A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND THE ARTS.

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Sur Joyce Royal 1809

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND THE ARTS:

ILLUSTRATED WITH ENGRAVINGS.

BY WILLIAM NICHOLSON.

VOL. IV.

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M,DCCCI.

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II. Account of a Series of Experiments, undertaken with the View of decomposing the Muriatic Acid. By Mr. William Henry. (Concluded from p. 214.) p. 245

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NOVEMBER 1800.

Engravings of the following Objects: 1. An Improvement of Mr. Goodwyn's Hydraulic Engine, by which its Powers are extended, and it is made to work itself. 2. Crystals of the Arragonite. And, 3. Herschel's Apparatus for measuring the Effects of radiant Heat.

I. Notice of some Observations on the Causes of the Galvanic Phenomena, and on certain Modes of increasing the Powers of the Galvanic Pile of Volta. By Mr. Davy, Superintendant of the Pneumatic Institution. Communicated by the Author - - - p. 337

Zinc in the Galvanic circuit undergoes no oxidation at common temperatures with *pure* water; but it is oxided when the water contains either atmoſpheric air, oxygen, nitrous gas, nitrous acid, or marine acid, &c. Theſe ſubſtances at the ſame time undergo chemical change. The pile of Volta does not act with pure water; but it does when the water contains any of the laſt enumerated ſubſtances. Its power appears to be proportional to the oxidation of the zinc; which may therefore be eſteemed the cauſe. This concluſion leads to methods of conſtructing piles of immenſe power. Experiments in proof. Pile with nitrous acid at leaſt ſix times as ſtrong as the common pile.

II. On raiſing Water by the Engine of H. Goodwyn, Eſq. through double or treble the Space of the deſcending Column, and on the proper Arrangement to make it require no Attendance. By a Correſpondent - 342

III. Obſervations and Experiments on Light and Heat, with ſome Remarks on the Enquiries of Dr. Herſchel, reſpecting thoſe Objects. In a Letter from Mr. John Leſlie - - - - p. 344

Experiments by the photometer, to determine the abſorbent and reflecting powers of coloured ſubſtances with regard to radiant heat; and the heat afforded by the different rays of the ſolar ſpectrum. Remarks on the optical diſcoveries of Newton, and the late experiments of Dr. Herſchel; againſt the latter of which and the inferences thence drawn, various objections are ſtrongly urged. Recommendation of the optics of Bouguer and the Photometria of Lambert.

IV. Account of a Memoir of M. Prouſt, on ſeveral intereſting Points in Chemiſtry - - - - - p. 350

Oil of camphor. Method of obtaining the pure taning principle. Theory and formation of ink with galls and ſulphate of iron. Sulphuric acid profitably obtained from the reſidue of ſulphuric ether. Detection of phoſphoret of carbon in the diſtillation of phoſphorus. Eſſential oil in crude iron. Native iron of Peru, which is conſiderably ductile, and does not ruſt; it is found to contain nickel. Experiments on fleſh. Pyrite of the Incas. Purification of zinc.

V. Experiments on the ſolar and on the terreſtrial Rays that occaſion Heat; with a comparative View of the Laws to which Light and Heat, or rather the Rays which occaſion them, are ſubject, in order to determine whether they are the ſame or different. By William Herſchel, LL. D. F. R. S. p. 360

A ſeries of experiments were made in which the light of the ſun, of a candle, of the ſolar priſmatic ſpectrum, of a red hot poker, and of a coal fire, were ſeverally reflected from metallic mirrors, and produced heat. The inviſible radiance from the ſame objects was alſo made to undergo optical reflection and condenſation, and produced heat. Experiments of the ſame kind were made by diverting the viſible as well as inviſible radiance, of the ſame objects out of its courſe by refraction, and condenſing it by the ſame means, in all which caſes heat was produced.

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VIII. Remarks on the Memoir in which M. Girtanner examines whether Azote be a ſimple or compound Body. By Cit. Berthollet p. 371

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I. On the Number of the Primitive Colorific Rays in Solar Light. By the Rev. Matthew Young, D. D. S. F. T. C. D. and M. R. I. A. p. 385

Whether the primitive colours be compoſed of three original tints or more? cannot be determined by mixture of powders, &c. That light of one colour is not all of the ſame refrangibility, is inferred from the extent of each colour on the ſpectrum. Probability that red, yellow and blue are the primitive colours, becauſe any two of theſe adjacent to each other will compoſe the intermediate tinge; though theſe ſuppoſed originals cannot be ſo compoſed of the others. Theoretic obſervations, experimental teſt of this doctrine by coloured glaſſes. Ocular ſpectra. Hypotheſis of three colours will ſolve the phænomena of chromatics.

II. An Account of ſome Additional Experiments and Obſervations on the Galvanic Phenomena. By Mr. Davy, Superintendant of the Pneumatic Inſtitution. Communicated by the Author - p. 394

Sulphuric acid excites the pile very little, but becomes active by the addition of water. Liquid ſulphurets are equal in power to water. Nitric and ſulphuric acids act in vacuo. Obſervations, &c. Enquiries to determine what happens in the pile itſelf. Examination of the power of different Galvanic combinations.

III. On the Quotients ariſing from the Diviſion of an Unit by prime Numbers. By H. Goodwyn, Eſq. - - - p. 402

IV. Conſtruction of a Wheel adapted to expreſs, by its Rotation, the unequal angular Motion of the Planets. By M. Roemer - p. 404

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V. On the Solutions and Precipitates of Mercury. By Cit. Berthollet p. 405

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III. Deſcription and Uſe of a cheap and ſimple Apparatus for teaching the firſt Principles of Mechanics. By Richard Lovell Edgeworth, Eſq. F.R.S. and M.R.I.A. - - - - p. 443

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Premiums offered by the Board of Agriculture.---Prizes offered by the Claſs of Mathematical and Phyſical Sciences of the National Inſtitute of France in its Public Sitting, 15th Germinal in the year 8 (April 4, 1800.)---Candles with wooden Wicks.---Ink capable of reſiſting the Action of Oxygenated Muriatic Acid.

FEBRUARY 1801.

Engravings of the following Objects: 1. An improved Hydraulic Engine, by Mr. Cloſe. 2. The Duke of Bridgewater's underground inclined Plane. 3. Figures illuſtrative of Galvanic Diſcoveries. And, 4 Mr. Home's Exhibition of the Structure of that ſingular Animal the Ornithorhynchus paradoxus.

I. Obſervations on a Method of reſtoring the Utility of Wells, which have been abandoned in conſequence of the Mephitization of the Ground. By Cit. Cadet-de-Vaux, of the Society of Agriculture of the Department of the Seine in France) Communicated at the Sitting of that Society on the 16 Brumaire, in the Year 8 - - - - p. 481

The method conſiſts in boring and then driving a wooden pipe into the cavity. Through this pipe the borer is made to act and increaſe the depth. Another pipe is driven in ſo as to ſink the firſt ſtill lower. By a continuation of this proceſs the length of pipe is carried to very great depths, if neceſſary, and water is conducted from the lower ſprings to the ſurface.

II. Memoir of ſeveral newly diſcovered Properties of Phoſphorated Hydrogen Gas. By Citizen Raymond, Profeſſor of Chemiſtry at the Central School of the Department of the Ardéche. (Concluded from page 475) p. 483

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IV. Concerning the Engine for raiſing Water by the lateral Communication of Motion. In a Letter from the Inventor, Mr. William Cloſe p. 493

V. On the Power of penetrating into Space by Teleſcopes; with a comparative Determination of the Extent of that Power in natural Viſion, and in Teleſcopes of various Sizes and Conſtructions; illuſtrated by ſelect Obſervations. By William Herſchel, LL.D. F.R.S. - - p. 496

VI. Some Obſervations on the Head of the Ornithorhynchus paradoxus. By Everard Home, Eſq. F. R. S. - - p. 506

VII. Inſtances of ſuſpended Animation in Vegetables. By Mr. John Gough p. 509

VIII. Extract of a Letter from Doctor G. M. to Dr. William Babington, dated Freiberg, Dec. 17, 1800. On the State of Galvaniſm and other ſcientific Purſuits in Germany. Communicated by Dr. Babington p. 511

IX. On the Chemical Effects of the Pile of Volta. By a Correſpondent p. 514

X. Analyſis of the Mellite, or in German, Honigſtein. By Citizen Vauquelin p. 515

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Method of aſcertaining the Inclination of the Magnetic Needle. By Cit. Coulomb.---New Production of Ammonia.---Diſcovery of a new Alkali.---Flour from the Bread Fruit.---Extract from a Memoir of Cit. Thénard, on the ſeveral Degrees of Oxigenation of the Oxide of Antimony, and on its Combinations with ſulphurated Hydrogen.---On the Structure of the Upper Pyreneans, by Cit. Raymond. Communicated to the National Inſtitute of France.---Letter from Mr. Davy, Superintendant of the Pneumatic Inſtitution, containing Notices concerning Galvaniſm. Parkinſon's Chemical Pocket Book.---Mr. Henry's Pocket Volume on Chemiſtry.

MARCH 1801.

Engravings of the following Objects: 1. A very ſimple Steam Engine, by Mr. Nancarrow. 2. Apparatus for Experiments with Heat, by Mr. Thompſon. 3. New application of the Syphon, by Mr. Cloſe; and, 4. Figure of the Ornithorhynchus paradoxus.

I. Experiments to determine whether or not Fluids be Conductors of Caloric. By Thomas Thomſon, M.D. Lecturer on Chemiſtry in Edinburgh. Communicated by the Author - - - - p. 529

II. Deſcription of a Steam Engine on the Principle of Savary, operating by a ſeparate condenſer; with other eſſential Improvements. By Mr. John Nancarrow - - - - - - p. 545

III. New Application of the Syphon to raiſe Water above the ſurface of the Reſervoir. In a Letter from Mr. William Cloſe - - p. 547

IV. On the Power of penetrating into Space by Teleſcopes; with a comparative Determination of the Extent of that Power in natural Viſion, and in Teleſcopes of various Sizes and Conſtructions, illuſtrated by ſelect Obſervations. By William Herſchel, LL. D. F. R. S. (Continued from page 506.) p. 550

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A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND

THE ARTS.

APRIL 1800.

ARTICLE I.

On the Antiquity of the Art of Etching on Glaſs. *By Mr.* FRED. ACCUM.

LOOKING over a parcel of old foreign newſpapers, I was not a little ſurpriſed to obſerve that the art of etching on glaſs had been known and practiſed amongſt our anceſtors upwards of a century ago.

In order that every one may judge for himſelf, whether this diſcovery belongs excluſively to Scheele, the Swediſh chemiſt, I ſhall tranſcribe an advertiſement inſerted in an old German periodical publication*, which is likewiſe copied into Beckman's Collections towards a Hiſtory of Inventions. The original advertiſement, literally tranſlated, runs thus: "*The diſcovery of a powerful acid, by means of which every imaginable kind of figures* "*may eaſily be etched upon glaſs.*

"Take ſpiritus nitri per deſtillationem, put it into a retort, and apply a ſtrong heat. "When it has paſſed over into the receiver, throw into it ſome powdered *green Bohemian* "*emerald* (which, when heated, ſhines in the dark), otherwiſe called *heſphorus*. This "being done, place the receiver, containing the mixture, on a heated ſand-bath, for about "four-and-twenty hours, and it will be fit for the purpoſe. To uſe this corroſive acid,

* Breſlawer's Collections for the year 1725. January. This receipt is likewiſe inſerted by Krunitz in his Economical Encyclopedy, XI. p. 678.

" take a pane of glaſs of any kind, clean it well, and free it from greaſe, by waſhing with a " ley, and when dry, trace out upon it, with ſulphur and varniſh, whatever you chooſe. " Put a border of bees'-wax round it, about one inch high, and then pour the corroſive " acid, prepared as before directed, carefully over the whole ſurface of the glaſs, and let it " ſtand undiſturbed for ſome time, the longer the better. The glaſs will become corroded, " and all you had traced before, will now appear as if raiſed, or elevated, above the ſurface " of the glaſs, in a very diſtinct and pleaſing manner."

This advertiſement is ſigned *I. G. Wigand*, and dated from *Goldingen*, in Courland. In a ſubjoined note, the author of it confeſſes that he is not the inventor of the corroſive acid, but that he had the receipt from *M. Pauli*, a famous phyſician reſident at Dreſden, and lately deceaſed. He further aſſerts, that the late doctor, during his life-time, had etched on glaſs ſeveral curious creſts, names, and figures, in a manner no leſs beautiful than ſurpriſing.

In a ſupplement to the before mentioned publication, the ſame author very earneſtly endeavours to convince the public, that the art of etching on glaſs he had made publiſhed ſome time before, was very different from the art of engraving on glaſs by means of emery, flint, red-hot iron, or other ſharp pointed inſtruments of the hardeſt kind. Nor is it that art, ſays he, by which Matheſius, the famous apothecary, operated, who formed elevated, or engraved figures, feſtoons, and other ornaments on glaſſes, drinking cups, &c. for all this I know very well is done by means of diamond pencils. But the method I have made public, ſeems to be, in fact, the very ſame admirable and ſecret art which was formerly practiſed by a ſkilful artiſt of Nuremberg, who worked in that art ſolely for the emperor Charles II.

On purſuing this ſubject a little further, there remains, no doubt, but that this old artiſt of Nuremberg, to whom our author alludes, is the perſon of whom Doppelmair * gives the following account: " Amongſt the artiſts of Nuremberg muſt be enumerated *Henry* " *Swanhard*, a ſkilful engraver in ſteel and ſtone, who found out by the glaſs of his " ſpectacles, upon which ſome corroſive liquid had fallen, a new art of etching upon glaſs, " which diſcovery he made in the year 1670." Wagenſeil †, on the contrary, relates, that the inventor derives more merit from his diſcovery, than accident entitled him to claim. " Swanhard," ſays he, " by the acuteneſs of his genius, proved what was hitherto deemed " impoſſible. He was the firſt who ever compoſed a corroſive, ſo active as to diſſolve the " hardeſt cryſtal glaſs, which hitherto reſiſted the force of the moſt powerful ſpirits of the " apothecaries. By means of this corroſive, Swanhard delineated and etched on glaſs " figures of men, ſome naked and ſome dreſſed, and all kinds of animals, flowers, plants, " trees, and ſhrubs, in a manner perfectly natural, and perfectly eaſy." The ſame is mentioned in Schneider's Biography of the Artiſts of Germany, 1740, p. 37.

How the above artiſt prepared his corroſive is not mentioned by any of the above authors. It is, therefore, very probable, that he kept his art a ſecret, as it ſeems that the

* Doppelmair's Hiſtory of the Artiſts of Nuremberg, 1734, p. 16.

† Wagenſeili Comment. de Civitate Norimbergenſi, Altdorf, 1697. 4to. p. 154.

receipt for that purpoſe was made public, for the firſt time, in January, 1725*, by the before mentioned M. Pauli. How he came to know it, I have not been able to learn.

That the inventor employed his corroſive to a purpoſe different from that for which it is uſed at preſent, is obvious from the effect it produced upon the glaſs. At preſent the glaſs is covered either with wax, iſinglaſs, or a varniſh, and thoſe figures which are intended to be etched, are traced through this covering, by means of a pointed inſtrument; but our ancient artiſt covered his figures, when traced, with a varniſh and ſulphur, and then applied the acid to corrode the glaſs around them, ſo that the figures which remained ſmooth and clear appeared, when the varniſh was removed, as if raiſed from a dim or dark ground. He adopted this method probably in order to render his invention more palpably different from the art of cutting the figures on the glaſs, as if engraven, long known and practiſed before this diſcovery was made.

That the Bohemian emerald, or heſphorus, made uſe of in this receipt, was our fluate of lime, can hardly be doubted. In old German authors who treat on the working of mines, this ſtone is claſſed amongſt the fluſſe (fluxes) becauſe it was an uſual ſubſtitute to accelerate the fuſion of certain ores. *Agricola*, who changed the German names of quartz, zinc, biſmuth, cobald, &c. into quartzum, zincum, &c. changed fluſs into fluor, which became afterwards very common †. If a paſſage of the ancients can be quoted that ſeems to allude to fluate of lime, it is that of Theophraſtus, where he ſays, that there are certain ſtones which, when added to ſilver, copper, and iron ores, become fluid. For Cronſtadt was the firſt ſyſtematic writer (if I am not miſtaken) who mentioned fluate of lime as a particular genus.

That the ſtone called emerald, or heſphorus, was really our fluor ſpar, becomes obvious from what Kirchmair, profeſſor at Wittemberg, in Germany, remarks, who was probably the firſt who made known what kind of ſtone it was, which had the peculiar property of ſhining in the dark after having been heated ‡, and which by the ancients was ſought for

* Breſlawer's Collections, l. c.

† Lapides ſunt gemmarum ſimiles, ſed minus duri, fluores liceat mihi verbum an e verbo exprimere, noſtri metallici appellant, nec meo judicio, inepte; ſiquidem ignis calore, ut glacies ſolis, liquefcunt et fluunt. Varii autem et jucundi colores eis inſident.

BERGMANNII OPUSCUL, p. 466.

‡ Ante annos pacuos admodum inventus mineralis alicujus viſu et proprietatibus in quibuſdam ſimilis ſmaragdo, ab artificibus duobus mihi per amicè notis uſus eſt. Conficiendi phoſphori et repræſentandi modus levis atque brevis ille. Recipe q. v. mineralis viridis ſmaragdum pene referentis; contare in pulverem, aqua madefac communi, pulvis inſtar ut fiat. Pencillo poſtea in lamina cuprea, magnitudine vel majoris plani alicujus manubrio inſtructa literas, quaſcunque voles, in lamina deſcribe craſſiuſculas. Ardentibus ſuper impone prunis vaſculo exceptis. Phœnomenon ſpectabis in obſcuro amæniſſimum ſine fume et odore lucens. Sed ut verum fatear, nec uſum, niſi curioſi animi explendi, artificium hoc, neque diuturnitatem habet. Pectus ergo avidum ſciendi meliora fatiari nequit ſive Heſphorus vocetur ſive Veſperugo.

G. C. Kirchmaieri De Phoſphoris et natura lucis, nec non de igne, commentatio epiſtolica. Wittembergae, 1680, p. 7.

with so much avidity. Neither need I to mention that the nitrous acid made use of in the receipt was equally capable of disengaging the fluoric acid, though we usually make use of the sulphuric.

There remains, therefore, little doubt, that the art of etching on glass does not entirely belong to the moderns, or to deny that the ancients were altogether unacquainted with it, would be doing them an injustice. It seems rather, that this art belongs to the discoveries which were made in those times, in which men were little inclined to transmit an account of their inventions to posterity, and thus this art must have been forgotten or lost. Scheele* discovered the fluoric acid, and re-invented the art of etching on glass in the year 1771. But had Swanhard been able to pursue properly what either accident, or ingenuity presented to him, he might have enriched the arts, with a discovery which acquired great reputation to this Swedish philosopher one hundred years after.

FREDERIC ACCUM.

II.

A Description of a new Instrument called the Blast Ventilator. Invented by J. W. Boswell.

It would be superfluous to offer any arguments to the cultivators of natural philosophy, respecting the importance of any discovery in that science. It is sufficient to announce it to those who so well know, that no operation of nature is unimportant; and that although the first person to whom a fact may occur, may not be able to point out all the advantages which may arise from it, yet others of more discernment coming after him, may improve upon his ideas, and perhaps use it for purposes of much higher importance.

What Dr. Hales has written of the great consequence of the subject of ventilation to health, and the preservation of the food of man, renders it unnecessary to expatiate on the importance of any new discovery in this art; and to his excellent treatise on this matter, I beg leave to refer those who have any doubts on the advantages arising from it.

The method of forcing air in any required direction, by a fall of water passing from a smaller into a larger tube, in an engine called the † Water Blast, is now well known, and frequently applied in mines and furnaces with great efficacy.

Some considerations on this machine led me to conjecture long since, that a current of air might be made to act instead of a fall of water, in an apparatus constructed on principles somewhat similar to the above, and thus applied so as to draw off foul air or smoke from any places required, in situations where the other could not be used. It was only lately that I have been able to think of any method of putting this matter to the test of ex-

* Transactions of the Swedish Academy for the year 1771. C. xxxiii. p. 122.

† Dr. Lewis, in his very useful work on the Arts, has laid down the best construction of this engine, from actual experiment.

periment,

periment, which would not be attended with too much inconvenience. This I have effected by the inſtrument of which I now ſend the draft and deſcription; and I found the reſult of the experiments made with it, fully to anſwer my expectations.

In the draft the firſt figure repreſents the external appearance of this inſtrument, and the ſecond ſhews it in ſection. Plate 1. From A to B in fig. 2, there is a free open communication in the larger tubes. The part C E D is an open truncated cone, ending in a tube E F, one third of the diameter of that which ſurrounds it, and which reaches into the larger tube the length of two of the diameters of the latter.

There it a ſcale with the draft for fig. 1 and 2, which marks the proportion of the ſmall inſtrument I had firſt made. But as the ſize of any other muſt vary according to the uſes for which it is intended, I have only ſet down the number of proportional parts, and have not mentioned their value, which may be encreaſed at pleaſure.

In uſing this inſtrument, the baſe C D of the cone muſt be turned towards the wind, which when it blows even moderately, will then cauſe a very ſenſible current of air to paſs up from A to B through the larger tubes. The ſmall inſtrument, which I tried at a time when the wind was low, when placed as above directed, oppoſite the opening of the upper ſaſh of a window let down about two inches, acted with ſuch power, as to draw the flame of a candle conſiderably into the tube A, held horizontally at ſome diſtance from it, and made the tube B, by which I ſupported it, ſo hot in a ſhort time, that it was painful to hold it.

This experiment I repeated before many gentlemen always with the ſame reſult; and which at leaſt entitles the inſtrument to a trial on a larger ſcale for uſeful purpoſes, in which I have no doubt of its ſucceeding.

The uſes to which this inſtrument may be applied, are of no ſmall importance, even ſo far as they have occurred to me; others may yet be found out which I have not thought of, thoſe which I have thought of are as follows:

1ſt. It will do extremely well for extracting the unwholeſome air from mines, when it is made of a ſize ſufficiently large.

2d. It will alſo be particularly convenient in ſhips for changing the air in them, rendered unfit for reſpiration by the breath and perſpiration of a numerous crew, by the effluvia from proviſions, bilge water, &c.; and if its efficacy may be judged of in this reſpect, from experiments made on a ſmall ſcale, it would with a moderate wind entirely change the air in a large veſſel in the courſe of two or three hours, even when made of no great ſize.

3d. It will conſiderably encreaſe the force of the draft in a blaſt furnace, if placed on the top of its chimney as hereafter directed, for chimneys in general.

4th. It will ſerve as a ventilator for corn, ſtores, magazines, hoſpitals, and crowded rooms.

5th. It is particularly well calculated to prevent or cure the ſmoking of chimnies, (which inconvenience frequently renders houſes ſo uncomfortable, as to induce the owners to quit

them; to ſay nothing of the injurious effects of ſmoke received into delicate lungs. One cauſe eſpecially of ſmoking chimneys it removes, for which no effectual cure has been before diſcovered.

Dr. Franklin, to whom the world is ſo much indebted for his many uſeful diſcoveries in natural philoſophy, and the arts, has given two very valuable papers on the ſubject of ſmoking chimnies, in the Tranſactions of the Philadelphia Society. In theſe he has recited nine cauſes, which occaſion chimneys to ſmoke, amongſt which that of high winds blowing the ſmoke down the funnel is a chief one: for all which he has propoſed effectual remedies; except for this laſt mentioned alone, for which, he acknowledges that there was no certain remedy diſcovered; we may therefore look on ſuch a remedy as an object the more valuable, as it compleats what the Doctor began: ſuch a remedy is the inſtrument deſcribed in this paper, which by removing this evil leaves no defect incident to chimneys that cannot be obviated; and it is ſo effectual for this purpoſe, that from the very principles of its conſtruction, the ſtronger the wind blows, the better will the chimney draw, thus changing what was formerly an evil into an actual benefit.

The manner in which the inſtrument ſhould be uſed for this purpoſe, is one with which we are already familiar. It ſhould be placed on the top of the chimney, in the ſame manner in which the contrivance, (intended for the ſame purpoſe, but very ineffectual) called the Boar's Head, is uſually put up: and ſhould like it be ſupported on a pivot, ſo as to turn round with its back to the wind, that the blaſt might fully enter its conical opening.

To prevent the external air from being drawn up between the turning tube and the fixed one, when placed on the chimney, ſome ſoft leather, or canvas, ſhould be faſtened round the outſide of the lower end of the turning tube, which ſurrounds the fixed tube; this leather or canvas, which ſhould hang down two or three inches below the interval between the tubes, will act as a ſpecies of valve to prevent the outer air from entering, and will thus cauſe the whole effect of the inſtrument to operate in increaſing the draft of the chimney.

There is another method of effecting this laſt purpose, more certain in its mode of acting, but which from its requiring a much greater expence, cannot be recommended for general uſe; this is repreſented in fig. 3. which figure is on a ſmaller ſcale than the other two, and is only intended to ſhew the beſt method of fixing the inſtrument on a chimney: it is drawn in ſection to exhibit the internal ſtructure. In it A repreſents the fixed part to be bedded in mortar on the top of the chimney in the uſual manner. B repreſents the moveable part, which turns with the wind, ſo that the conical opening G ſhall be always oppoſite to the blaſt. E is the upright rod on whoſe point B turns round; it is faſtened below to the two bars D D, which are fixed acroſs in the lower immoveable tube A, and paſſes through a collar in the bar H, which is faſtened at its extremities to the moveable tube B. By this means the rod preſerves its perpendicular poſition; and the part of the moveable tube, which ſurrounds the upper part of the fixed one, will revolve round it very cloſe without coming in contact in any part.

C C is an external tube, cloſely ſoldered or cemented to the fixed tube A, ſo that, with its upper part, it may form a deep groove of four or five inches, in which the lower extremity of the moveable tube may freely revolve: this groove ſhould be filled with mercury, high enough to cover the bottom of the moveable tube about half an inch; which contrivance will effectually prevent the outer air from being drawn in between the tubes, without impeding the motion of the upper one in the leaſt. F F is a ſmall projection faſtened to the moveable tube, to prevent the rain or duſt from falling into the groove.

The Blaſt Ventilator would be particularly ſerviceable to ſhip chimnies above all others. Any one who has ever been at ſea, muſt have obſerved the difficulty of preventing ſhip-chimnies from ſmoking when the wind riſes to any height, and what an advantage any contrivance would be that would prevent this inconvenience; and that this inſtrument would be quite effectual for this purpoſe, (there is every reaſon to believe from the experiments already made) and even make thoſe chimnies draw better as the wind blew harder.

The inſtrument repreſented in the two firſt figures would be the fitteſt for this purpoſe, any of the men on deck could eaſily ſhift it about as the wind changed; and as this way of uſing it might be made for a few ſhillings, the expence will be no object to prevent ſhip-owners from giving it a fair trial.

It is ſcarcely neceſſary to mention, that it would do equally well for the ſame purpoſe in canal paſſage-boats, which are often as much incommoded by ſmoke as ſhips are; a mode of conveyance to which in ſome ſituations, elegance is added to eaſe and cheapneſs, and which well deſerves farther extenſion on the Engliſh canals.

The manner in which the wind operates in this apparatus, to cauſe a current of air through the upright tube, is moſt probably the following:

When the conical opening C D, Fig. 2, is turned to the wind, the portion of the current of air which enters this opening, will be compreſſed againſt the ſides of the cone, as it paſſes on, more and more, till it comes to E; and after it has paſſed F, the extremity of the ſmall tube, it will begin to expand itſelf; but as it moves forward while thus expanding, the union of the two motions will cauſe it to form the figure of a cone or conoid, ſomewhat ſimilar to that by which it entered, which is marked by the dotted lines terminating at G and H.

This conical blaſt ſtriking obliquely the air before it in the tube B, will cauſe it to move forward only, its lateral motion being prevented by the ſides of the tube; and the preſſure of the atmoſphere forcing the air forward at A, to replace what has been removed at B by the conical blaſt, will of courſe cauſe the current of air from A through B already mentioned.

In ſituations where coals may be had cheap, ſteam may be made to operate on the blaſt ventilator inſtead of wind, for many uſeful purpoſes, by a contrivance ſomewhat ſimilar to the eolipile; with ſome alteration as to its form, but preſerving the ſame principle; particularly ſteam might be uſed with this inſtrument ſo as to force air on a blaſt furnace, and would

would do beſt for ſmelting iron; where ſome degree of dampneſs in the blaſt is rather beneficial.

To deſcribe the apparatus minutely for this purpoſe, would ſwell this paper to too great a bulk; but of its poſſibility I could eaſily convince any one, and would engage to conſtruct it, in ſuch a ſituation as before mentioned, at an expence comparatively trifling to any other mode of cauſing a blaſt, where a fall of water could not be procured.

Even where fuel is not very cheap, yet ſteam may be applied to the purpoſe of ventilation with this inſtrument, in the manner hinted at here, to great advantage, in thoſe ſituations where labour is difficult to be procured, or inconvenient to be uſed; or where habits and prejudice operate ſtrongly againſt working manual ventilators. This laſt is too frequently the caſe aboard men of war, and other ſhips, though in no other place is ventilation ſo neceſſary to preſerve health, and ſecure proviſions from decay.

An apparatus for ventilating ſhips in this manner might eaſily be fixed beſide the ſhip's boiler, to be uſed in calms, when the wind would not operate on the inſtrument before deſcribed, and which at other times might be applied to boil water for various uſes; and the ſhip's boiler itſelf might be ſo adjuſted as to ſerve for this purpoſe, without preventing or impeding its uſe in preparing proviſions.

To conclude, I will juſt mention a matter this ſubject has ſuggeſted of ſome importance, though ſomewhat differing from what has already been treated of.

From obſerving the effects of the conical opening in the blaſt ventilator, it occurs, that walls might be ſo conſtructed about a windmill, as to operate in a ſimilar manner, and that thus the wind might be conducted with increaſed force, to operate in any direction required on a fixed wind wheel, though it blew from various directions; and that a windmill thus conſtructed, would have the additional advantage of being capable to be regulated or ſtopped at pleaſure, in a manner ſomewhat ſimilar to a water-mill. This mode of conſtructing thoſe mills would prevent many fatal accidents; and would not coſt ſo much as might at firſt ſeem, as the granaries, and other buildings annexed to them, might be ſo arranged, as in a great meaſure to anſwer the purpoſe of the walls propoſed to be built *.

III.

Experiments on Whinſtone and Lava. By Sir JAMES HALL, *Bart. F. R. S. & F. A. S. Edin* †.

THE experiments deſcribed in this paper were ſuggeſted to me many years ago, when employed in ſtudying the *geological* ſyſtem of the late Dr. Hutton, by the following plauſible objection, to which it ſeems liable.

* On the ſubject of this paper, ſee Phil. Journ. I. II. Art. Venturi. N.

† Read before the Royal Society of Edinburgh, and communicated by the author. An abridged account of the contents of this paper was given in our Journal II, 285.

Granite,

Granite, porphyry, and baſaltes, are ſuppoſed, by Dr. Hutton, to have flowed in a ſtate of perfect fuſion into their preſent poſition; but their internal ſtructure, being univerſally rough and ſtony, appears to contradict this hypotheſis; for the reſult of the fuſion of earthy ſubſtances, hitherto obſerved in our experiments, either is glaſs, or poſſeſſes, in ſome degree, the vitreous character.

This objection, however, loſes much of its force, when we attend to the peculiar circumſtances under which, according to this theory, the action of heat was exerted. Theſe ſubſtances, when in fuſion, and long after their congelation, are ſuppoſed to have occupied a ſubterraneous poſition far below what was then the ſurface of the earth; and Dr. Hutton has aſcribed to the modification of heat, occaſioned by the preſſure of the ſuperincumbent maſs, many important phenomena of the mineral kingdom, which he has thus reconciled to his ſyſtem.

One neceſſary conſequence of the poſition of theſe bodies, ſeems, however, to have been overlooked by Dr. Hutton himſelf; I mean, that, after their fuſion, they muſt have cooled very ſlowly; and it appeared to me probable, on that account, that, during their congelation, a cryſtallization had taken place, with more or leſs regularity, producing the ſtony and cryſtallized ſtructure, common to all unſtratified ſubſtances, from the large grained granite, to the fine grained and almoſt homogeneous baſalt. This conjecture derived additional probability from an accident ſimilar to thoſe formerly obſerved by Mr. Keir, which had juſt happened at Leith: a large glaſs-houſe pot, filled with green bottle gtaſs in fuſion, having cooled ſlowly, its contents had loſt every character of glaſs, and had completely aſſumed the ſtony ſtructure.

Theſe views made part of a paper which I had the honour of laying before this Society in 1790*; and about the ſame time I determined to ſubmit my opinions to the teſt of experiment. I communicated this intention to all my friends, and in particular to Dr. Hutton; from him, however, I received but little encouragement. He was impreſſed with the idea, that the heat to which the mineral kingdom has been expoſed was of ſuch intenſity, as to lie far beyond the reach of our imitation, and that the operations of nature were performed on ſo great a ſcale, compared to that of our experiments, that no inference could properly be drawn from the one to the other. He has ſince expreſſed the ſame ſentiments in one of his late publications, (*Theory of the Earth, vol. I. p.* 251.), where he cenſures thoſe who "judge of the great operations of the mineral kingdom, from having "kindled a fire, and looked into the bottom of a little crucible."

But, notwithſtanding my veneration for Dr. Hutton, I could not help differing from him on this occaſion: for, granting that theſe ſubſtances, when in fuſion, were acted upon by a heat of ever ſo great intenſity, it is certain, nevertheleſs, that many of them muſt have congealed in moderate temperatures, ſince many are eaſily fuſible in our furnaces; for it

* Particular reaſons induced me not to publiſh this paper at full length; but, wiſhing to preſerve a record of ſome opinions peculiar to myſelf which it contained, I introduced a ſhort abſtract of it into the Hiſtory of the Tranſactions.

is impoſſible that a ſubſtance ſhould congeal at a higher point than that at which it may afterwards be melted. If, then, theſe phenomena depend upon the circumſtances of congelation, the imitation of the natural proceſs is an object which may be purſued with rational expectation of ſucceſs: and could we ſucceed in a few examples on a ſmall ſcale, and with eaſily fuſible ſubſtances, we ſhould be entitled to extend the theory, by analogy, to ſuch as, by their bulk, or by the refractory nature of their compoſition, could not be ſubjected to our experiments. It is thus that the aſtronomer, by obſerving the effects of gravitation on a little pendulum, is enabled to eſtimate the influence of that principle on the heavenly bodies, and thus to extend the range of accurate ſcience to the extreme limits of the ſolar ſyſtem.

Encouraged by this reaſoning, I began my projected ſeries of experiments in the courſe of the ſame year (1790), with very promiſing appearances of ſucceſs. I found that I could command the reſult which had occurred accidentally at the glaſs-houſe; for, by means of ſlow cooling, I converted bottle glaſs, after fuſion, into a ſtony ſubſtance, which again, by the application of ſtrong heat, and ſubſequent rapid cooling, I reſtored to the ſtate of perfect glaſs. This operation I performed repeatedly with the ſame ſpecimen, ſo as to aſcertain that the character of the reſult was ſtony or vitreous, according to the mode of its cooling.

Some peculiar circumſtances interrupted the proſecution of theſe experiments till laſt winter, when I determined to reſume them. Deliberating on the ſubſtance moſt proper to ſubmit to experiment on this occaſion, I was decided by the advice of Dr. Hope *, well known by his diſcovery of the earth of ſtrontites, to give the preference to whinſtone.

The term whinſtone, as uſed in moſt parts of Scotland, denotes a numerous claſs of ſtones, diſtinguiſhed in other countries by the names of baſaltes, trap, wacken, grünſtein and porphyry. As they are, in my opinion, mere varieties of the ſame claſs, I conceive that they ought to be connected by ſome common name, and have made uſe of this, already familiar to us, and which ſeems liable to no objection, ſince it is not confined to any particular ſpecies †.

The following experiments were performed with various kinds of whinſtone, and have likewiſe been extended to lava. To inveſtigate the relation between theſe two claſſes of ſubſtances, ſeems, in the preſent ſtate of geology, an object of conſiderable importance; for they reſemble each other in ſo many reſpects, that we are naturally led to aſcribe the

* In the courſe of laſt winter, when I firſt thought of reſuming my experiments, I propoſed to this gentleman, that, in imitation of a practice, common in the Academy of Sciences of Paris, we ſhould perform them in company. To this propoſal he cheerfully agreed; but, before any experiments had been begun, he found himſelf ſo much occupied by profeſſional duties, that he could not beſtow upon the ſubject the time which it neceſſarily required; and we gave up the idea of working in company.

† In characteriſing the particular ſpecimens, I have adopted, with ſcarcely any variation, deſcriptions drawn up by Dr. Kennedy, whoſe name I ſhall have occaſion frequently to mention in the courſe of this paper. In the employment of terms, we have profited by the advice of Mr. Deriabin, a gentleman well verſed in the language of the Wernerian ſchool.

formation

formation of both to the ſame cauſe, and to believe that whinſtone, as well as lava, has been expoſed to the action of heat. In the courſe of the paper, I ſhall mention ſeveral accidental reſults, which, if conſidered ſeparately, might ſeem unworthy of notice, but which, by affording the means of compariſon between the two claſſes, are of great ſervice in the general inveſtigation.

The whinſtone firſt employed was taken from a quarry * near the Dean, on the water of Leith, in the neighbourhood of Edinburgh. This ſtone is an aggregate of black and greeniſh-black hornblend, intimately mixed with a pale reddiſh-brown matter, which has ſome reſemblance to felſpar, but is far more fuſible. Both ſubſtances are imperfectly and confuſedly cryſtallized in minute grains. The hornblend is in the greateſt proportion; and its fracture appears to be ſtriated, though in ſome parts foliated; that of the reddiſh-brown matter is foliated. The fracture of the ſtone *en maſſe* is uneven, and it abounds in ſmall facettes, which have ſome degree of luſtre. It may be ſcratched, though with difficulty, by a knife, and gives an earthy ſmell when breathed on. It frequently contains ſmall ſpecks of pyrites.

On the 17th of January 1798, I introduced a black lead crucible, filled with fragments of this ſtone, into the great reverberating furnace at Mr. Barker's iron foundery. In about a quarter of an hour, I found that the ſubſtance had entered into fuſion, and was agitated by a ſtrong ebullition. I removed the crucible, and allowed it to cool rapidly. The reſult was a black glaſs, with a tolerably clean fracture, interrupted however by ſome ſpecks.

In ſubſequent experiments, I endeavoured, by ſlow cooling after fuſion, to prevent the whinſtone from becoming vitreous, and to compel it to reſume its original character by cryſtallization. In this I ſo far ſucceeded as to obtain a ſubſtance, which was not glaſs, though it did not poſſeſs the properties of whinſtone. The production of this intermediate ſubſtance, which much reſembled the liver of an animal, is accompanied with ſome curious particulars, which I ſhall enumerate and explain in another part of this paper. On ſome occaſions, too, I obtained a vitreous maſs in which were a multitude of little ſpheres, having a dull or earthy fracture.

At laſt, on the 27th of January, I ſucceeded completely in the object I had in view. A crucible, containing a quantity of whinſtone, melted in the manner above deſcribed, being removed from the reverberatory, and conveyed rapidly to a large open fire, was immediately ſurrounded with burning coals, and the fire, after being maintained ſeveral hours, was allowed to go out. The crucible, when cold, was broken, and was found to contain a ſubſtance, differing in all reſpects from glaſs, and in texture completely reſembling whinſtone. Its fracture was rough, ſtony and cryſtalline; and a number of ſhining facettes were interſperſed through the whole maſs †. The cryſtallization was ſtill more apparent in cavities

* Called Bell's Mills Quarry.

† It contained a number of ſmall globules like lead-ſhot, which were found to conſiſt of regulus of iron, reduced from the oxide in the whinſtone, by means of the carbonic matter of the black lead crucible.

cavities produced by air bubbles, the internal ſurface of which was lined with diſtinct cryſtals *.

Having ſhewn this reſult to ſeveral of my friends, Dr. Hope regretted that the ſubſtance, previouſly to its artificial cryſtallization, had not been reduced to the ſtate of ſolid glaſs; ſince the adverſaries of the ſyſtem might alledge, that, during the action of heat, the original cryſtallized texture of the ſtone had never been completely deſtroyed. Being convinced of the propriety of this obſervation, I determined, in future, to reduce the ſtone firſt to glaſs, and to perform the cryſtallization after a ſecond fuſion.

For this purpoſe, with the aſſiſtance of Dr. Kennedy, to whoſe co-operation I am greatly indebted for the ſucceſs of all the following experiments, I reduced a quantity of the ſame whinſtone to moſt perfect black glaſs. A crucible, filled with fragments of this glaſs, being then expoſed to a heat, which, from previous trials, was judged to be more than ſufficient to reduce its contents to fuſion, the fire was very gradually lowered till all was cold. I thus expected to obtain a reſult ſimilar to that laſt mentioned, but found, to my great ſurpriſe, that the fragments had never been in complete fuſion, ſince they ſtill, in a great meaſure, retained their original ſhape. This extraordinary fact, which afterwards led to the diſcovery of ſome curious properties of whinſtone, will be fully accounted for in a ſubſequent part of the paper.

Another portion of the ſame glaſs being perfectly melted by a very ſtrong heat, the temperature was reduced to about 28 of Wedgwood, and was maintained at that pitch during ſix hours. The reſult was a perfectly ſolid maſs, cryſtallized to a certain depth from the outſide, though ſtill vitreous in the heart. In another experiment, performed like the laſt in all reſpects, except that the heat was maintained at 28 during twelve hours, I obtained a maſs entirely cryſtalline and ſtony throughout, with facettes appearing in the ſolid parts, and ſmall cryſtals ſhooting into ſome of the cavities.

Soon after I had communicated theſe reſults to Dr. Hope, he performed, with complete ſucceſs, an experiment ſimilar to the firſt, in which I had obtained a cryſtallized ſubſtance, by the gradual cooling of the melted ſtone. The ſame was likewiſe, ſoon afterwards, performed by Mr. Boſwell of Auchinleck.

My experiments, already deſcribed, were confined to one ſpecies of whinſtone; but have ſince been extended to ſix other varieties. They were all firſt reduced to glaſs by the application of a ſtrong heat, and ſubſequent rapid cooling. After a ſecond fuſion they

By this reduction, as a portion of its iron was withdrawn from the maſs, and as the relative proportion of the component elements was thus varied, the nature of the original ſubſtance could not fail to be changed. I determined, on this account, to lay aſide black lead crucibles in future. The propriety of this has ſince been fully proved; for the firſt reſult is found to differ eſſentially from thoſe obtained in all my ſubſequent experiments, which were performed with Heſſian crucibles, or with others, which, like them, contain no ſenſible quantity of carbonic matter.

* I ſhowed this reſult at a meeting of the Society on 5th of February.

were

were cryſtallized, by being kept long in a ſtationary temperature, between 28 and 30. This laſt operation was beſt performed in a long and narrow muffle, wholly ſurrounded with burning coals, according to a practice long followed by Dr. Kennedy, by which the heat could be maintained with ſo great ſteadineſs as to render the reſult almoſt certain.

The fuſibilities were determined in an open muffle, in which a fragment of the ſubſtance under trial was placed contiguous to a pyrometer pieee. As ſoon as the fragment, in conſequence of the gradual riſe of heat, had ſo far ſoftened as to yield to the touch of a bent iron rod, the pyrometer was removed and meaſured. The fuſibilities, thus obtained, in degrees of Wedgwood's ſcale *, have been ſtated in a table, to which I would be underſtood always to refer. I have diſtinguiſhed the cryſtallized ſubſtances, obtained from the glaſſes, by the name of *cryſtallite*, a term ſuggeſted by Dr. Hope. It may be obſerved in this table, that the original whins ſoften in a range from 38 to 55; the glaſſes from 15 to 24, and the artificial cryſtallites from 32 to 45.

No. 1. *Whin of Bell's Mills Quarry.*

This ſtone was the ſubject of all the foregoing experiments, which were frequently repeated with ſucceſs on a large ſcale.

In trying the fuſibility of the glaſs obtained from it, a curious circumſtance occurred, which accounts for the unexpected reſults already mentioned. I had placed in the muffle a long and ſlender fragment of this glaſs, with its extremities reſting on two ſupports of clay, and its middle unſupported. Having then increaſed the temperature by ſlow degrees, I expected to diſcover the loweſt point of emolleſcence, by obſerving when the fragment ſunk by its own weight. The muffle having attained a moderate heat, I obſerved the glaſs to loſe its ſhape a little. Wiſhing to ſee it completely melted, the ſame heat was continued, but no further change took place. The heat was then raiſed ſeveral degrees, but without effect. At laſt, being urged ſtill further, the glaſs ſunk down completely between its ſupports. The pyrometer being then withdrawn, denoted a temperature above 30.

It occurred to me, that, on this occaſion, the glaſs, by the firſt application of heat, had ſoftened, and then had cryſtallized, ſo as to become hard again; that, in cryſtallizing, it had acquired ſuch infuſibility as to yield to no heat under 30. I immediately confirmed this conjecture by the following experiment.

A piece of the ſame glaſs, placed in a cup of clay, was introduced into the muffle, heated to 21. In one minute it became quite ſoft, ſo as to yield readily to the preſſure of an iron rod. After a ſecond minute had elapſed, the fragment, being touched by the rod, was

* The meaſurement of the temperatures may be relied upon as accurate; they were determined by two ſets of pieces, one purchaſed by me during the lifetime of the late Mr. Wedgwood, and the other likewiſe made by him, belonging to Dr. Kennedy. The two ſets correſpond exactly; and Dr. Kennedy's had, at his requeſt, been carefully examined by the preſent Mr. Wedgwood, who found them true by his father's original ſtandard.

found

found to be quite hard, though the temperature had remained ſtationary. The ſubſtance, thus hardened, had undergone a change throughout; it had loſt the vitreous character; when broken, it exhibited a fracture like that of porcelain, with little luſtre; and its colour was changed from black to dark brown. Being expoſed to heat, it was found to be fuſible only at 31; that is, it was leſs fuſible than the glaſs by 13 or 14 degrees.

Numerous and varied experiments have ſince proved, in the cleareſt manner, that, in any temperature, from 21 to 28 incluſive, the glaſs of this whin paſſes from a ſoft, or liquid ſtate, to a ſolid one, in conſequence of cryſtallization; which is differently performed at different points of this range. In the lower points, as at 23, it is rapid and imperfect; in higher points, ſlower and more complete, every intermediate temperature affording an intermediate reſult. I likewiſe found, that cryſtallization takes place, not only when the heat is ſtationary, but likewiſe when riſing or ſinking, provided its progreſs through the range juſt mentioned is not too rapid. Thus, if the heat of the ſubſtance, after fuſion, exceeds one minute in paſſing from 21 to 23, or from 23 to 21, the maſs will infallibly cryſtallize, and loſe its vitreous character.

Theſe facts enabled me to account for the production of the ſubſtance reſembling the liver of an animal, which I obtained in my firſt attempts to cryſtallize the melted ſtone. Not being then aware of the temperature proper for complete cryſtallization, I had allowed it to be paſſed over rapidly by the deſcending heat, and I had begun the ſlow cooling in thoſe lower points, at which the formation of this intermediate ſubſtance takes place.

By the ſame means I was enabled to explain the other unexpected reſult, which I obtained in endeavouring to convert the glaſs of this ſtone into cryſtallite. The fire applied to the crucible, containing fragments of the glaſs, had been raiſed very ſlowly, which I know to have been the caſe by ſome circumſtances of the experiment. The glaſs had ſoftened by the firſt application of heat, but had cryſtallized again as the heat gradually roſe; ſo that the ſubſtance conſolidated, while ſtill ſo viſcid as to retain the original ſhape of the fragments; at the ſame time it acquired ſuch infuſibility as to reſiſt the application of higher degrees of heat during the reſt of the proceſs.

No. 2. *Whin of the Rock of Edinburgh Caſtle.*

This is a baſalt of a blackiſh blue colour. Its grain is fine, and its fracture uneven, partaking of the ſplintery. It is in general homogeneous, although, in ſome pieces, a very few minute cryſtals of hornblend are perceptible. It has ſome luſtre, from a number of ſmall ſhining facettes; has an earthy ſmell when breathed on; and gives fire ſlightly with ſteel.

The pure glaſs which this whin yielded, by rapid cooling after a moderate heat, was cryſtallized in three experiments, and produced maſſes greatly reſembling the original. In one of theſe, formed on a large ſcale in the glaſs-houſe, the reſemblance is ſo ſtrong, both as to colour and texture, that it would be difficult, or perhaps impoſſible, to diſtinguiſh them,

but

but for a few minute air bubbles viſible in the artificial cryſtallite. The glaſs is leſs fuſible than that of No. 1. and ſeems not to poſſeſs the property of producing the liver cryſtallite.

No. 3. *Whin of the Baſaltic Columns on Arthur's Seat, near Edinburgh.*

Its baſis is a baſalt of a dark grey colour, and uneven fracture. It contains numerous laminar cryſtals of felſpar, which ſeem to be almoſt colourleſs, and have conſiderable luſtre and tranſparency. It alſo contains ſome black hornblend. It has an earthy ſmell when breathed on, and gives ſparks ſlightly with ſteel.

In the temperature of 100, or upwards, the whole was changed to pure black glaſs; but in a more moderate heat, (about 60), the felſpar remained unchanged, while the hornblend diſappeared, and formed a glaſs along with the baſis of the ſtone. Both kinds of glaſs yielded highly characterifed cryſtallites; that laſt mentioned, having its felſpars entire, produced a ſubſtance like porphyry, in which the white felſpars were embedded in a black cryſtalline baſis. The cryſtals formed in this baſis are ſo complete in one example, that they are ſeen projecting into the cavities, and ſtanding erect on the external ſurface, ſo as to make it ſparkle all over. Theſe black cryſtals ſeem to be hornblend of new formation. We have found, by ſome late experiments, that they are conſiderably more refractory than the cryſtallite in which they lie, and are equally infuſible with ſome ſpecies of natural hornblend.

No. 4. *Whin from the Neighbourhood of Duddingſtone Loch.*

It has for its baſis a black baſalt of an uneven fracture. In it are embedded augit in numerous cryſtals, felſpar in a ſmaller proportion, and diſperſed grains of olivin. The felſpar ſeems to be greeniſh-white, with conſiderable luſtre and tranſparency. The ſtone gives fire with ſteel, and has a ſlight earthy ſmell when breathed on. Its glaſs yields a fine grained cryſtallite, like that of No. 1.

No. 5. *Whin of Saliſbury Craig near Edinburgh.*

This ſpecies is an aggregate of black hornblend, and of a greeniſh-white matter, both in minute grains. The greeniſh-white matter reſembles felſpar, but is much more fuſible. The general characters are nearly the ſame with thoſe of the ſpecimen already deſcribed, No. 1. It has conſiderable luſtre, chiefly from the hornblend; an earthy ſmell when breathed on; and gives ſome ſparks with ſteel. Its glaſs yielded a highly facetted cryſtallite, approaching to the ſtructure of the original whinſtone, No. 4.

No. 6. *Whin from the Water of Leith.*

It is found in great blocks in the bed of the river, and has been brought there no doubt from a maſs of the ſame kind in the mountains above. It conſiſts of black hornblend, and of a whitiſh matter reſembling felſpar, as in No. 1. and No. 5. Theſe two ſubſtances are nearly in equal proportion, and are confuſedly and imperfectly cryſtallized in minute maſſes. If the whitiſh ſubſtance were felſpar, this ſtone, as well as that laſt mentioned, would be

be the grünſtein of Werner; but this white ſubſtance is far more fuſible than felſpar, and melts at a lower heat than the hornblend, with which it is mixed. It has an earthy ſmell when breathed on, and may be ſcratched with difficulty by a knife.

In fuſion and cryſtallization it reſembled the other whins. A fragment ſimilar to this in all reſpects, which I found in the neighbourhood of Edinburgh, manifeſted ſo ſtrong a diſpoſition to cryſtallize, that, though cooled in the open air after fuſion, it was found ſtony in the heart, with a vitreous outſide. When cryſtallized, however, with every precaution, it yielded no remarkable reſult.

No. 7. *Whin of the Baſaltic Columns of Staffa.*

I received this ſpecimen from a gentleman who broke it from the original rock. It is baſalt of a bluiſh-black colour. It is fine grained and homogeneous; and its fracture is uneven. It has a ſmall degree of luſtre, from a number of minute ſhining points perceptible in a ſtrong light. It gives an earthy ſmell when breathed on, and may be ſcratched with difficulty by a knife. It yielded a perfect and very hard glaſs, which, in a regulated heat, produced a uniform ſtony cryſtallite, greatly reſembling the original.

It has thus been ſhown, that all the whins employed aſſume, after fuſion, a ſtony character, in conſequence of ſlow cooling; and the ſucceſs of theſe experiments, with ſo many varieties, entitles us to aſcribe the ſame property to the whole claſs. The arguments, therefore, againſt the ſubterraneous fuſion of whinſtone, derived from its ſtony character, ſeem now to be fully refuted.

Experiments on Lava.

In the inveſtigation of Dr. Hutton's ſyſtem, great advantage may be expected from an examination of lavas. They have undoubtedly flowed on the ſurface by means of heat; and whinſtone, according to his hypotheſis, having flowed in the bowels of the earth by the influence of the ſame agent, the two claſſes ought to poſſeſs many properties in common, by which the hiſtory of both may be illuſtrated.

I have been enabled to inſtitute a compariſon between them, by means of a cabinet of volcanic productions which I collected in 1785, in company with Dr. J. Home of this Society, on Veſuvious, Ætna, and the Lipari Iſles. On this occaſion we were greatly aſſiſted by the celebrated M. Dolomieu*, who accompanied us in part of our expedition. This author complains, in his writings, that travellers, in collecting volcanic productions, have brought away only the ſuperficial ſcoria of lavas, which nearly reſemble each other in all

* Though I differ widely from this gentleman in many of his theoretical opinions, I cannot too ſtrongly expreſs my admiration of his merit as a natural hiſtorian. His deſcriptions of countries, as well as of minerals, preſent the moſt lively repreſentations to the mind of the reader, which, in the numerous inſtances I have witneſſed, are perfectly correct.

caſes, and convey no idea of the real character of the lava, which can only be ſeen in the interior parts of the currents. In forming our collection we ſcrupulouſly avoided this error, and choſe ſuch ſpecimens only as were the moſt compact and free from the ſcorified appearance of the ſurface.

When theſe ſolid lavas are compared with our whinſtones, the reſemblance between the two claſſes is not only ſtriking at firſt ſight, but bears the cloſeſt examination. They both conſiſt of a ſtony baſis, which frequently contains detached cryſtals of various ſubſtances, ſuch as white felſpar and black hornblend. The analogy between the two claſſes ſeems to hold through all their varieties; and I am confident that there is not a lava of Mount Ætna to which a counterpart may not be produced rom the whinſtones of Scotland.

This reſemblance in external character is accompanied with an agreement no leſs complete in chemical properties. But before I mention the experiments which tend to prove this agreement, it will be neceſſary firſt to examine the opinion of two very celebrated authors concerning lavas. M. Dolomieu and Mr. Kirwan, though they differ widely in many reſpects, agree in believing, that lavas have never been acted upon by heat of ſufficient intenſity to produce complete fuſion; and endeavour, each by an hypotheſis peculiar to himſelf, to account for their fluidity. The opinion of theſe gentlemen is of ſuch importance in the preſent queſtion, and the arguments they have uſed are ſo extraordinary, that I muſt beg leave to quote their words at full length.

M. Dolomieu ſtates his opinion in the following paſſage, (*Iſles Ponces*, p. 7.): "Il eſt "eſſentiel de conſtater, par beaucoup d'exemples et d'obſervations, quelques vérités que "j'ai annoncées il y a pluſieurs années, ſavoir, que le feu des volcans ne dénature pas ordi- "nairement les pierres qu'il a miſes en état de fuſion; qu'il ne les altere pas au point de "ne pouvoir les reconnoître, de ne pas diſtinguer quelle a pu être la baſe des laves; que "ce feu agit différemment que le feu de nos fourneaux, tel que nous l'employons dans la "chimie et dans les arts; qu'il produit dans les laves une fluidité qui n'a aucun rapport "avec la fluidité vitreuſe, que nous opérons, lorſque nous traitons à grand feu les mêmes "matières qui leur ſervent de baſe, et lorſque nous voulons rendre aux laves elles mêmes "leur fluidité. Celui des volcans n'a point d'intenſité; il ne peut pas même vitrifier les "ſubſtances les plus fuſibles, tels que les ſchorls, qui ſe trouvent comme parties conſti- "tuantes dans l'intérieur des laves; il produit la fluidité par une eſpece de diſſolution par "une ſimple dilation, qui permet aux parties de gliſſer les unes ſur les autres, et peutêtre "encore par le concours d'une autre matière qui ſert de véhicule à la fluidité."

Mr. Kirwan cenſures this ſuppoſition as ſtrange and inconceivable; but in my opinion, that which he has brought forward is not leſs ſo. In the *Elements of Mineralogy, ſecond edition*, vol. I. p. 396. he ſays: "Now, there are but three ſorts of fuſion with which we are ac- "quainted: that which produces porcelain; that which produces enamels and ſemi-vitri- "fications; and that which produces glaſs. By inſpecting lava we ſhall find that very "little of it has been in any of theſe ſtates; ſince therefore it has flowed, it is plain it has "derived its liquifaction not from the fuſion of its own materials, but from that of ſome

" foreign ſubſtance mixed it. This fact is ſo plain, that it has even ſtruck M. Dolomieu, " in the midſt of his prepoſſeſſions in favour of ſome ſtrange inconceivable power, which " he attributes to volcanic fire, of melting earthy ſubſtances, without effecting an alteration " in their ſenſible qualities. " I hope," ſays he, " to prove, that lavas contain, in their " interior, a combuſtible matter, which burns and conſumes in the ſame manner as other " inflammables," *Iſles Ponces*, 10. Yet he neglects telling us what this matter is; though " it plainly appears to be no other than ſulphur and bitumen, of which an immenſe quan- " tity is found in all volcanos, which liquefies in a low degree of heat, and cauſes all the " ſtony ſubſtances to flow that are immerſed in it."

(To be continued.)

IV.

On the Hydraulic Machine erected at the Mines of Schemnitz in Hungary.

To Mr. NICHOLSON.

SIR,

THE early inſertion of the extract which I ſent you from the Micrographia of Robert Hooke in your laſt Number, encourages me to requeſt you will give ſome account, with your opinion, of a machine for raiſing water at the mines in Hungary, upon the principle of the fountain of Hiero. It is ſlightly mentioned in many elementary books, but I cannot point out the work in which it was originally publiſhed, nor ſay thing more than that I believe it has not been accurately deſcribed in any Engliſh work.

I am, &c.

R. B.

London, Feb. 20, 1800.

The account was firſt given to the Royal Academy at Paris by their correſpondent, M. Jars, and inſerted in their Memoirs for the year 1768. The machine was executed in the year 1755, and uſed to raiſe the water of a ſhaft named *Amalie*, in the mines at Schemnitz. Fig. 1, Plate 2, is copied from the engraving of Jars. It is placed at the depth of forty toiſes beneath the ſurface of the ground above. The wooden trough A is a kind of reſervoir at the end of a channel which conveys the water by which the machine is worked. The pipes are not drawn in the proportion of their lengths, but contracted to the ſpace of the deſign. B B conveys the water from it into the reſervoir D, which is twenty-two toiſes lower than A. This pipe deſcends very nearly to the bottom of D, as is ſhewn by the dotted line, with the intention that the included air ſhall be forced to aſcend

aſcend and paſs through the pipes H into another reſervoir I ſtill lower. The pipes N, through which the ſubterraneous waters are raiſed, are ſixteen toiſes in height. They begin very near the bottom of the veſſel I, in order that the air from that reſervoir may not eſcape until all the water has been raiſed.

The pipes B and N are four and a half (French) inches in diameter within; but thoſe H for the air are only three inches in diameter at iſſuing from the reſervoir D, and two and a half when they enter the reſervoir I, and this alſo is the diameter of the pipe P.

The wooden trough L is the termination of a trough or channel from another engine, which raiſes the waters from a yet greater depth. From this proceeds a pipe with a cock K, in order that the water from L may either be admitted into I, or intercepted at pleaſure.

The reſervoir D, which, as well as I, is made of an alloy of copper and tin, is of double the capacity of I. It is eight feet and a half high, and five feet diameter inſide meaſure, and its thickneſs is two inches. The lower reſervoir I is four feet in diameter, and ſix feet and a half high inſide meaſure, and its thickneſs one inch and a half. Each of theſe veſſels was caſt in three pieces, as the drawing ſhews, which are joined by flanches and ſcrews, a ring of lead and another of leather being placed between, to ſecure the joint, and prevent the tranſmiſſion of any fluid. M. Jars obſerves, that the pipes would have been better if connected in the ſame manner; but the practice is to drive the ends of the pipes into hollow cylinders of very dry wood, iron bound with three hoops. Theſe anſwer very well, and are of conſiderable durability.

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

When the machine is to be put into action, all the cocks are cloſed, and as the reſervoir A is always full, the pipe B is alſo full, as far as the cock C. The reſervoir L is alſo conſtantly full of water from the mine which is to be raiſed ſixteen toiſes to O. For this purpoſe the cock K is opened, and the water flows into I, the air being ſuffered to eſcape from that veſſel by turning the cock M. The veſſel is known to be full by the emiſſion of water through P; at which inſtant both the cocks K and M are cloſed. Immediately afterwards the cocks C and G are opened, and the water from A entering B, compreſſes the included air, and forces it through the pipes H, where it preſſes on the ſurface of the water contained in the inferior reſervoir I, and forces that fluid to aſcend through N to O, or the Adit through which it is diſcharged. This water being raiſed, and the reſervoir I being empty, the cocks C and G are ſhut, and E and F is then opened, the firſt to ſuffer the contents of D to flow off, and the ſecond to accelerate the diſcharge, by admitting the external air. Both theſe cocks are again cloſed as ſoon as the evacuation is completed. During this laſt operation, another man below opens the cocks K and M, by which the included air iſſues with great force through P, and the water from L again fills the reſervoir I as at firſt. The operations of cloſing K and M, and opening C and G, being therefore again repeated, the contents of I are again forced up to, and thus the engine may be kept continually at work.

Each alternation employs about three minutes, and raiſes between twenty-nine and thirty cubic feet of water, which, in the courſe of the natural day, amounts to twelve or thirteen thouſand cubic feet of water, raiſed by the fall of about double the quantity through a ſomewhat greater height. Two men * are required to attend it; but M. Jars ſeems to think, that on account of the ſimplicity and cheapneſs of its conſtruction, and the little wear and tear, together with the facility with which it may be made to work and ſtop for very ſhort periods of time, it would be of great value in ſuch places as afford the requiſite fall of ſuperior water, and do not require a higher ſingle lift than fifteen or twenty toiſes (or fathoms.)

The fall of twenty-two toiſes given to the ſuperior water is not neceſſary for raiſing the column of ſixteen, though it is profitable, by increaſing the velocity of aſcent. But it was at firſt intended to force the lower water as high as twenty-one toiſes, which could not be performed with the apparatus then ſet up. For at the very firſt introduction of water into the veſſel D, it burſt with an effect which ſufficiently ſhewed the power of ſuch a column of water compreſſing a maſs of air which, by its elaſticity, was diſpoſed to give a a vibratory or jerking motion to the agent.

When the machine is near the end of its action, that is to ſay, when nearly the whole of the water has been raiſed out of the reſervoir I, if the cock M be opened to give vent to the compreſſed air, and a hat, or miner's bonnet, be preſented to the aperture P, the aqueous vapours diſperſed through the compreſſed air, and perhaps alſo, ſays M. J. part of thoſe of the external air, are condenſed on the bonnet, in the form of very white and compact ice, very much reſembling hail, and not eaſily ſeparated from the bonnet: it ſoon melts, which is not to be wondered at, as the temperature of the place itſelf is not cold. Meſſrs. du Hamel and Jars remained in Hungary from January to July, 1758, and obſerved the ſame phenomenon at all ſeaſons; but as they had not a thermometer, they could not make a number of experiments, which might have been of value in the inveſtigation of the ſubject.

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

On the above, which is tranſlated from the Memoir of M. Jars, with very little abridgement, I have ſcarcely any additional remark to make. The utility of this engine, under the circumſtances here ſtated, is ſufficiently clear, and its applications might become more extenſive, if the improvements ſuggeſted in the preceding note were added. In particular, where a ſtream flows with the poſſibility of carrying off part of the water by a deep

* It ſeems very eaſy to connect the levers of the cocks above and below, ſo as to require only one man to work the whole ſet: and, indeed, there would be little difficulty in making the machine work itſelf ſafely without any attendant except to ſet it off at firſt, or ſtop it when requiſite.---N.

ſhaft

ſhaft or drain, it would be practicable by the fall of part to raiſe the remainder to the top of an houſe or building for domeſtic or other purpoſes. In this caſe it would be requiſite to place the firſt veſſel D at the bottom of the ſhaft, and the ſecond I at the level of the ſtream, and the operation of this inverted engine would force water nearly as high above that level as the depth of the ſhaft might be below it.

If the aſcending and deſcending columns were of equal length, they would be in equilibrio, and no more water would riſe than juſt to fill the lower tube. The velocity of aſcent, ſuppoſing ſufficient water way, and other circumſtances, ſuch as the inflexions of the pipes, to be properly diſpoſed, will depend on the exceſs of length in the deſcending column, and this exceſs is capable of a maximum relative to the quantity raiſed to a given height, or as engineers call it, the effect. The longer the lift, the leſs the quantity raiſed, ſuppoſing the upper reſervoir to be of a given magnitude, the denſities of air being inverſely as the preſſures, or length of the preſſing column, and the quantity raiſed being equal to that of the air in its compreſſed ſtate. Whence it follows, that the whole quantity raiſed will be leſs the fewer the lifts.

I do not underſtand the hypotheſis upon which this machine was conſtructed. The reſervoirs have their capacity as 2 to 1. But the air ſubjected to the re-action of a column of 16 toiſes, beſides the common preſſure, would ſuſtain the preſſure of four atmoſpheres, and therefore be condenſed into one-fourth the ſpace. If there be no fallacy in this plain remark, it muſt follow, that the lower veſſel I was only half emptied when the ſtream ceaſed to be afforded at O, and, conſequently, the effect was only half what is here ſtated.

That air condenſed to one-fourth ſhould take up and diſſolve more water than in its ordinary rare ſtate, and afterwards depoſit it when it recovered its original dimenſions, is conſentaneous with other well known facts: and the modern theoriſts will eaſily apply the doctrine of latent heat, or the increaſed capacity of expanded air, to account for the phenomenon of its robbing the water not only of the heat which maintained its ſtate of elaſtic ſolution, but even that which would have been requiſite to keep up the ſtate of common denſe fluidity.

W. N.

V.

An Account of the Pearl Fiſhery in the Gulph of Manar, in March and April 1797. By HENRY J. LE BECK, *Eſq.*

(*Concluded from Vol. III. page* 547.)

THE diving ſtone is a piece of coarſe granite, a foot long, ſix inches thick, and of a pyramidical ſhape, rounded at the top and bottom. A large hair rope is put through a hole in the top. Some of the divers uſe another kind of ſtone ſhaped like a half moon, to bind

bind round their belly, ſo that their feet may be free. At preſent theſe are articles of trade at *Condatchey*. The moſt common, or pyramidical ſtone, generally weighs about thirty pounds. If a boat has more than five of them, the crew are either corporally puniſhed or fined.

The diving, both at *Ceylon* and at *Tutucorin*, is not attended with ſo many difficulties as authors imagine. The divers, conſiſting of different caſts and religions, (though chiefly of *Parrawer* * and *Muſſelmans*,) neither make their bodies ſmooth with oil, nor do they ſtop their ears, mouths, or noſes with any thing, to prevent the entrance of ſalt water. They are ignorant of the utility of diving bells, bladders, and double flexible pipes. According to the injunctions of the ſhark conjurer they uſe no food while at work, nor till they return on ſhore, and have bathed themſelves in freſh water. Theſe *Indians*, accuſtomed to dive from their earlieſt infancy, fearleſsly deſcend to the bottom in a depth of, from five to ten fathoms in ſearch of treaſures. By two cords a diving ſtone and a net are connected with the boat. The diver putting the toes of his right foot on the hair rope of the diving ſtone, and thoſe of his left on the net, ſeizes the two cords with one hand, and ſhutting his noſtrils with the other, plunges into the water. On reaching the bottom, he hangs the net round his neck, and collects into it the pearl ſhells as faſt as poſſible, during the time he finds himſelf able to remain under water, which uſually is about two minutes. He then reſumes his former poſture, and making a ſignal, by pulling the cords, he is immediately lifted into the boat. On emerging from the ſea, he diſcharges a quantity of water from his mouth and noſe, and thoſe who have not been long enured to diving frequently diſcharge ſome blood; but this does not prevent them from diving again in their turn. When the firſt five divers come up and are reſpiring, the other five are going down with the ſame ſtones. Each brings up about one hundred oyſters in his net, and if not interrupted by any accident, may make fifty trips in a forenoon. They and the boat's crew get generally from the owner, inſtead of money, a fourth of the quantity which they bring on ſhore; but ſome are paid in caſh, according to agreement.

The moſt ſkilful divers come from *Colliſh*, on the coaſt of *Malabar*; ſome of them are ſo much exerciſed in the art, as to be able to perform it without the aſſiſtance of the uſual weight; and for a handſome reward will remain under water for the ſpace of ſeven minutes; this I ſaw performed by a *Caffry* boy, belonging to a citizen at *Karical*, who had often frequented the fiſheries of theſe banks. Though Dr. Halley deems this impoſſible, daily experience convinces us, that by long practice any man may bring himſelf to remain under water above a couple of minutes. How much the inhabitants of the South Sea iſlands diſtinguiſh themſelves in diving we learn from ſeveral accounts; and who will not be ſurpriſed at the wonderful *Sicilian* diver Nicholas, ſurnamed the Fiſh †?

* Fiſhermen of the Catholic religion.

† According to Kircher, he fell a victim amongſt the *Polypes* in the gulph of *Charybdis*, on his plunging, for the ſecond time, in its dangerous whirlpool, both to ſatisfy the curioſity of his king, Frederic, and his inclination for wealth. I will not pretend to determine, how far this account has been exaggerated.

Every

Every one of the divers, and even the moſt expert, entertain a great dread of the ſharks, and will not, on any account, deſcend until the conjurer has performed his ceremonies. This prejudice is ſo deeply rooted in their minds, that the government was obliged to keep two ſuch conjurers always in their pay, to remove the fears of their divers. Thirteen of theſe men were now at the fiſhery from *Ceylon* and the coaſt, to profit by the ſuperſtitious folly of theſe deluded people. They are called in *Tamul*, *Pillăl Kadtăr*, which ſignifies one who binds the ſharks and prevents them from doing miſchief.

The manner of enchanting conſiſts in a number of prayers learned by heart, that nobody, probably not even the conjurer himſelf, underſtands, which he, ſtanding on the ſhore, continues muttering and grumbling from ſun riſe until the boats return; during this period, they are obliged to abſtain from food and ſleep, otherwiſe their prayers would have no avail; they are, however, allowed to drink, which privilege they indulge in a high degree, and are frequently ſo giddy, as to be rendered very unfit for devotion. Some of the conjurers accompany the divers in their boats, which pleaſes them very much, as they have their protectors near at hand. Nevertheleſs, I was told, that in one of the preceding fiſheries, a diver loſt his leg by a ſhark, and when the head conjurer was called to an account for the accident, he replied that an old witch had juſt come from the coaſt, who, from envy and malice, had cauſed this diſaſter, by a counter-conjuration, which made fruitleſs his ſkill, and of which he was informed too late; but he afterwards ſhewed his ſuperiority by enchanting the poor ſharks ſo effectually, that though they appeared in the midſt of the divers, they were unable to open their mouths. During my ſtay at *Condatchey*, no accident of this kind happened. If a ſhark is ſeen, the divers immediately make a ſignal, which, on perceiving, all the boats return inſtantly. A diver who trod upon a hammer oyſter, and was ſomewhat wounded, thought he was bit by a ſhark, conſequently made the uſual ſignal, which cauſed many boats to return; for which miſtake he was afterwards puniſhed.

The owners of the boats * ſometimes ſell their oyſters, and at other times open them on their own account. In the latter caſe ſome put them on mats in a ſquare, ſurrounded with a fence; others dig holes of almoſt a foot deep, and throw them in till the animal dies; after which they open the ſhells and take out the pearls with more eaſe. Even theſe ſquares and holes are ſold by auction after the fiſhery is finiſhed, as pearls often remain there, mixed with the ſand.

In ſpite of every care, tricks in picking out the pearls from the oyſters can hardly be prevented. In this the natives are extremely dexterous. The following is one mode they put in practice to effect their purpoſe: when a boat owner employs a number of hired people to collect pearls, he places over them an inſpector of his own, in whom he can confide; theſe hirelings previouſly agree that one of them ſhall play the part of a thief, and bear the puniſhment, to give his comrades an opportunity of pilfering. If one of the gang happens

* Theſe are the individuals which farm one or more boats from the renter; and though they are in poſſeſſion of them only during the fiſhery, they are commonly called the owners of the boats.

to

to meet with a large pearl, he makes a ſign to his accomplice, who inſtantly conveys away one of ſmall value, purpoſely, in ſuch a manner as to attract notice. On this the inſpector and the reſt of the men take the pearl from him: he is then puniſhed and turned out of their company. In the mean time, while he is making a dreadful uproar, the real thief ſecures the valuable pearl, and afterwards the booty is ſhared with him who ſuffered for them all. Beſides tricks like theſe the boat owners and purchaſers often loſe many of the beſt pearls, while the dony is returning from the bank; for, as long as the animal is alive and untouched, the ſhells are frequently open near an inch; and if any of them contain a large pearl, it is eaſily diſcovered and taken out by means of a ſmall piece of ſtiff graſs or bit of ſtick, without hurting the pearl fiſh. In this practice they are extremely expert. Some of them were diſcovered whilſt I was there, and received their due puniſhment.

Gmelin aſks if the animal of the *mytilus margaritiferus* is an *aſcidia?* See Linn. Syſt. Nat. tom. I. p. vi. 3350. This induces me to believe that it has never yet been accurately deſcribed; it does not reſemble the *aſcidia* of Linnæus, and may, perhaps, form a new genus. It is faſtened to the upper and lower ſhells by two white flat pieces of muſcular ſubſtance, which are called by *Houttuin* * *ears*, and extend about two inches from the thick part of the body, growing gradually thinner. The extremity of each *ear* lies looſe, and is ſurrounded by a double brown fringed line. Theſe lie almoſt the third of an inch from the outer part of the ſhell, and are continually moved by the animal. Next to theſe, above and below, are ſituated two other double fringed moveable ſubſtances, like the branchiæ of a fiſh. Theſe *ears* and *fringes* are joined to a cylindrical piece of fleſh; of the ſize of a man's thumb, which is harder and of a more muſcular nature than the reſt of the body. It lies about the centre of the ſhells, and is firmly attached to the middle of each. This, in fact, is that part of the pearl fiſh which ſerves to open and ſhut the ſhells. Where this column is faſtened, we find on the fleſh deep impreſſions, and on the ſhell various nodes of round or oblong forms, like imperfect pearls. Between this part, and the hinge *(cardo)*, lies the principal body of the animal, ſeparated from the reſt, and ſhaped like a bag. The mouth is near the hinge of the ſhell, enveloped in a veil, and has a double flap or lip on each ſide; from thence we obſerve the throat, (œſophagus) deſcending like a thread to the ſtomach. Cloſe to the mouth there is a carved browniſh tongue, half an inch in length, with an obtuſe point; on the concave ſide of this deſcends a furrow, which the animal opens and ſhuts, and probably uſes to convey food to its mouth †. Near its middle are

* Vide Houtt. Nat. Hiſt. Vol. I. p. xv. p. 381, ſeq.

† The depth at which the pearl fiſh generally is to be found, hindered me from paying any attention to the locomotive power, which I have not the leaſt doubt it poſſeſſes, uſing for this purpoſe its tongue. This conjecture is ſtrengthened by the accurate obſervations made on *muſcles* by the celebrated Reaumur, in which he found that this body ſerves them as a leg or arm, to move from one place to another. Though the divers are very ignorant with regard to the œconomy of the pearl fiſh, this changing of habitation has been long ſince obſerved by them. They alledge, that it alters its abode when diſturbed by an enemy or in ſearch of food. In the former caſe they ſay it commonly deſcends from the ſummit of the bank to its declivity.

two

two bluiſh ſpots, which ſeem to be the eyes. In a pretty deep hole near the baſe of the tongue, lies the beard *(byſſus)*, faſtened by two fleſhy roots, and conſiſting of almoſt one hundred fibres, each an inch long, of a dark green colour, with a metallic luſtre; they are undivided, parallel, and flattened. In general the *byſſus* is more than three quarters of an inch, without the cleft *(rima)*; but if the animal is diſturbed, it contracts it conſiderably. The top of each of theſe threads terminates in a circular gland or head, like the *ſtygma* of many plants. With this *byſſus* they faſten themſelves to rocks, corals, and other ſolid bodies; by it the young pearl fiſh cling to the old ones, and with it the animal procures its food, by extending and contracting it at pleaſure. Small ſhell fiſh, on which they partly live, are often found clinging to the former. The ſtomach lies cloſe to the root of the beard, and has, on its lower ſide, a protracted obtuſe point. Above the ſtomach are two ſmall red bodies, like lungs; and from the ſtomach goes a long channel or gut, which takes a circuit round the muſcular column above-mentioned, and ends in the anus, which lies oppoſite to the mouth, and is covered with a ſmall thin leaf, like a flap. Though the natives pretend to diſtinguiſh the ſexes, by the appearance of the ſhell, I could not find any genitalia. The large flat ones they call males, and thoſe that are thick, concave, and vaulted, they call females, or *pedoo-chippy*; but, on a cloſe inſpection, I could not obſerve any viſible ſexual difference.

It is remarkable that ſome of theſe animals are as red as blood, and that the inſide of the ſhell has the ſame colour, with the uſual pearly luſtre, though my ſervants found a reddiſh pearl in an oyſter of this colour; yet ſuch an event is very rare. The divers attribute this redneſs to the ſickneſs of the pearl fiſh; though it is moſt probable that they had it from their firſt exiſtence. In the ſhade they will live twenty-four hours after being taken out of the water. This animal is eaten by the lower claſs of *Indians*, either freſh in their curries, or cured by drying; in which ſtate they are exported to the coaſt; though I do not think them by any means palatable.

Within a mother of pearl ſhell I found thirteen *murices nudati* (vide Chemnitz's New Syſtem, Cabt. vol. XI. tab. 192, f. 1851 and 1852), the largeſt of which was three quarters of an inch long; but as many of them were putrid, and the pearl fiſh itſelf dead, I could not aſcertain whether they had crept in as enemies, or were drawn in by the animal itſelf. At any rate turtles and crabs are inimical to the animals, and a ſmall living crab was found in one of them.

The pearls are only in the ſofter part of the animal, and never in that firm muſcular column above-mentioned. We find them in general near the earth, and on both ſides of the mouth. The natives entertain the ſame fooliſh opinion concerning the formation of the pearl which the ancients did. They ſuppoſe them formed from dew-drops in connection with ſun-beams. A *Brâhmen* informed me that it was recorded in one of his *Sanſcrit* books, that the pearls are formed in the month of *May* at the appearance of the *Sooatee* ſtar (one of their twenty-ſeven conſtellations) when the oyſters come up to the ſurface of the

water, to catch the drops of rain. One of the moſt celebrated conchologiſts *, ſuppoſes that the pearl is formed by the oyſter in order to defend itſelf from the attacks of the *pholades* and *boreworms*. But we may be aſſured that in this ſuppoſition he is miſtaken, for although theſe animals often penetrate the outer layers of the pearl ſhell, and there occaſion hollow nodes, yet, on examination, it will be found, that they are never able to pierce the firm layer, with which the inſide of the ſhell is lined. How can the pearls be formed as a defence againſt exterior worms, when, even on ſhells that contain them, no worm-holes are to be ſeen? It is, therefore, more probable theſe worms take up their habitations in the nodes, in order to protect themſelves from the attacks of an enemy, than that they are capable of preying on an animal, ſo well defended as the pearl-fiſh is. It is unneceſſary to repeat the various opinions and hypotheſes of other modern authors; it is much eaſier to criticiſe them, than to ſubſtitute in their place a more rational theory. That of Reaumur, mentioned in the memoirs of the *French* Academy for 1712, is the moſt probable, viz. that the pearls are formed like bezoars and other ſtones in different animals, and are apparently the effects of a diſeaſe. In ſhort it is very evident, that the pearl is formed by an extravaſation of a glutinous juice either within the body, or on the ſurface of the animal: the former caſe is the moſt common. Between one and two hundred pearls have been found within one oyſter. Such extravaſations may be cauſed by heterogeneous bodies, ſuch as ſand, coming in with the food, which the animal, to prevent diſagreeable friction, covers with its glutinous matter, and which, as it is ſucceſſively ſecreted, forms many regular lamellæ, in the manner of the coats of an onion, or like different ſtrata of bezoars, only much thinner; this is probable, for if we cut through the centre of a pearl, we often find a foreign particle, which ought to be conſidered as the nucleus, or primary cauſe of its formation. The looſe pearls, may originally have been produced within the body, and on their encreaſe may have ſeparated and fallen into the cavity of the ſhell. Thoſe compact ones, fixed to the ſhells, ſeem to be produced by ſimilar extravaſation, occaſioned by the friction of ſome roughneſs on the inſide of the ſhell. Theſe and the pearl-like nodes have a different aſpect from the pearls, and are of a darker and bluer colour. In one of the former I found a pretty large, true oval pearl, of a very clear water; while the node itſelf was of a dark blueiſh colour. The yellow or gold coloured pearl, is the moſt eſteemed by the natives; ſome have a bright, red, luſtre; others are grey or blackiſh, without any ſhining appearance, and of no value. Sometimes when the grey lamella of a pearl is taken off, under it is found a beautiful genuine one, but it oftener happens that after having ſeparated the firſt coat you find a worthleſs impure pearl. I tried ſeveral of them, taking one lamella off after another, and found clear and impure by turns, and in an impure pearl I met with one of a clear water, though in the centre of all I found a foreign particle. The largeſt and moſt perfect pearl which I ſaw during my ſtay at *Condatchey*, was about the ſize of a ſmall piſtol bullet, though I have been told ſince my departure, many others of the

* The Rev. Mr. Chemnitz at *Copenhagen*.

ſame

ſame ſize have been found. The ſpotted and irregular ones are ſold cheap, and are chiefly uſed by the native phyſicians as an ingredient in their medicines.

We may judge with greater or leſſer probability by the appearance of the pearl-ſhell, whether they contain pearls or not. Thoſe that have a thick calcareous cruſt upon them, to which *ſerpulæ* (ſea tubes) *Tubuli marini irregulariter intorti*, *Criſta-gali Chamar lazuras*, *Lepas tintinabulum*, *Madreporee*, *Millipore*, *Cellipore*, *Gorgoniæ*, *Spongiæ*, and other zoophytes are faſtened, have arrived at their full growth, and commonly contain the beſt pearls; but thoſe that appear ſmooth, contain either none, or ſmall ones only.

Were a naturaliſt to make an excurſion for a few months to *Manâr*, the ſmall iſland near *Jafna* and the adjacent coaſt, he would diſcover many natural curioſities, ſtill buried in obſcurity, or that have never been accurately deſcribed.

Indeed no place in the *Eaſt Indies* abounds more with rare ſhells, than theſe: for there they remain undiſturbed, by being ſheltered from turbulent ſeas, and the fury of the ſurf. I will juſt name a few of them; viz. *Tellina foliaca* Lynn *, *Tell*, *Spenglerii*, *Arca culculata* †, *Arca Noæ*, *ſolen anatinus* Linn. *Oſtrea Iſognomum*, *Terebullum*, *albidum*, *ſtriatum*, *Turbo ſcalaris* ‡ *Bula volva* Linn §, *Vexillum ingritarum*, *&c.* Amongſt the beautiful conc ſhells: *conus thalaſſiarchus Anglicanus cullatus* ‖, *amadis thaſſiarchus*, *con. generalcis* Linn. *c. capitaneus* **, *c. miles* ††, *c. ſtercus muſcarum* ‡‡. *c. reteaureum*, *c. glaucus* §§, *c. cereola*, *regia corona murus lapedius*, *canda erminea ſocietas cordium*. There are many other beſides thoſe already mentioned, equally valuable and curious.

The great ſucceſs of the Rev. Doctor John in conchology when at *Tutucorin*, and aſſiſted by G. Angelbeck, with a boat and divers: and the capital collections made by his agents, whom he afterwards ſent there with the neceſſary inſtructions and apparatus, may be ſeen in Chemnitz's elegant cabinet of ſhells in 4to. (with illuminated plates), and how many new ſpecies of Zoophytes he diſcovered, we learn from another German work by Eſper at *Erlangen*, the third volume of which is nearly finiſhed.

* The golden tong.
† Mounkſcape.
‡ Royal ſtaircaſe.
§ Weaver's ſhuttle.
‖ Red *Engliſh* admiral.
** Green ſtamper.
†† Garter ſtamper.
‡‡ Great ſand ſtamper.
§§ Capſ. Gottw.

VI.

Proceſs for extracting Sugar from the Beet, communicated in a Letter from Mr. ACHARD *to Citizen* VAN MONS*.

IT is the beta vulgaris L. which is proper for making of ſugar, though all the varieties are not equally ſo. That of which the internal part is white: the ſkin of a pale red, and the root of a long ſpindle ſhape, is the beſt. All the varieties of the beet yield ſugar, but this muſt be choſen when it is to be manufactured to advantage; beſides which, it is on the culture principally the quantity of ſugar produced by the root depends.

It is aſcertained from the operations of extracting ſugar from the beet root, which I have performed under the inſpection of a committee, nominated by the King of Pruſſia, that the beſt method is as follows. The root not peeled, but in the ſtate in which it is dug out of the ground, with no other preparation than that of carefully ſeparating the leaves and the heart, is to be boiled in water till it is ſoft enough to be pierced with a ſtraw. A ſhort time of ebullition is ſufficient to give it this degree of ſoftneſs, which is well known to the confectioners, who give it to ſome fruits before they preſerve them. The beet when cold is divided and reduced into ſlices by means of the machine uſed by farmers to ſlice potatoes for cattle. A deſcription of this machine is to be found in a publication of Buſch, entitled: *Ueberſicht der fortſchritte in wiſſenſchaften, kunſten, manufacturen und handwerken von Oſtern* 1796, *bis Oſtern* 1797. *Erfurt* 1798: and the engraving which renders the ſubject clearer is copied in the firſt plate of my work. This method of dividing the root is the beſt I have yet found. Two men with this machine can cut nearly 100 pounds into very fine ſlices in three minutes. To extract the juice from the roots when ſliced, they are ſubjected to the action of a preſs which ſhould act with force ſufficient to extract at firſt as much juice as poſſible. The pulp which remains in the preſs ſtill contains a conſiderable portion of ſugar, which is worth extracting. To effect this it is diluted in a ſufficient quantity of water for twelve hours, after which the fluid part is drawn out by preſſure. The ſaccharine matter, after this ſecond extraction, is ſtill ſufficiently abundant to afford by fermentation, brandy or vinegar, with profit.

The liquids thus obtained are afterwards mixed and ſtrained through a flannel, and reduced by conſtant boiling to about two thirds. It is then paſſed a ſecond time through a woollen cloth, or a piece of cloth, ſuch as is uſed in ſugar refineries; after which the liquor is boiled in a ſmaller veſſel than the firſt till it is reduced to one half. The liquor is again boiled in a ſtill ſmaller veſſel which gives it the conſiſtency of a liquid ſyrup. It is neceſſary to remark, that by endeavouring to give to the ſyrup a too ſtrong conſiſtency there will be danger of ſpoiling the whole.

* Decade. An. VIII. p. 15. No. 15. p. 324.

This ſyrup poured into ſhallow earthen veſſels, which preſent a large ſurface to the air, is to be placed in a ſtove at the heat of 20 or 30 degrees, or if agreeable at 30 or 40 of Reaumur, in order to cryſtalize it. During this inſenſible condenſation of the ſyrup the cryſtalline incruſtation, which is formed at the ſurface, ſhould be occaſionally broken, in order that by favouring the evaporation the product of cryſtals may be haſtened. As ſoon as it is obſerved that, inſtead of the cryſtalline incruſtation, a thick gummy pellicle, not granulated, is formed on the ſurface of the ſyrup, it is a ſign that the matter does no longer cryſtalize, but begins to dry, and the evaporation ſhould then be ſtopped. This reſidue forms a mixture more or leſs thick, of a cryſtalline ſubſtance and a fluid viſcid matter. In order to ſeparate the cryſtalized ſugar from the gummy extract, they are put together into a ſack of wet cloth tied tight, and then by means of a preſs, gradually applied, the fluid part is to be paſſed through the cloth, and the ſugar remains in the bag. This ſugar after drying is a yellow muſcovado, compoſed of regular cryſtals, which when pulverized form a white powder of which the taſte is very good, being ſweet and clear, and may be applied to a number of uſes for which refined ſugar is employed. By the operation of refining, ſugar may be made from this muſcovado of whatever quality is agreeable, and by repeating it the fineſt ſugar may be had. The waſte in this manufacture, that is to ſay the reſidual pulp, the ſyrup or mucilage which paſſes through the cloth when ſubjected to the preſs, the ſyrup in which the ſugar has cryſtalized, the waſhings, &c. &c. all theſe are ſtill very uſeful, and a conſiderable quantity of rum or brandy may be obtained from them, which may be uſed in making up the fineſt compounds. The muſcovado, ſuch as is obtained by the firſt opperation, coſts about a groſs and a half of Pruſſia, without reckoning the watter which may be had by turning the reſidues to uſe. When we add this product, and when the manipulations ſhall be more perfect, to effect which I ſhall employ myſelf this winter, I am perſuaded that our European muſcovado will only coſt half the price, or 9 fennins; and in the countries, where fuel is dearer, at 1 groſs *. The manufacture of ſpirits from the waſte of the ſugar is of great importance, as by this means a great ſaving of corn will be made, and the manufacturing of beet ſugar, which delivers Europe from a deſtructive monopoly becomes ſtill more intereſting. I am at preſent employed in the attempt to diſcover a method of pouring the juice of the roots when ſufficiently condenſed into moulds or forms, in order that it may acquire the figure of a ſugar loaf, and afterwards by claying become very white at a ſingle operation. I have already found ſeveral methods of obtaining this object very ſpeedily. This new manipulation will facilitate the art of ſugar-making, and diminiſh the price ſtill further.

* The pound in uſe at Berlin, being 476, 28 grammes, and the value of the groſs, or of 12 fennins, being 17 centimes, French money, it follows that the hectogramme does not amount to more than about 5 or 6 centimes, (or the pound, poids de marc, from 28 to 50 centimes). Note of the French editor.--(about 2½ d. per lb. avoirdup.)

VII.

Letter to the EDITOR *from Mr.* WILLIAM HENRY, *on his Diſcovery of a new and improved Method of preparing the Pruſſiate of Pot-aſh; and on the diſputed Queſtion, Whether Pruſſiate of Pot-aſh be decompoſed by Muriate of Barytes?*

Mancheſter, March 23, 1800.

SIR,

IN conſequence of a paper, inſerted in your Philoſophical Journal, I have been favoured with the following letter from Mr. Kirwan. As the references, which it contains, to authorities on a diſputed point, may be intereſting to others as well as to myſelf, I take the liberty of ſending you a copy of it for publication; premiſing, that I have ſtated to Mr. K. my intention of making you this communication, and that he has not expreſſed any objection.

"*To Mr.* WILLIAM HENRY.

"DEAR SIR,

"On looking over Mr. Nicholſon's valuable Philoſophical Journal, which, though of "ancient date, I had not until lately leiſure to inſpect, I find, in the 29th No. Vol. ii. "p. 170, that you ſeem to regret I had not mentioned on what grounds I denied the pre- "cipitation of barytic earth from muriatic acid by the Pruſſian alcali, and then ſuggeſt that the "relation of the Pruſſian alcali to this earth had not been an object of attention to Klaproth "or Pelletier, &c. I hope, therefore, it will be agreeable to you that I ſhould ſtate thoſe "grounds. That Pruſſian alcali, properly prepared, does not precipitate barytic ſolutions, "was firſt proved by that accurate chemiſt, Mr. Meyer, of Stetin, as you may ſee in 2 "Crell's Chemical Annals for 1786, p. 142, 143. As I ſuppoſe you have that work, I "ſhall not trouble you with the detail of his experiments. You may, alſo, ſee that both "Pelletier and Klaproth did treat of this fact, Pelletier affirming the precipitation of this "earth by the Pruſſian alcali (21 Journal des Mines, p. 45); and Klaproth expreſsly deny- "ing it, and aſſerting that Pelletier was miſtaken. (See 2 Klaproth, p. 91.)

"I am, dear Sir,

"With high regard and reſpect, &c.

"R. KIRWAN."

"*Dublin, Jan.* 20.

Unfortunately it is not in my power to conſult any one of the works, to which Mr. K. has kindly referred me; and highly as I reſpect the authorities, to which he has appealed, yet I did not feel diſpoſed to acknowledge myſelf in an error, till convinced by a circum-

ſtantial detail of the experiment of Meſſrs. Meyer and Klaproth. I reſolved, therefore, to appeal to the deciſion of experiments conducted with all poſſible accuracy and attention.

The queſtion in diſpute is, whether or not a double elective affinity be exerted between pruſſiate of pot-aſh and muriate of barytes? If ſuch an affinity really ſubſiſts, and produces, on the admixture of the two ſolutions, two new compounds, one of theſe (the pruſſiate of barytes) muſt neceſſarily, from its known inſolubility, appear under the form of a precipitate. Now, on mixing the two ſolutions, a precipitation generally takes place; but this, it is affirmed by certain chemiſts, is owing to the impurity of the pruſſiate of pot-aſh, and is occaſioned by the decompoſition of ſulphate of pot-aſh by muriate of barytes. The truth of this explanation may be aſcertained, either by an attentive examination of the precipitate, or by employing a pruſſiate of pot-aſh perfectly free from ſuch impurity.

The former of theſe teſts, as I have ſtated in your Journal, II. 171, I employed ſeveral months ago. Having found that pruſſiated barytes is ſoluble in diluted muriatic acid, which exerts no action on the ſulphate of that earth, I digeſted a precipitate, thrown down from muriated barytes by pruſſiated pot-aſh, with diluted muriatic acid. Part of the precipitate was taken up; and the ſolution betrayed, to the proper teſts, deciſive characters of its containing pruſſiated barytes. Since the receipt of Mr. Kirwan's letter, I have repeated this experiment ſeveral times; occaſionally with the reſult, which has juſt now been ſtated; while, at other times, none of the precipitate was diſſolved by the acid. Theſe contradictory reſults will be explained by what follows; but not being able to deviſe the cauſe of them, at the time they occurred, I had recourſe to the remaining expedient, viz. the employment of a pruſſiate of pot-aſh, perfectly free from ſulphuric ſalts.

The difficulty of obtaining a pruſſiate of the required purity in the common mode, is hardly conceivable, except by thoſe who have made the attempt. In your Journal, II. 171, I have aſſerted that both carbonate and ſulphate of pot-aſh are decompoſed by pruſſiated barytes; and it has ſince occurred to me, that an excellent mode of preparing pruſſiate of pot-aſh might be founded on theſe facts. For the ſmall portion of ſulphate of pot-aſh, contained in all carbonates, may be expected to be decompoſed by the pruſſiated barytes, provided this laſt be employed in ſufficient quantity. On making the experiment, the reſult anſwered my expectation; and I ſhall, therefore, give the proceſs, which I have ſince frequently repeated with the ſame ſucceſs, under the form of a practical rule.

1. Calcine any quantity of carbonate of barytes in a ſtrong fire, a ſufficient length of time to expel its carbonic acid. Diſſolve the pure barytes in boiling water, and add by degrees pure Pruſſian blue in powder, till it ceaſes to be diſcoloured. Filtre the ſolution through paper, and if it ſhould become muddy during cooling, owing to the depoſit of oxyde of iron, filtre it again. After having ſtood a few hours, ſmall yellowiſh cryſtals will appear, which are the pruſſiated barytes. From the remaining ſolution a further quantity of cryſtals may be obtained by evaporation.

2. To a ſolution of carbonate of pot-aſh, gently heated, add by degrees the pruſſiate of barytes in powder, till the ſolution no longer reſtores the colour of reddened litmus paper.

Rather

Rather more of the pruſſiate of barytes ſhould be employed than is required to decompoſe the carbonate. After digeſting the mixture about half an hour, filtre the liquor, which, when gently evaporated, will ſhoot into beautiful cryſtals of pruſſiate of pot-aſh. Theſe cryſtals contained, in one inſtance, 24 per cent. of oxyde of iron; but of this oxyde a conſiderable part may be ſeparated, by digeſting the ſolution, before evaporating it, with a little acetic acid (radical vinegar.) The acetic has this advantage over all other acids, that its combination with pot-aſh affords a ſalt incapable of cryſtallizing; and which cannot, therefore, mix with the cryſtals of pruſſiated pot-aſh.

The carbonate of barytes, which is thus re-generated, may be reſerved; and may be again fitted by calcination for the ſame proceſs.

With the view of deciding the queſtion in diſpute, I added to a ſolution of pruſſiate of pot-aſh prepared, in the above manner, a ſolution of muriated barytes, No precipitation enſued; nor was the tranſparency of the mixture in the leaſt degree diſturbed. This experiment, therefore, in addition to thoſe before related, convinced me that I had been deceived; and that Meſſrs. Meyer and Klaproth were correct in denying the precipitation. Happening, however, to examine the jar, about half an hour afterwards, I obſerved that a number of ſmall cryſtals had formed on its inner ſurface; and theſe, on allowing the mixture to ſtand a few hours, increaſed conſiderably in number. I next mixed the two ſolutions in larger quantity, with the ſame reſult. No immediate effect was apparent; but after a few hours, an abundant crop of ſmall cryſtals had formed at the bottom and on the ſides of the jar. Theſe cryſtals had the following character:

1. They diſſolved very ſparingly in cold water, viz. in about the proportion of a quarter of a grain to each ounce.

2. Hot water diſſolved them more readily, but ſtill only in very ſmall proportions.

3. From theſe watery ſolutions ſulphate of pot-aſh, or ſulphuric acid, precipitated ſulphate of barytes; and on adding the ſulphate of iron to another portion of the ſolution, an abundant precipitation of Pruſſian blue occurred.

4. The cryſtals were totally diſſolved by dilute muriatic acid; and the ſolution gave decided marks, to the proper teſts, of containing pruſſiated barytes.

5. When heated ro redneſs in a ſilver veſſel, they grew black and loſt their form. On adding dilute muriatic acid to this coal, an effervеſcence enſued, and the ſolution was muriated barytes.

The foregoing characters are peculiar to the ſalt termed pruſſiate of barytes, the formation of which, under the above circumſtances, proves, beyond all doubt, that a double elective affinity is exerted between muriate of barytes and pruſſiate of pot-aſh. In this reſpect, barytes differs from other earths, and approaches the metals.

The above experiments furniſhed a clue, which led to the explanation of the contradictory properties, obſerved, at different times, in the precipitate from muriated barytes by pruſſiate of pot-aſh. In trials, which I have ſince made, it has uniformly happened, that common pruſſiate of pot-aſh has precipitated muriate of barytes. When the

ſupernatant

ſupernatant liquor was decanted immediately, the precipitate, after having been waſhed, proved to be ſimply ſulphate of barytes; but when the two ſolutions were allowed to ſtand together ſome time, before ſeparating them from the precipitate, this laſt had conſtantly the properties of a mixture of ſulphate of barytes, with pruſſiate of barytes; and ſometimes cryſtals of the latter ſalt were perceivable in the mixture.

Before taking my leave of the ſubject, allow me to correct an erroneous ſtatement, which I have made in your Journal, II. 171. I have there ſtated that cauſtic barytes does not precipitate pruſſiate of pot-aſh. This experiment I have ſince repeated with pure pruſſiate deſcribed above. No immediate precipitation enſued (the circumſtance that before miſled me); but after a few hours ſmall cryſtals were depoſited, which had every character of pruſſiate of barytes. It follows, therefore, that in a table of the elective affinities of Pruſſian acid, barytes ſhould be placed above pot-aſh.

I am, Sir, very reſpectfully,

your obedient ſervant,

WILLIAM HENRY.

VIII.

On the Genuineneſs and Purity of Drugs and Medicines. By Mr. FRED. ACCUM.

(*Continued from page* 122. *Vol. II.*)

EXAMINATION *of* ALKALINE SUBSTANCES.

Prepared Kali. Pharm. Lond. *Salt of Tartar.*

THE ſalt of tartar of the ſhops, if prepared according to the London Pharmacopeïa, cannot be obtained pure from pearl-aſhes by mere ſolutions, colature, evaporation, and cryſtallization; hence this article generally contains a conſiderable portion of *ſulphate* and *muriate of potaſh*, and is never perfectly free from *ſiliceous* and *calcareous earth*. In order to diſcover its purity, one part ought to be diſſolved in eight parts of diſtilled water, and then neutralized with pure nitric acid: if the mixture remain perfectly tranſparent when cold, the alkali is free from ſiliceous earth; whereas on the contrary, if ſiliceous earth be preſent the mixture will become turbid, the ſiliceous earth will be ſeparated, and its quantity may thus be aſcertained.

Sulphate of pot-aſh, the next article generally found in this ſalt, is beſt diſcovered by adding gradually to a ſimilar neutraliſed ſolution, a ſolution of muriate of barytes, or acetite of lead. If ſulphuric acid be preſent, a white precipitate will be produced, but no ſuch effect will take place if no ſulphuric combination be preſent. One hundred parts of the precipitate, occaſioned by the admixture of the muriate of barytes, indicate 26 per cent. of ſul-

phuric acid, and 100 parts of the acetite of lead indicate 30 per cent. of acid. The preſence of muriatic acid may be aſcertained by adding to a like ſaturated ſolution of this ſalt, a few grains of nitrate of ſilver. If the alkali did not contain any combination of muriatic acid, it will have no effect upon it; but if the minuteſt quantity of muriatic acid is preſent, a white precipitate will be produced, which after ſome time acquires a bluiſh hue; neither nitric nor acetic acid will rediſſolve it. Calcareous earth is manifeſted in a ſimilar manner, by adding drop by drop, a ſolution of oxalic acid. The quantity of the precipitate thus obtained, if calcareous earth be preſent, gives the proportion of this earth in a given quantity of the ſalt ſubmitted to the experiment.

Pure ſalt of tartar, which ſtands all theſe teſts, is of a ſnow whiteneſs, inodorous, perfectly dry, and ſoluble without *any* ſediment in an equal quantity of pure cold water, it then contains generally 70 parts of alkali, 23 carbonic acid, and 7 of water.

Water of Kali. Pham. Lond. *Solution of Salt of Tartar.*

When ſalt of tartar is expoſed in a ſhallow veſſel to the action of a moiſt atmoſphere, it ſoon deliquieſces, or attracts ſo much water, as is ſufficient to render it liquid. This fluid ought to contain at leaſt one part of alkali in four. If ſo, it feels extremely greaſy or ſlippery between the fingers, on account of it diſſolving the epidermis, and converting it into a kind of ſoap. If the alkali made uſe of has been pure, this fluid is *perfectly colourleſs*, clear, void of ſmell, and poſſeſſes all the properties of a pure ſalt of tartar. But as the alkali made uſe of in general, by our chemiſts, is far from being ſo, the article we meet with has generally a yellowiſh tinge, a diſagreeable, ſomewhat urinous, ſmell, and ſoon depoſits a conſiderable quantity of earthy inſoluble matter.

Water of Pure Kali. Ph. L. *Solution of Cauſtic Pot-aſh.*

As it is called in our Pharmacopeia, ought to be a ſolution of cauſtic alkali in water, of ſuch a ſtrength that an exact pint ſhall weigh juſt 16 oz. troy. When well prepared, it is as limpid as water, and inodorous. It ought not to occaſion any precipitate with lime water, neither ought it produce the leaſt effervescence with acids. A redundancy of lime is beſt known by blowing into this fluid, through a tobacco pipe, or other tube. If too much lime be preſent, the fluid will then turn turbid. Inſtead of obtaining this article in the ſhops, we take common ſoap-leys of the ſoap manufacturers, diluted with water, hence this article is always yellow, and hence the redundancy of lime, and other heterogeneous ſalts found in it.

Prepared Natron. Ph. L. *Mineral Alkali.*

As it is no eaſy taſk to obtain mineral alkali *perfectly pure*, we need not expect to find it ſo in commerce. This article, if prepared agreeably to the directions of the Royal College of Phyſicians, cannot but be contaminated with *ſulphate* and *muriate of ſoda*. But what is ſtill worſe, the fraudulent chemiſts mix ſulphate of ſoda with it intentionally. In order

order to diſcover the ſulphuric and muriate ſalt, a determinate quantity of the alkali is to be ſaturated with acetous acid, and then divided into three different glaſſes. By adding to the firſt gradually a ſolution of muriate of barytes, the quantity of ſulphuric acid may be diſcovered, in the ſame manner as mentioned before. In the ſecond glaſs, having let fall a few drops of nitrate of ſilver, the quantity of muriatic acid may be inveſtigated in a ſimilar manner; and by adding gradually a little tartareous acid to the third glaſs, an acidulous tartraite of pot-aſh will be ſeparated in the form of a white powder, 300 parts of which contain 107 per cent. of vegetable alkali, as $75\frac{1}{3}$ per cent. pure alkali, free from carbonic acid.

The beſt mineral alkali, free from any heterogeneous admixture, cryſtallizes in oblong druneated rhomboidal cryſtals, as clear as glaſs. It is ſoluble in an equal quantity of cold water, and generally contains 80 parts of alkali, 64 carbonic acid, and 256 of water.

Water of Pure Ammonia. Ph. L. *Water impregnated with Ammoniac.*

The *perfectly cauſtic* ſpirit of ſal ammoniac, as it is uſually called, is one of thoſe articles we ſeldom meet with. It generally contains a conſiderable portion of carbonic acid, and is alſo not ſufficiently ſtrong (particularly for philoſophical purpoſes). If this liquid is conſiderably ſtrong, a phial containing exactly 224 grains of diſtilled water muſt compriſe no more than about 216 grains of aqua ammonia.

Water of Ammonia. Ph. L. *Solution of Carbonate of Pot-aſh.*

In order to judge of the relative ſtrength of this article, which is nothing elſe but a mere ſolution of carbonate of ammoniac in water; ſtrong ardent ſpirit may afford no mean criterion of the ſtrength or proper ſaturation, as well as of the purity of this fluid. If this fluid be fully ſaturated with carbonate of ammoniac, a quantity of ſtrong ardent ſpirit, poured ſlowly down the ſides of the glaſs, will ſeparate the alkaline ſalt, by uniting with the water, which kept it in ſolution, in conſequence of which an opake denſe coagulum will be formed on the ſurface where the fluids touch each other; and if on ſhaking them briſkly together, the whole mixture ſhould become converted into a nearly conſiſtent maſs, this article is very good. Whereas, on the contrary, if weak, the effect will be far leſs conſiderable, and the coagulum will conſtantly remain ſeparated into two diſtinct parts, viz. a ſolid and a fluid one.

Water of ammonia fully ſaturated with carbonate of ammoniac has the ſpecific gravity 1,150.

Prepared Ammonia. Ph. L. *Carbonate of Ammoniac.*

This ſalt ſhould be totally volatile if laid on an ignited ſubſtance. It is frequently offered for ſale by chemiſts in the form of a coarſe powder, which is nothing elſe than a mixture of muriate of ammoniac and pot-aſh; this compoſition of courſe is not entirely volatiliſed by heat The carbonate of ammoniac imported from abroad always contain veſtiges

of iron, and ſometimes a conſiderable quantity of lime. In order to diſcover the preſence of iron, a little of the ſalt is to be ſaturated with acetic acid, a few drops of pruſſiate of pot-aſh is then to be added, which will impart to the ſolution a blue tinge if the minuteſt quantity of iron be preſent. The preſence of calcareous earth is manifeſted by means of oxalic acid, occaſioning a white precipitate of carbonate of ammoniac; that containing the leaſt quantity of iron has a yellowiſh tinge, whereas pure carbonate of ammoniac is of a ſnow whiteneſs, perfectly dry, ſomewhat ſonorous, volatile before 212° Fahr. and ſoluble in 2 parts of diſtilled water at 55° Fahr. Its ſpecific gravity is generally 1,4076, and its component parts are 40 ammoniac, 53 carbonic acid, and 7 water.

Salt of Hartſhorn. Ph. L. *Carbonate of Ammoniac ſoiled with Animal Oil.*

The genuineneſs of this article (which differs from the former, merely, in being impregnated with a ſmall quantity of animal oil) may be diſcovered in a ſimilar manner.

Solution of the above in an Aqueous Fluid. Volatile Liquor of Hartſhorn. Ph. L.

Is in general imitated by mixing a quantity of aqua ammoniae purae with the officinal ſpirit of hartſhorn, in order to make it ſtronger, and to give it the appearance of a ſpirit well ſaturated with volatile ſalt. The ſpirit thus becomes more pungent, ſo as to bear an addition of a conſiderable portion of water, without betraying the impoſition either by the taſte or ſmell. This fraud may be diſcovered by adding ſtrong ardent ſpirit to the ſophiſticated ſpirit; for if no conſiderable quantity of cryſtallized volatile ſalt becomes precipitated, the adulteration may be ſuſpected. It may even be diſcovered by the circumſtance of the ſpirit not effervеſcing briſkly with acids.

Spirit of hartſhorn carefully diſtilled is colourleſs. Its taſte is not very unpleaſant (ſaline not pungent), and its ſmell ſomewhat empyreumatic. By long keeping it contracts a yellowiſh tinge, and acquires a bitter taſte and nauſeous fœtid ſmell. If fully impregnated with volatile alkali, its ſpecific gravity is about 1,500.

IX.

A Memoir on the Ammoniuret of Cobalt, and upon a new Acid contained in the Grey Oxide of that Metal, known by the Name of Zaffre. By LOUIS BRUGNATELLI*.

MY attention has been for ſome time directed to the ammoniacal combinations of the metals, or the ammoniurets. They have hitherto been little examined, excepting that of copper, though their characteriſtic properties diſtinguiſh them very prominently from other

* Tranſlated from the Italian manuſcript of the author, by Van Mons, into French in the annals de Chemie XXXIII, 114, whence the preſent tranſlation is made.

bodies.

bodies. The ammoniuret of cobalt is that to which I directed my firſt reſearches *, and I now ſend you an account of the peculiarities they have offered.

1. I had ſeveral times obſerved that the precipitate, formed by ammonia in the ſolution of the nitrate of cobalt, was rediſſolved in that alkali. I collected this precipitate on a filtre, and waſhed and dried it. Its colour was dark. Upon half an ounce of this precipitate I poured two ounces of liquid ammonia, after which I cloſed the bottle, and left the mixture at reſt; the temperature of the atmoſphere being 20° above the zero of Reaumur. At the expiration of 24 hours the alkali had acquired a deep red colour †, and the precipitate was entirely diſſolved. I ſuppoſed I had formed a perfect ammoniuret; but nevertheleſs I endeavoured to procure a larger quantity by other means.

I attempted without effect to diſſolve ſmalt, or the blue (glaſs) of cobalt, in cauſtic ammonia, even with the aſſiſtance of long continued digeſtion; but ſolution took place without difficulty with the grey oxide of the ſame metal, commonly called Zaffre. This ſubſtance afforded me an eaſy means of procuring the ammoniuret in abundance, and to repeat and vary my experiments in ſeveral different manners.

3. I evaporated the ammoniuret obtained from zaffre to dryneſs. The concrete reſidue which I obtained was compoſed of two very diſtinct ſubſtances, one of which was of a deep red colour, and the other of a pale yellowiſh tinge.

4. I poured diſtilled water upon this reſidue, agitating the mixture with a ſpatula of glaſs. The red portion was totally diſſolved, and communicated a beautiful roſe-colour to the water. The yellowiſh matter remained undiſſolved.

5. The yellowiſh ſubſtance may be obtained by evaporating the liquid ammoniuret, from which it is ſeparated, the moment the fluid is reduced to half its original bulk. The red ſubſtance remained diſſolved in the laſt fourth part of the liquid ‡.

6. Ammonia therefore takes from zaffre in its ſolution two very diſtinct ſubſtances, of which the one ſoluble in water has a red colour, and the other inſoluble in the ſame liquid is yellowiſh. This laſt ſubſtance is the pure oxide of cobalt. We think we have diſcovered a peculiar acid in the former, diſtinct in its properties from every other known acid.

Concerning the pure Oxide of Cobalt.

7. The yellowiſh ſubſtance which is ſeparated by ſlow evaporation in the air, or in the ſun's light, may be conſidered as the pure oxide of cobalt. In fact it is inſipid, inodorous, inſoluble in water, and ſoluble in the mineral acids. The nitro-muriatic acid forms with it

* I have ſince examined the ammoniurets of mercury, zink, copper, and arſenic. B.

† Bergman obſerved only that ammoniae aſſumed a red colour with cobalt. "Cobaltum," ſays he, "a "niccolo differt quod omnibus acidis et alcali volatile ſolvatur colore rubro." This circumſtance has been repeated by chemiſts without addition. B.

‡ A yellow matter is ſeparated from the ammoniuret of cobalt, if kept for a time, even in well cloſed bottles. B.

a yellowiſh ſolution, which loſes moſt of its colour by the addition of a ſmall portion of diſtilled water.

8. This ſolution may be uſed as a ſympathetic ink, like the common muriate of cobalt. Sometimes the acid refuſes to diſſolve the whole of the oxide; but the ſolution is completed by the addition of a ſmall quantity of water.

9. This ſolution is precipitated by the pruſſiate of pot-aſh, of a blueiſh green, which does not change. It is not precipitated by the gallic acid, but the ſolution becomes of a deeper colour. In other reſpects this ſolution has the ſame habitudes as the common ſolution of cobalt in the ſame acid.

10. The muriatic acid diſſolves the yellow oxide very well, and aſſumes a very deep green colour, which immediately diſappears with the nitrous acid, and alſo by a ſmall portion of water. But it is revived again by the addition of a ſmall quantity of well concentrated muriatic acid.

Of the pure Ammoniuret of Cobalt.

11. The yellow oxide is totally ſoluble in ammonia, and forms the pure ammoniuret. Its colour is yellow, and ſometimes roſe coloured; the acids do not decompoſe it; the muriatic acid diſcolours it: pruſſiate of pot-aſh gives it a grey colour, and afterwards throws down a precipitate of the ſame colour. The ſulphuret of pot-aſh cauſes it to aſſume a deep colour, inclining to black, and throws down ſulphuret of cobalt *.

Concerning the Acid obtained from the Ammoniuret of Cobalt, and its Properties.

12. The red ſubſtance of the preceding experiments was ſeparated from the yellow oxide. For this purpoſe I evaporated the liquid ammoniuret in the ſun, and when it was reduced to about one-fourth of its volume, and no longer afforded any yellow precipitate, I filtered it through paper. The fluid was of a deep red colour, like that of cochineal. This liquid emitted no ſmell, but its taſte was very ſharp. It was expoſed to the ſun's light till perfectly dry.

13. The remaining maſs was diſſolved in diſtilled water, which acquired a fine ruby colour. This ſolution exhibited unequivocal ſigns of acidity. It depoſited on cooling ſome ſmall brilliant cryſtals, which I found to be a combination of the acid with ammonia. This acid appearing to be diſtinct from every other, I have thought fit to call it the *cobaltic acid*.

In order to aſcertain whether heat was capable of raiſing the cobaltic acid, I ſubmitted one pound of the ammoniuret of cobalt to diſtillation in a retort. When three-fourths of the liquid had paſſed into the receiver, I ſtopped the diſtillation. The retort contained

* The ſulphuret of cobalt, dried in the air, reſembles zaffre in its colour. When rubbed on paper, it aſſumes the metallic brilliancy, as do moſt of the other metallic ſulphurets. It emits a ſulphureous ſmell when heated, and takes fire when thrown on ignited coals. B.

a liquid rendered turbid by the precipitated yellow oxide. I decanted the liquid after the precipitate had ſettled, and evaporated it to dryneſs. The reſidue was yellowiſh, and partly ſoluble in water, to which it communicated a yellow tinge. This ſolution exhibited all the acid characters of the red liquid, No. 15.

15. In another experiment, I put one pound of the ammoniuret of cobalt into a retort, and urged the diſtillation to dryneſs. The fixed matter which remained on the bottom of the retort was blue at the ſurface, but internally yellow. After ſome hours the blue colour totally diſappeared, and was changed into red.

16. A remarkable difference between the reſidue of the evaporation by the ſun's light, and that by the fire, was that the latter tranſmits the cobaltic acid nearly colourleſs; ſo that the cold ſolution is nearly as limpid as water. I have beſides remarked, that by this laſt proceſs the acid contains little or no cobalt of ammonia.

17. I ſhall here preſent the principal characters which diſtinguiſh this new acid. They are

1. Its form is concrete, and it is not volatilized by fire.

2. In ſome inſtances it is red (13); in ſome pale yellow (14); and in ſome colourleſs (16).

3. It is without ſmell.

4. It has a ſharp, and not unpleaſant taſte.

5. It ſtrongly reddens the tincture of turnſole.

6. It is perfectly ſoluble in water.

7. It decompoſes all the ſulphurets of alcali, and precipitates the ſulphur.

8. It precipitates the ammoniuret of copper of a light green, and that of zink of a clear white.

9. It precipitates the ſulphuret of copper of the ſame colour as the ammoniuret of that metal.

10. It precipitates the nitrate of ſilver white.

11. The nitro muriate of tin the ſame.

12. The nitrate of mercury of a light ſtraw colour.

13. The acetite of lead white.

14. It does not ſenſibly affect the ſolutions of gold and platina.

15. It precipitates lime water in a white coagulum, inſoluble in water, and in exceſs of acid.

16. It precipitates the acetites and muriates of barytes.

17. It is ſeparable by alcohol from its ſolution in water.

18. When employed as a ſympathetic ink, it does not give a green or blue colour, like the ſolutions of cobalt; but gives a brown and afterwards a black colour to paper when rather ſtrongly heated, as happens with other acids.

19. It affords, with new made tincture of galls, a yellow abundant precipitate.

20. With

20. With the ſaturated ſolution of ſoda, it affords an irregular tranſparent ſalt ſoluble in water, and not deliquieſcent.

21. With pot-aſh it affords a cryſtallizable ſalt in ſquare cryſtals, which are tranſparent and permanent in the air.

22. With ammoniac it forms a ſalt ſoluble in its acid.

23. With barytes it forms an opake ſalt, cryſtallizable with difficulty.

Supplement.

The preſence of an acid in zaffre, induced me to ſuſpect that it might probably be arſenical: but this doubt ſoon vaniſhed, by comparing the characters of each.

1. The arſenical acid does not precipitate the ſolutions of ſilver, as does the cobaltic acid. 2. The arſenical acid precipitates lime water; this arſeniate is re-diſſolved by the acid, as well as by a new quantity of lime water. The contrary happens with the acid of cobalt. 3. The arſenical acid does not decompoſe the muriate and acetite of barytes, as does the cobaltic acid. 4. The arſenical acid is ſoluble in alcohol, which precipitates the cobaltic in a concrete form.

It remained to be proved, whether the acid obtained from zaffre exiſted ready formed in that oxide, or whether it was produced by the action of the ammonia.

As the acid of cobalt is very ſoluble in water, I boiled ſix pounds of zaffre in eight pounds of water for a quarter of an hour, and filtered the liquid while yet warm. That which paſſed was tranſparent and colourleſs; but had a perceptible taſte. I evaporated the liquid, taking care to cover the veſſel with a piece of ſilk. When it was reduced to one half, it became turbid, but the matter which was ſeparated was not perceptibly coloured. I continued the evaporation till no more than one-third of the liquid remained, and then removed it from the fire. It depoſited a very white matter, which the contact of the air changed to a beautiful roſe colour. I ſeparated this matter, and collected it on the filtre.

The filtered fluid was of a bright yellow colour, and perfectly tranſparent. It had a very decided acid taſte; reddened the tincture of turnſole, ſpeedily decompoſed lime water, the ſalts of barytes and of ſilver, was precipitated by alcohol, &c. In a word, its habitudes were in every reſpect the ſame as thoſe of the cobaltic acid obtained by the foregoing proceſſes.

The red depoſition which remained on the filtre had no taſte, and coloured the muriatic acid of a very fine green. It was the pure oxide of cobalt. This oxide is largely ſoluble in its own acid, and is precipitated in proportion as the acid is concentrated.

The acid which the ammonia ſeparated from the zaffre, exiſts therefore ready formed in that ſubſtance. Its radical ſtill remains to be poſitively aſcertained. In the mean time I have thought it proper to deſignate it by the name of the *Cobaltic Acid.*

X.

The Apparatus of Woulfe improved, ſo as not to require luting. By Cit. GIRARD.*

AS the ingenious apparatus of Woulfe, which has been ſo highly uſeful in modern chemiſtry, always requires a conſiderable time for its arrangement in thoſe operations in which it is uſed, the attention of philoſophers has been long directed to the means of ſimplifying it. Various forms have been contrived to conſtruct this apparatus, hermetically cloſed, without the aſſiſtance of luting; but they are in general too difficult in the execution. That which I now offer to the Inſtitute, may be put together or diſmounted in a few ſeconds, and appears applicable in all the circumſtances of experiment.

It conſiſts ſimply in cauſing the veſſels to be made at the glaſs houſe, with the neck A, to receive the interior tube A B (Pl. II. Fig. 2.) which is welded in the neck itſelf by means of a projection in the ſide of the glaſs. The tube on the oppoſite ſide is firſt drawn to a point, or thin tube as uſual; but then inſtead of breaking this tube near the bottle, to make it agree with the ſubſequent fittings, it is left entire and bended, ſo that it terminates in a curve, which may be introduced into the tube A B. It is unneceſſary to remark, that the tube A B, and the neck into which it enters, ſhould have the ſame curvature, which is very eaſily effected by bending both on the ſame cylinder of earth or wood.

It may be eaſily underſtood, that the neck of the firſt bottle being introduced into the tube of the ſecond, beyond which it projects, and both tubes entirely immerſed in the water, no gas can eſcape from the firſt veſſel, but by paſſing through its neck, and through the liquid it contains.

Fig. 3. repreſents another apparatus of Woulfe's, which will ſupply the place of the other in caſe of diſtance from a glaſs houſe. It is compoſed of large necked bottles and tubes. Take a ſomewhat thick tube, of ſufficient bore to receive another. The upper part of this muſt be enlarged by heating and blowing, and it may afterwards be ground and made to fit in the form of a ſtopper.

Another tube ſhould be then taken, which can enter the firſt ſo looſely that it can be moved with eaſe. The extremity A of this tube is then ground in the ſame manner, in order that it may fit another bottle, after which the uſual curve A B C is given to it.

Laſtly, it is introduced into the tube E F, fig. 4. and the prominent part D is bended upwards. The veſſel may then be conſidered as hermetically cloſed, as ſoon as the lower aperture of the large tube is immerſed in the included water.

The curve of the tubes and necks of the bottles is only intended to direct the bubbles of gas which eſcape through the neck, that they may not again enter the tube out of which they are required to paſs. This curvature is not required, except in ſmall apparatus.

* Annales de Chimie, xxxii. 283.

When a projection of an inch, or more, can be given to the neck beyond the lower opening of the tube, the bubbles muſt neceſſarily eſcape without that precaution.

Fig 5. exhibits another conſtruction of the ſame apparatus.

If an apparatus, compoſed of a very long ſeries of bottles were employed, it might be feared, that the gas contained in the firſt veſſel having a very ſtrong reſiſtance to conquer, would cauſe the fluid of the firſt bottle to expand and riſe in the tube; but it is very eaſy to remedy this inconvenience, either by uſing bottles of different ſizes, or by putting a ſmaller quantity of fluid in the firſt bottles, than in the following ones.

XI.

A Memoir on the Diſcovery of certain Bones of a Quadruped of the Clawed Kind in the Weſtern Parts of Virginia. By THOMAS JEFFERSON, *Eſq.*

IN a letter of July 3d, I informed our late moſt worthy preſident, that ſome bones of a very large animal of the clawed kind had been recently diſcovered within this ſtate, and promiſed a communication on the ſubject as ſoon as we could recover what were ſtill recoverable of them. It is well known that the ſubſtratum of the country beyond the Blue Ridge is a limeſtone, abounding with large caverns, the earthy floors of which are highly impregnated with nitre; and that the inhabitants are in the habit of extracting the nitre from them. In digging the floor of one of theſe caves, belonging to Frederic Cromer in the county of Greenbriar, the labourers at the depth of two or three feet, came to ſome bones, the ſize and form of which beſpoke an animal unknown to them. The nitrous impregnation of the earth, together with a ſmall degree of petrification, had probably been the means of their preſervation. The importance of the diſcovery was not known to thoſe who made it, yet it excited converſation in the neighbourhood, and led perſons of vague curioſity to ſeek and take away the bones. It was fortunate for ſcience that one of its zealous and well informed friends, Colonel John Stewart of that neighbourhood, heard of the diſcovery, and, ſenſible from their deſcription, that they were of an animal not known, took meaſures without delay for ſaving thoſe which ſtill remained. He was kind enough to inform me of the incident, and to forward me the bones from time to time as they were recovered. To theſe I was enabled accidentally to add ſome others by the kindneſs of a Mr. Hopkins of New York, who had viſited the cave. Theſe bones are,

1ſt. A ſmall fragment of the femur or thigh bone; being in fact only its lower extremity, ſeparated from the main bone at its epiphyſis, ſo as to give us only the two condyles, but theſe are nearly entire.

* American Tranſactions, IV. 246.

2d. A

2d. A radius, perfect.

3d. An ulna, or fore-arm, perfect, except that it is broken in two.

4th. Three claws, and half a dozen other bones of the foot; but whether of a fore or hinder foot, is not evident.

About a foot in length of the refidue of the femur was found, it was fplit through the middle, and in that ftate was ufed as a fupport for one of the falt petre vats; this piece was afterwards loft, but its meafures had been firft taken, as will be ftated hereafter.

(To be continued.)

SCIENTIFIC NEWS, ACCOUNTS OF BOOKS, &c.

Letter from Dr. Beddoes; with a Propofal for a Courfe of Lectures.

To Mr. NICHOLSON.

SIR,

IF you approve the fpirit of the undertaking, announced in the enclofed paper, pray notice it in your Journal. I hope the example will be followed. Whether the number of perfons, aware of the paramount importance of the fcience of animal nature, is at prefent fufficient to enfure a reafonable compenfation to thofe who may attempt to explain it in lectures, I am not uncertain. But this æra is faft approaching. I am perfuaded we fhall fee inftitutions for this purpofe, fimilar to thofe which have long exifted, or been lately formed for important, but very inferior purpofes.

The fucceſs at firft experienced in the treatment of palfy by the gas, before fpoken of in your Journal, continues. I repeat my undoubting conviction, that the introduction of factitious air into medicine, will amply recompence the pains that have been taken to bring it about. I had engaged an able diffector and draughtfman, for the purpofe of co-operating with Mr. Davy and myfelf in phyfiological refearches. But an opportunity offering for his advantage, I of courfe relinquifhed my claims upon him; I am much in want of a fucceffor, and I wifh fome ingenious young man, accuftomed to manage the fcalpel and the pencil, may be induced, by this notification, to join us in an enterprize which muft be congenial to the feelings of every ardent cultivator of medical philofophy. I fhould make the conditions as agreeable to him as it lies in my power to do.

I am, Sir,

Your's, with great eſteem,

THOMAS BEDDOES.

March 2, 1800.

Lectures on the Laws of Animal Nature, and on the Means of preſerving the Syſtem from Injury upon the moſt important Occaſions of common Life.

At ſome convenient place in *Briſtol*, Dr. Beddoes propoſes to attempt a popular expoſition of the principles of the animal œconomy, with their application to the purpoſes of individual and domeſtic welfare, upon a plan widely different from that of any exiſting publication. For his opinion on the advantage of diſſeminating phyſiological information, he may refer to his *Lecture introductory* to Meſſrs. Bowles & Smith's Courſe of Anatomy; and an exemplification of the manner in which he thinks the ſubject ought to be treated will be found in his *Eſſay on Conſumption.*

Heretofore an acquaintance with the cauſes of his perſonal condition has ſeldom been numbered among the *accompliſhments* of the ſcholar, or the *qualifications* with which the man of buſineſs is fitted out for ſucceſs in the world. Yet it will be confeſſed, that neither ſucceſs in buſineſs, nor proficiency in the ſciences, accounted *liberal*, are ſeparately ſufficient for rendering the condition of human life deſireable. And, in fact, to endeavour by any combination of theſe materials, to conſtruct a ſyſtem of perſonal happineſs, is to project an edifice which ſhall ſtand ſecure without a foundation.—Of a truth, ſo long and ſo generally neglected, a portion of the public, it is believed, begins to feel that degree of conviction which operates upon conduct. In this belief, the preſent opportunity of inſtruction is offered to thoſe who may be deſirous of it.

If it be allowed that the moral and phyſical attributes of human nature are inſeparable, perſons intereſted in the art of education will ſcarce require to be reminded of the value of that ſpecies of knowledge which the lectures, here announced, are intended to communicate.

They ought to prevent many of thoſe mortal bruiſes which travellers along the road of life give themſelves for want of knowing the quality and poſition of the objects in their way.

By preſenting a juſt eſtimate of *that art* to the operations of which almoſt every one is ſooner or later doomed to ſubmit, they ſhould afford ſome protection againſt groſs medical incapacity or fraud.

They ſhould reduce to their juſt value many of thoſe axioms that wander about the world concerning what is wholeſome or unwholeſome in diet or exerciſe:—axioms which the inſtinct of ſelf-preſervation impels men to take up; and upon which, however looſely adopted, they act with as full aſſurance as if they knew them to have the moſt ſolid foundation in phyſiological ſcience.

Numbers fall victims to their own impatience under illneſs, or to the wavering conduct of their friends. Frequently in the onſet of dangerous diſeaſes, people by ſuffering themſelves to be amuſed by trifling domeſtic expedients, loſe an opportunity which no medical ſkill can ever retrieve. Upon theſe evils the prevalence of juſter ideas would act as a check. Nor is it paradoxical to ſuppoſe that the mortality among infants would be ſmaller, and debility of conſtitution at all periods of life more rare, if parents (however inſtructed in

other things) were not in common nearly upon a level with nurſes in that which it ſo much imports them to poſſeſs—an acquaintance with the powers that operate to the injury or advantage, the deſtruction or preſervation, of the objects of their affection.

The Author further hopes (if he may repeat his own words) to contribute towards preventing the "ignorant from tampering with the ſick; towards promoting the aſcendancy "of ſcience over intrigue; alluring curioſity from the pernicious frivolities of literature, "and elevating the conceptions of men to the level of their higheſt intereſts."

As the whole courſe will be connected, the tickets will not be transferable—The number of lectures cannot be determined beforehand—But that there may be little chance of excluſion by reaſon of narrow circumſtances, the ſubſcription is fixed at ONE GUINEA—The lectures will be calculated for both ſexes and different ages—They will be delivered in the evening, and commence ſometime in April next—probably near the middle of the month—provided fifty perſons ſhall have entered their names by the 31ſt of March. This condition is indiſpenſable. Without a tolerably numerous audience, the author preſumes he could beſtow his time in a manner more advantageous to the public.

Subſcriptions received by Mr. SHEPPARD, Bookſeller, *oppoſite the Exchange*, with whom conditions for printing a SYLLABUS may be ſeen.

RODNEY-PLACE, CLIFTON, *March* 3, 1800.

Extract of a Letter from M. Fabbroni of Florence, to Cit. Van Mons, on the Ethiops of Iron, the Formation of Alcohol and Fermentation. (*An. de Chim. XXX.* 220.)

Take a pound of iron filings, reduce them to a paſte with water, and put it in a capſcule, or what is ſtill better, a glaſs matraſs, kept in a water bath at about 50 or 60 degrees (Reaumur). Pour on it gradually one or two ounces of aqua fortis, rather diluted, or of nitrous acid very much diluted, and continue ſtirring it with a ſpatula. It is remarkable, that it undergoes a kind of effervescence, after which the iron is changed into a very fine black powder, and oxided to the firſt degree of oxidation; that is to ſay, converted into martial ethiops. The operation is performed in leſs than half an hour. If the mixture be put in a cloſed veſſel, and not ſhaken, but left from evening till the next day, the ſurface of the ethiops is found to be covered with a kind of champignons extremely white, and ſeveral lines high, which are nothing but volatile alkali, or carbonate of ammoniac. The air in the veſſel is in this laſt caſe, compoſed in a large portion of oxigenated nitrous gas. A decompoſition here takes place of the water and nitrous acid, both at the ſame time, by the iron which ſeizes their oxygen, in order to become converted into the oxide; and the component parts of theſe two liquids, that is, the azote and hydrogen, which being diſengaged at the ſame time, meet whilſt they are yet in a ſtate of condenſation, or before they have taken the form of a gas, by combining are transformed into ammoniac. A portion

tion of oxigen appears alſo to be precipitated on the carbon of the iron, which affords the carbonic acid, and cryſtalliſes the ammoniac, by ſaturating it as it is formed.

Chemiſts in general, have believed and advanced, that alcohol is the produce of the vinous fermentation. I am aſſured that it is not all ſo, for it does not exiſt in wine. I think I can render this very evident, if I have a method by which I can recover an hundredth part of alcohol, when completely mixed with ſtrong wine, in which, by the ſame method, I could not before diſcover the ſmalleſt atom, although I could obtain 20 or 25 of brandy, from a hundred parts by diſtillation. Theſe were the ſimple means by which it was performed: take a glaſs tube of ſufficient ſize to introduce the finger, and divide it into an hundred equal parts; take freſh wine, with which you have mixed one hundredth part of alcohol, and to that put as much pot-aſh in powder, as is found by a previous experiment, to be neceſſary to precipitate the reſinous coloring reſidue. Then ſtrain the wine, and pour it into the tube, and add as much pot-aſh in powder as is required to ſaturate it. The centime of alcohol, which had been mixed with the wine, will then be ſeen to riſe, and ſwim diſtinctly on the ſurface of the alkaline ſolution. It will be found of the ſame degree of ſtrength, and in the ſame proportion that it had been added, if the operation is performed with ſufficient quickneſs to avoid loſing any thing by evaporation. The previous ſeparation of the coloring matter ſerves merely to render the reſult more perceptible. Now, if by this means I procure only the ſame quantity of alcohol from the wine that I knew it contained before, and not a drop more, it appears to me, I have a right to conclude, that that which I obtain from the ſame wine by diſtillation, did not exiſt in it before, but that it is the operation of diſtillation which forms it; that its formation is determined by the heat; and laſtly, that this liquid is a product, and not an educt of the diſtillation of the wine. The heat neceſſary to effect this is not therefore very conſiderable, for it is formed by the heat of the fermentation, to an heat of diſtillation of 14 degrees, ſuch as may be obtained during winter. It may be formed in bottles by the warmth of the atmoſphere, &c. It is for this reaſon, that I have recommended new wine to be uſed in my experiment. All this has been printed in my *Arte di fare il vino*, which was publiſhed at Florence in 1788; but Italian books ſeldom paſs the Alps. The anatomical examination of the grape precedes the chemical part in this work. The theory of fermentation is there found explained according to the ancient principles, though at that epocha I had, for a conſiderable time, renounced the phlogiſtic theory. The eſſential ingredients, the active and paſſive principles, that is to ſay, of fermentation, are there deduced from experiment; and the making of artificial wine is the confirmation of them. The work is concluded, by expoſing the chemical means neceſſary to diſcover the alteration which adulterated wines undergo, and a ſummary of all the theories of fermentation that have been preſented, to the time of its publication. You will there, perhaps, find a phenomenon which contradicts them all, and which is very remarkable. It is that the acceſs of air is not eſſential to fermentation; for I have excited it in the vacuum of Toricelli.

Principles

Principles of modern Chemiſtry, ſyſtematically arranged, by Dr. Frederic Charles Gren, late Profeſſor at Halle, in Saxony. Tranſlated from the German, with Notes and Additions concerning late Diſcoveries, by the Tranſlator, and ſome neceſſary Tables. Illuſtrated by Seven Plates. In two Volumes, Octavo, 964 Pages. Price 16s. Cadell and Davies.

The character of the late Dr. Gren as a chemical philoſopher is well known, as is likewiſe the value of the work from which the preſent tranſlation is made. I ſhall, therefore only give a ſhort account of the plan: After a conciſe hiſtorical introduction, the author enters upon his ſubject, which he divides into twelve chapters, each of which is again ſubdivided into heads or titles, and thoſe into numerous paragraphs or ſections. The firſt treats of preliminary or general objects, and the operations and inſtruments of chemiſtry. 2. The ſimple ſubſtances and proceſs of combuſtion. 3. Salts in general. 4. Earths. 5. Mineral Acids. 6. Conſtituent parts of vegetables. 7. Of animal ſubſtances. 8. Spontaneous changes in the mixture of organic bodies, fermentation, &c. 9. Bitumens. 10. Mineral coal. 11. Metals. To theſe the tranſlator, beſides many uſeful notes and additions through the work, has added an appendix, containing the doctrine and tables of chemical attraction, the chemical characters of Haſſenfratz and Adet, ſpecific gravities, compariſon of thermometers, of weights and meaſures, together with an index to the whole.

The Chemical Pocket Book, or Memoranda Chemica, arranged in a Compendium of Chemiſtry, according to the lateſt Diſcoveries, with Bergman's Table of ſingle elective Attractions, as improved by Dr. G. Pearſon. Calculated as well as for the occaſional Reference of the profeſſional Student as to ſupply others with a general Knowledge of Chemiſtry. By James Parkinſon. Small Twelves, 229 Pages. Price 5s. Symonds.

This is a very good compendium. By uſing the ſmall type, called burgeois, the author has contrived to give nearly the ſame quantity of matter in the pages of his little pocket volume as is uſually contained in an octavo page. The greater merit, however, conſiſts in the induſtry he has exerted in collecting the numerous particulars of modern chemiſtry from the moſt authentic ſources, and condenſing them with a degree of neatneſs and perſpicuity which will render his book equally uſeful as a manual of ſcience to the philoſopher and the ſtudent. He quotes his authorities much more frequently than is the modern cuſtom; but it will greatly add to the value of his book if in a future edition he ſhould refer in all places by the real title and page to every author of eminence to whom he might wiſh to refer his reader.

Royal

Royal Inſtitution of Great Britain.

A courſe of philoſophical and chemical lectures is at preſent delivered at the houſe of the Royal Inſtitution by Dr. Garnett, which are received with the moſt marked attention by an audience of the firſt reſpectability. The ordinances, bye laws, and regulations of this eſtabliſhment have likewiſe been printed. They conſiſt, for the moſt part, of a developement and organization of the ſubjects contained in their proſpectus of laſt year. The managers are charged to erect a laboratory and theatre for lectures, and to appoint profeſſors. They elect all the ſubſcribers. Proprietors are to be propoſed as candidates by a manager, and elected at the ſubſequent monthly meeting by a majority of two-thirds, and the ſum to be paid will be 60l. after May, 1800;—70l. after May, 1801;—80l. after May, 1802;—90l. after May, 1803; and 100l. after May, 1804. Subſcribers for life, or annual, muſt be propoſed by a manager, and elected at the ſubſequent weekly meeting. Ladies for theſe two claſſes are admitted by recommendation of certain ladies intruſted by the managers to hold books for that purpoſe. I do not find any ſpecific mention of the ſums to be paid by life and annual ſubſcribers; but upon enquiry at the houſe, I am informed, that on Friday the 7th of this month, the ſum for the former claſs was raiſed from ten to twenty guineas, and for the latter from two to three guineas. Whether the managers of this great eſtabliſhment have ſhewn a *laudable* partiality to their own claſs by giving them five regular notices of the advances they are to pay, while the the reſt of the public is called upon without ceremony for augmentation of fifty and one hundred per cent. may perhaps be queſtioned.

Plate 1. Phil. Journal Vol. IV. facing page 48.

Mr. Boswell's Blast Ventilator.

Fig. 1.

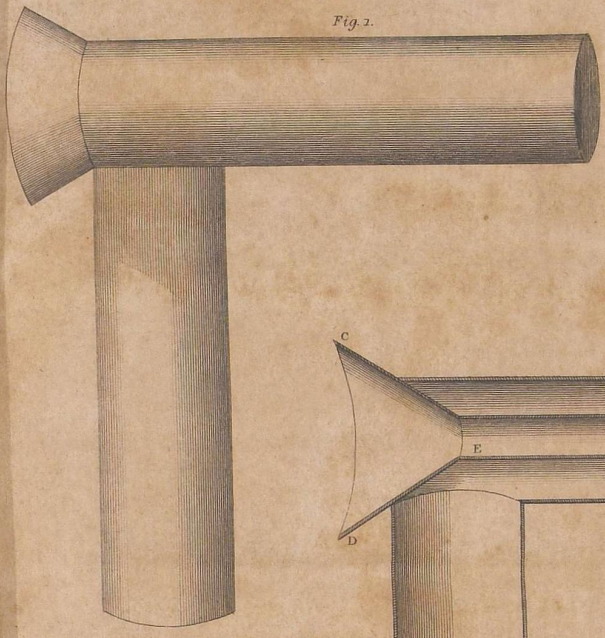


Fig. 2.

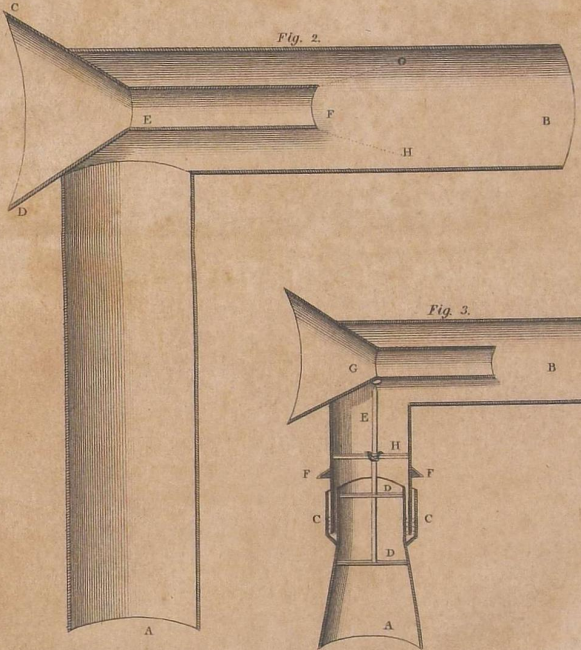
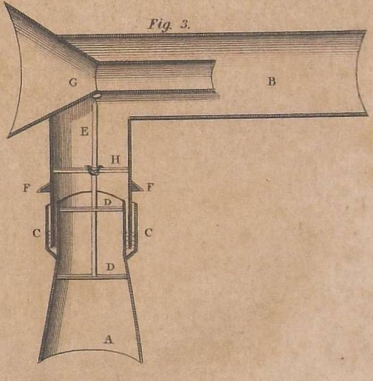


Fig. 3.







Mutlow, fc.

Hydraulic Machine at Schemnitz

Apparatus without Lute

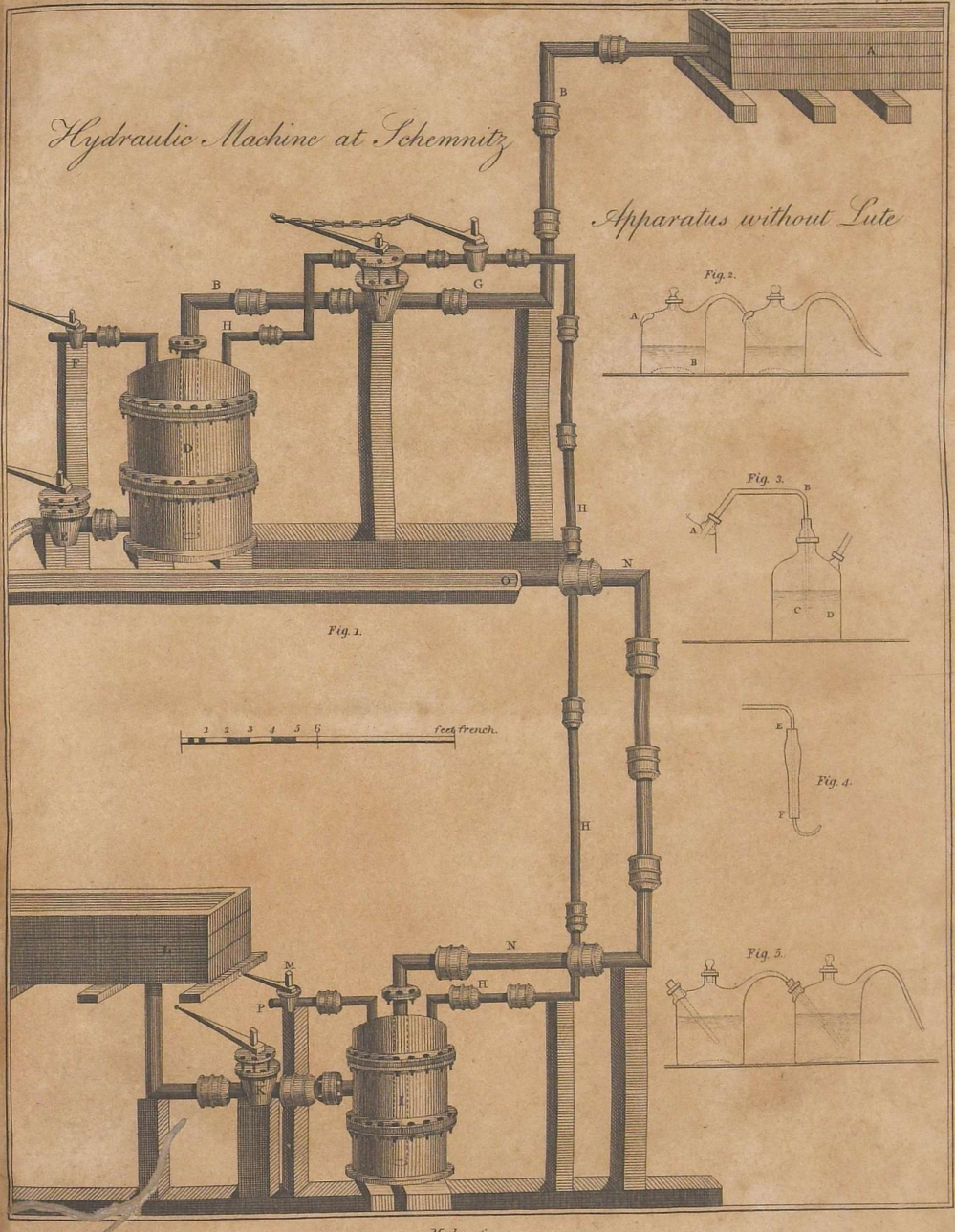


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Mudlow. fc.

A

JOURNAL

OF

NATURAL PHILOSOPHY, CHEMISTRY,

AND

THE ARTS.

MAY 1800.

ARTICLE I.

On the different Effects of the Alkalis in the Production of Alum. By Professor HILDEBRANDT, *of Erlangen*.*

IT is a known fact, in the usual preparation or extraction of alum, that pot-ash, or urine, is added to the first solution, which is procured by lixiviating the roasted and weathered aluminous ores. *Bergman* †, being of opinion that these additions tended only to saturate the superabundant acid of the lye by which the crystallization of the salt is impeded, has advised to add pure aluminous earth, or argil, instead of the preceding substances, on the supposition that those additions do contaminate the alum with foreign salts; while, on the contrary, pure alumine would not only saturate the superfluous acid, but increase the quantity of the sulphate of alumine. *Professor Lampadius* ‡, who adopted the same opinion, tried by experiments, according to Bergman's idea, whether he could not render

* Translated from Dr. Scherer's (now Professor at Halle in Saxony) Chemical Journal, Vol. II. pag. 419.

† *Bergman, de confectione aluminis*, § *II. Opusc. Chem. et Phys. I. Lipsiæ* 1783. 8*vo. pag.* 308. Quum autem argilla pura basin aluminis constituat, excedens lixivii acidum nullo alio modo melius, quam ea donatur, quæ superfluum acidum non tantum aufert, sed etiam salis quæsiti copiam auget.

‡ *Lampadius*, pract. chemische Abhandlungen I. Dresden 1795, § 14.

the

the addition of pot-aſh or urine unneceſſary, and with this view he had, in the alum-works of Lederbur at Weiſgrun, added to the crude lye ſome white argil, dug up near the village Chotta.

The ſuperabundant acid here ſpoken of, is not that portion which is eſſential to the alum, the acid in this ſalt being never fully ſaturated with argil; but that quantity only is meant, which may happen to be preſent in the lye as foreign, or not belonging to the compoſition of alum, as is the caſe, when the aluminous ore is too abundant in ſulphur, or when a ſufficient portion of its argillaceous part has not been combined with the ſulphuric acid generated in the proceſs.

If we admit that the crude lixivium of alum does really contain an exceſs of acid, and that it is this only which impedes the cryſtallization of the ſalt, the addition of argil ſeems much more proper, than that of either pot-aſh or urine; becauſe more alum muſt be obtained by the former, while the latter affords ſulphate of pot-aſh or ammoniac, which diminiſh the purity of the product.

But *Marggraf* * has long ago obſerved, that the ſulphate of alumine cannot be generated from argil and ſulphuric acid alone, and that an alkaline ſalt is one of its eſſential ingredients. To prove this fact, I have ſeveral times diſſolved ſome aluminous earth (that had been precipitated from Roman alum by means of pot-aſh, and properly edulcorated) in ſulphuric acid carefully rectified, and attempted to cryſtallize the clear filtered lye, by evaporation and cooling. But I never obtained the leaſt appearance of cryſtallized alum. The mixture conſiſting of argil and ſulphuric acid, rather in exceſs, is more ſoluble in water than true alum: ſo that two parts of water at a temperature of 50° Fahrenheit, are ſufficient to diſſolve one part of that maſs, merely dried without ignition; whereas the alum requires at the ſame temperature, 35, or more parts of water, to diſſolve it. Even after that lye had been reduced by evaporation to a much ſmaller compaſs, than a lixivium of true alum would admit of without cryſtallizing, it continued liquid, though expoſed to a freezing cold. On evaporating it ſtill farther, and by ſubſequent cooling, it affords indeed a compact maſs, but without any determinate figure, which occupies the bottom of the veſſel in the form of a dried jelly. It was but ſeldom that, in a certain degree of the evaporation, I could perceive a kind of cryſtallization in groups; but there was no appearance of ſuch hard octahedral cryſtals, as preſent themſelves in a ſolution of true alum, containing upwards of twenty parts of water to one of ſalt diſſolved in it †.

If, on the contrary, to the above ſolution of argil in ſulphuric acid, a ſmall quantity of vegetable alkali only be added, and it be then evaporated and left to cool, regular cryſtals of alum will be obtained at each ſubſequent refrigeration.

* *Marggraf*, Chim. Schriften. I. Berlin, 1768. S. 196.

† *Marggraf*, however, obſerved that when the argil was ſtrongly calcined, it afforded ſome cryſtals with the ſulphuric acid, which reſembled thoſe of alum, but were not ſo fine as thoſe obtained by the addition of an alkaline lye. I wiſh he had ſtated this more accurately. But, as my preſent object was to aſcertain, which of the alkalis may be moſt ſuitable to the generation of alum, I have not yet repeated that experiment.

In

In order to discover the proportion of the alumine to the sulphuric acid, nothing more is required, than to combine as much of the earth with the acid, as it will dissolve in the common temperature (from 50° to 60° Fahrenheit). An excess of the acid will, in that case always remain, as shewn by the test of Litmus. For at that temperature the acid does not take up so much of the argil as to become neutralized. The solution must, however, be left standing long enough (24 hours) upon the remaining undissolved part of the earth, because the argil is dissolved much more slowly by this acid, than the calcareous and magnesian earths.

In order to discover the due proportion of pot-ash in this process, *Marggraf* directs us to continue adding gradually of the alkaline lye by drops, till a light pulverulent precipitate (that is to say, precipitated argil) appears. In the following experiments I added so much alkali, whether pot-ash, or either of the other two, that (the quantity of dissolved pure alumine being half an ounce) there remained a sufficiently perceptible quantity of precipitated earth, though very small in proportion to the whole. For, it is to be observed, that the very first drops of the alkaline lixivium, if neither itself nor the solution of the earth be too weak, produce a turbidness; but this first precipitate is re-dissolved in the excess of the acid present. I am much inclined to suppose, that it may be immaterial to determine the precise quantity of alkali, because I have constantly obtained alum by the addition of pot-ash, notwithstanding that in some instances I added more of it, and in others less.

To ascertain the regular form of the crystals of alum, one or more threads should be hung into the lye, in order that perfect, or nearly perfect octahedrons may be formed round them; for those crystals which are formed at the bottom, or on the sides of the vessel, are always defective in one or more of their angles.

Having decided from these experiments, that a small portion of alkali is essentially requisite to the production of sulphate of alumine, I mentioned the fact in the advertisement of *Prof. Lampadius's Chemical Essays*. It cannot be denied, but that in one of his experiments * he has obtained alum, from mere argil and sulphuric acid, without the addition of either pot-ash or urine: but not to mention, that the quantity of alum obtained by the said process was indeed exceeding small, in proportion to what has been produced on adding pot-ash or urine, it is probable, that as much vegetable alkali as was sufficient for the formation of that small portion of alum may have entered into the crude lixivium, from the ashes of the wood employed in the roasting of the aluminous ore, and of which a greater or less portion is unavoidably mixed, with the roasted mineral. Or that alkali may actually have pre-existed in the ore; (or if not, at least the nitrogen and hydrogen, from which the alkali was generated, may have been present.) *Profess. Klaproth* † has discovered pot-ash in

* *Lampadius*, loc. cit. pag. 16.

† *Klaproth* discovered in the *native alum* from *Miseno* so large a proportion of pot-ash, that 1000 grains of it afforded 470 grains of crystallized alum, and in these 27 grains of sulphate of pot-ash. (*Beytrage zur Kenntnis der Mineral Koerper*. I. Berlin, 1795. deile 313.)

the *native alum* from *Miseno*. Only one part of its aqueous solution would crystallize into genuine alum, in which also he traced out the alkali; the remaining portion of the lye yielded no alum spontaneously, but only when a little pot-ash had been superadded. *Bergman* * likewise, found that alkali in the artificial alum, even in the Roman; and Prof. *Lampadius* † himself considers it at present as an essential principle of alum, in consequence of having found it in four different species of factitious alum: namely, those from *Commotin* and *Weissgrün* in Bohemia, and those from *Reichenbach*, and from the *Schwemsal* in Saxony.

On considering the share, which the vegetable alkali has in the production of alum, the question naturally arises: whether *pot-ash* alone, or *soda* likewise, as well as *ammoniac*, are capable of combining with sulphuric acid and argillaceous earth into alum ‡ ?

The aptitude of volatile alkali to enter into such union, seems to be deducible from the circumstance, that, in some alum-works, urine only and no pot-ash is employed. However, as I have already observed in another respect, it is not impossible but that a quantity of vegetable alkali may be afforded by ashes formed in the roasting of the alum-ore, sufficient to complete the alum.

The alkaline portion of the alum may be ascertained in three different ways by analysis.

1. Let the argil be thrown down from a watery solution of alum by means of *ammoniac*; cause then the salt contained in the clear decanted lixivium to crystallize, and subsequent to this expose it to a subliming heat. In this process, the *sulphate of ammoniac* sublimes, but the *fixed sulphate of pot-ash*, if any has been in the alum, remains behind it in a compact form. This method discovers the presence of fixed alkali only.

2. To a boiling hot aqueous solution of alum, add carbonate of lime. By this management the sulphate of argil is decomposed, and the lime is converted into gypsum; at the same time that the sulphate of pot-ash, if any was present, remains unaltered. This last would likewise be decomposed by caustic or pure lime; but it is well known that the crude calcareous earth, on account of its strong attraction for carbonic acid, has no such power on sulphate of pot-ash. What quantity of crude lime may be necessary to accomplish that decomposition, may in some manner be determined, by the known proportions of argil to sulphuric acid in alum, as well as by the proportion of calcareous earth to the same acid in gypsum, and lastly that of crude lime to carbonic acid in carbonate of lime. However, as this determination is subject to some difficulties, it will be sufficient to be attentive to the effervescence of the lime, and according to this effect, to add rather too much than too little, because the redundant calcareous earth falls down, unchanged, together with the

* *Bergman*, cit. § 77, page 307. Yet he says: *haud raro*.

† *Lampadius*, Pract. Chim. Abhandlungen II. 1797. S. 228.

‡ *Marggraf* (cit. loc. page 196) says only, that the addition of fixed alkali is necessary.---*Lampadius* (cit. p. 230) has not yet given any results of his experiments, made with the mineral and volatile alkali.---*Bergman* (cit. 307.) says: *crystallizationis obstaculum alcali volatili æque tollitur, non vero alcali minerali et calce*; yet without relating any experiment.

precipitated

precipitated argillaceous earth, from which it may be ſeparated by the known methods, if it ſhould be required to aſcertain the quantity of the argil. A certain portion of the ſulphate of lime, thus produced, is likewiſe precipitated at the ſame time, and in greater quantity, the leſs water there is in the ſolution. The remainder of the gypſum continues diſſolved in that fluid. Let the liquor be carefully poured off from the precipitate, and let this laſt be edulcorated with a ſufficient quantity of boiling water; let the waſhings be added to the fluid at firſt decanted; and the whole of the fluid be gradually evaporated, and left to cool, by alternations. By this management the gypſum will by degrees be ſeparated, and afterwards the ſulphate of alkali, which was an ingredient into the alum, whether it has been pot-aſh, or ammoniac. The ſulphate of lime will fall firſt, becauſe moſt difficultly ſoluble; the ſulphate of pot-aſh will be the next in order; and, laſtly, the ammoniac, being the moſt ſoluble of all. If at the ſame time the alum under examination has contained a portion of ſulphate of ſoda*, it will be more difficult to ſeparate this from the ſulphate of ammoniac, becauſe it is alſo very ſoluble. But it will preſently be ſhewn, that no ſoda is contained in alum.

3. Pour into a ſaturated ſolution of alum, in ſix times its quantity of water (heated to about 120° Farenh.) a ſaturated ſolution of acetate of lead. Sulphate of lead will be produced, which falls down; and alſo, the acetate of alumine as well as the acetate of pot-aſh (or of ammoniac), which, being readily ſoluble, remain diſſolved in the water. The ſupernatant fluid muſt then be decanted from the ſulphate of lead, and ſubjected to evaporation, until it beomes turbid; for by this means a little of the metallic ſulphate, that was ſtill held in ſolution by the water, is thrown down. When the fluid has been a ſecond time filtered, it muſt be evaporated to dryneſs. The dry reſiduum conſiſts of acetated argil and acetated pot-aſh. And if it be then ignited, the acetic acid, together with the ammoniac, if preſent, will be volatilized. Water muſt now be poured upon the reſidue; which, if only ammoniac has entered into that compound, extracts nothing from it, by reaſon of the volatilization of this alkali, and of the inſolubility of aluminous earth in water. But if a portion of vegetable alkali was contained in it, it is on account of its fixity, left behind in the argil, and will be diſſolved in the water. The alkali receives ſome carbonic acid from the deſtruction of the acetic, but is ſtill far from being ſaturated with it; and hence a part of the argil will be diſſolved along with it by the water. The earth muſt, in that caſe, be precipitated, by ſaturating the ſolution with carbonic acid, or letting it ſtand for a long time in open veſſels, ſlightly covered.

Analytical experiments alone are, nevertheleſs, inſufficient to decide with certainty, whether all the three alkalis, or only one, or two, of them are by their acceſſion capable of producing alum; and therefore our arguments cannot yet reſt on a complete induction. For, ſuppoſing I had decompoſed artificial as well as native alum in a thouſand different ways, and had found no ſoda in it, I cannot fairly conclude that the mineral alkali is

* I need not here obſerve, that ſalts of more difficult ſolubility are, for the moſt part, (though not perfectly) ſeparated by the gradual and ſucceſſive diminution of the water, and cryſtallization.

unfit

unfit for the production of alum. Not to mention the few ſpcies of alum, which I have examined, I ſhould not chooſe to draw ſuch an inference from the reſults I did obtain from them.

Synthetical experiments, on the contrary, I am perſuaded, ought to decide in this caſe. And by theſe, (although *Marggraf* mentions, in a general way only, the pot-aſh as a neceſſary requiſite to the generation of ſulphate of alumine, without excluding the ſoda) I have until the preſent moment been convinced, that the combination of ſoda with ſulphuric acid and argil does *not* yield *any alum*, I mean that very ſalt, which is known by that name; but that it is generated by the addition of pot-aſh.

I employed, in my experiments, native ſoda (natrum) from Hungary, purified in a high degree. It was this purity that induced me to inſtitute thoſe experiments. And to aſſure myſelf that no portion of pot-aſh did interfere, I have precipitated the argil from Roman alum, not by means of pot-aſh, but by ſoda. If, therefore, ſomewhat of the neutral ſulphate, generated by the precipitation, had remained in the earth after it was edulcorated, it muſt neceſſarily have been ſulphate of ſoda.

The precipitated alumine was then properly waſhed; and I thought it needleſs to free it, according to *Richter*, from the adhering ſulphuric acid, the preſence of which was not detrimental in this inſtance. I then diſſolved it in purified ſulphuric acid, in exceſs, ſo that the ſolution reddened litmus-paper dipped in it. As I have already obſerved, the due proportion of the earth to the acid is found of itſelf, by permitting the acid, moderately diluted, to diſſolve as much of the earth as it can in a low temperature. When I afterwards added to the filtered ſolution ſucceſſive portions of diſſolved carbonate of ſoda, till part of the alumine itſelf began to precipitate, I filtered the ſolution once more, and began to attempt the cryſtallization of the ſalt, by gradually repeated evaporation and alternate cooling.

But in none of theſe inſtances did I obtain alum; but rather a *very ſoluble ſalt*, altogether *different* in its *form*. This combination is of ſo eaſy ſolution, that I might at firſt have repeatedly ſuſpected an accidental tranſpoſition of my evaporating diſhes, if I had not been ſure of the contrary, by the ſmall quantity of the reſidual liquor, and its refuſing to cryſtallize. That great ſolubility agrees very well with that of Glauber's ſalt (ſulphate of ſoda) as *vice verſâ*, the difficult ſolution of alum correſponds with that ſulphate of pot-aſh. When, in one of my experiments, I added juſt ſo much of ſoda, that the lixivium began to acquire a permanent cloudineſs (owing to the argillaceous particles firſt precipitated, and which are rediſſolved by the redundant acid, if the fluid be agitated, and thus the earthy particles be brought into contact * with its not yet alkalized part), there reſulted from its farther evaporation and cooling ſome minute, ſingle, ſhort needled cryſtals, reſembling thoſe of gypſum. Theſe, however, merely contained aluminous, and no calcareous earth; for they readily diſſolved in water; the oxalic acid precipitated nothing from their ſolution; pure

* The earthy particles newly precipitated are, in general, more ſoluble, than thoſe of a longer ſtanding and deſiccated; becauſe the former are ſubtilely divided, and moiſtened through the whole of their maſs.

(cauſtic) ammoniac, on the contrary, threw down the argillaceous earth they contained. And when the lye was ſtill farther evaporated, it coaleſced upon refrigeration into a coherent ſaline maſs, in which, however, the needle-ſhaped texture could be diſtinguiſhed. In another experiment, in which I added a little more of (the ſame) ſoda in ſuch proportion that the quantity of precipitated argil became ſomewhat more conſiderable, I obtained by evaporating the filtered lixivium to a ſmall remainder, and as it cooled, longiſh, flat, tabular ſix-ſided cryſtals; (that is, very low hexagonal priſms, with broad ends and very low lateral facets, the two oppoſite ones of which were longer, and the other four ſhorter.) After the mother-water, which in proportion to the cloſely grouped cryſtals was but ſmall in quantity, had been decanted, and the cryſtals waſhed with a little cold water, I attempted to take them out of the veſſel by means of a ſilver ſpoon; but they were too ſoft, and were immediately compreſſed. Cold water (at 60° Farenh.) eaſily and quickly diſſolved them; I have not yet determined the quantity required for that purpoſe; but certainly no more than *three* parts are neceſſary for *one* of the ſalt. The ſolution taſted like that of alum; it gave to paper, ſtained with litmus, of a faint red; (the undiminiſhed ſolution, before the ſhooting of the cryſtals, afforded a ſtronger red); whence it follows, that there was a ſmaller proportion of the acid in the cryſtallized ſalt than in the whole fluid.

My attempts to produce alum by the acid of ſoda, being thus fruſtrated, I doubted very much whether *ammoniac*, the properties of which is far leſs analogous to thoſe of pot-aſh, than the properties of ſoda, would ſerve to produce alum, by combination with ſulphuric acid and argillaceous earth. However, experience teaches that in this as well as in various other caſes, reaſonings from analogy prove very often incorrect, when reſorted to in our enquiries into nature. Precipitate the argil from an aqueous ſolution of Roman alum, by means of ammoniac, waſh the precipitate well; diſſolve it then in pure ſulphuric acid, in the manner pointed out above; and then continue adding ammoniac (either carbonated or cauſtic) by degrees, until the ſolution begins to aſſume a permanent turbidneſs. Let the whole then be reduced by evaporation ſo much, that for *one* part of the diſſolved ſalt (the quantity of which may be aſcertained by the quantity of alum employed at the beginning of the proceſs) there ſhall remain from ſix to eight parts of water. As this lye cools, a ſalt will cryſtallize, which, with reſpect to its octahedral form, (in the beſt way to be perceived around the threads hung into the liquid) to the ſolidity and hardneſs of its cryſtals, and to its difficult ſolubility, &c. perfectly agrees with the alum, which is formed by means of pot-aſh *.

* On this ſubject ſee this Journal, I. 318.

Experiments