dissolved in diluted nitric acid with the necessary precautions; the loss of weight indicated the quantity of carbonic acid. The charcoal remaining undissolved, was allowed to subside, carefully washed by repeated affusions of water, and then dried in a glass or porcelain capsule. It must not be separated by the filter, for it adheres so obstinately that it cannot be taken off the paper, nor weighed. The nitric acid solution was precipitated by carbonate of soda, and the carbonate of lime obtained was violently heated in a platinum crucible. What remained was pure lime.

6. I shall now detail one of my experiments more particularly. Eighty-nine grains of well dried oxalate of lime were exposed in a small retort to a heat gradually raised to redness; the products were the following:

	Grains.
45·6 cubic inches of gas* weighing	14·8
Water - - -	6·4
Residue in retort - -	62·4
	83·6
Loss - - -	5·4
Total	89·0

The loss is obviously owing to the gas which filled the retort and tube when the experiment was concluded. We are warranted therefore to add it to the weight of the gaseous products obtained.

* The gas obtained measured 60 cubic inches, but 14·4 inches of these were found to be common air which had previously filled the retort and tube; this quantity was therefore deducted.

Now

Now the gas was composed of

Carbonic acid	10·5 cubic inches	= 4·9 grains.
Inflammable air	35·1 - -	= 9·9

so that one-third of the weight was carbonic acid, and two-thirds inflammable air. If we divide the 5·4 grains of loss, in that proportion we obtain 1·8 grains carbonic acid, and 3·6 grains of inflammable air. Adding these quantities to the weight obtained, we get for the weight of the whole gaseous product

	Grains.
Carbonic acid	6·7
Inflammable air	13·5
	20·2

The 62·4 grains of residue in the retort were composed of

Lime - -	33·4
Carbonic acid	26·4
Charcoal -	2·6
	62·4

Now it is clear, that the 89 grains of oxalate of lime were composed of

Lime - -	33·4
Acid - -	55·6
	89·0

The acid was completely decomposed and resolved into the following products:

Carbonic acid	33·1
Inflammable air	13·5
Water - -	6·4
Charcoal -	2·6
	55·6

Had the experiment been made upon 100 grains of oxalic acid instead of 55·6, it is clear that the proportions would have been as follows:

Carbonic

	Grains.
Carbonic acid	59·53
Inflammable air	24·28
Water - -	11·51
Charcoal -	4·68
	100·00

The most remarkable circumstance attending the decomposition of oxalic acid by heat, is the great proportion of carbonic acid formed; the quantity amounts to 6-10ths of the whole weight of acid decomposed.

As the composition of all these products of oxalic acid is known with considerable accuracy, it is obvious that they furnish us with the means of ascertaining the constituents of that acid itself.

59·53 grains of carbonic acid are composed of

Oxygen -	42·86
Carbon -	16·67
	59·53

24·28 grains of inflammable air, according to the analysis given in a preceding part of this paper, are composed of

Oxygen -	11·96
Carbon -	10·13
Hydrogen -	1·89
	24·28

11·51 grains of water are composed of

Oxygen -	9·87
Hydrogen -	1·64
	11·51

As for the charcoal, though it probably contains both oxygen and hydrogen as well as carbon, yet as the proportion of the two first ingredients is probably very small, and as we have no means of estimating them, we must at present rest satisfied with considering it as composed of pure carbon.

When

When these different elements are collected under their proper heads, we obtain

	Grains.
1. Oxygen in carbonic acid	42·86
— — inflammable air	11·96
— — water - -	9·87
	64·69
2. Carbon in carbonic acid	16·67
— — inflammable air	10·43
— — charcoal -	4·68
	31·78
3. Hydrogen in inflammable air	1·89
— — — water - -	1·64
	3·53

Hence oxalic acid is composed of oxygen	64·69
— — — — — — — carbon	31·78
— — — — — — — hydrogen	3·53
	100·00

7. The result of two other experiments on oxalate of lime was very nearly the same as the preceding. The following may be stated in round numbers as the mean of the whole. Oxalic acid is a compound of

Oxygen -	64
Carbon -	32
Hydrogen -	4
	100

8. The only other analysis of oxalic acid with which I am acquainted has been given by M. Fourcroy, as the result of his own experiments, in conjunction with those of Vauquelin *. It is as follows:

* *Systeme de Connois. Chem.* vii. 224.

Oxygen

		Grains.
Oxygen	-	77
Carbon	-	13
Hydrogen	-	10
		100

It gave me considerable uneasiness to observe, that my experiments led to conclusions irreconcileable with those of chemists of such eminence and consummate skill, and it was not without considerable hesitation that I ventured to place any reliance upon them. I am persuaded, however, that some mistake has inadvertently insinuated itself into their calculations; since the carbonic acid alone, formed during the distillation of oxalate of lime, contains considerably more carbon than the whole quantity which they assign to the oxalic acid decomposed. M. Fourcroy informs us, that oxalic acid is converted into carbonic acid and water, when acted upon by hot nitric acid; and this decomposition seems to have been the method employed to ascertain the proportion of the constituents of oxalic acid; but the numbers assigned by him do not correspond with this statement. For 10 parts of hydrogen require 60 of oxygen to convert them into water, and 13 of carbon require at least 33 of oxygen. So that instead of 77 parts of oxygen, there would have been required no less than 98 to convert the hydrogen and carbon into water and carbonic acid. It is true, that the surplus of oxygen may be conceived to be furnished by the nitric acid; but if this be admitted (and I have no doubt from experience that the nitric acid actually does communicate oxygen), it is difficult to see how the constituents of oxalic acid could be determined by any such decomposition, unless the quantity of oxygen furnished by the nitric acid were accurately ascertained.

[To be continued.]

XLVII. *Description of Mr.* G. Atkins's *Hydrometer for determining the Specific Gravity of both Solids and Liquids.*

To Mr. Tilloch.

SIR,

The present improved state of chemistry; its application to so many of our principal manufactures, and the necessity of determining the specific gravity of the various substances which are used in them, or affording in all cases an important indication with regard to their qualities, and being in many the only accurate measure of their value, may perhaps render the following description of an instrument for this purpose not unacceptable to your numerous readers.

By giving it a place in your valuable Magazine you will therefore oblige, Sir, your obedient servant,

Geo. Atkins.

57, Dorset-Street, Fleet-Street,
Sept. 10, 1808.

The specific gravity, or comparative weight of the majority of those substances which fall under the observation of the manufacturer, the mineralogist, or the chemist, having always been considered as one of their most distinguishing characteristics, a variety of methods have at different periods been resorted to for ascertaining it.

In point of accuracy, perhaps, the best mode of taking the specific gravity of a body is by a very good hydrostatic balance. This instrument, however, we may venture to affirm, can scarcely ever be obtained sufficiently perfect to be depended on for so nice a purpose.

Persons who are in the habit of adjusting balances, and those who use them with considerable care, well know the various sources of error to which they are liable. The circumstance of the arms of a beam being in equilibrio, is no proof of its correctness, unless it will remain so when either loaded or unloaded, and with exchange of scale-pans. The necessity of having a piece of steel for the beam which shall be perfectly homogeneous; the uncertainty with regard to the exact equality of the arms, in both weight and length; and, even when very nicely adjusted, its liability to acquire polarity,

polarity, and consequent derangement by magnetism; the expansion of either arm by the heat of the hand, or its contraction by a current of air, renders those instruments extremely liable to give anomalous results.

But supposing the balance not liable to error, it is too complicated in its use for any other than the man of science, in his closet, where time and close attention may be afforded; and since the application of science to the arts has become so general, chemists, manufacturers of acids, brewers, dyers, distillers, and all others whose manufacture consists of any chemical process, require a more simple and expeditious mode of ascertaining the specific gravity, and consequently the value of their articles, than by the hydrostatic balance. Indeed, in many concerns its use would be impracticable, it being necessary to intrust the business of examining the qualities of the substances in question to persons who have neither time or knowledge sufficient to enable them to apply an instrument of such a kind.

The HYDROMETER, on a variety of constructions, has been long made use of by distillers and all dealers in spirituous-liquors; and of late years brewers have generally adopted it, for its simplicity and facility in use compared with the hydrostatic balance or weighing bottle. But as the hydrometer for spirituous-liquors, and the saccharometer for malt-liquors, (which the author of this paper is in the habit of manufacturing,) are adapted solely to their respective purposes, he has long thought it a very desirable object to construct an instrument which would combine *simplicity* with an universality of application to all substances, fluid and solid, of which it might be requisite to ascertain the specific gravity. And it is presumed that this object is accomplished in the instrument about to be described.

Among the principal subjects of consideration in the construction of hydrometers, are, the form of the instrument which shall be best adapted to facilitate its motion in a fluid, and that it be of a convenient size, both for the sake of portability, and that it may require as small a sample of a fluid as possible to make an experiment with.

With these views, the spheroidical form is that which has

has been preferred for the bulb of this instrument, on account of its more readily dividing the fluid in its passage up and down; and the size of it is such, that half a pint of any liquid is sufficient for trial with it.

The hydrometer (see Plate IX.) consists of the bulb *b*, a small stem *a c*, with a cup *d* on its top to receive weights, and a shank *e f* beneath the bulb with a pointed screw, to which is affixed a cup *g*, to receive weights or solids when their specific gravities are required to be taken.

The instrument is accompanied with an accurate set of grain weights.

The weight of the hydrometer itself is 700 grains, and on adding 300 grains in the *upper cup*, and immersing it in distilled water, at the temperature of 60 degrees, Fahr. it will subside to the middle mark on the stem, and will then consequently displace 1000 grains of water.

It follows, therefore, from this adjustment of the bulk of the instrument, that each grain in the upper cup will represent one thousandth part of the specific gravity of the water, or one unit in specific gravity, if that of water be taken to be 1000; and one-tenth of a grain one-tenth of unit, which is also the value of each of the small divisions on the stem; and accordingly, when the hydrometer is immersed in any liquid until it sinks to the middle point on the stem, the specific gravity of such fluid will be indicated by the sum of the weight of the instrument (which is, as before stated, 700 grains) and the grains added in the upper cup.

Suppose, for example, that, on immersing the instrument in ether, it requires 34 grains in the top cup to make it subside to the middle mark on the stem. The specific gravity of such ether will in this case be $700 + 34 = \cdot 734$. And on putting the instrument into alcohol or wort, if it requires in the former case 125 grains, and in the latter 355, the specific gravity of the spirit will be ·825, and that of the wort 1·055.

To ascertain the specific gravity of a solid, we have to take any fragment less than 300 *grains; find its weight in air, and its weight in water, and take their difference; and on dividing*

dividing its weight in air by this difference the quotient will be its specific gravity.

The weight of a body in air is found by putting it in the *upper cup*, and adding grains until the hydrometer sinks in water to the mark on the stem. Now, as the substance and the additional weights in the cup will be altogether 300 grains, the weight of the body will of course be so many grains as the weights put in fell short of 300. Its weight in water will be found by putting it into the *lower cup*, and adding grains in the *upper cup* until the instrument sinks as before: the complement of the weights in the top cup to 300 being in like manner its weight in water.

Example.—If a body weighs in air 120 grains, and in water 104, the difference is 16. On dividing 120 by 16, we have for the quotient ·75, or (taking, as before, the specific gravity of water at 1000) 7·500 for the specific gravity of the body.

This instrument affords us consequently a very ready way of determining the purity or value of any alloy or metallic ore, and is therefore particularly adapted to the mineralogist. Thus, for example, the weight of a guinea, or its weight in air, is 128 grains; and if the gold is of its proper standard, it will weigh about 121 grains in water, or will lose one-eighteenth part *only* of its weight in air. If it loses more, therefore, it is not of its proper specific gravity, and consequently not of standard gold.

To find the specific gravity of any of the different species of wood or other bodies lighter than water;—after taking its weight in air as before, fix it on the small screw of the shank, and see how many grains it will then be necessary to add in the top cup, to sink the instrument to the mark, with the body on the screw; which will in this case be more than 300, on account of its buoyancy; and dividing its weight in air by the difference between the weights put in the top cup in each case, the quotient will be its specific gravity.

Thus, if on putting a piece of *willow* in the upper cup, it requires 258 grains to sink the hydrometer in water, the weight of the wood in air will be 42 grains; and if on fixing it to the screw beneath, the instrument requires 328 grains to sink it to the mark in water, (being 28 grains more than would be necessary to sink the instrument itself,) we have only to find the difference between the weights put into the top cup, which in this case is 70 grains; and dividing 42 by 70, we have ·6 or ·600 for the specific gravity of the wood.

For the man of science, the instrument with its set of weights is all that is necessary, and it is packed into a very small compass*; but to accommodate it to those who are concerned with spirituous liquors, and to brewers, the inventor attaches a scale, showing the relation between specific-gravities and the commercial or technical denominations of *per centage* with the former, and *pounds per barrel* with the latter.

It is needless to enumerate the various departments in which an attention to the specific gravities of bodies is now become of the first consequence, and wherein this instrument might be applied with advantage; and although many may be satisfied if they have any arbitrary standard to regulate their process by, yet it must be acknowledged that the universal standard of *specific gravity* is by far the best; for, by its currency all over Europe, it enables a person to know what relation their practice may bear to that of others in the same pursuit; and it would, by the universal adoption of it, prevent the many differences which exist among mercantile men, especially those who deal in, or pay duty on, spirituous liquors.

Indeed the wide field which opens, on considering the importance of paying attention to the specific gravity of bodies, convinces us that we are yet in infancy on the subject.

* The price of it is five guineas.

XLVIII. *De-*

XLVIII. *Description of Mr.* CHRISTOPHER WILSON'S *secure Boat, or Life Boat**.

SIR,

HEREWITH you will receive drawings of a neutral-built self-balanced boat, with an explanation, which I request you will have the goodness to lay before the Society for the Encouragement of Arts, &c. for their inspection and approbation. I have made the explanation as clear as I can. Its construction will obviate the danger of its being overset by persons crowding on one side in getting in or out of the boat; it will facilitate the landing of men on shore or in boarding ships, and will carry a much greater press of sail without danger.

As to the building part, I think that may be easily understood. My boat was made by men that had never before seen a boat built, and I flatter myself the Society will approve of it. I am, sir, your most obedient servant,

CHRISTOPHER WILSON.

March 10, 1806.

To C. TAYLOR, M.D. Sec.

An Explanation of the Engravings of a neutral-built self-balanced Boat.

By the term neutral is meant, what is neither of the two present modes now in use, *i. e.* clincher and carver, but both united, viz. clincher in the inside and carver on the outside, which neutralizes both the two into a third; and as every thing has a distinguishing name, I have taken the liberty to present it to the public under the name of a Neutral Boat.

The two modes of clincher- and carver-built have each their separate advantages and disadvantages in regard to each other.

I shall begin with the clincher first. As the sides of the planks are firmly fastened to each other, by lapping over and riveting, they are much stronger than if the edges only butted,

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce*, for 1807.——The gold medal of the Society was voted to Mr. Wilson for this invention.

butted, and they have the property of being made tight without caulking, only in the huddings and keel seams, and are much lighter than carver-built boats, and more adapted for many uses; beside saving the difference between thick and thin plank. But they have their disadvantages also: In the first place, both unfair sides and unfair water lines, which make them liable to be injured by other bodies they come in contact with, and have the edges of the planks broke so as to make a leak, which would not happen to a smooth-sided boat; neither can the uneven side move so well through the water, on account of its various resistances. They have also this disadvantage, that if damaged they require the skill of a professional workman to repair them.

The carver-built boats have the advantage of having smooth sides and fair water lines, together with having the planks of an equal thickness all over the boat, which makes them less liable to receive injuries when meeting with other bodies, and more adapted to move in the water, by their fair sides and fair water lines. They are also more readily repaired: if a professional boat-builder is not at hand, it can be done by a common shipwright, or any workman that is used to wood work.

But they have also their disadvantages. In the first instance they are under the necessity of being built of plank of a great thickness to stand caulking; at the same time they require larger timbers, which makes them heavy and unfit for many uses, and also a great consumption of timber on account of the thickness of the plank necessary. They are also more subject to leaks from various causes than clincher-built boats.

We will now look to the neutral system, and see if both their advantages are not united, and both the disadvantages got clear of.

Plate VIII. Fig. 2, shows the section of the fore part of a boat. The longitudinal slips are represented lighter-coloured, and placed over the joints where the edges of the planks meet; they must be riveted on to each adjoining plank, near the edge, in the same manner as clincher-built vessels, with a sufficient quantity of blair, made of tar and flocks,

flocks, such as is in common use in the North of England, (or any other caulking,) between the slips and planks, which will always keep them tight, as long as the boat remains unstaved, or the planks worn through. These slips, each being riveted to the two adjoining edges of the planks, as shown in Fig. 4, will make the joint as strong as the joint of a common clincher-built boat, and as tight, without the risk of any external damage. Those joints have also this advantage, that the planks will not have their sides bevelled off, but be of an equal thickness from edge to edge, which is not the case in clincher-built vessels; for at the ends they are half bevelled away, so as not to bear clinching. By the neutral system two inches in the breadth of each plank will be saved in the laps, which may be considerable in the conversion of plank. I set little value on the slips, as there is always a sufficiency of waste in cutting the planks to a proper form.

A boat of this construction has all the strength of one clincher-built, and can be made as light or lighter. It is free from the disadvantages of irregular outsides, and from the difficulty of repairing, which in this can be performed by any common workman in wood, as I have found by experience. A boat built this way has a fair and smooth outside, it has all the advantages of a carver-built one, at the same time it is clear of the disadvantages of being loaded with unnecessary wood, which makes the carver-work very heavy, the liability of leaks, and frequent want of caulking. There is one evil which both carver- and clincher-built boats have in common, that of having keel seams, and a vacancy between the sand or garboard streak, and the upper part of the keel, which soon gets filled with dirt, and remains so, which naturally retains moisture, and speedily rots the wood. In this mode that evil is removed, by having the midship plank bolted on to the keel, wide enough to come over each side of the keel to clinch the slips on: this not only removes the evil, but saves a great deal of trouble in making the rabbets in the keel, and various bevellings in the sand streaks, which must be done by a good workman.

These boats require no larger timbers than common clincher-built boats, as the timbers need no greater notches; but with this difference, that these timbers will catch the slips that are riveted over the joints of the planks each way, and so the timbers and slips will brace one another, and add an additional strength; but in the clincher-built boats, the timbers catch the laps of the seams only one way, and consequently form no brace whatever.

All I need to explain further on the neutral system is its application. It can be applied to all open boats, of whatever form or use, to all coal and other barges, lighters, or any vessels used in rivers or canals, and also to all large cutters and luggers, which are now clincher-built.

Explanation of Plate VIII. *Fig.* 1, 2, 3, 4.

Fig. 1, is a bird's-eye view of the boat, showing the projecting balance bodies, or hollow sides *a b*, one of which, *a*, is left open to show the partitions which are placed opposite to each timber, and are water-tight; by this means if one or more should be broken, the rest would keep the vessel buoyant. These partitions gradually lessen towards each end, where the planks unite, so as to make a similar appearance to any other boat when in the water.

Fig. 2, shows the depth and form of the cells or hollows, as they appear in a section of the boat; also the manner in which the slips are placed over the joinings, or seams of the planks.

Fig. 3, is a perspective view of the boat, in which *a b* show the projecting balance bodies, or hollow sides, which would render the boat buoyant if her bottom was staved in. *c*, the lower part or body of the boat, from which the projections commence; *d*, the keel.

Fig. 4, shows the manner in which the planks or timbers of the boat are united; *e f*, are two planks of the boat; *g*, the slip of wood placed over them, and secured to them by the rivets *h h*.

The section Fig. 2, will best explain the nature and utility of the self-balanced boat. The balance bodies form two separate holds, to put any thing in, such as provision, arms, &c. which are wanted to be kept dry, having locker lids,

lids, to open at the top of the different partitions in the holds, as fancy or utility may require; or part of them may be filled with cork shavings, and by that means, if the boat should happen to fill by any accident, she cannot sink.

In the boat I have altered for government, the balance bodies (if the interior of the boat was filled with water) would exclude as much water, between the inside of the boat and the outside, as is equal to a body of water of one ton 17cwt. 2qrs., which is a great deal more than the weight of men that will go in her, consequently they can run no risk whatever of being drowned; and even if she had a hole through her bottom, she would always keep a sufficient height out of the water either for rowing or sailing.

But the main object is to make her sail and row much faster than other boats; and both on calculation and trial my boat will be found to sail much faster and with much less danger than other boats.

I now come to the advantage of rowing.—As the balance sides project a foot beyond the resisting part in the water, there is that leverage on the boat (over a common one), and also the same in the length of the loom of the oar, that is in the inside from the gunwale of the boat, which allows the whole of the oar to be lengthened, and by that means it describes a larger circle in the water, and makes a longer pull: the oars for the government boat I have made are lengthened from 14 to 18 feet.

The experiment of having two spars fixed at a distance from a boat's gunwale, and the oars to work from them, has often been tried and found to answer, but this has a great advantage over that method.

There is another advantage or property which this boat has, she cannot roll at sea, but always keeps a level position as far as the surface of the sea will allow; she may heel but not roll, as the balances are always ready to catch either way, and the opposite one assists the other by its weight out of water and gravitation; neither can this boat pitch like another, for the balance bodies being out of the water, and the breadth of six feet only in the water, it can only act with a gravity on the water, equal to a boat of the weight of six feet, but as the resistance of the water upwards equal to a boat of eight feet wide.

Or I may make this mechanical simile: Suppose a workman uses a chisel to smooth a surface of wood; by laying too great a stress on the tool it will go too far into the wood for him to force it along in the direction wanted, but put that chisel into a stock like a plane-stock, and set it to the depth required, then the stock will prevent its going too far in, and he can work easily though the plane be pressed on ever so hard. A view of the engraving will elucidate that comparison, as the balance bodies lie parallel with the surface of the water lengthways. The national importance of such boats I leave to the public to decide. I must here observe, that my plan contains two distinct and separate improvements, viz. my neutral mode of building, and the application of the balance bodies.

The first improvement relates to the *building* of boats, barges, &c. in general. The second is only partial, and applicable to boats of peculiar descriptions or uses; that is, all such as are wanted for dispatch, safety, or pleasure, or occasionally for life-boats, as there can be no question of the self-balanced boats built upon my plan, rowing and sailing faster than other boats, and they may be used to go to sea when others cannot; but the application of the balance bodies is not meant as a general one, as it is not fit for vessels of burden that are sometimes light and at others heavy laden, when the difference of the draught of water is considerable.

CHRISTOPHER WILSON.

Certificate.—We whose names are hereunto subscribed have examined the boat building on Mr. Wilson's plan, (which he calls the neutral plan,) and are of opinion that it will be attended with many advantages.

The boats can be built as light as those that are clincher-built, preserving a smooth surface, and will not require caulking; and they can be easily repaired by any carpenter.

The advantage this boat possesses by having air gunwales is obvious, and from the partial trial we have had of the boat's sailing which he has altered, we are of opinion that his

his improvement in the keel and formation of the boat's bottom, will give her greater stability than other boats of the same dimensions, with the properties of sailing well and drawing very little water. MALCOLM COWAN, R.N.

JAMES NICOLSON, R.N.

London, May 7, 1806.

GENTLEMEN,

PERMIT me to present my thanks and acknowledgments for the truly polite and distinguished manner in which (though a stranger) you have permitted me to visit your committee; the society of which the same is formed I hold in the highest estimation, and have deeply to regret the distance that prevents my offering myself a candidate for a seat amongst you.

The last time I had the honour of attending your committee, Mr. Wilson's new life-boat became the subject of discussion, the operation of which you did me the honour of requesting me to acquaint you of as soon as an opportunity presented itself for a fair trial of her at sea.

About three o'clock in the afternoon of Friday last, the tide being about quarter flood, and the wind at souh-west, blowing excessively hard, an object was discovered in the offing at about two leagues distance, bearing from the piers of Newhaven W. S. W. which had the appearance of a vessel water-logged, and with only her foremast standing. This induced Mr. Thomas Tasker, (the person whom I appointed master of the boat, and which I have named the *Adeline*,) with seven others, to put to sea, with a view of rendering assistance to the supposed distressed vessel; and although the breakers were tremendous, and the sea without them running very high, the boat, under the management of the crew before mentioned, ranged as coxswain, six setters, and a bowman, went out of the harbour in a very lively style, and soon came up with the object in pursuit, which proved to be a beacon, or light-house, of a singular construction, triangularly built, and clench-board covered in its floating case, with a mast rigged out in the centre of one of the sides, and supposed to have broken adrift

adrift from the enemy's coast by the boisterous weather. Finding its magnitude too vast for their strength to tow, and the evening approaching, they returned. Numbers of persons were assembled on the piers to witness the action, power, and performance of the boat, who were highly pleased and gratified. I was not present myself, but the next morning one of the crew was sent to me from Newhaven to this place, who stated that the whole of them were so fully satisfied with the safety and superior powers of the boat, that they shall not be afraid to put to sea in any weather when the distresses of their fellow-creatures claim their exertions and assistance. They particularly observed, she, with the six oars manned, pulled extremely light and easy through the water, and that though the breakers they pulled through, and the heavy seas they rode over were awful, she did not ship ten gallons of water the whole trip, neither were the men wet on the seats. We have now at Newhaven one of Mr. Greathead's boats, provided by subscription; but from the difficulty of getting her to sea, and her weight and construction rendering it almost impossible to pull her through the broken water, it is very improbable she will ever be used.

My opinion is, that Mr. Wilson's boat will answer. Its cost I conceive will exceed 150*l.* including the building and fitting her out.

I have the honour to subscribe myself, with the greatest respect, Gentlemen, your obliged and most obedient humble servant,

WILLIAM BALCOMBE LANGRIDGE.

P. S. I should have observed, that the crew pulled her *stern on* at every sea, and that such water as in general fills over the bow of ordinary boats, is received by the fore-part of her flammings, or floor of extended sides, and sent or dispersed side-ways.

Lewes, Sussex,
December 25, 1806.

To C. TAYLOR, M.D. Sec.

XLIX. *De-*

XLIX. *Description of a Capstan, which works without requiring the Messenger or Cable coiled round it to be ever surged.* *By* J. WHITLEY BOSWELL, *Esq.**

SIR,

I REQUEST you will lay before the Society of Arts, &c. the model of a capstan contrived by me, which works without requiring the messenger or cable coiled round it to be ever surged, an operation necessary with common capstans, which is always attended with delay, and frequently with danger. Capstans of this kind can be made by a common shipwright, and would not be liable to be put out of order. They also would not occasion any additional friction or wear to the messenger or cable, in which particulars they would be superior to the other contrivance hitherto brought forward for the same purpose; they also would much facilitate the holding on.

The great loss of time and great trouble which always attend applications to the navy board, prevent my attempting to bring the matter before the public through that channel, though I have had the most unequivocal approbation of the capstan from the two gentlemen of that board best qualified to judge of it. I mention this, lest it might be thought that my not applying there first was from any doubt of the goodness of the invention. If the society should approve of the capstan, I will draw up a more minute account of it for publication. I am, sir, your very humble servant,

J. W. BOSWELL.

Hatton Garden,
October 29, 1806.

To C. TAYLOR, M.D. Sec.

SIR,

I HAVE examined your model of a capstan, which is calculated to prevent the surging of the messenger when heav-

* From *Transactions of the Society for the Encouragement of Arts, Manufactures, and Commerce,* for 1807.——The gold medal of the Society was voted to Mr. Boswell for this invention.

ing

ing in the cable: it certainly possesses great merit, and the idea to me is quite new. I am, sir, your humble servant,

WILLIAM RULE.

Somerset-place,
November 19, 1806.
To Mr. BOSWELL.

SIR,

ACCORDING to your desire, I transcribe the part of the letter from Mr. Peake (surveyor of the navy) to me, which relates to the capstan laid before the society.

Extract of a Letter from Henry Peake, Esq.

"With regard to your ideas on the capstan, I have tried all I can to find some objection to it, but confess I hitherto have been foiled, and shall more readily forward it, if it was only to supersede a plan now creeping into the service, more expensive, and much worse than one lately exploded."

As you and the members of the committee have seen the letter, I imagine further attestation needless relative to it.

I request you will mention, that all friction of the revolutions of the cable (or messenger) in passing each other between the barrels of the capstan, must be effectually prevented by the whole thickness of one of the rings that passes betwixt each crossing. I add this, because one of the gentlemen of the committee wished to be informed on this point.

I am, sir, your very respectful humble servant,

J. W. BOSWELL.

Hatton Garden,
November 26, 1806.
To C. TAYLOR, M.D. Sec.

SIR,

IN obedience to your intimation, that a written explanation of the advantages to be obtained by the use of capstans made according to the model which I laid before the Society for the Encouragement of Arts, &c. would be acceptable, I send the following, which I hope will make the subject sufficiently clear.

As

As few but mariners understand the manner in which cables are hauled aboard in large ships, it will probably render the object of my capstan more manifest, to give some account of this operation.—Cables above a certain diameter are too inflexible to admit of being coiled round a capstan; in ships where cables of such large dimensions are necessary, a smaller cable is employed for this purpose, which is called the *messenger*, the two ends of which are made fast together so as to form an endless rope, which, as the capstan is turned about, revolves round it in unceasing succession, passing on its course to the head of the ship, and again returning to the capstan. To this returning part of the messenger, the great cable is made fast by a number of small ropes, called nippers, placed at regular intervals; these nippers are applied, as the cable enters the hawse hole, and are again removed as it approaches the capstan, after which it is lowered into the cable tier.

The messenger, or any other rope coiled round the capstan, must descend a space at every revolution equal to the diameter of the rope or cable used; this circumstance brings the coils in a few turns to the bottom of the capstan, when it can no longer be turned round, till the coils are loosened and raised up to its other extremity, after which the motion proceeds as before. This operation of shifting the place of the coils of the messenger on the capstan is called *surging the messenger*. It always causes considerable delay; and when the messenger chances to slip in changing its position, which sometimes happens, no small danger is incurred by those who are employed about the capstan.

The first method that I know of, used to prevent the necessity of surging, was by placing a horizontal roller beneath the messenger, where it first entered on the capstan so supported by a frame, in which it turned on gudgeons, that the messenger in passing over it was compelled to force upwards all the coils above the capstan, as it formed a new coil.

This violent forcing of the coils upwards along the barrel of the capstan, not only adds considerably to the labour in turning the capstan, but from the great friction which the messenger

messenger must suffer in the operation, while pressed so hard against the capstan, (as it must be by the weight of the anchor and strain of the men,) could not but cause a very great wear and injury to the messenger, or other cable wound round the capstan; and that this wear must occasion an expense of no small amount, must be manifest on considering the large sums which the smallest cables used for this purpose cost.

The next method applied to prevent surging, was that for which Mr. Plucknet obtained a patent, the specification of which may be seen in the Repertory of Arts, No. 46. In this way a number of upright puppets or lifters, placed round the capstan, were made to rise in succession, as the capstan turned round by a circular inclined plane placed beneath them, over which their lower extremities moved on friction wheels; and these puppets, as they rose, forced upwards the coils of the messenger on the barrel of the capstan. This was a superior method to the first, as the operation of forcing upwards the coils was performed more gradually by it; but still the wear of the messenger from the lateral friction in rising against the whelps of the capstan remains undiminished.

The third method used for the same purpose was that proposed by captain Hamilton. It consisted in giving the capstan a conical shape, with an angle so obtuse, that the strain of the messenger forced the coils to ascend along the sloped sides of the barrel. The roller first mentioned was sometimes used with this capstan, of which a full account is inserted in the Repertory of Arts, vol. ii. The lateral friction, and wear of the messenger against the whelps of the capstan, is equally great in this method as in the others; and it, besides, has the inconvenience of causing the coils to become loose as they ascend; for as the upper part of the barrel is near a third less in diameter than the lower part, the round of the messenger that tightly embraced the lower part, must exceed the circumference of the upper extremity in the same proportion.

In the method of preventing the necessity of surging, which the model I have had the honour of laying before the

the society represents, none of the lateral friction of the messenger or cable against the whelps of the capstan, (which all the other methods of effecting the same purpose before mentioned labour under,) can possibly take place, and of course the wear of the messenger occasioned thereby will be entirely avoided in it, while it performs its purpose more smoothly, equally, and with a less moving power than any of them.

My method of preventing the necessity of surging, consists in the simple addition of a second smaller barrel or capstan of less dimensions to the large one; beside which it is to be placed in a similar manner, and which need not in general exceed the size of a half-barrel cask. The coils of the messenger are to be passed alternately round the large capstan and this small barrel, but with their direction reversed on the different barrels, so that they may cross each other in the interval between the barrels, in order that they may have the more extensive contact with, and better gripe on each barrel. To keep the coils distinct, and prevent their touching each other in passing from one barrel to the other, projecting rings are fastened round each barrel, at a distance from each other equal to about two diameters of the messenger and the thickness of the ring. Those rings should be so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel: and this is the only circumstance which requires any particular attention in the construction of this capstan. The rings should project about as much as the cable or messenger from the barrels, which may be formed with whelps, and in every other respect, not before mentioned, in the usual manner for capstan barrels, only that I would recommend the whelps to be formed without any inclination inwards at the top, but to stand upright all round, so as to form the body of the capstan in the shape of a polygonal prism, if the intervals between the whelps are filled up, in order that the coils may have equal tension at the top and at the bottom of the barrels, and that the defect which conical barrels cause in this respect may be avoided.

The

The small barrel should be furnished with falling palls as well as the large ones; a fixed iron spindle ascending from the deck will be the best for it, as it will take up less room. This spindle may be secured below the deck, so as to bear any strain, as the small barrel need not be much above half the height of the large barrel; the capstan bars can easily pass over it in heaving round, when it is thought fit to use capstan bars on the same deck with the small barrel. As two turns of the messenger round both barrels will be at least equivalent to three turns round the common capstan, it will hardly ever be necessary to use more than four turns round the two barrels.

The circumstance which prevents the lateral friction of the messenger in my double capstan, is, that in it each coil is kept distinct from the rest, and must pass on to the second barrel, before it can gain the next elevation on the first, by which no one coil can have any influence in raising or depressing another; and what each separate coil descends in a single revolution, it regains as much as is necessary in its passage between the barrels, where in the air, and free from all contact with any part of the apparatus, it attains a higher elevation without a possibility of friction or wear.

I have described my double capstan, as it is to be used in large vessels, where messengers are necessary, from the great size of the cables; but it is obvious that it is equally applicable in smaller vessels, as their cables can be managed with it in the same manner as is directed for the messenger. The same principle may also be easily applied to windlasses, by having a small horizontal barrel placed parallel to the body of the windlass, and having both fitted with rings, in the same way as the capstan already described. The prope place for the small horizontal barrel is forward, just befo the windlass, and as much below its level as circumstances will admit; it should be furnished with catch-palls as well as the windlass.

Besides the advantages already stated, my proposed improvement to the capstan has others of considerable utility. Its construction is so very simple, that it is no more liable to derangement or injury than the capstan itself. Its cost can

can be but small, and every part of it can be made by a common ship carpenter, and be repaired by him at sea if damaged by shot. It will take up but little room, only that of a half-barrel cask; and it is of a nature so analogous to that kind of machinery to which sailors are accustomed, that it can be readily understood and managed by them.

In order to render the description of my double capstan more clear, I annex a sketch of it, as fitted up in the manner proposed. I am, sir, your very humble servant,

J. WITLEY BOSWELL.

To C. TAYLOR, M.D. Sec.

Reference to the Engraving of Mr. Boswell's improved Capstan, to prevent the Necessity of surging. Plate VIII. Fig. 5.

A Represents the larger or common capstan used on board ships.

B Another capstan of less dimensions, placed in a similar manner.

C The coils of the messenger passing alternately round the large and small capstans, but with their direction reversed on the different barrels, so that they may cross each other in the interval between them.

DDDD Projecting rings round each capstan or barrel, so fixed on the two barrels, that those on one barrel should be exactly opposite the middle of the intervals between those on the other barrel.

L. *On the Nature of the Earths.*

To Mr. Tilloch.

SIR,

THE result of the late experiments by Messrs. Davy, Berzelius*, and Pontin, has only confirmed the idea entertained by Lavoisier and others with regard to the nature of earths and alkalis, which were suspected to be merely metallic oxides

* Phil. Mag. vol. xxxi. p. 149.

oxides irreducible by any hitherto known process. This opinion was first adopted with reference to barytes, which participates of the properties of both classes of bodies, and was from analogy extended to the other members of the two species.

Very shortly after Lavoisier's *Elemens de Chimie* were published, some experiments, made at Schemnitz in Lower Hungary, by Toudi* and Ruprecht, were given to the world, by which it appeared that they had effected the reduction of barytes, magnesia, and lime. These results, the translator of that work, Mr. Robert Kerr, introduced into the second English edition, immediately succeeding the speculations of Lavoisier above alluded to, and accompanied them with some original remarks on the nature and arrangement of physical bodies, which, as they are peculiarly applicable to the present moment, I have thought proper to transmit to you.

He observes †: "These discoveries give reason to hope, that chemistry may one day arrive at a most beautiful state of simplicity. It is, perhaps, no improbable conjecture, that all the bodies in nature may be referred to *one class of simple combustible elementary substances, to oxygen and caloric*; and that, from the various combinations of these with each other, all the variety produced by nature and art may arise. The only known difference between metals and pure combustibles, as they are called, is in degrees of qualities. They are all combustible; that is, they all combine with oxygen, though under different degrees of temperature; and in different states of saturation with that body form oxides, which have *alkaline* ‡ or acid properties."

* Although Klaproth (*a*) and Tihawski have called the accuracy of Toudi and Ruprecht's results into question, their objections do not affect the purpose for which the experiments are here introduced.

† Elements of Chemistry, vol. i. p. 265, fifth edit.

‡ His opinion on this subject received corroboration from some experiments published in the *Transactions of the Turin Academy*, which gave reason for supposing that soda was a modification of magnesia, this latter body being, according to Toudi and others, a metallic oxide; and he concludes with observing that, "*from analogy, we may presume potash to be a metallic substance, in some hitherto unknown state of combination.*"

(*a*) *Annales de Chimie*, tome ix. p. 53, 54.

Such

Such were Mr. Kerr's views of chemical science at least fourteen years ago. Of their correctness and claim to attention, we cannot have a stronger proof than the aptness of their reference to the present reformed state of knowledge. The classification, for instance, into oxygen and inflammable matter*, which he suggests, is precisely the arrangement according to which natural bodies now divide themselves; and with regard to his idea, that alkalinity depended upon the dose of oxygen with which the combustible was united, (chimerical as it might have appeared in the day it was elicited,) we now possess proof of its truth. So that, although this respectable philosopher has forborne to obtrude his speculations on the world at the present moment, and is, therefore, suffering himself to creep into the charnels of obscurity, we find that he is entitled to some attention, and I have allotted myself the present task solely for the purpose of dragging him into view.

That future experiments will demonstrate hydrogen to be the common inflammable principle, and teach us that that substance and oxygen are the ultimate constituents of matter, is more than probable: there exist many facts which might be adduced to prove the point; amongst which, the late most ingenious experiments of Braconnot † are by no means inconspicuous, notwithstanding the captious and jejune objections made to them by an English professor of high respectability. Oxygen and hydrogen, in fact, are the only well characterized elementary substances in nature.

I am, sir, your obedient servant,

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* The test by which we have hitherto judged of the combustibility or incombustibility of matter, has depended upon the affinity which carbon possesses for oxygen; all those substances which enjoy a stronger affinity than carbon for that body having been called incombustible, and those bodies whose affinity has been weaker having been ranked among the class of inflammables.

† *Annales de Chimie*, tome lxi. p. 187.

LI. *On Super-acid and Sub-acid Salts.* By William Hyde Wollaston, *M.D. Sec. R. S.**

In the paper which has just been read to the society, Dr. Thomson has remarked, that oxalic acid unites to strontian as well as to potash in two different proportions, and that the quantity of acid combined with each of these bases in their super-oxalates, is just double of that which is saturated by the same quantity of base in their neutral compounds.

As I had observed the same law to prevail in various other instances of super-acid and sub-acid salts, I thought it not unlikely that this law might obtain generally in such compounds, and it was my design to have pursued the subject, with the hope of discovering the cause to which so regular a relation might be ascribed.

But since the publication of Mr. Dalton's theory of chemical combination, as explained and illustrated by Dr. Thomson †, the inquiry which I had designed appears to be superfluous, as all the facts that I had observed are but particular instances of the more general observation of Mr. Dalton, that in all cases the simple elements of bodies are disposed to unite atom to atom singly, or, if either is in excess, it exceeds by a ratio to be expressed by some simple multiple of the number of its atoms.

However, since those who are desirous of ascertaining the justness of this observation by experiment, may be deterred by the difficulties that we meet with in attempting to determine with precision the constitution of gaseous bodies, for the explanation of which Mr. Dalton's theory was first conceived, and since some persons may imagine that the results of former experiments on such bodies do not accord sufficiently to authorize the adoption of a new hypothesis, it may be worth while to describe a few experiments, each of which may be performed with the utmost facility, and each of which affords the most direct proof of the proportional redundance or deficiency of acid in the several salts employed.

* From Philosophical Transactions for 1808.

† Thomson's Chemistry, 3d edit. vol. iii. p. 425.

Sub-

Sub-carbonate of Potash.

Experiment I. Sub-carbonate of potash recently prepared, is one instance of an alkali having one-half the quantity of acid necessary for its saturation, as may thus be satisfactorily proved.

Let two grains of fully saturated and well crystallized carbonate of potash be wrapped in a piece of thin paper, and passed up into an inverted tube filled with mercury, and let the gas be extricated from it by a sufficient quantity of muriatic acid, so that the space it occupies may be marked upon the tube.

Next, let four grains of the same carbonate be exposed for a short time to a red heat; and it will be found to have parted with exactly half its gas; for the gas extricated from it in the same apparatus will be found to occupy exactly the same space as the quantity before obtained from two grains of fully saturated carbonate.

Sub-carbonate of Soda.

Experiment II. A similar experiment may be made with a saturated carbonate of soda, and with the same result; for this also becomes a true semi-carbonate by being exposed for a short time to a red heat.

Super-sulphate of Potash.

By an experiment equally simple, super-sulphate of potash may be shown to contain exactly twice as much acid as is necessary for the mere saturation of the alkali present.

Experiment III. Let twenty grains of carbonate of potash (which would be more than neutralized by ten grains of sulphuric acid) be mixed with about twenty-five grains of that acid in a covered crucible of platina, or in a glass tube three quarters of an inch diameter, and five or six inches long.

By heating this mixture till it ceases to boil, and begins to appear slightly red hot, a part of the redundant acid will be expelled, and there will remain a determinate quantity forming super-sulphate of potash, which when dissolved in water will be very nearly neutralized by an addition of twenty grains more of the same carbonate of potash; but it is generally found very slightly acid, in consequence of the small quantity of sulphuric acid which remains in the vessel in a gaseous state at a red heat.

In the preceding experiments, the acids are made to assume a determinate proportion to their base, by heat which cannot destroy them. In those which follow, the proportion which a destructible acid shall assume cannot be regulated by the same means; but the constitution of its compounds previously formed, may nevertheless be proved with equal facility.

Super-oxalate of Potash.

Experiment IV. The common super-oxalate of potash is a salt that contains alkali sufficient to saturate exactly half of the acid present. Hence, if two equal quantities of salt of sorrel be taken, and if one of them be exposed to a red heat, the alkali which remains will be found exactly to saturate the redundant acid of the other portion.

In addition to the preceding compounds, selected as distinct examples of binacid salts, I have observed one remarkable instance of a more extended and general prevalence of the law under consideration; for when the circumstances are such as to admit the union of a further quantity of oxalic acid with potash, I found a proportion, though different, yet analogous to the former, regularly to occur.

§. *Quadroxalate of Potash.*

In attempting to decompose the preceding super-oxalate by means of acids, it appeared that nitric or muriatic acids are capable of taking only half the alkali, and that the salt which crystallizes after solution in either of these acids, has accordingly exactly four times as much acid as would saturate the alkali that remains.

Experiment V. For the purpose of proving that the constitution of this compound has been rightly ascertained, the salt thus formed should be purified by a second crystallization in distilled water; after which the alkali of thirty grains must be obtained by exposure to a red heat, in order to neutralize the redundant acid contained in ten grains of the same salt. The quantity of unburned salt contains alkali for one part out of four of the acid present, and it requires the

the alkali of three equal quantities of the same salt to saturate the three remaining parts of acid.

The limit to the decomposition of super-oxalate of potash by the above acids, is analogous to that which occurs when sulphate of potash is decomposed by nitric acid; for in this case also, no quantity of that acid can take more than half the potash, and the remaining salt is converted into a definite super-sulphate, similar to that obtained by heat in the third experiment.

It is not improbable that many other changes in chemistry, supposed to be influenced by a general redundance of some one ingredient, may in fact be limited by a new order of affinities taking place at some definite proportion to be expressed by a simple multiple. And though the strong power of crystallizing in oxalic acid, renders the modifications of which its combinations are susceptible more distinct than those of other acids, it seems probable that a similar play of affinities will arise in solution, when other acids exceed their base in the same proportion.

In order to determine whether oxalic acid is capable of uniting to potash in a proportion intermediate between the double and quadruple quantity of acid, I neutralized forty-eight grains of carbonate of potash with thirty grains of oxalic acid, and added sixty grains more of acid, so that I had two parts of potash of twenty-four grains each, and six *equivalent* quantities of oxalic acid of fifteen grains each, in solution, ready to crystallize together, if disposed to unite, in the proportion of three to one; but the first portion of salt that crystallized, was the common binoxalate, or salt of sorrel, and a portion selected from the after crystals (which differed verey discernibly in their form) was found to contain the quadruple proportion of acid. Hence it is to be presumed, that if these salts could have been perfectly separated, it would have been found, that the two quantities of potash were equally divided, and combined in one instance with two, and in the other with the remaining four out of the six *equivalent* quantities of acid taken.

To account for this want of disposition to unite in the pro-

 portion

portion of three to one by Mr. Dalton's theory, I apprehend he might consider the neutral salt as consisting of

	2 particles potash	with	1 acid,
The binoxalate as	1 and 1, or 2	with	2,
The quadroxalate as	1 and 2, or 2	with	4;

in which cases the ratios which I have observed of the acids to each other in these salts would respectively obtain.

But an explanation, which admits the supposition of a double share of potash in the neutral salt, is not altogether satisfactory; and I am further inclined to think, that when our views are sufficiently extended, to enable us to reason with precision concerning the proportions of elementary atoms, we shall find the arithmetical relation alone will not be sufficient to explain their mutual action, and that we shall be obliged to acquire a geometrical conception of their relative arrangement in all the three dimensions of solid extension.

For instance, if we suppose the limit to the approach of particles to be the same in all directions, and hence their virtual extent to be spherical (which is the most simple hypothesis); in this case, when different sorts combine singly there is but one mode of union. If they unite in the proportion of two to one, the two particles will naturally arrange themselves at opposite poles of that to which they unite. If there be three, they might be arranged with regularity at the angles of an equilateral triangle in a great circle surrounding the single spherule; but in this arrangement, for want of similar matter at the poles of this circle, the equilibrium would be unstable, and would be liable to be deranged by the slightest force of adjacent combinations; but when the number of one set of particles exceeds in the proportion of four to one, then, on the contrary, a stable equilibrium may again take place, if the four particles are situated at the angles of the four equilateral triangles composing a regular tetrahedron.

But as this geometrical arrangement of the primary elements of matter is altogether conjectural, and must rely for its conformation or rejection upon future inquiry, I am desirous that it should not be confounded with the results of

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the facts and observations related above, which are sufficiently distinct and satisfactory with respect to the existence of the law of simple multiples. It is perhaps too much to hope, that the geometrical arrangement of primary particles will ever be perfectly known; since even admitting that a very small number of these atoms combining together would have a tendency to arrange themselves in the manner I have imagined; yet, until it is ascertained how small a proportion the primary particles themselves bear to the interval between them, it may be supposed that surrounding combinations, although themselves analogous, might disturb that arrangement; and in that case, the effect of such interference must also be taken into the account, before any theory of chemical combination can be rendered complete.

LII. *On the Uses of Sugar for fattening Cattle.*

The honourable the West India committee having made their fourth report to the house of commons on the distillation of sugar and molasses, we make the following extracts from that part which relates to the feeding of cattle with sugar, and which we think will be interesting to the majority of our readers.

"In the course of their inquiries it has appeared obvious to your committee, that effectual relief to the West Indian colonies was only to be expected in one of the three following ways: a change of their staple commodity, sugar, for some more lucrative produce; a reduction of the expenses attending its cultivation and sale; or an advance of price, whether effected by an increase of the demand, or a diminution of the supply.

"Under such circumstances, your committee could not but favourably entertain the consideration of a plan for employing sugar in fattening cattle. The advantages of this scheme, supposing the success to be but moderately answerable to the expectations formed, are obvious and peculiar; the relief it offers would be of the most desirable kind, that of opening a new source of consumption—within ourselves,

selves, and therefore independent of external accidents, or war; not interfering with the interest of any body of men whatever; extensive in proportion to the degree in which it should prove beneficial to those great classes, the feeders and consumers of cattle; and on the favourable supposition of eminent success, it would be attended with this especial advantage, that whatever increase of the price of sugar might be occasioned by the increased consumption from this cause, the burden would fall generally on the whole country, and might perhaps be even compensated by a reduction in the price of cattle, arising from the improvement in the mode of feeding them." "As, however, it is evident, that even the present price of sugar, swelled as it is by the duty, must prove an insuperable bar to its adoption for this purpose, your committee thought it adviseable to inquire into the possibility of admitting a drawback, to be received on all so employed, without risk to the present revenue, which appears, by the evidence of Mr Frewin, to form the only ground of doubt concerning the allowance."

"On private application, Mr. Parkes*, a very intelligent practical chemist, took the subject into consideration, and in a manner very creditable to his public spirit undertook a course of experiments, and has detailed in a very clear and able paper (which will be found in his evidence) several substances, which appear capable of being so united with sugar, as to prevent its being again used either for common œconomical purposes, or in wash for distillation, and from which it cannot be again separated without very considerable skill, difficulty and expense, at the same time not injuring, as is supposed, its nutritive qualities."

The committee then relate to the house some of the circumstances that have occasioned the present distresses of the West India planters, and conclude by recommending it to the house to reduce the duty on sugar for common consumption.

APPENDIX TO THE REPORT.

25th day of May 1808. Lord Binning in the chair.

* Author of the Chemical Catechism.

Sir

Sir John Sinclair, Bart. M.P. called, and examined by the committee.

"Has the board of agriculture been taking any steps to ascertain the effects of sugar in feeding or fattening live stock?" "Directions were given to Mr. Arthur Young, secretary to the board, to collect as many facts as he possibly could, tending to point out the advantages of the use of sugar in feeding or fattening live stock, which are now given in; and a premium has been offered by the board to the following effect: '*To the persons who shall make and report to the board the most satisfactory experiments to ascertain the quantity, the effect, and the value of brown muscovado sugar, in feeding or fattening oxen, cows, hogs, or sheep, a piece of plate of the value of 25 guineas.*'

"The board would have been very happy to have given a larger premium, had its funds admitted of it; but full justice cannot be done to so extensive an inquiry, unless premiums to so large an amount as 1000*l.* in all were granted by parliament for that special purpose."

John Curwen, Esq. M.P. was then examined by the committee, who stated that he had tried sugar and molasses on calves, without success: "But," said he, "I conceive it may be applied for rearing stock, giving a part skim-milk." He stated that he had used it in the proportion of 2 oz. of molasses boiled in two gallons of water, which was found to produce great laxity in the animal. On this the committee remark (page 395): "The apparent results from the evidence of an honourable member of this house appear discouraging; but it does not seem impossible to account for them, without concluding against the general effect of sugar given in larger quantities, and in a less *diluted* form. Experiments, which it is hoped will prove more decisive, are about to be instituted."

27th day of May 1808. Lord Binning in the chair.

Arthur Young, esq. called, and examined by the committee.

"Can you give the committee any information as to the probability

probability of feeding live stock with sugar or molasses with success?"

"Whatever I know relative to this subject has been from reading, and a very little personal information from one or two individuals; and the whole is detailed in a paper, which the president of the board of agriculture informed me he had delivered in to the committee." "Should it be found upon experience to answer, it seems to offer a very considerable market for sugar; for on the average of the last six years London has consumed 123,000 oxen, and 827,000 sheep." Calculating from the London consumption, he goes on to show that if the use of sugar were general for feeding cattle, the whole consumption of the kingdom, at 2 oz. for each animal per day for six months, (which, at 4*d.* per pound, would be only ½*d.* per day,) would amount to 140,000 hhds. annually. "Do you conceive the sugar would be nourishing to the cattle, from the bulk of the food, or merely by assisting the nutriment derived from other substances?" "I do not apprehend that the bulk of any quantity of sugar that could be given would be material in fattening a beast; but the quality of the food I conceive to be so good, that it would render other articles of nourishment of a much more fattening nature; for instance, you could not fatten a beast upon cut straw or bran, but with the addition of a small quantity of sugar, I should apprehend such an effect might take place."

13th day of June 1808. Lord Binning in the chair.

Mr. Samuel Parkes called, and examined by the committee.

"What is the business in which you are engaged?" "A manufacturing chemist."

"Have you made any experiments on the mixture of different substances with sugar, so as to prevent its being used for domestic purposes, or for distillation, without injuring its nutritious qualities?" "I have made many experiments, the results of which I am ready to state to the committee."

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The witness here read, and afterwards, on the 16th of June, delivered in to the committee the following statement:

"When I was informed of your inquiries respecting the possibility of rendering sugar unfit for common use, without destroying its nutritious properties, and received your requisition to engage in the investigation of the subject, I lost no time in instituting such a series of experiments as I conceived would be necessary to ascertain the fact.

"This being entirely new ground, no chemist having ever engaged in such an undertaking that we know of, I made a great number of experiments, the chief of which I will endeavour to describe, and their results, with as much brevity as the nature of the subject will permit.

"Interwoven with these details you will perceive an account of some facts already known to chemists; but I was desirous of furnishing you with every thing of importance on the subject. To this end I have examined a large body of chemistry with great care, and I hope no work has escaped me that would have thrown any light upon the inquiries in which you are engaged.

"Sugar is said to contain more nutriment in the same bulk than any other known substance*; but how to allow its use duty free for the purpose of feeding cattle, and at the same time guard against any encroachment upon the revenue now arising from it, may be attended with considerable difficulties.

"The chief difficulty, in my estimation, arises from the soluble nature of sugar; for, if sugar be mixed with ground corn, barley meal, or other farinaceous matter, which it might be in the presence of an excise officer, there would be danger of its afterwards being washed out by means of water, the water evaporated, and the sugar brought again into the market.

"One pound of water is capable of dissolving one pound of sugar. Lime-water renders sugar still more soluble, and deprives it of a part of its sweetness; but as water takes up so small a portion of lime, (300 parts of water dissolving only

* See the papers of Dr. Rush, of Philadelphia, on this subject.

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one part of lime,) I conceive this would not be a proper means of rendering sugar unfit for common use. Lime in powder, if mixed with sugar, might perhaps answer better, if this would not injure the cattle; and it would prevent the sugar so mixed from being fraudulently used for the still, as lime, even in small quantities, has the property of rendering sugar incapable of fermentation*.

" An aqueous solution of sugar may be preserved a long time unaltered if the sugar be pure; but if mixed with mucilaginous or farinaceous matters, it quickly enters into the vinous fermentation. This property of sugar is an objection to its being mixed in a state of solution with any kind of ground corn for any considerable time before it is intended for use.

" Sugar is found by analysis to be a triple compound, consisting of 28 parts, by weight, of carbon, 8 parts of hydrogen, and 64 parts of oxygen.

" Sugar being of vegetable origin, few bodies are capable of uniting chemically with it. Most substances therefore, if mixed with it, would form mere mixtures and not chemical compounds. There is one substance, however, which mixes readily with sugar, which destroys its taste entirely, and yet does not decompose it. This is a fixed alkali. If, therefore, potash or soda be mixed with sugar, either of them will completely destroy its saccharine taste; but the sugar will not be decomposed, for it may be recovered unchanged by the addition of sulphuric acid, which would form an alkaline sulphate which might be precipitated from the solution by alcohol. Hence it may be supposed, that the mixture of a small quantity of an alkali with sugar would not deprive it of its nutritious qualities.

* On the 4th of August 1798, Mr. Cruickshank made the following experiment. He dissolved two separate ounces of sugar each in five oz. of water in separate vessels, and added a two-drachm measure of yeast to each. To the one he afterwards added a little fresh lime in powder, and placed both vessels in a favourable situation for fermentation. In twelve hours one mixture began to ferment, but that containing the lime showed no signs of fermentation, though it was continued in a favourable situation during a period of twenty-four days. A similar experiment was made with potash with the same result.

" Having

" Having mixed 112 grains of good brown sugar with 10 grains of a very strong solution of caustic potash, the sugar lost its sweetness entirely, and the whole acquired a disagreeable urinous taste. One cwt. of sugar would require about 4lbs. of American potash to reduce it to this state, the expense of which would be about 2*s.* 9*d.* or 3*s.* On the mixture of potash and sugar I poured three grains of sulphuric acid, diluted with a little water. This restored the sugar to its usual flavour, the sulphuric acid having formed a salt by its union with the alkali. The expense of thus recovering the saccharine taste of the sugar would be only 1*s.* per cwt.; but as a salt would then be in solution with it, this would prevent its being applied to common purposes, for the affusion of alcohol would be too dear an expedient to recover it; and if the solution of sugar and potash were boiled, the sulphate of potash that might be formed by the addition of sulphuric acid could not be separated from the sugar even by alcohol.

" Sugar has the property of rendering oil miscible with water: any cheap refuse oil therefore that the cattle would eat might be mixed with it, and this property would give facility to the mixture.

" I mixed intimately four grains of palm oil with 112 grains of sugar. The mixture acquired a full taste of the oil, so as to render it unfit for household purposes; but the flavour is so grateful, that it is very probable cattle would eat it with greediness. Four pounds of palm oil, which on an average would cost 2*s.* 6*d.*, would be sufficient to prepare one cwt. of sugar.

" There is, however, another oil that would come much cheaper, which might readily be mixed with sugar, though I have some doubts whether cattle could be brought to eat any food with which it were united. What I refer to is animal oil, or oil of hartshorn.

" A single drop of oil of hartshorn was carefully mixed with 224 grains of raw sugar (a proportion of half a pound of oil to one cwt. of sugar) and was found more than sufficient to spoil it, both in taste and smell, for common use. If however cattle would eat sugar mixed with this article,

nothing

nothing could be cheaper, for one pennyworth would be enough for one cwt. of sugar; and it is not very unlikely but that they might be brought to eat it, for it is well known that at first all cattle refuse oil cake, and afterwards eat it with great relish.

"Since I engaged in this inquiry I have been informed that cattle will eat rancid fish oil with avidity; if so, such oil, and especially the dregs of oil, usually called oil foot, which comes very cheap, might be put into the hhds of sugar at the West India Docks in the presence of an officer, and if once poured on sugar no common expense would ever be able to separate it. Linseed oil being more fluid might be poured into the hhds at the cane holes. This would so spread itself throughout the whole hogshead, that I am persuaded the sugar could never afterwards be used for any domestic purpose. Moreover, it is well known that sugar, when mixed with oil, is incapable of the vinous fermentation; this would be an additional security against a fraudulent use of it.

"Sulphuret of potash or soda has the property of converting sugar into a mucilaginous substance not unlike gum. Mucilage and sugar are both highly nutritive, but they differ in their chemical properties. Sugar is soluble not only in water, but in alcohol: mucilage is soluble in water, but insoluble in alcohol. Sugar is an essential ingredient in all vinous fermentation; mucilage is incapable of that process.

"In order to ascertain the expense of treating sugar with an alkaline sulphuret, I mixed 14 grains of dry sulphuret of potash with 112 grains of sugar. The mixture soon became clammy, and lost all flavour of sugar. If a sulphuret of potash were manufactured directly for this purpose, a sufficient quantity for mixing with one cwt. of sugar would cost near 14*s.*; but I apprehend there are common alkaline sulphurets which might be had cheap enough, if the cattle would not refuse the mixture. Respecting the nature of this mixture, or the nutritious quality of sugar when reduced by an alkaline sulphuret, it may be remarked that mucilage is very similar in some of its properties to sugar, for many plants

plants which yield sugar at a certain period of their growth, only contain mucilage at an earlier period. This is the case with several of our wall-fruits. In the operation of malting, the mucilage of the barley absorbs oxygen, and is converted into sugar. No chemical means, however, have yet been discovered of effecting the same purpose. We can, as you have seen, readily convert sugar into mucilage, but have not yet acquired the means of regenerating sugar from the same mucilage. This circumstance is in favour of adopting this method for the deterioration of sugar, if it should be found to agree with the cattle.

"Having moistened 112 grains of sugar with water, two drops of a solution of sulphate of iron, and two drops of tincture of galls were mixed with the mass; by exposure to the air this sugar became quite black, and tasted of iron very strongly. It would cost 1*s.* per cwt. to blacken sugar in this way; but as oak bark or any other substance that contains the gallic acid might be employed instead of galls, it could be done in quantities at less expense, and I know of no cheap method by which sugar thus treated could be rendered again fit for sale or common use. Indeed, if the gallic acid were separated from the gallate of iron by means of potash, the sugar might then be fermented and fraudulently used for the still: but this could not be expected to succeed, unless it were done by an experienced chemist, for an excess of potash would render the sugar incapable of fermentation. And even if the mixture were submitted to distillation, it is probable that part of the iron would come over in the process, and contaminate the spirit.

"One hundred and twelve grains of sugar were mixed with ten grains by weight of oil of vitriol, previously diluted with a little water. This rendered the mixture so sour, that it would be impossible to use such sugar for common purposes. The oil of vitriol also blackens it considerably. It would cost 3*s.* or 3*s.* 6*d.* per cwt. to treat sugar in this way, but a less quantity of oil of vitriol might be sufficient, and when mixed with a large portion of other food, I think the acid would not be disagreeable to cattle.

"No experiment was made with nitrous acid, because

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the operation of that acid on sugar has been long known to chemists. By its means two new acids are formed from sugar, first the malic, and then the oxalic, acid, neither of which would be of any use as food for cattle.

"I mixed 112 grains of sugar with ten grains of common alum. Here the sugar lost a great portion of its sweetness, and acquired a disagreeable astringent taste. One cwt. of sugar would require 10 lbs. of alum for the formation of such a mixture, which would cost 2*s*. 3*d*. In this and the last experiments the sugar might be completely restored by the addition of nitrate or muriate of barytes, which would precipitate the sulphuric acid from the sugar in the one case, and from the earth of alum in the other; but as both these are poisonous salts, no one would think of using them to regenerate sugar for domestic purposes.

"One hundred and twelve grains of sugar were mixed with 20 grains of common salt. This proportion of salt destroys the sweetness of the sugar, and renders it unfit for human consumption. If government would allow the farmer waste salt free of duty, of which a sufficient quantity may be had at the salt-works, called the 'pickings of the pans,' at 5*s*. or 10*s*. per ton, it appears to me, that this would be the most suitable, convenient, and œconomical article that could be used to prevent the sugar from being again brought into common consumption. Cattle and horses are fond of it, it is known to agree well with them, and there is no cheap way by which the sugar could be separated from it. Cattle are so fond of salt, that they will even devour large quantities of marle if mixed with it. In America it is a common practice to sprinkle salt in layers upon hay when making it into hay-ricks, and it is found to assist in preserving the hay, and to render the cattle healthy. If it were thought adviseable to mix it with sugar in this country, such a mixture might be consumed in this way in large quantities, and the mixture might be made by means of a cheap and simple apparatus, similar to that employed by architects for mixing their mortar, called a mortar cylinder-mill.

"Should parliament not think it adviseable to allow the farmer waste salt, duty free, the salt contained in sea-water might

might be used with advantage. Whenever an excise officer shall witness the complete solution of sugar in sea-water, I apprehend the duty on sugar may be remitted, without any danger of that sugar ever being taken for any purpose of common consumption: 30 lbs. of sea-water contain on an average one pound of common salt; and would take up near 30 lbs. of sugar.

"On this subject I have consulted some farmers of great intelligence and experience, who are of the class of improved breeders, and feed both sheep and cattle on an extensive scale. These gentlemen entered cordially into my views, and communicated to me the following particulars. They say that with sugar salt may be used in the proportion of one-sixth with advantage; but that for the purpose of securing the revenue, the mixture might be one part salt, one part train oil, and ten parts of sugar. From my own experiments, I am persuaded, that less than five per cent. of train oil would effectually prevent sugar from ever being used for domestic purposes. These gentlemen are of opinion, that the salt causes a quick circulation of the fluids, and that chalk, which has long been given with salt to calves, acts upon this principle. The salt induces the calf to lick up the chalk, but the improvement in the colour of the flesh may be owing to the salt impelling the fluids, which otherwise, from a calf's confinement, would be stagnant.

"I next tried saltpetre with sugar, and made several experiments with it; but it appeared to me that the quantity necessary to alter the flavour of the sugar sufficiently, would be too dear for the use of the farmer.

"I then tried assafœtida; 112 grains of sugar were mixed with a quarter of a grain of this gum in solution. This rendered the mixture so strong in flavour and smell as to make it unfit for any common purpose; but whether this offensive property could be sufficiently disguised for cattle by the mixture of other food can only be known by trial. It would cost about 4*d*. per cwt. only to treat sugar thus with assafœtida.

"Many other experiments were made; but as their results did not seem to bear so much on the question as I expected they would, I forbear to take up your time by reciting them.

"In addition to those substances on which I have operated, several others have occurred to me; but it would depend upon the taste of the cattle, whether any of them could be brought into use. The articles I allude to are, rape oil, whale oil, foot oil, horse turpentine, coal tar, common tar*, the gall of animals, blood, wood ashes, soap lye, madder, wormwood, gentian, quassia, &c. in decoction, and the residuum procured from makers of oil of vitriol, called sulphur ashes.

"In this list I have not adverted to urine; but I am inclined to think that, all things considered, this might be the best to mix with sugar, to prevent its getting again into common consumption. If farmers were allowed sugar duty free, on condition of an officer of excise seeing a certain quantity of urine mixed with every cwt. of the sugar, there could, I think, be no danger of the farmer ever using it for other purposes than those for which government would allow him to draw the duty. Besides, the disgusting nature of urine is such that the quantity might safely be fixed so low that there would be no danger of the cattle not eating the sugar, when mixed with a large portion of other food. The beneficial effect of urine upon horses is so well known, that it has become a common practice with grooms, whenever they want a horse to have a remarkably fine coat, to mix urine in the manger with his corn.

"Chaff is an article much used by feeders of cattle; sugar stained with oil might be mixed with chaff, as another preventative. Besides, as chaff is naturally astringent, the quantity of chaff that can now be given to cattle is limited. By mixing such sugar with it, more might be used, and more sugar also might be given to cattle than they could otherwise bear. Such a mixture would be much cheaper than feeding in the usual way with oil-cake, on account of the fattening property of sugar, and the small value of chaff. The largest show-ox supposed to have been ever fed in England,

* Mr. Davy has suggested also, "petroleum:" and, as an astringent, terra Japonica.

gland, I am told, is now feeding by Lord Talbot in Staffordshire, and that a part of his food is treacle. Horses, oxen, and sheep, prefer the sweetest vegetables, and thrive best with such food. Hence the Swedish turnip, now so generally cultivated, is preferred to the old sorts, the Swedish containing one-fourth more sugar.

"There are many testimonies on record to the nutritious properties of sugar. Mons. Lennes, first surgeon to the late duke of Orleans, relates the following circumstance: 'A vessel,' said he, 'laden with sugar, bound from the West Indies, was becalmed for several days on her passage, during which the stock of provisions was exhausted. Some of the crew were dying with the scurvy, and the rest were threatened with death by famine. In this emergency recourse was had to the sugar. The consequence was, the symptoms of the scurvy went off, the crew found it a wholesome and substantial aliment, and returned in good health to France.'

"It is related, that sugar given alone, was found to fatten horses and cattle, during the war before last in St. Domingo, for a period of several months, in which the exportation of sugar and importation of grain were prevented by the want of ships.

"According to Dr. Rush, sugar has the most favourable effect on the animal œconomy; and that eminent physician, Sir John Pringle, remarked, that the plague has never been known in any country, where sugar composes a material part of the diet of the inhabitants.

"Sugar has this advantage over most kinds of aliment, that it is not liable to have its nutritious qualities affected by time or weather; hence it is preferred by the Indians in their excursions from home. They mix maple sugar with an equal quantity of ground Indian corn, and pack the mixture in little baskets, which frequently get wet in travelling, without ever injuring the sugar. A few spoonfuls of this mixture, in half a pint of water, afford them a pleasant and strengthening meal.

"Another way of using sugar for cattle has occurred to me: that is, to mix it with various kinds of damaged meal, such meal as would be totally unfit for human consumption.

 Or

Or a mixture of damaged barley meal, oat meal, damaged flour, rape cake, or linseed cake might be made, and then baked with sugar into bread. This would form a kind of gingerbread, with which cattle might be fed very cheaply. The trial perhaps might be made at his majesty's bakehouse at Deptford. A large quantity of the different kinds of damaged meal is annually baked in London into what is called dog-bread, for kennels, &c. The bakers of that would easily come into the way of baking this also. Horses at sea will eat ship biscuit; this is well known to mariners. Should there be any difficulty in getting cattle to eat this new kind of sweet bread, it might at first be ground for them.

" I have been induced to suggest this method of using sugar for cattle, and some others mentioned above, because I conceive it would be a desirable thing, should government give sugar to farmers free of duty, to allow them an option in the articles to be employed for the deterioration of the sugar. This would tend to bring feeders of cattle sooner into the general use of it, and indeed different localities may perhaps require something of the kind, in order to occasion a general consumption.

" As for charcoal, I am inclined to think that it could not be employed for such a purpose, for the following reasons:

" 1st. Before charcoal could be so used, it must be finely levigated, and levigated charcoal cannot be had but at a considerable expense.

" 2d. I apprehend that charcoal cannot afford any nutriment to cattle, and that probably it would be prejudicial to the animal œconomy.

" 3d. The mixture of charcoal with sugar, I imagine, would not prevent that sugar from being afterwards fraudulently used for the still, for it is a common practice with rectifiers to mix charcoal with coarse spirit, this being found to improve its flavour.

" 4th. Charcoal being mixed with sugar, could never prevent the use of the sugar for general consumption; for this substance might be separated with the greatest ease. All that would be necessary would be to dissolve the sugar in water, and separate the charcoal by filtration.

" I now

"I now proceed, in conformity with your suggestion, to make a brief recapitulation of the most material parts of this paper, and to endeavour to enumerate, and to place in one point of view, those articles recommended above, which appear to me to be best calculated to answer the desired purpose:

"Caustic potash, train oil, waste salt, mixture of salt and oil, urine, oil of hartshorn, linseed oil, sea water, assafœtida, chaff and refuse oil.

"Any of these, in my opinion, might be employed with perfect safety to the revenue.

"I have the honour to be, gentlemen,

"your faithful and obedient humble servant,

"SAMUEL PARKES."

LIII. *Essay upon Machines in General. By* M. CARNOT, *Member of the French Institute, &c. &c.*

[Continued from p. 228.]

LV. THESE reflections should seem sufficient for undeceiving those who think that with machines charged with levers arranged mysteriously, we may put an agent, though never so feeble, in a condition to produce the greatest effects: the error proceeds from persuading ourselves, that it is possible to apply to machines in movement what is not true except with respect to the case of equilibrium: from the circumstance of a small power holding a very great weight in equilibrium, many persons think that it could in the same way raise this weight as quickly as they please: now this is a very striking mistake, because, in order to succeed, the agent must procure for itself a velocity beyond its faculties, or which would at least make it lose so much the greater part of its effort upon the machine as it would be obliged to move itself more quickly. In the first case the agent has no other object to attain than to make an effort capable of counterbalancing the weight; in the second case, besides this effort, there must be also another to overcome the inertia, both of the body on which it impresses the movement and of its own proper mass: the total effort which in the first

first case would be employed entirely in conquering the weight of the body, is here divided into two, the first of which continues to make an equilibrium in the weight, and the other produces the movement. We therefore cannot augment one of these efforts except at the expense of the other; and this is the reason why the effect of machines in motion is always so limited that it can never surpass the momentum of activity exercised by the agent which produces it.

It is, without doubt, for want of paying sufficient attention to these different effects of one and the same machine, considered sometimes in a state of repose and sometimes in movement, that some persons not unacquainted with sound theory frequently abandon themselves to the most chimerical ideas, while we see simple workmen turning to advantage, as it were by instinct, the real properties of machines, and judging very accurately of their effects. Archimedes only wanted a lever and a fixed point, in order to move the globe of the earth; how did it happen then, it may be said, that so great a man as Archimedes could not, even when furnished with the best machine in the world, raise a weight of one hundred pounds in one hour to a small given height? It is because the effect of a machine at rest and of one in movement are two very different things, and somewhat heterogeneous: in the first case it is requisite to destroy and to hinder the movement; in the second, the object is to produce it and to keep it up; now it is clear that this last case requires more consideration than the first: viz. the real velocity of each point of the system;—but we shall better perceive the reason of this difference by the following remark.

Any given fixed points or obstacles are forces purely passive, which may absorb a movement however great it may be, but which can never produce one, let it be never so small, in a body at rest: now it is very improperly that in the case of equilibrium we say of a small power, that it destroys a great one: it is not by the small power that the great one is destroyed; it is by the resistance of the fixed points: the small power in reality destroys but a small part of the great, and the obstacles do the rest. If Archimedes had possessed what he wished for, it would not have been he who would have

have supported the globe, it would have been his fixed point: all his art would have consisted not in redoubling his efforts to contend against the mass of the globe, but to put in opposition two great forces, the one active, and the other passive, which he would have had at his disposal: if, on the contrary, it had been requisite to produce an effective movement, in this case Archimedes would have been obliged to draw it entirely from his own proper person; and yet it would have been very small, even after several years: let us not attribute therefore to active forces, what is owing to the resistance of obstacles only, and the effect will not appear more disproportioned to the cause in machines at rest than in machines in motion.

LVI. What is the true object therefore of machines in motion? We have already said, that it is to procure the faculty of varying at pleasure the terms of the quantity Q, or the *momentum* of activity which should be exercised by the moving forces. If time be precious, if the effect must be produced in a very short time, and if we have only a power capable of very little velocity, but of a great effort, we may find a machine capable of supplying the velocity necessary for the force: if, on the contrary, we must raise a very considerable weight, and we have but a weak power, although capable of great velocity, we may contrive a machine with which the agent will be in a condition to compensate by its velocity the force of which it is deficient. Lastly, if the power is neither capable of a great effort nor of a great velocity, we may still, with a proper machine, make it produce the effect desired, but then it will require much time; and herein consists the well-known principle, *that in machines in movement, we always lose in time or in velocity what we gain in force.*

Machines are therefore very useful, not by augmenting the effect of which powers are naturally capable, but by modifying this effect: it is true we shall never succeed by means of them in diminishing the expense or *momentum* of activity necessary for producing an effect proposed; but they will assist us in making a proper division of this quantity for attaining the design in view: it is by their assistance

that

that we shall succeed in determining, if not the absolute movement of each part of the system, at least in establishing among these different particular movements the relations which are most proper: it is by them, lastly, that we shall give to the moving forces the most convenient situations and directions, the least fatiguing, and the most proper for employing their faculties in the most advantageous manner.

LVII. This naturally leads us to the following interesting question—Which is the best method of employing any given powers, the natural effect of which is known, on applying them to machines in motion? In other words, What is the method of making them produce the greatest possible effect?

The solution of this problem depends upon particular circumstances; but we may hereupon make some general observations applicable to all cases. The following are among the most essential.

The effect produced being the same thing (LII.) with the momentum of activity exercised by the resisting forces, the general condition is, that q is a *maximum:* now q never being able to surpass Q, 1st, The quantity Q must itself be the greatest possible; 2dly, All this momentum Q must be solely employed in producing the effect proposed.

In order to make Q a *maximum*, we must consider that it depends upon four things, viz.: upon the quantity of force exercised by the agent which should produce the effect q, upon its velocity, upon its direction, and upon the time during which it acts. Now, 1st, As to what regards the direction of the force, it is evident that this power should be in every thing, besides being equal, directed in the same ratio with its velocity, for the momentum of activity which during $d\,t$ a power F exercises, the velocity of which is V, and the angle comprehended between F and V, Z, being (XXXII) $F\,V\,d\,t$ cosine z, it is clear that this produce will never be greater than when cosine z will be equal to the total sinus, *i. e.* when the force and its velocity shall be directed in the same ratio: 2dly, As to what regards the intensity of the force exercised, its velocity, and the time during which it is exercised; we should not determine these things

things in an absolute manner, but solely place them in the relations in which experience has shown they will be of most advantage: for instance, I shall suppose that a man attached or eight hours in a day to a winch of one foot radius, ·ight make continually an effort of 25 tons by making one turn every two seconds, which nearly amounts to the velocity of three feet per second; but if we forced this man to go quicker, thinking thereby to hasten the business, we should retard it, because he would not be in a condition to make an effort of 25 tons, or could no longer work at the rate of eight hours a day. If, on the contrary, we diminished the velocity, the force would augment, but in a less degree, and the momentum of activity would also diminish: thus, according to experience, in order that this momentum should be a *maximum*, we must proportion the machine so as to preserve to the power the velocity of three feet per second, and not let it work more than eight hours a day. It is well known that each kind of agent has, in respect of its physical nature or constitution, a *maximum* analogous to that of which we have spoken, and that this *maximum* can in general only be found by experience.

LVIII. This first condition being fulfilled, nothing remains to be done, to produce with any given machine the greatest effect possible, but to manage matters so as that the whole quantity Q is employed in producing this effect; for if this be done, we shall have $q = Q$; and this is all we can expect, since Q can never be less than q.

Now in order to fulfil this condition, I say, in the first place, that we should avoid every shock or sudden change whatever; for it is easy to apply to all imaginable cases the reasoning which has been laid down (XLVII.) as to machines with weights; whence it follows, that every time there is a shock, there is at the same time a loss of momentum of activity on the part of the soliciting forces; a loss so real that the effect of it is necessarily diminished, as we have shown with respect to machines with weights in the above article: it is therefore with reason that we have advanced (LI.), that in order to make machines produce the greatest effect possible, they must of necessity never change their

movement,

movement, except by insensible degrees;—we must solely except those which by their very nature are subject to undergo different percussions, like most kinds of mills; but even in this case, it is clear that we should avoid every sudden change which is not essential to the constitution of the machine.

LIX. We may conclude from this, for example, that the method of producing the greatest possible effect in a hydraulic machine moved by a current of water, is not to adapt a wheel to it, the wings of which receive the shock of the fluid. In fact, two good reasons prevent us from producing in this way the greatest effects: the first is, as we have already said, because it is essential to avoid every kind of percussion whatever; the second is, because after the shock of the fluid there is still a velocity which remains to it as a pure loss, since we should be able to employ this remainder in still producing a new effect to be added to the first. In order to make the most perfect hydraulic machine, *i. e.* capable of producing the greatest possible effect, the true difficulty lies, 1st, In managing so as that the fluid may lose absolutely all its movement by its action upon the machine, or at least that there should only remain precisely the quantity necessary for escaping after its action; 2d, Another difficulty occurs in so far as it loses all this movement by insensible degrees, and without there being any percussion, either on the part of the fluid, or on the part of the solid parts among themselves: the form of the machine would be of little consequence; for a hydraulic machine which will fulfil these two conditions will always produce the greatest possible effect: but this problem is very difficult to resolve in general, not to say impossible; it may even happen that in the physical state of things, and in respect of their simplicity, there can be nothing better than wheels moved by shocks: and in this case as it is impossible to fulfil at once the two conditions most desirable, the more we wish to make the fluid lose of its movement in order to attain the first condition, the stronger will be the shock; the more, on the contrary, we wish to moderate the shock in order to approach the second, the less will the fluid lose of its movement.

ment. We perceive that there is a medium, by means of which we shall determine, if not in an absolute manner, at least, having regard to the nature of the machine, that method which will be capable of the greatest effects.

LX. Another general condition, which is not less important when we wish that machines should produce the greatest possible effect, is, to contrive that the soliciting forces should give rise to no movement inapplicable to the object in view. If my object, for example, is to raise to a given height the greatest quantity of water possible, whether with a pump or otherwise, I should contrive that the water on flowing into the upper reservoir should only have precisely as much velocity as was necessary and no more, for all beyond this quantity would uselessly consume the effort of the motive power. It is clear in fact (XLV.), that in this case this power would have to consume an useless momentum of activity, and which would be equal to the half of the real force with which the water would have arrived in the reservoir.

It is not less evident, that in order to give the machines the greatest effect possible, we should avoid or diminish, at least as much as possible, the passive powers, such as friction, rubbing of cords, the resistance of the air, which are always, in whatever direction the machine moves, among the number of the forces I have called resisting*.

It would be easy to extend these particular remarks, but my object is not to enter at present into any larger detail.

LXI. It may be concluded, from what has been said on the subject of friction and other passive bodies, that perpetual motion is a thing absolutely impossible, by only employing in order to produce it bodies which would not be solicited by any motrix force, and even heavy bodies; for

* We often hear of passive forces; but where is the difference between an active and a passive force? I think this question has never yet been answered. Now it appears to me that the distinctive character of passive forces consists in this, that they never can become soliciting forces, whatever may be the movement of the machine, while active forces can act sometimes in the quality of soliciting and sometimes as resisting forces. In this view, obstacles and fixed points are evidently passive forces, since they can neither act as soliciting nor as resisting forces (XXXI).

these

these passive forces from which nothing can be subtracted being always resisting, it is evident that the movement must continually slacken: and from what we have said (XLV.), we see that if bodies are not solicited by any motrix force, the amount of the active forces will be reduced to nothing; *i. e.* the machine will be reduced to a state of rest, when the momentum of activity, produced by the friction since the commencement of the motion, will have become equal to half the amount of the initial active forces: and if the bodies are heavy, the motion will finish when the momentum produced by the frictions shall be equal to half the amount of the initial active forces, plus the half of the active force which would take place if all the points of the system had one common velocity, equal to that which is owing to the height of the point where the centre of gravity was at the first instant of the motion, above the lowest point to which it can descend: this is evident from (XLII).

It is easy to apply the same reasoning to the case of springs, and in general to all cases in which the friction being subtracted, the soliciting forces are obliged, in order to make the machine pass from one position to another, to exercise a momentum of activity as great as that which is produced by the resisting forces when the machine returns from this last position to the former.

The motion would end much sooner if some percussion took place, since the sum of the active forces is always diminished in such cases (XXIII).

It is therefore evident, that we ought entirely to despair of producing what is called a perpetual motion, if it be true that all the moving powers which exist in nature are nothing else than attractions, and that this force, as it should seem, has a general property, that of being always the same at equal distances between given bodies, *i. e.* of being a function which only varies in cases where the distance of these bodies itself varies.

LXII. One general observation resulting from all that has been said, is, that the kind of quantity to which I have given the name of *momentum of activity*, performs a very conspicuous part in the theory of machines in a state of motion; for

for it is in general this quantity which we must œconomize as much as possible, in order to draw all the effect we can from one agent.

If it be required to raise a weight, water for example, to a given height; you will be able to raise more in a given time, not from having exhausted a greater quantity of power, but in proportion as you have exercised a greater momentum of activity (XLIV).

If it be required to turn a mill, either by water, or wind, or animals, it is not necessary that the shock of the water, the wind, or the effort of the animal be greater; but these agents should be made to consume the greatest momentum of activity possible.

If we wish to make a vacuum in the air in any way whatever, we must, in order to succeed, consume a *momentum of activity* as great as that which would be necessary for raising to the height of 30 feet a volume of water equal to the vacuum which we wish to produce.

If it be a vacuum in an indefinite mass of water like the sea, we must consume the same *momentum of activity* as if the sea were a vacuum; as if the vacuum which we wish to make were a volume of sea water, and as if we must raise this volume to the height of the level of the sea.

If it be required to produce a vacuum in a vessel of a given figure, it is evident that we cannot succeed without causing to ascend the centre of gravity of the total mass of the fluid in a quantity determined by the figure of the vessel; we must therefore consume a *momentum of activity* equal to that which would be necessary to raise all the water in the vessel in a quantity equal to that from which the centre of gravity of the fluid must ascend.

In a machine at rest, where there is no other force to overcome except the *vis inertiæ* of the bodies, if we wish to produce any movement by insensible degrees, the *momentum of activity* which we have to consume will be equal to half the amount of the active forces we wish to produce; and if it be merely required to change the movement it has already, the *momentum of activity* to be produced will only be the

quantity

quantity in which this half amount will be increased by the change (XLV).

Finally, supposing we have any system of bodies, that these bodies attract each other, on account of any function of their distances; even supposing, if we please, that this law is not the same with respect to all the parts of the system, *i. e.* that this attraction follows any law we please, (providing that, between two given bodies, it only varies when the distance of these bodies in itself varies,) and it be required to make the system pass from any given position to another: this being done, whatever be the path that we wish each of the bodies to take, in order to attain this object, whether we put all these bodies in motion at once, or the one after the other, whether we conduct them from one place to another by a rectilinear or curvilinear motion, and varied in any manner (providing no shock nor rapid change occur); lastly, whether we employ any kind of machines whatever, even by a spring, providing that in this case we ultimately replace the springs in the same state of tension in which they were at the first moment, the *momentum of activity* which they will have to consume, in order to produce this effect, the external agents employed to move this system, will always be the same, supposing the system to be at rest at the first instant of the movement, and at the last also.

And if, besides all this, it be necessary to produce in the system any given movement, or if it be already in motion at the first moment; and if it be requisite to modify or change this movement, the *momentum of activity* which the external agents will have to consume will be equal to that which it would be necessary to consume if it were merely requisite to change the position of the system, without impressing any motion upon it (*i. e.* considered as at rest at the first and last instants,) plus the half of the quantity by which we must augment the sum of the active forces.

It is of very little importance therefore, as to the expenditure or *momentum of activity* to be consumed, that the forces employed are great or small, that they employ such and

and such machines, or that they act simultaneously or not: this *momentum of activity* is always equal to the produce of a certain force, by a velocity, and by a time, or the sum of several products of this nature; and this sum should always be the same, in whatever way we take it: the agents therefore will gain nothing on the one hand, which they do not lose on the other.

To conclude, let us suppose that in general we have any system of animated bodies, of any motrix forces, and that several external agents, such as men or animals, are employed to move this system in various and different ways, either by themselves or by machines:—This being granted,

Whatever be the change occasioned in the system, the momentum of activity consumed during any time by the external powers, will be always equal to the half of the quantity by which the sum of the active forces will have augmented during this time, in the system of bodies to which they are applied: minus the half of the quantity by which this same sum of active forces would have augmented, if each of the bodies were freely moved upon the curve it has described, supposing that it had then undergone at each point of this curve the same motrix force as that which it really undergoes: providing always that the motion changes by insensible degrees, and that if we employ machines with springs, we leave these springs in the same state of tension in which we found them.

[To be continued.]

LIV. *Memoirs of the late* ERASMUS DARWIN, *M. D.*

[Continued from vol. xxx. p. 115.]

DARWINIANA.

HAVING laboured under a severe illness, the author of this memoir must apologize for so long delaying the continuation of the remarkable medical opinions of the great Dr. Darwin, whose powers of mind, fully bent upon one important subject, namely health, and the causes of disease, and the remedies to be applied, with the rationale of each, cannot fail to interest the philosophic world.

Dr. Darwin relates a remarkable cure of *bleeding piles.*—Mrs. —— had for twelve or fifteen years, at intervals of a year or less, a bleeding from the rectum without pain; which, however, stopped spontaneously after she became weakened, or by the use of injections of brandy and water. Lately the bleeding continued above two months, in the quantity of many ounces a day, till she became pale and feeble to an alarming degree. Injections of solutions of lead, of bark, and salt of steel, and of turpentine, with some internal astringents and opiates, were used in vain. An injection of the smoke of tobacco, with ten grains of opium mixed with the tobacco, was used, but without effect the two first times on account of the imperfection of the machine: on the third time it produced great sickness and vertigo, and nearly a fainting fit; from which time the blood entirely stopped. Was this owing to a fungous excrescence in the rectum; or to a blood-vessel being burst from the difficulty of the blood passing through the vena porta from some hepatic obstruction, and which had continued to bleed so long?—Was it stopped at last by the fainting fit? or by the stimulus of the tobacco?

His method of curing *spitting of blood* is equally new and extraordinary.—Venous hæmoptoe frequently attends the beginning of the hereditary consumptions of dark-eyed people; and in others, whose lungs have too little irritability. These spittings of blood are generally in very small quantity, as a tea-spoonful; and return at first periodically, as about once a month; and are less dangerous in the female than in the male sex, as in the former they are often relieved by the natural periods of the menses. Many of these patients are attacked with this pulmonary hæmorrhage in their first sleep; because in feeble people the power of volition is necessary, besides that of irritation, to carry on respiration perfectly; but, as volition is suspended during sleep, a part of the blood is delayed in the vessels of the lungs, and in consequence effused, and the patient awakes from the disagreeable sensation.

M. M. Wake the patient every two or three hours by an alarum clock. Give half a grain of opium at going to bed,

or

or twice a day. Onions, garlic, slight chalybeates. Issues. Leeches applied once a fortnight or month to the hemorrhoidal veins to produce a new habit. Emetics after each period of hæmoptoe, to promote expectoration, and dislodge any effused blood, which might by remaining in the lungs produce ulcers by its putridity. A hard bed, to prevent too sound sleep. A periodical emetic or cathartic once a fortnight.

Also his plan of preventing *miscarriages*.—Some delicate ladies are perpetually liable to spontaneous abortion, before the third, or after the seventh, month of gestation. From some of these patients I have learnt, that they have awakened with a slight degree of difficult respiration, so as to induce them to rise hastily up in bed; and have hence suspected, that this was a tendency to a kind of asthma, owing to a deficient absorption of blood in the extremities of the pulmonary or bronchial veins; and have concluded from thence, that there was generally a deficiency of venous absorption; and that this was the occasion of their frequent abortion. Which is further countenanced, where a great sanguinary discharge precedes or follows the exclusion of the fetus.

M. M. Opium, bark, chalybeates in small quantity. Change to a warmer climate. I have directed with success in four cases, half a grain of opium twice a day for a fortnight, and then a whole grain twice a day during the whole gestation. One of these patients took besides twenty grains of Peruvian bark for several weeks. By these means being exactly and regularly persisted in, a new habit became established, and the usual miscarriages were prevented.

His opinion of *extracting the cataract* to remove blindness is so very unexpected, that unless it came from such a source it would scarcely obtain credit, so much has fashion to do both in medicine and surgery.—

Cataracta is an opacity of the crystalline lens of the eye. It is a disease of light-coloured eyes, as the gutta serena is of dark ones. On cutting off with scissars the cornea of a calf's eye, and holding it in the palm of one's hand, so as to gain a proper light, the artery which supplies nutriment to the crystalline humour is easily and beautifully seen; as it rises from the centre of the optic nerve through the vitreous humour to the crystalline. It is this point, where the artery enters the eye through the cineritious part of the optic nerve, (which is in part near the middle of the nerve,) which is without sensibility to light; as is shown by fixing three papers, each of them about half an inch in diameter, against a wall about a foot distant from each other, about the height of the eye; and then looking at the middle one, with one eye, and retreating till you lose sight of one of the external papers. Now as the animal grows older, the artery becomes less visible, and perhaps carries only a transparent fluid, and at length in some subjects I suppose ceases to be pervious; then it follows, that the crystalline lens, losing some fluid, and gaining none, becomes dry, and in consequence opake; for the same reason, that wet or oiled paper is more transparent than when it is dry, as explained in Class I. 1. 4. 1. The want of moisture in the cornea of old people, when the exhalation becomes greater than the supply, is the cause of its want of transparency; and which, like the crystalline, gains rather a milky opacity. The same analogy may be used to explain the whiteness of the hair of old people, which loses its pellucidity along with its moisture.

M. M. Small electric shocks through the eye. A quarter of a grain of corrosive sublimate of mercury dissolved in brandy, or taken in a pill, twice a day for six weeks. Couching by depression, or by extraction. The former of these operations is much to be preferred to the latter, though the latter is at this time so fashionable, that a surgeon is almost compelled to use it, lest he should not be thought an expert operator. For depressing the cataract is attended with no pain, no danger, no confinement, and may be as readily repeated, if the crystalline should rise again to the centre of the eye. The extraction of the cataract is attended with considerable pain, with long confinement, generally with fever, always with inflammation, and frequently with irreparable injury to the iris, and consequent danger to the whole eye. Yet has this operation of extraction been trum-

peted

pcted into universal fashion, for no other reason but because it is difficult to perform, and therefore keeps the business in the hands of a few empirics, who receive larger rewards, regardless of the hazard which is encountered by the flattered patient.

A friend of mine returned yesterday from London after an absence of many weeks; he had a cataract in a proper state for the operation, and, in spite of my earnest exhortation to the contrary, was prevailed upon to have it extracted rather than depressed. He was confined to his bed three weeks after the operation, and is now returned with the iris adhering on one side so as to make an oblong aperture; and which is nearly, if not totally, without contraction, and thus greatly impedes the little vision which he possesses. Whereas I saw some patients couched by depression many years ago by a then celebrated empiric, Chevalier Taylor, who were not confined above a day or two, that the eye might gradually be accustomed to light, and who saw as well as by extraction, perhaps better, without either pain, or inflammation, or any hazard of losing the eye.

As the inflammation of the iris is probably owing to forcing the crystalline through the aperture of it in the operation of extracting it, Could it not be done more safely by making the opening behind the iris and ciliary process into the vitreous humour? But the operation would still be more painful, more dangerous, and not more useful than that by depressing it.

[To be continued.]

LV. *On Vaccination. By* Ralph Blegborough, *M.D.*

To Mr. Tilloch.

SIR,

Perceiving that you are impartial, at least on the subject of vaccination, I send you the following letter, already sent to the editor of another work, but which I much fear he will not find it convenient to insert;

and remain yours, &c.

Ralph Blegborough.

To

To the Editor of the Medical Observer.

SIR,

On perceiving (in the tenth number of your Observer,) among the cow-pox failures and mischiefs which you are so kind as to favour the public with, the case of Mrs. Hawkins's daughter, of No. 4, Pleasant Place, Lambeth, and which makes the 40th of your list, I was a little surprised, as I had attended the child occasionally, and her parents frequently, during three years previous to her death, but had never heard that any part of her sufferings had been attributed to the cow-pox by her parents. She died of psoas abscess! Some time prior to her death, her father died of hydrothorax, and I have since occasionally been attending her mother in ascites. I mention these circumstances as no further important than to state that they gave me an opportunity of inquiring whether they had ever in the least blamed the cow-pox for her complaints; the mother says No, though some person, sent by Dr. Moseley, wished to convince them it was so: unless indeed it may be considered important to contemplate how far it was wonderful that a child of parents so unhealthy, should die of psoas abscess *without the aid of the cow-pox.*

Just as the circumstances of this case were passing my mind, Mr. Vaughan of Lambeth, the case of whose daughter makes your 69th, in number 12 of your Observer, came to desire I would call at his house, as the child in question had a slight eruption on the skin, but without complaint. On seeing her, I immediately wrote the following, which I desired Mrs. Vaughan (a sensible intelligent woman, who entered mightily into the joke,) to copy, and send to Dr. Moseley and Mr. Birch.

"Sir,—*A case of small-pox has occurred after vaccination by Dr. Walshman, at No. 4, Pratt-street, Lambeth, (Mr. Vaughan's oil-shop,)—Perhaps you will like to look at it. I remain yours,* "Nurse."

July 20, 1808.

I took the child immediately to Mr. Young the surgeon of Lambeth, whom I found along with his friend Dr. Higgins: without making them in the least acquainted with my my plan, I desired them to say what the eruption was. They both immediately declared it to be the chicken-pox. I desired the nurse to take the child in the course of the day to Dr. Walshman, who was to know nothing about what was going on. He declared the same thing. Mr. Foster, Mr. Key, and other *respectable* surgeons, saw the child; and, I believe, never saw a more well marked case of chicken-pox.

In consequence of Mrs. Vaughan's copies of my note, first came (as was expected) Mr. Lipscombe. Mrs. V.'s father knew Mr. Lipscombe at Warwick. He declared that it was *not* the small-pox; but that he had no doubt Dr. Moseley and Mr. Birch would say so. He was perfectly right, they said so sure enough; but they were not quite clear about it the first time they saw the child, while any one else might have judged of the disease; but when the spots had waned so that it was impossible any one, who might not have seen the child before, could judge what it had been—then indeed they grew bolder, and would have taken their oaths it was the small-pox.

Now, Mr. Editor, I wish to know who the other medical men are, who saw my little patient in the small-pox, besides Mr. Lipscombe, and particularly if Dr. Moseley and Mr. Birch are among them. I wish also to know who this Mr. Lipscombe is; and if he has any other wicked propensities, besides this unmanly talent of frightening women, and men like women. You, sir, I observe, wish to bring the question of vaccination to an issue.—When you balance the account, pray do let this statement of facts go for its full weight. I remain, sir, yours, &c.

RALPH BLEGBOROUGH.

Nelson-square,
September 18, 1808.

LVI. *Project of an Institution for the Prevention and Cure of Pulmonary and other Disorders by Air of a warm and nearly equal Temperature. By a Correspondent.*

EXPERIENCE has demonstrated, that certain persons are affected with coughs and other complaints in the winter, but not in the summer season: that many patients have been recovered by changing their residence from a cold to a warm and equal climate—that especially pulmonary complaints are rare occurrences in warm climates with little variability of temperature—and some physicians have availed themselves of these facts, in employing artificial means of warming the sitting-rooms and bed-chambers of certain patients. To these facts and remarks it is proper to produce as evidence the much less fatality of our climate in mild than in cold winters. The common opinion of the salubrity of long continued severely cold or frosty weather, and of the unhealthiness of hot summers, is certainly less popular, particularly among the medical profession, than formerly. The contrivances for preserving the warmth of rooms by double windows and double doors have been more generally adopted of late years, especially since the publication of Count Rumford's Essays; but they have been employed rather upon the œconomical than the medicinal principle, and they are inadequate for this latter purpose. A few plans have been executed of warming houses by means of the heat of the steam of water, or by passing air through tubes heated by a fire; but either on account of the expense, or of some defect in these constructions, such modes of furnishing warm air have been neglected. Unfortunately too, on one account, our climate is neither sufficiently cold in the winter months, and for a sufficient duration, to urge the inhabitants to employ fit means of defence, as in Russia; nor is the climate subject to so inconsiderable a variation of temperature as to allow, with impunity, many persons to be exposed in the usual manner to the air in the spring and summer months. On this account, the ancient rude method of warming houses by a fire in the wall of one side of a room continues to be adopted, although it is obvious to any one acquainted with the laws of the communication of heat through air, that no benefit, or at least very little benefit, can be derived from fire in such a situation, but in so far as the radiation or oscillation extends. Hence one part of a room so heated is frequently different in temperature in different parts, as much as twenty degrees or more; and the

difference

difference is still greater between the temperature of such a sitting-room and the passages into other rooms. The method of warming houses by fires as above stated would never, in all probability, have been employed, if the constructor had been previously acquainted with the laws of passage of heat from one body to another body; and inveterate custom and prejudices can only account for so unreasonable a method. It is true, Count Rumford, in particular, has occasioned improvements in the form of grates, to extend the oscillating or radiating property of heat and to save expense of fuel; but to render the air of every part of a large room, and every part of a house, of nearly the same warm temperature, further and different modes of building the house itself must be introduced. That this is œconomically practicable is evident from the mode of warming the air of manufactories, work-shops, hot-houses, &c. All that is further requisite is, to build a dwelling-house of such a form as to unite the advantages of diffusing heat by the several different modes of its communication; namely, oscillation, alteration of density of the portions of air with which it is in contact, and diffusion by elasticity or attraction from particle to particle of air. The plan for such a building must be devised by some ingenious architect, under the direction of a medical professional man competently informed on the subject of the philosophy which furnishes the principle. From the success of ten years' practice, which has been produced by warming rooms even by clumsy, rude and expensive contrivances in our present ill-suited houses, in the hands of a physician who has furnished these observations, there seems a certainty that the undertaking of such a building will become profitable to the proprietor. The physician alluded to would willingly incur the expense on this occasion, but it is necessary that he should be precluded from the possibility of pecuniary benefit. He is willing, however, to afford his best assistance gratuitously, and of course to support, as far as he is able, the proprietor by his recommendation in practice.

The editor of this work is authorised to give further information

formation to any architect who chooses to undertake such a building, or to any infirm person who may require the benefit of an equal and warm temperature. Z.

LVII. *Report of Surgical Cases in the City and Finsbury Dispensaries, for February and March* 1808. *By* John Taunton, *Esq.*

In February and March there were admitted on the books of the City and Finsbury Dispensaries 506 surgical patients.

Cured or relieved	—	465
Died —	—	7
Irregular —	—	1
Under cure	—	33
		506

During the summer months, ulcers in general, particularly those seated on the lower extremities, have been more irritable than usual. In many instances they have inflamed and extended on the surrounding parts very rapidly, but apparently from the high temperature of the atmosphere only: the pain has been frequently great, and could not be mitigated by the usual remedies, large doses of opium being required to produce but a very moderate degree of ease.

Anodyne fomentations with poultices made with crumb of stale bread, water, and a small quantity of new milk, gave more ease than any of the lotions in common use. How does this fact coincide with the supposed cause of high temperature? All greasy applications contributed greatly to increase the sufferings of the individual.

Nitrous acid, ferri rubigo, and opium were the internal remedies which afforded the most effectual relief.

Mrs. Ann Turner, ætat. 67, has been visited several times in the last two years by Mr. Jackson, for symptoms resembling those which arise from strangulated hernia; but the existence of that disease was never made known till after the attack came on which terminated fatally.

Nov.

Nov. 30, 1807.—She complained of a tightness across the umbilical region, great pain over the abdomen, with hiccup and vomiting. These symptoms having frequently yielded to purgative remedies, they were had recourse to, but without effect.

Dec. 1.—She had passed a very restless night, and was much worse in every respect. This day, for the first time, she mentioned the swelling in the groin. Some draughts, each containing 25 drops of tincture of opium, were given, but not retained on the stomach; an enema composed of an infusion of nicotiana was injected, and attempts were made to reduce the hernia, but without effect.

I first saw her at 9 o'clock in the evening, when she appeared very low, but the hiccup returned only when she attempted to swallow; the pain on the abdomen was not so great as on the preceding day; the pulse was regular, moderately full, and did not exceed 90: the hernia was small, and seated under Poupart's ligament, on the inside of the femoral vessels: on continued pressure it receded under the ligament between the lower edge of the external oblique and transversalis muscles. This circumstance has occasionally misled inexperienced practitioners, one fatal instance of which is recorded in the Surgical Report for December 1806, vol. xxvi. page 255.

She had had this complaint for several years, but could not state when it had been reduced, as it did not appear to her to have been of the least consequence, and she never noticed it with much attention; neither could we make her believe that her present complaint arose from that small swelling: however, she consented with considerable reluctance to have the operation performed early in the morning, provided the symptoms continued.

2d. Four A. M.—She appeared much the same as on the preceding evening; but her countenance, and in some instances incoherent answers, argued an unfavourable termination.

On dividing the integuments, cellular and adipose substance with the fascia, a small tumour of a rough unequal surface

surface came into view, the contents of which were evidently in a fluid state; and on its being opened, about an ounce of a limpid fluid escaped. At the posterior part of the *sac* containing the limpid fluid (which was a hydatid) was seated the hernial sac, forming a tumour not larger than a chesnut, but adhering firmly in *every part* to the surface of the contained intestine, so as to render its separation wholly impossible. The sac was returned with the intestine, after the contracted part at the neck had been carefully divided by a longitudinal incision. One suture was passed through the integuments, and the edges of the wound supported by straps of adhesive plaister. From these difficulties, the operation took more time than is usually required, but she scarcely expressed any sense of pain. The pulse was full, and did not exceed 80. Small doses of magn. vit. in aq. am. acet. et aq. menth. sat. were ordered to be taken frequently during the day.

Three P. M.—Every unfavourable symptom had subsided: the medicine and some broth had been retained on the stomach, and a gentle perspiration was diffused over the body. The medicines were ordered to be continued, and a purging clyster to be injected.

3d. Five A. M.—She had slept for several hours during the night, and had not had any return of either the hiccup or sickness, but no evacuation by stool. Notwithstanding the cessation of pain, the nourishment taken and retained on the stomach, and the sleep which she had had, she was evidently lower.

One P. M.—Quite composed and sensible, but sinking fast; and she died at five P. M., 33 hours after the operation.

On examining the part by dissection, the hydatid was found to adhere to the anterior part of the true peritoneal herniary sac, which from being very small, and the adhesions not permitting its enlargement, was entirely covered by the same.

The "rough irregular" appearance on the outside of the sac appeared to be produced by the adhesion of the remains

mains of some hydatids, which had burst within the large one.

The intestine within the sac was inflamed, but only a small part of the circumference was included within the stricture; so that the canal was preserved, even at the diseased part, of sufficient size to admit a bougie the size of a large finger.

The intestine above the stricture was slightly inflamed, and rather distended with flatus; below, it was contracted, and without any appearance of inflammation.

The fatal termination of this disease, when only a small part of the circumference of the gut is included in the sac, has been noticed by the late Mr. Joseph Else, in a case in St. Thomas's Hospital, which was mistaken for an enlarged gland*. The two cases are also similar in proving, that stools could not be procured, although the intestinal canal was pervious in each. I have also observed the same circumstance to occur in omental hernia, though Mr. Charles Bell, in his work on Operative Surgery, has given an opposite opinion.

JOHN TAUNTON,
Surgeon to the City and Finsbury Dispensaries, and City Truss Society, Lecturer on Anatomy, Surgery, Physiology, &c.

Greville street, Hatton Garden,
Sept. 20, 1808.

LVIII. *Notices respecting New Books.*

An Essay on the Teeth of Wheels, comprehending Principles, and their Application in Practice to Millwork and other Machinery. With numerous Figures. By ROBERTSON BUCHANAN, *Engineer. Revised by* PETER NICHOLSON, *Architect, &c.*

IN our xxixth vol. page 272, we noticed an Essay on the warming of Buildings by Steam by this writer. Mr. Nicholson is well known to the public by his writings on Architecture. Professor Robison, in the Encyclopædia Britannica,

* See Medical Observations and Enquiries, vol. iv. page 355.

mentions

mentions what Mr. N. had published on carpentry, in terms of warm commendation.

Though only now published, the Essay on the Teeth of Wheels was written several years ago. The author's intentions in this publication will appear from his short preface, which we shall here transcribe.

Preface.

"Led from situation, as well as curiosity, to attend very minutely to some parts of practical mechanics, one of the objects, which early attracted the notice of the author of the following short Essay, was the figure of the teeth of wheels. He observed, that, in forming these teeth, workmen followed rules for which they could assign no satisfactory reason:—nor did he then find in books the information he wanted: the subject seemed to him to require a detail and simplification, which no English writer, with whom he was acquainted, had given it. Afterwards, indeed, he found that some French mathematicians had treated it with much attention. But their works, though sufficiently clear to those who have studied mathematics, are too abstract to be of general utility. In the following Essay, therefore, such an elucidation of the subject has been attempted, as might render it plain to the operative mechanic—an object, which will appear the more important the more we consider the great variety of useful purposes to which wheel-work is applied.

"De La Hire and Camus are the two French writers who have treated most extensively this branch of mechanics. From the work of the latter, who has written more accurately and more fully, the author has borrowed largely; nor has he scrupled to take from others whatever he found to suit his purpose, and to make the fullest use of the communications of his friends.

"Of the method followed, it will be sufficient to remark, that the subject naturally suggested these two general divisions—First, The principles of the configuration of the teeth of wheels:—Secondly, The application of these to practice.

"The first chapter contains the principles. The second, their application, with certain modifications—1st, to *Spur Geer,*

Geer, under which are comprehended, the *wheel* and *trundle;* the *wheel* and *pinion;* the *internal pinion*, and the *rack* and *pinion*—and, 2dly, to *Bevel Geer*.

"A third chapter is added, which contains a manner of forming *spur wheels*, upon principles somewhat different from those considered in the preceding chapter.

"In the following pages no pretensions are made either to invention or profound investigation. The writer has studied perspicuity alone, and will have completely attained his object, if he has only been fortunate enough to give such a view of the various kinds of teeth, as will enable the artist to form some judgment of their respective merits, and to execute any of them with accuracy and ease. For this purpose it has been his aim to divest every part of the subject of obscurity, and to accommodate it to those who possess not the advantages of a mathematical education. But he is far from saying that they will not find some difficulties, particularly in the first chapter; nor will they, perhaps, fully understand the truths it contains, till they see their relation to practice pointed out in the second. He found, that without becoming exceedingly prolix, there was no avoiding the use of some mathematical terms; but of these he has given definitions, either as the terms themselves occur, or at the conclusion of the Essay*."

The Essay is followed by a letter containing some scientific and useful observations on the friction of the teeth of wheels, by Dr. Young, formerly professor of natural philosophy at the Royal Institution†. There follows a Postscript and Appendix. The appendix contains "*A practical inquiry respecting the Strength and Durability of the Teeth of Wheels used in Millwork.*" This subject we consider of much importance, but it is involved in considerable difficulty.

"I am aware," says Mr. B. "that owing to a great variety of circumstances, this subject is involved in much difficulty, and that it is no easy task to form any general rule

* This preface was written several years before the translation of Camus was published.

† This gentleman's Lectures on Natural Philosophy, lately published, we beg leave to recommend to the attention of our readers.

with

with regard to the pitches and breadths of the teeth of wheels. I do not pretend to more than a mere approximation towards general rules; yet, were this judiciously done, I am of opinion that it might be useful to the millwright who has not had leisure or opportunity for scientific inquiries. A rule, though not absolutely perfect, is better in all cases, than to have no guide whatever."

In order to clear the ground of inquiry, he proceeds to make some *general observations on the wheel-work of mills,* which we think merit attention. The elementary propositions which serve to guide the inquiry are next laid down, and their application considered. Afterwards the *measure* of the stress on the teeth of wheels is considered.

"In order to take experience as our guide, several examples in the annexed tables, actually in use, are selected.

"The pitch, velocity, and strain, are all stated; the strain is measured by the *horse's power;* at which the resistance is valued. Horse's power is a term now in general use, to express the force required in order to drive any kind of mill, and it may be proper here to give some further account of it.

"*Horse's power.* Although horses are not all of one strength, yet there is a certain force now generally agreed upon among those who construct steam engines, which force is denominated a *horse's power,* and hence steam engines are distinguished, in size, by the number of horses' power to which they are said to be equal."

The table contains a number of examples of wheel-work in actual use driven by water wheels, horse mills and steam engines. On this table a number of observations are made and practical rules deduced. These are followed by a very useful communication from Mr. John Roberton, engineer.

The next subject we consider as also very important, and on which we believe nothing had previously appeared in print. It is entitled "*Practical Observations with regard to the making of Patterns of Cast Iron Wheels.*"

The book concludes with Mr. Donkin's table of the radii of wheels, which may save millwrights the trouble of much calculation.

Upon

Upon the whole, we are of opinion that this book will be very useful to the operative millwright and clockmaker, while it may save the trouble of much explanation to engineers and others in carrying their plans into effect.

The "*Procédé Grammatical, pour amener le Sourd-muet de Naissance du Point où il est à celui de l'Homme civilisé, par la Méthode synthétique et par la Méthode analytique,*" invented by Abbé Sicard, was first printed by his pupils on two very large sheets, one containing the method, the other the explanation. Mr. Savage of Bedfordbury has now reprinted these grammatical rudiments on a single sheet, with a view not only to the instruction of the deaf and dumb, but also in hopes that those who are charged with the education of youth may take the hint, and examine whether the English, and every other language, may not be taught according to the method laid down in these tables. The process is executed in chalk, on a black board, six or eight scholars to a board, one writing while the other repeats.

LIX. *Intelligence and Miscellaneous Articles.*

ASTRONOMY.

To Mr. Tilloch.

SIR,

I NOW send for your insertion an ephemeris of Vesta for the ensuing two months; with a diagram* of its motion in right ascension and declination, as seen from the Earth. The configuration with the four stars, on July 30th and Aug. 1st, was the appearance, as described in my last. The ecliptic opposition was Sept. 8th, at $7\frac{1}{2}$ hours, in longitude 345° 54′ 26″. The aphelion, long. 183°. Eccentricity, 0,0953 of the Earth's radius. The planet will be stationary in longitude, Oct. 21st, and in right ascension, Oct. 23.

I remain your obedient servant,

Blackheath,
Sept. 26, 1808.

S. GROOMBRIDGE.

* It was impossible, at a period so near the day of publication, to get the diagram executed in time for the present Number. It shall be given with our next.

Ephemeris of Vesta at Midnight.

1808.	Appar. A.R.	Dec. South.	Passage over the Meridian.
	° ′	° ′	h. ′
Sept. 28	347·9	18·38	10·48
Oct. 1	346·35	18·47	10·35
4	346·5	18·53	10·22
7	345·39	18·55	10·9
10	345·16	18·56	9·57
13	344·58	18·53	9·45
16	344·45	18·49	9·33
19	344·36	18·41	9·21
22	344·32	18·31	9·9
25	344·32	18·20	8·57
28	344·37	18·5	8·46
31	344·46	17·49	8·35
Nov. 3	345·0	17·31	8·24
6	345·18	17·11	8·14
9	345·40	16·50	8·3
12	346·5	16·28	7·52
15	346·34	16·4	7·42
18	347·7	15·38	7·32
21	347·43	15·11	7 22
24	348·21	14·44	7·12
27	349·3	14·15	7·2
30	349·48	13·45	6·52

ON THE HEALTH OF SILK-WORMS *.

An ingenious member of the academy of Nismes, M. Alexander Vincens, has made a discovery relative to the health and nourishment of silk-worms, which may be of considerable advantage to the breeders and keepers of these curious insects in this country. "Experience," says the author of this discovery, "has demonstrated, that the primary necessity of the aurelia of the insect which yields us silk, is an atmosphere abounding in oxygen, and that nothing is so injurious to it as impure air mixed with foreign vapours. Silk-worms prosper in the mountains: the north winds vivify them, by causing a more pure fluid to circulate between the layers of reeds on which they are placed; but they languish and decline in the vicinity of marshes, and under the

* From Transactions of the Academy of Gard (Nismes) for 1806.

relaxing

relaxing influence of the south wind. It was natural, therefore, to suppose that an agent, which, in destroying the deleterious miasmata suspended in the air, likewise diffuses that vital air, the first element of our existence, should be particularly favourable to the breeding of silk-worms. The use of oxygenated muriatic acid answers this purpose effectually. The disengagement of this gas, (the manner of which is now sufficiently known) two or three times every day in the apartment destined for the keeping and feeding silk-worms, will be attended with very important advantages. The absence of the offensive smell, dryness of the layers, the appetite, activity, and equal march of the worms, are usually the first symptoms of its salutary effects, of which the greatly increased richness of their products is the fortunate result." M. Vincens relates the following experiment: Having had a large and full chamber of worms suffocated by the negligence of their attendants, who, not perceiving a sudden change in the temperature, imprudently continued the fire; a total loss is always the consequence of such accidents, as the few worms which do survive are so debilitated, that they soon perish in their turn amidst heaps of dead. In this case M. Vincens had recourse to the disinfecting fumigations with oxygenated muriatic acid, which he doubled and even trebled, till he had the pleasure of seeing all those worms which were not, familiarly speaking, burnt, resume their pristine health, and finish their business of spinning with the greatest success. By these means he succeeded in saving about the half of his worms. The value of this discovery will be best appreciated by those who have either for amusement or profit occupied themselves in rearing silk-worms, which unquestionably might be bred in this country in quantities sufficient to prevent any disagreeable scarcity of the useful article of silk. These fumigations are likewise so simple, that any person, taking two parts of common salt, adding one of black manganese, and putting them in an earthen pan and pouring on as much oil of vitriol mixed with a little water as will moisten them, may produce this gas, so salutary to the worms.

POWER-

POWERFUL FURNACE.

To Mr. Tilloch.

SIR,

Having a desire to know what is the greatest heat that can be produced by a close fire, I constructed a furnace, which I buried in pounded charcoal to prevent the escape of heat.

The furnace opens in the middle into a cupel, is supplied with fuel at the top, and at the bottom with oxygen air impelled into it by forcing-pumps.

The furnace being only recently finished, I have not had time to try many experiments:—*Exp.* 1st, A seven-shilling piece *disappeared* in ten minutes. 2d, Platina was *melted*, but I am not certain that it was pure. 3d, Charcoal buried in sand, and exposed to the heat for a quarter of an hour, became so hard as to resist the action of the knife.

T. A. Z.

Penrith, Aug. 1808.

NEW VOLCANO.

A Letter from John B. Dabney, Esq., Consul of the United States of America, to a Friend at St. Michael's.

"Fayal (Azores), June 25, 1808.

"Dear Sir,—A phænomenon has occurred here not unusual in former ages, but of which there has been no example of late years; it was well calculated to inspire terror, and has been attended with the destruction of lives and property. On Sunday, the 1st of May, at one *p. m.*, walking in the balcony of my house at St. Anthonio, I heard noises like the report of heavy cannon at a distance, and concluded there was some sea-engagement in the vicinity of the island. But soon after, casting my eyes towards the island of St. George's, ten leagues distant, I perceived a dense column of smoke rising to an immense height: it was soon judged that a volcano had burst out about the centre of that island; and this was rendered certain when night came on, the fire exhibiting an awful appearance. Being desirous of viewing this wonderful exertion of Nature, I embarked on the 3d of May, accompanied by the British consul, and ten other gentlemen, for St. George's—we ran over in five hours, and arrived

arrived at Vellas, the principal town, at eleven *a. m.* We found the poor inhabitants perfectly panic-struck, and wholly given up to religious ceremonies and devotion. We learned that the fire of the 1st of May had broken out in a ditch, in the midst of fertile pastures, 3 leagues S. E. of Vellas, and had immediately formed a crater, in size about 24 acres. In two days it had thrown out cinders or small pumice stones, that a strong N E. wind had propelled southerly—and which, independent of the mass accumulated round the crater, had covered the earth from one foot to four feet in depth, half a league in width, and three leagues in length; then passing the channel five leagues, had done some injury to the east point of Pico. The fire of this large crater had nearly subsided; but in the evening preceding our arrival, another small crater had opened, one league north of the large one, and only two leagues from Vellas. After taking some refreshment, we visited the second crater, the sulphurous smoke of which, driven southerly, rendered it impracticable to attempt approaching the large one. When we came within a mile of the crater, we found the earth rent in every direction, and, as we approached nearer, some of the chasms were six feet wide: by leaping over some of these chasms, and making windings to avoid the larger ones, we at length arrived within 200 yards of the spot, and saw it in the middle of a pasture, distinctly, at intervals, when the thick smoke which swept the earth lighted up a little. The mouth of it was only about 50 yards in circumference; the fire seemed struggling for vent, the force with which a pale blue flame issued forth, resembled a powerful steam-engine, multiplied a hundred fold; the noise was deafening, the earth where we stood had a tremulous motion, the whole island seemed convulsed, horrid bellowings were occasionally heard from the bowels of the earth, and earthquakes were frequent. After remaining here about ten minutes, we returned to the town—the inhabitants had mostly quitted their houses, and remained in the open air or under tents. We passed the night at Vellas, and the next morning went by water to Ursulina, a small sea-port town, two leagues south of Vellas, and viewed that part of the

the country covered with the cinders before mentioned, and which has turned the most valuable vineyards in the island into a frightful desert. On the same day (the 4th of May) we returned to Fayal, and on the 5th and succeeding days, from twelve to fifteen small volcanoes broke out in the fields we had traversed on the 3d, from the chasms before described, and threw out a quantity of lava, which travelled on slowly towards Vellas. The fire of those small craters subsided, and the lava ceased running about the 11th of May; on which day the large volcano, that had lain dormant for nine days, burst forth again like a roaring lion, with horrid belchings, distinctly heard at twelve leagues distance, throwing up prodigious large stones, and an immense quantity of lava, illuminating at night the whole island. This continued with tremendous force until the 5th of June, exhibiting the awful yet magnificent spectacle of a perfect river of fire (distinctly seen from Fayal) running into the sea. On that day (the 5th) we experienced that its force began to fail, and in a few days after it ceased entirely. The distance of the crater from the sea is about four miles, and its elevation about 3,500 feet.

The lava inundated and swept away the town of Ursulina and country-houses and cottages adjacent, as well as the farm-houses, throughout its course. It, as usual, gave timely notice of its approach, and most of the inhabitants fled; some few, however, remained in the vicinity of it too long, endeavouring to save their furniture and effects, and were scalded by flashes of steam, which, without injuring their clothes, took off not only their skin but their flesh. About sixty persons were thus miserably scalded, some of whom died on the spot, or in a few days after. Numbers of cattle shared the same fate. The judge and principal inhabitants left the island very early. The consternation and anxiety were for some days so great among the people, that even their domestic concerns were abandoned, and amidst plenty they were in danger of starving. Supplies of ready-baked bread were sent from hence to their relief, and large boats were sent to bring away the inhabitants who had lost their dwellings. In short, the island, heretofore rich in cattle,

cattle, corn, and wine, is nearly ruined; and a scene of greater desolation and distress has seldom been witnessed in any country.

A fish called by the Spaniards the *curbinata*, the largest of which does not weigh more than two pounds, abounds in the river Oronoko, in South America. It is of an excellent flavour, but it is less appreciated for its nutritive quality than for two stones lodged in the head, in the place which the brain ought to occupy. They have each the shape of an almond without the shell, and the brilliant colour of mother of pearl. These stones are bought for their weight in gold, on account of their specific virtue against a retention of urine. It is sufficient to take three grains finely powdered in a spoonful of wine or water, to cause an instant discharge; but too large a dose relaxes the muscles, and occasions an inability of retention.

LECTURES.

Mr. George Singer will commence his Lectures, at the Scientific Institution, early in November, with an extensive Course, on the Nature, Use, and Properties of the Atmosphere; a Historical Sketch of the Progress of Atmospherical Discovery, and an Experimental Elucidation of every interesting Phænomenon dependent on the Agency of Air. Including the Subjects of Pneumatics, Hydrostatics, Natural Chemistry and Meteorology, illustrated by an extensive and appropriate Apparatus.

Particulars may be had at the Institution, 3, Prince's Street, Cavendish Square.

Mr. Accum's Lectures on Experimental Chemistry and Analytical Mineralogy commence at the Chemical Laboratory, Compton Street, Soho, October the 18th. The Lectures on Experimental Chemistry comprise the Practical Operations of the Scientific Laboratory; general Rules to be observed in the Performance of Experiments, and Summary Experimental Elucidations of the Science of Chemical Philosophy. The Lectures on Analytical Mineralogy devolve to the Art of distinguishing Minerals, the Modes of examining them by Chemical Agencies; and General Process of Analysis,

Analysis, with a Summary View of Mineralogical Science, and its Application to the useful Arts.

LIST OF PATENTS FOR NEW INVENTIONS.

To Joseph Mason Guest, of Birmingham, in the county of Warwick, thread-manufacturer, for a mill for twisting thread for various purposes. July 30.

To John Curr, of Bellevue House, in the parish of Sheffield, in the county of York, gent., for a method of applying flat ropes, flat bands, or belts, of every kind to capstans and windlasses of ships and vessels of every description, for the purpose of towing or conveying the said ships and vessels, in, out of, or about ports, harbours, rivers, seas, or creeks; and also a method of applying flat or round ropes, lines, bands, or belts, for the purpose of catching and detaining whales. July 30.

To Luke Hebert, of the parish of Saint Stephen Walbrook, in the city of London, gent., for a machine on an improved construction for polishing, embossing, and graining leather, and extending and flattening the same. July 30.

To Charles Gostling Townley, of Ramsgate, in the county of Kent, esq., for a key which regulates the tone of the flute, or other musical instrument capable of the improvement, by causing the box of it to lengthen or contract at pleasure, which key may be called the tone regulating key. August 9.

To James Gale, of Shadwell, in the county of Middlesex, rope-maker, for certain improvements in rope-making. August 18.

To Alexander Tilloch, of Barnsbury-street, Islington, in the county of Middlesex, gent., for a new physico-mechanical power, or, in other words, improved machinery or apparatus, capable of being employed as a moving power to work or drive machinery and mill work, and applicable to other useful purposes. August 20.

To Thomas Price, of Bilston, in the county of Stafford, coal-master, for improvements in the application of steam for useful purposes; and in the apparatus required to effect the same. August 24.

To

To Thomas Mead, of Scott-street, in the parish of Sculcoates, in the county of York, engineer, for his method or methods of making and constructing circular or rotative steam engines, upon an entire new principle, and employing the elastic or expansive force of steam in a much more efficacious and advantageous manner than has hitherto been done. August 24.

To William Congreve, of Garden-court, in the Temple, in the county of Middlesex, esq., for his new principle of measuring time, and constructing clocks and chronometers. August 24.

To Joseph Cuff the younger, of Whitechapel, in the county of Middlesex, cheesemonger and bacon merchant, for certain machinery for the more easy expeditious and better method of slaughtering hogs, bullocks, and other cattle, whereby much labour will be saved, and the flesh of such cattle greatly improved in quality, and will be more easily and better cured and preserved. August 25.

To John Dumbell, of Mersey Mills, in the parish of Warrington, and county palatine of Lancaster, miller, for his new method or methods of flax spinning, and of preparing or making a special twist, thread, furniture, cloth, frills, or attire, which he calls telary teguments from silk, wool, cotton, flax, hemp, or tow, as well as from a very great variety of other articles, (in a combined or uncombined state,) and for a method or methods of refabricating or renovating the same, and of producing or reproducing from tatters in general a new body. August 25.

ERRRATA.

Page 38, line 5 from top, for "Borsal" read "Bonsal:" line 12 from bottom, for "as the miners call it" read "as the miners *here* call it." Page 40, line 29, for "concoctions" read "concretions." Page 127, line 19, for "Fig. 9, Plate IV." read "Fig. 8, Plate III."

METEOROLOGICAL TABLE,

BY MR. CAREY, OF THE STRAND,

For September 1808.

Days of the Month.	Thermometer. 8 o'Clock, Morning.	Noon.	11 o'Clock, Night.	Height of the Barom. Inches.	Degrees of Dryness by Leslie's Hygrometer.	Weather
Aug. 27	58°	66°	56°	29·65	65	Cloudy
28	56	68	55	·75	62	Fair
29	56	69	55	·88	75	Fair
30	66	72	61	·72	56	Cloudy
31	60	68	57	·60	52	Cloudy
Sept. 1	59	68	56	·67	38	Showery
2	56	64	54	·82	27	Showery
3	55	67	56	·85	42	Cloudy
4	56	64	54	·86	40	Fair
5	55	64	55	·78	36	Rain
6	56	64	56	·75	37	Showery
7	55	66	60	·78	36	Showery
8	59	65	52	·52	52	Fair
9	58	63	57	·31	26	Stormy
10	58	65	56	·32	28	Stormy
11	59	64	55	·48	21	Stormy
12	56	60	54	·68	20	Rain
13	55	65	57	·70	23	Stormy
14	56	66	60	·82	56	Rain
15	61	68	57	30·11	57	Fair
16	57	64	54	·29	62	Fair
17	54	64	57	·21	52	Fair
18	55	64	58	29·96	51	Rain
19	60	66	57	·97	52	Fair
20	58	66	54	30·26	55	Fair
21	51	66	53	·30	40	Fair
22	51	67	57	·01	39	Fair
23	53	54	49	29·68	10	Rain
24	46	54	50	·95	54	Fair
25	50	56	54	30·08	15	Cloudy
26	48	63	57	29·99	43	Fair

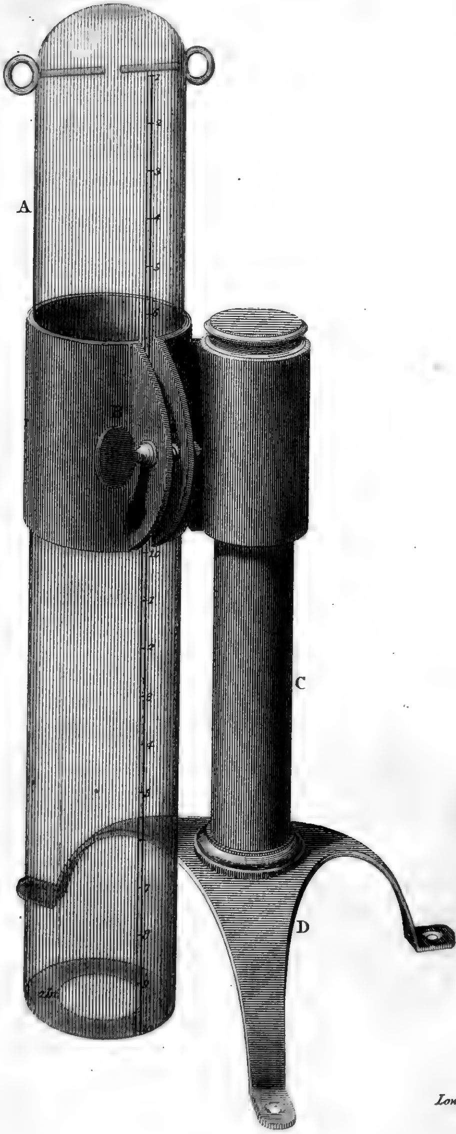
N. B. The Barometer's height is taken at one o'clock.

INDEX TO VOL. XXXI.

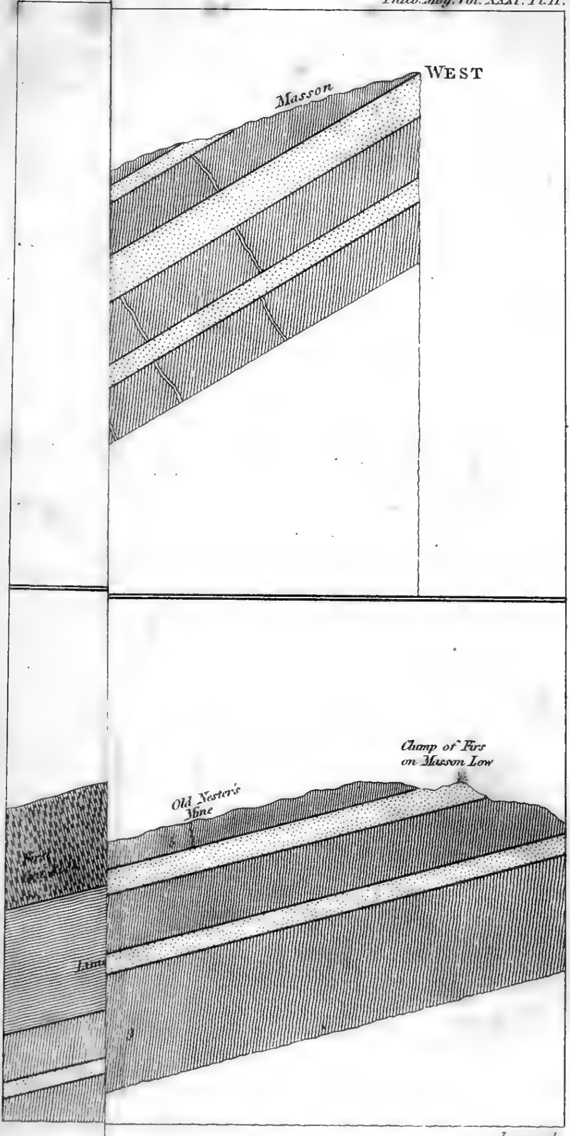
END OF THE THIRTY-FIRST VOLUME.

Printed by Richard Taylor and Co., Shoe Lane.

Davy's improved Eudeometer.

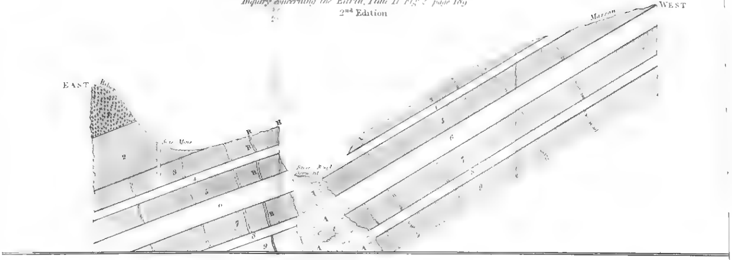


Lowry sculp.

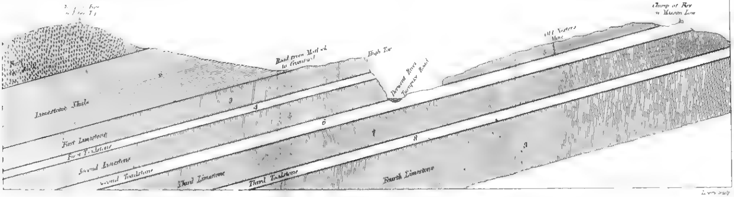


Lowry sculp.

Mr. Whitehurst's Section of the Strata at Matlock High Tor.
Inquiry concerning the Earth, Plate II Fig. 2 page 189
2nd Edition



A Section of the Strata between Riber Hill and Masson Hill
in MATLOCK, DERBYSHIRE,
passing the High-Tor Rock, by Mr. John Farey May 1808



Scales { of Furlongs for Lengths
{ of Yards for Thicknesses

Chinese Method of propagating Fruit Trees by Abscision.

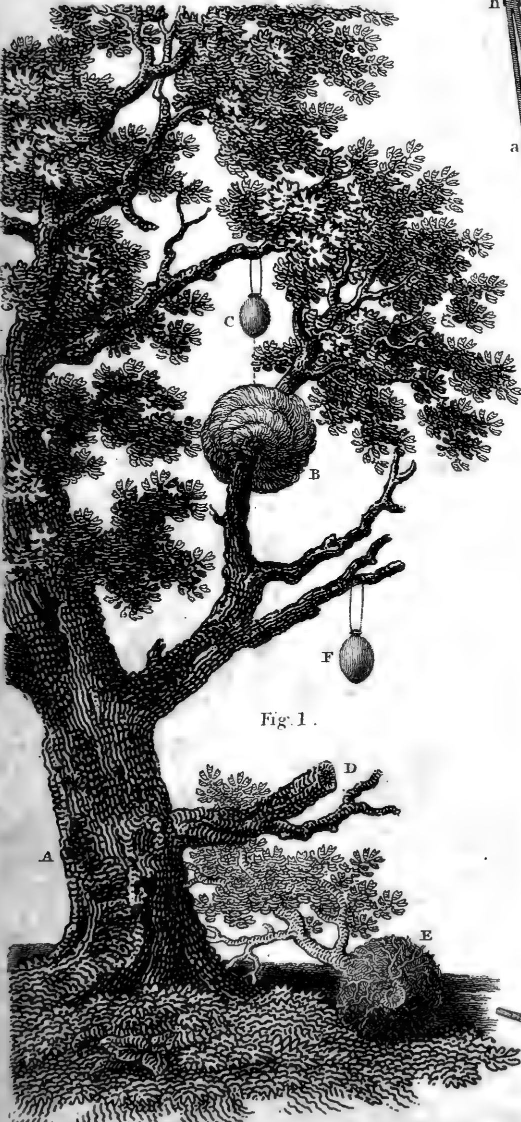


Fig. 1.

Mr. I. Broad's Timber Gauge.

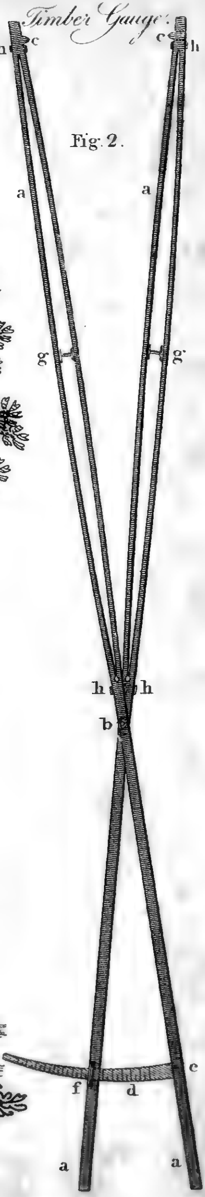
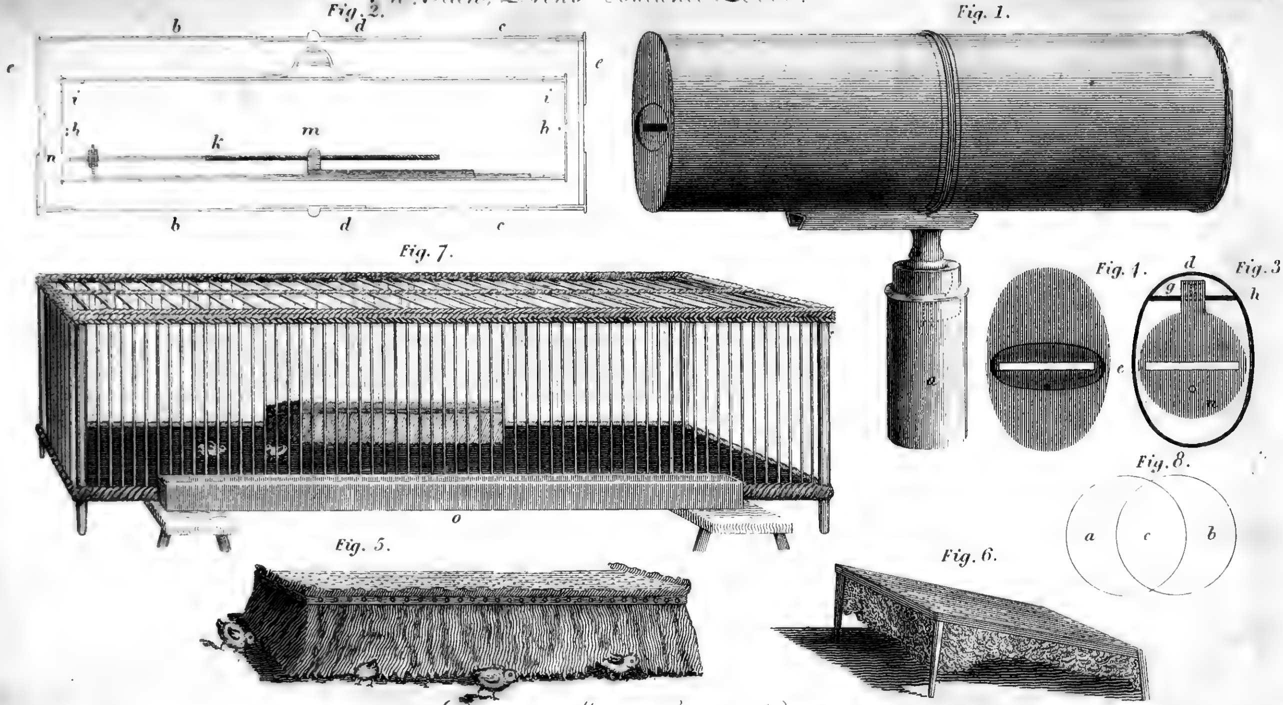


Fig. 2.

S. [illegible] sculp

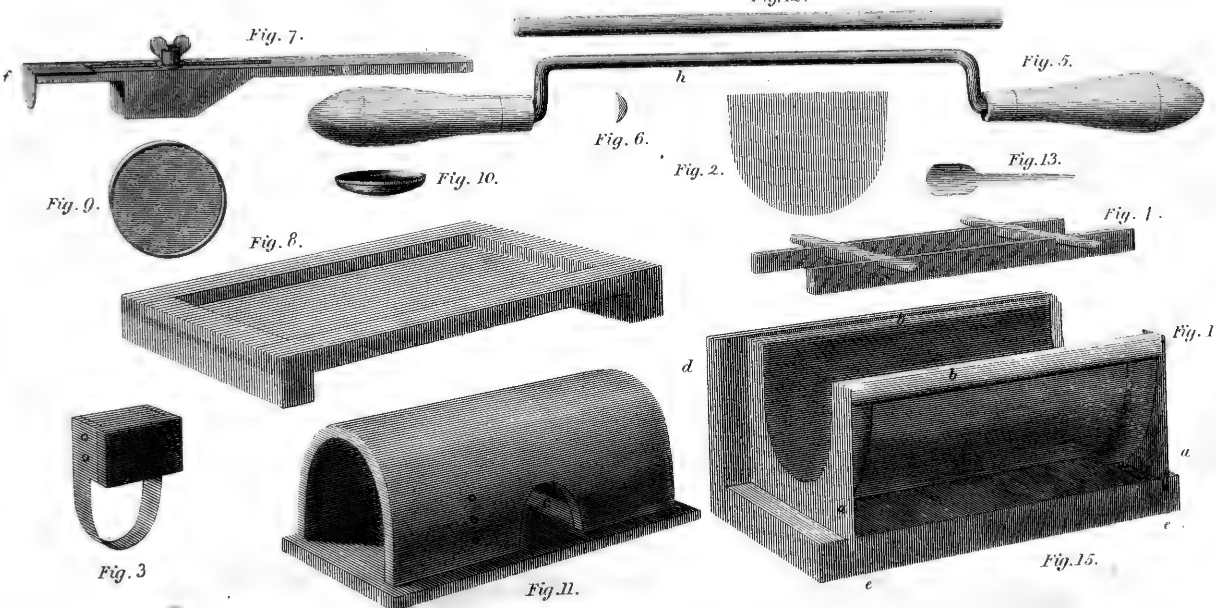
Mr. Richd. Dren's Balance Level.



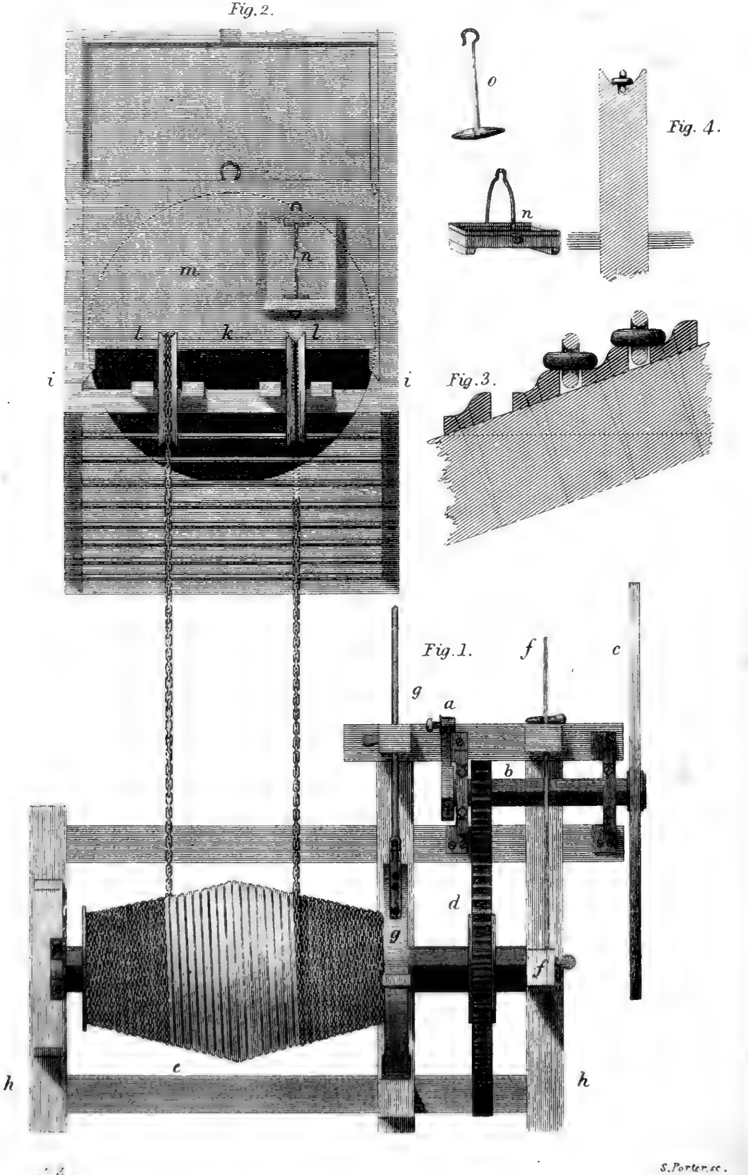
Mrs. D'Oyley's Method of rearing Poultry.

S. Porter, sc.

Mr E. Turrell's Construction of Chemical Muffles.



Mr. Gilpin's Machine for raising Coals, Ore &c.



S. Porter sc.

Mr. C. Wilson's secure Sailing, or Life Boat.

Fig. 1.

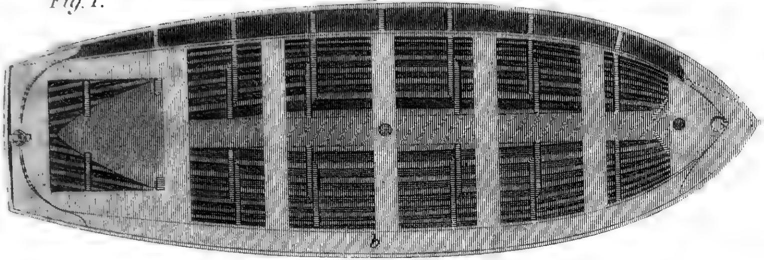


Fig. 2.

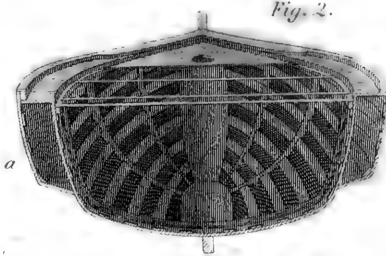


Fig. 3.

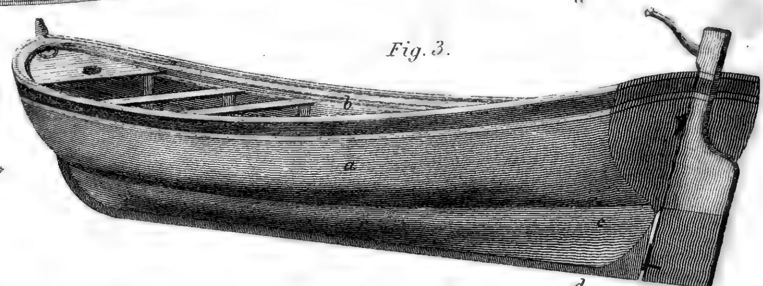
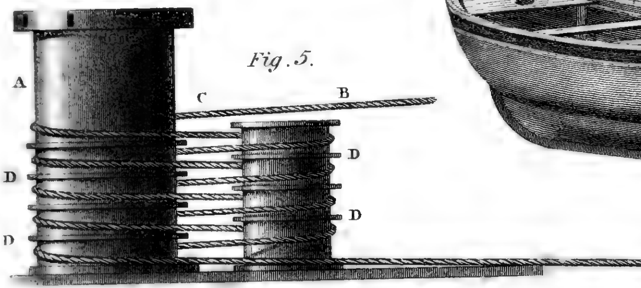


Fig. 4.

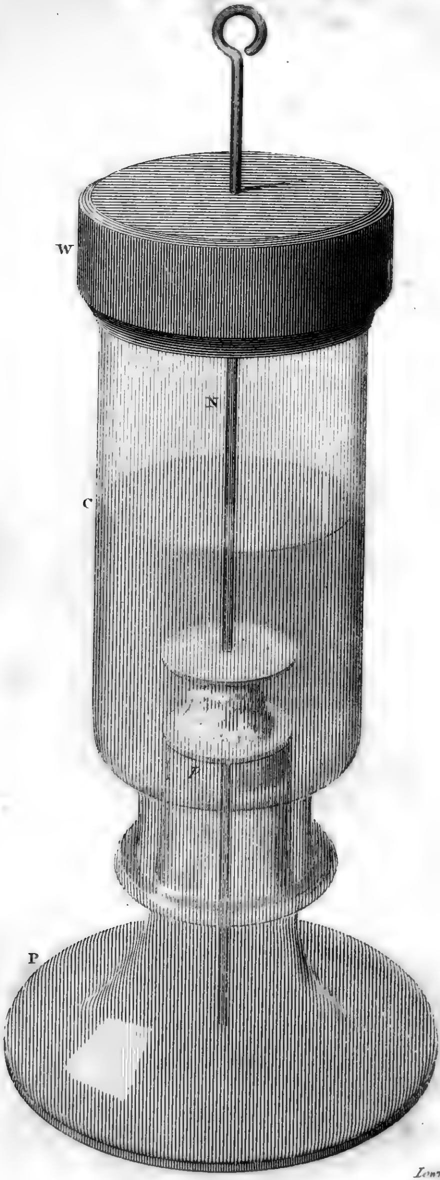
Fig. 5.



Mr. J. W. Boswell's improved Capstan.

S. Porter sc.

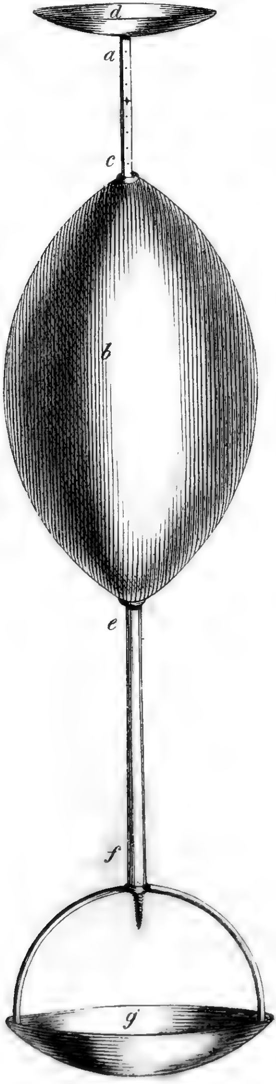
M^r. PEPYS *Apparatus for the Decomposition of the* ALKALIS *under* NAPTHA.



Lowry del et sculp.

Atkins's Universal Hydrometer;

for Ascertaining the Specific Gravities of Solids & Fluids.



No. 124.