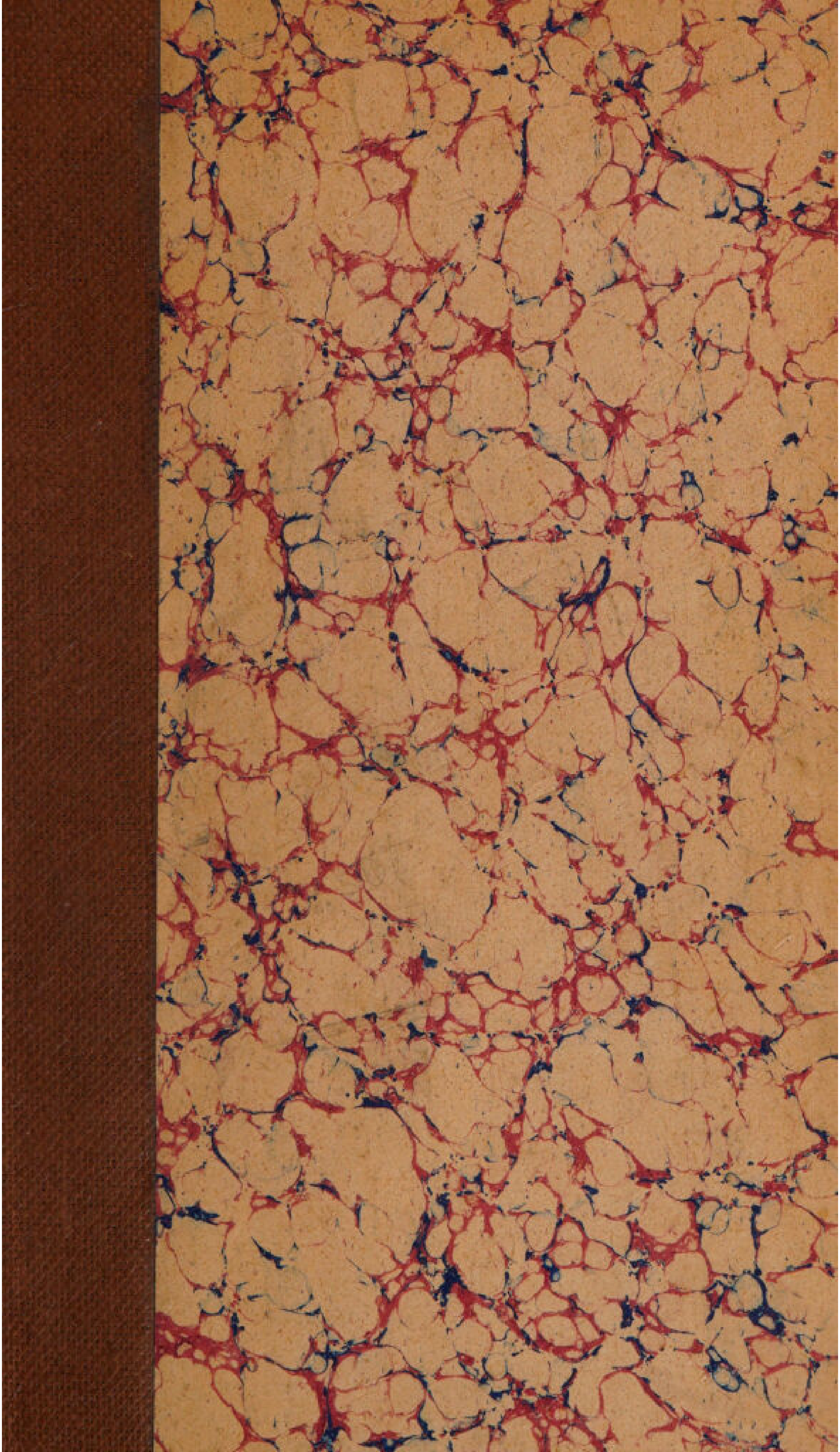
Manual of chemistry, or a brief account of the operations of chemistry and their products / Translated from the French of M. Beaumé [by J. Aikin].

Contributors

Baumé, Antoine, 1728-1804.
Aikin, John, 1747-1822.

Publication/Creation

Warrington : W. Eyres, for J. Johnson, 1786.



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A

MANUAL

OF

CHEMISTRY,

OR A BRIEF ACCOUNT OF THE

OPERATIONS OF CHEMISTRY,

AND THEIR PRODUCTS.

TRANSLATED FROM THE FRENCH OF

M. BEAUMÉ,

DEMONSTRATOR IN CHEMISTRY AT PARIS, AND MEMBER
OF THE ROYAL ACADEMY OF SCIENCES.

THE SECOND EDITION CORRECTED,

WITH ADDITIONS.

WARRINGTON,
PRINTED BY W. EYRES, FOR J. JOHNSON, NO. 72,
ST. PAUL'S CHURCH-YARD, LONDON.
MDCCLXXXVI.

PREFACE

TO THIS EDITION OF THE

TRANSLATION.

THIS Tranſlation was undertaken principally for the purpoſe of furniſhing ſome Gentlemen to whom I was giving a courſe of lectures in Chemiſtry, with a conciſe work, which might ſerve as a reference for all the moſt important facts relative to this uſeful ſcience. The author's profeſſed deſign is to give a brief recapitulation for the uſe of thoſe who have paſſed through a courſe of regular inſtruction; and at the ſame time to provide a ſort of elementary work for thoſe who mean only to take a general and curſory view of the ſubject. His MANUAL, therefore, conſiſts of a ſhort *rationale* of all the principal operations in Chemiſtry, introduced by ſo much of the theory of the ſcience, and of the chemical hiſtory of bodies, as may render it intelligible to thoſe who have not enjoyed the benefit of previous information. Thus it contains a large ſtore of knowledge in a very ſmall compaſs; and may be peruſed with great advantage, either by the ſtudent who wiſhes to review his former acquiſitions, or by the artiſt, who is obliged to content himſelf with a conciſe abſtract of the ſcience.

The tranſlation was made from the ſecond edition of the original, omitting, however, a few notes, which were intended as replies to ſome criticiſms on the work, publiſhed in one of the French Literary

Literary Journals. In lieu of theſe, I added a few of my own, relating to ſome doctrines and facts with which M. Beaumé appeared unacquainted or miſinformed.

My opinion of the utility of this work has been confirmed by its reception from the public; which has produced a demand for a new edition. On this occaſion, I thought it my duty not to leave the reader unacquainted with ſuch eſtabliſhed facts and doctrines as have appeared ſince the former publication, whereby the ideas of the original author are in ſome important caſes either corrected or extended. But as my own chemical ſtudies had for ſome time been intermitted, I took the liberty of requeſting the aſſiſtance of my friend, the Rev. George Cadogan Morgan, who has for a conſiderable time been aſſiduouſly employed in a courſe of chemical reading and experiment, the reſult of which will probably be given to the public, in an extenſive collection of chemical facts, formed on the plan of Mr. Beaumé's larger work. He has kindly furniſhed me with a number of notes for my purpoſe, with which I have enriched the preſent edition. They are diſtinguiſhed by the letter M. affixed.

J. A.

A

MANUAL

OF CHEMISTRY.

INTRODUCTION.

CHEMISTRY is a ſcience founded on experiment. Its object is the analyſis or decompoſition of all the bodies in nature; and the combination of all theſe bodies, or their principles, with each other, for the purpoſe of forming new compounds.

Mechanical diviſion does not decompoſe bodies; it only divides them into more and more minute parts, but ſtill homogeneous and of the ſame nature. Mechanical diviſion is therefore totally inſufficient for the analyſis of bodies; and it is neceſſary to have recourſe to other inſtruments leſs confined in their action. The elements, or primitive principles of bodies, of which we are ſoon to treat, become, in the hands of chemiſts, inſtruments fit for producing theſe diviſions, and for ſeparating the conſtituent parts of bodies. It is this latter kind of diviſion that is termed the *analyſis*, or *chemical decompoſition* of bodies.

GENERAL IDEA OF THE UNION AND COMPOSITION OF BODIES.

When ſeveral particles come inſenſibly into union, they form a larger maſs. When this maſs is formed of parts of the ſame nature, or homogeneous, and becomes evident to the ſenſes, it forms what Becher and Stahl have termed *aggregation*; and they have called the maſs reſulting from this union an *aggregate* or *aggregated body*, becauſe it produces only an addition of particles of the ſame nature, or a maſs merely larger in bulk, and not a compoſition.

But when two bodies of a different nature join together, there reſults from this union a new mixed body, which partakes of the properties

ties of each of the component bodies. This is what Becher and Stahl have termed *mixture*, and what we ſhall call the *combination* or *chemical compoſition* of bodies.

We ſhall give the name of *compound bodies* to thoſe which are formed by the union of parts of a different nature. Theſe heterogeneous parts are termed *principles* or *conſtituent parts*, which it is of importance clearly to diſtinguiſh from *integrant parts*. Natural philoſophers underſtand by integrant parts the ſmalleſt *moleculæ* of an extremely divided body, which is not ſuſceptible of a further diviſion without decompoſition.

ON AFFINITIES.

In Chemiſtry the terms *relation* or *affinity* are uſed to expreſs the tendency which the particles of matter have to unite or combine with each other, whether theſe particles are of the ſame, or of an abſolutely different nature. Chemiſtry and Natural Philoſophy are not as yet ſufficiently advanced for the explanation of the cauſe of this phenomenon, which is a general one, and perpetually met with in nature and in all the operations of chemiſtry.

Some Chemiſts, without having ſufficiently examined the properties of bodies, have ranked chemical affinities among the number of thoſe ingenious ſyſtems which are formed only to ſubſiſt till new ones ſpring up to deſtroy them; but this is by no means the caſe with reſpect to theſe affinities, which, on the contrary, are a property inherent in matter.

Several able chemiſts, who have conſidered the ſcience in a more general point of view, have recognized this inherent property of matter, and the diſpoſition which certain bodies have to unite with each other; they have remarked that there are ſome which unite with great facility, while others do not combine but with much difficulty, and a third ſet refuſe to enter into the leaſt union by any methods as yet diſcovered. It would be wrong, however, to conclude that theſe bodies have no affinity, becauſe we have not as yet found means to make them unite; on the contrary, there is every reaſon to ſuppoſe that the effect might be produced by more ſtudied methods.

To determine by a ſufficient number of experiments the order in which different bodies will unite

unite ſucceſſively with each other, is one of the moſt important ſervices that can be rendered to Chemiſtry. The late M. Geoffroy the phyſician was the firſt who thought of comprizing in a table the fundamental relations or affinities in Chemiſtry. Although this table be liable to various exceptions and alterations which we ſhall remark as occaſion offers, it ought, however, to be regarded as a maſter-piece in its kind; and may ſerve as a chart or guide to all who deſire to perfect or augment it. It forms a kind of connected ſeries of knowledge, which has thrown more light upon Chemiſtry and Phyſics than all the criticiſms which have been made upon it to the preſent day.

M. Geller has conſiderably augmented this table; but I conceive it would be moſt advantageous to give two ſuch tables at once; one of which ſhould preſent the order of the affinities of bodies by the *moiſt way*, the other, the ſame order by the *dry way*. There are in Chemiſtry an infinite number of circumſtances, which will be pointed out, in which bodies that ſhew no affinity by the moiſt way, do by the dry way; and *vice verſa*. This is what has led me to imagine that the double table which I propoſe would be extremely uſeful.

M. Macquer has treated on what relates to affinities at large in a particular memoir, which is the ſubject of one of our chemical lectures. He lays down a methodical diviſion of affinities or rather a diviſion of the different ſtates in which affinities are met with in the operations of Chemiſtry; though otherwiſe he admits only a ſingle ſpecies of affinity, which is abſolutely the ſame, and which he traces as proceeding from the ſame cauſe. He arranges all the chemical affinities under ſeven claſſes.

1. AFFINITY OF AGGREGATION.

The affinity of aggregation is the power which cauſes two homogeneous bodies to tend towards each other, and to cohere after they are united. Such, for example, is the coheſion of two poliſhed ſurfaces applied to each other, or the movement which two drops of a homogeneous liquor, placed near each other, make to come into union.

2. SIMPLE AFFINITY OF COMPOSITION.

Simple affinities of compoſition are thoſe from which new combinations reſult. Such are the ſolutions of bodies in acids. If, for example, white marble is put in ſome nitrous acid, it diſſolves in this liquid, and the compound which reſults has properties participating of thoſe of the acid and the earth.

3. COMPOUND AFFINITY.

Compound affinities are thoſe of heterogeneous bodies which have mutually an equal affinity, whence reſults a mixture without any decompoſition. But the compound has properties different from thoſe of each of the bodies ſeparately. For example, if four drams of lead, and as much tin are melted together, and two drams of mercury are added to this mixture, the mercury unites with the two bodies, becauſe its affinity to each of them is nearly equal; and the product is eager, brittle, and more fuſible than the tin and lead ſeparately. Theſe properties proceed

proceed from the mercury, which has only a fluid conſiſtence.

4. AFFINITY BY MEANS OF A MEDIUM.

Affinities by means of a medium are thoſe of bodies which are unable to enter into union except through the addition of ſome other body which has an affinity with each of the primitive bodies. If water is poured upon white marble; no union takes place; but on adding nitrous acid the water and marble unite. The nitrous acid is the proper *medium* for uniting calcareous earths with water.

5. AFFINITY OF DECOMPOSITION.

Affinities of decompoſition are thoſe whence reſult decompoſitions and new combinations. To a ſolution of white marble in the nitrous acid, add fixed alkali. This will unite with the acid, and precipitate the earth of the marble.

6. RECIPROCAL AFFINITY.

Reciprocal affinities are thoſe whence reciprocal decompoſitions proceed. For example, nitre

nitre is decompoſed by the vitriolic acid, becauſe this acid diſengages the acid of the nitre, and combines with its alkaline baſis. Thus is formed a vitriolated tartar. But this ſame nitrous acid, which has thus been detached by the vitriolic acid, being afterwards mixed with the vitriolated tartar, diſengages the vitriolic acid in its turn, takes poſſeſſion of its alkaline baſis, and forms with it a true nitre, the ſame that exiſted before theſe operations.

7. DOUBLE AFFINITY.

Double affinities, or affinities of four bodies, are thoſe from which reſult two decompoſitions and two new combinations, from the reciprocal changes of the ſeveral bodies. Such are, firſt, the decompoſitions of vitriolated tartar and Glauber's ſalt by all metallic ſolutions in the nitrous acid, and alſo by vinegar of lead. 2dly. The proceſs for making Pruſſian blue. 3dly. That in which the butter and cinnabar of Antimony are made at the ſame time. 4thly. The decompoſition of ſea ſalt by ſolutions of lead and ſilver. There are in chemiſtry a great number

number of ſimilar examples of affinities of four bodies which act ſimultaneouſly when mixed together.

The agency of the four ſubſtances in this claſs of affinities, ſhews that there are bodies which, when in an aggregate maſs, are abſolutely inſoluble in ſuch or ſuch an acid, but which become perfectly ſoluble when greatly divided. This diviſion is very effectually produced by diſſolving them beforehand in that acid or menſtruum which agrees beſt with them. From hence it follows, that if, by any mechanical means, bodies are ſufficiently divided, an union may be effected between thoſe that appear to have the leaſt diſpoſition towards combination; and this is what I have, in fact, obtained in many operations which we ſhall have occaſion to mention.

ON THE

ELEMENTS

OR

PRIMITIVE PRINCIPLES OF BODIES.

THE greater part of Philoſophers have admitted *primitive principles*; that is to ſay, bodies of great ſimplicity, which ſerve for the formation of all the bodies in nature, but, as we ſhall preſently mention, in a progreſſive order. To theſe principles they have given different appellations, as *elements*, *atoms*, *monades*, *proper matter*, &c; and they have ſometimes attributed to them properties which were purely relative only to what they propoſed to explain.

However

However this be, and under what denomination ſoever the primitive principles of bodies be conſidered, we ought to conceive of them as eſſentially of the greateſt ſimplicity, without conſtituent parts, and on account of the tenuity and ſubtility of their particles, not perceivable or cognizable by any of our ſenſes.

Stahl has reaſoned a good deal upon theſe ſimple principles, and has employed them advantageouſly in elucidating the theory of Becher and eſtabliſhing his own. But whilſt he explains himſelf clearly concerning the ſimple and homogeneous nature of theſe principles, he does not with the ſame preciſion determine whether we ought to admit ſeveral ſpecies of them, which are heterogeneous with reſpect to each other, and poſſeſs different properties. In fact, it is impoſſible for us to acquire the knowledge of this ſubject.

He ſhews only that this was his opinion; and, in reality, it appears difficult to conceive how a ſingle ſimple and homogeneous principle can form all the different bodies exiſting in nature.

The *moleculæ* of this ſingle principle by uniting ſhould only form aggregations, which would always be of the ſame ſpecies, and not compounds. It appears reaſonable, therefore, to admit ſeveral kinds of principles equally ſimple, but differing from each other in properties. We imagine it to be difficult to determine their number; and the reaſons of this will be better perceived when we ſhall examine the properties of the true principles of bodies, or at leaſt of thoſe which we ought to regard as ſuch.

What Becher and Stahl term *ſecondary principles*, *principled principles*, or *mixts*, are the bodies which are formed directly by the combination of the different ſimple principles which we have juſt mentioned. Theſe compounds of the firſt order form, according to Becher and Stahl, FIRE, AIR, WATER, and EARTH. They partake conſiderably of the properties of the ſubſtances whence they are formed; that is, they have ſtill ſuch a degree of ſimplicity as to be indeſtructible and unalterable by all our chemical analyſes. In a word, all the efforts made to the preſent time to decompoſe them, have

have been totally inſufficient.* For this reaſon, we ſhall name them *elements* or *primitive principles* of bodies. The union of theſe principles, their different proportions and methods of arranging themſelves, produce all the variety of bodies which exiſt in nature. We ſhall demonſtrate theſe truths in a large detail, by giving the analyſis of the bodies of the different kingdoms.

Becher and Stahl, purſuing further and further the combinations of the primitive principles, and of thoſe which they term ſecondary, eſtabliſh different orders of compound bodies, to which they give improper denominations. The ſignification of many of theſe terms is even contrary to the ideas uſually affixed to them, and is liable to occaſion obſcurity.

The bodies which they name *compounds* are thoſe formed by the union of their ſecondary principles; thoſe which they term *decompounds* are ſuch as are formed by the union of compounds;

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* Common or atmoſpherical air muſt be excepted, as will be preſently ſhewn. J. A.

pounds; and they call *ſuper-decompounds* thoſe which reſult from the union of decompounds. This, in a few words, is the whole theory which Becher and Stahl have laid down with regard to ſimple principles, and the combination of theſe principles to form more compound bodies, and thus in an indefinite progreſſion.

It appears to us much more convenient to adopt the denominations given by M. Macquer to theſe different orders of compounds. He terms them *compounds of the firſt order*, *of the ſecond order*, &c. which leaves no room for any kind of obſcurity.

Chemiſts have not always agreed among themſelves concerning either the number, or the nature of the principles of bodies. Paracelſus admitted as principles the products which animals and vegetables furniſhed during their analyſis. Of theſe he eſtabliſhes two ſpecies, the *active* and the *paſſive*. His active principles are three in number, SPIRIT, OIL, and SALT; his paſſive, two, WATER and EARTH.

By *ſpirit*, or *mercury*, he underſtands ſalt diſſolved in water; by *oil*, or *ſulphur*, all

all oily liquors; by *ſalt*, all ſaline matters; by *water*, which he alſo termed *phlegm*, all watery liquors; and by *earth*, all fixed matters.

This doctrine, eſtabliſhed by Paracelſus, was adopted by the chemiſts of his time, and has been followed by ſeveral of the more modern. But Paracelſus and thoſe of his ſect have conſidered as principles, ſubſtances which are not ſo. They have not, by any means, the ſimplicity of real principles; on the contrary, they are, as we ſhall find, maſſes of compounded ſubſtances, very different among themſelves, and which may be reduced into others much more ſimple.

Becher, perceiving the obſcurity of this theory, attempted to rectify it. He eſtabliſhed only two principles or elements of bodies, *water* and *earth*; but that he might be able to account for the properties of all compound bodies, he admitted three kinds of ſimple and elementary earths. The firſt of theſe he termed *vitrifiable earth*, the ſecond, *imflammable earth*, and the third, *mercurial earth*.

Vitri-

Vitrifiable earth, according to him, is the principle of fixity and hardneſs in bodies, and of vitrification.

By inflammable earth he underſtands that which contains the principle of inflammability.

And by mercurial earth he means the principle of metalliſation; that is to ſay, that which combined with the other two, is proper for the formation of metals.

Stahl, in rectifying, in his turn, the theory of Becher, has proved after a ſatisfactory manner the exiſtence of the two firſt earths; but he calls into queſtion the exiſtence of the third, as not appearing to him ſufficiently demonſtrated.

In agreement with the beſt chemiſts and natural philoſophers, we ought to regard WATER, FIRE, and EARTH, as the elements or true primitive principles of bodies. To theſe three, may be added AIR: the experiments of Boyle, and particularly thoſe related by Hales in his *Vegetable Statics*, ſhew, at leaſt, that this element

ment makes a part of many compound bodies, and that it is one of the conſtituent principles of organiſed bodies.

Nature preſents to us theſe four elements or primitive principles under two different ſtates; 1ſt. detached, not making part of any compound body, and in a ſtate of purity ſufficient for being recognized: 2dly. combined with each other in an infinite variety of ways, and in all kinds of proportions, forming all the compound bodies with which we are acquainted.

We ſhall examine the properties of theſe elements in both theſe ſtates; and firſt thoſe which they poſſeſs when not conſtituting a part of any body. When we come to treat of the analyſes of bodies, we ſhall inveſtigate their properties in thoſe compounds of which they make a part.

ON FIRE.

FIRE is a matter eſſentially fluid, the principle of fluidity in other bodies, and always in motion. It is the principal agent and cauſe of almoſt all the compoſitions and decompoſitions which take place in nature.

Fire, with reſpect to us, is a ſimple element, appearing to have no conſtituent parts; however, as the light which proceeds from the ſun may be decompoſed into ſeven different colours by means of the priſm, and as theſe differently coloured rays have, moreover, each their proper refrangibility, we may ſuſpect that fire is compoſed of parts, very ſimple indeed, but heterogeneous with regard to each other.* This reflexion adds probability to the opinion of thoſe philoſophers who think that the bodies which, on account of their ſimplicity, we are obliged to regard as elements, are themſelves compounded of ſtill more ſimple ſubſtances. However this be, we ſhall conſider elementary fire as not having con-

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* Mr. Beaumé ſeems to regard light and fire as the ſame bodies. The different effects which in ſimilar circumſtances are produced by them; the appearance of light in ſeveral caſes without heat, and *vice verſa*, of heat without light, afford ſufficient reaſons for doubting any theory which is founded on their identity, or, on the ſuppoſition that in all caſes they act as one and the ſame element. M.

ſtituent parts, till the ſphere of our knowledge is more enlarged in this reſpect.

The particles of which fire is compoſed have ſcarcely any mutual coheſion. They are of an inconceivable ſmallneſs, ſurpaſſing that of other bodies. We ſhall conſider fire under two different ſtates.

When it is pure, detached, and not a part of any compound, it has an action upon all bodies, and even becomes an inſtrument proper for analyſes and recompoſitions.

When it is combined with other ſubſtances, and makes one of the conſtituent principles of compound bodies, it is inactive, and in perfect repoſe, and cannot put itſelf in motion but when it is excited.

The ſigns by which the preſence of fire is diſcovered are the effects which it produces; *viz.* 1. heat, 2. light, 3. colour, 4. the dilatation or rarefaction both of fluids and ſolids, 5. combuſtion, fuſion, &c.

Some philoſophers think that light is a certain ſign of the preſence of fire; but this may be be queſtioned, ſince heat and light may exiſt without each other. A very hot iron gives no light in a dark place, and yet is in a ſtate capable of inflaming combuſtible bodies: the focus of a concave mirror is not luminous, although it is of ſuch exceſſive heat as to be capable of inſtantly fuſing and vitrifying the hardeſt bodies.*

It is the ſame with reſpect to light: it may exiſt without heat. The rays of the moon, collected by means of a concave mirror, or a large lens, form a very luminous point,† which, received upon the ball of a thermometer, indicates not the leaſt heat.

An unequivocal proof of the preſence of fire, is the dilatation which it occaſions in all

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* Perhaps the heat which fire manifeſts wherever it is preſent, is only occaſioned by the action which it exerts on the bodies it touches. It is difficult, and perhaps impoſſible, to ſupport this opinion by experiments; I offer it, therefore, only as a conjecture founded on ſome probabilities.

† Surely the point formed by the collected lunar rays is not more luminous than that of the ſolar rays. When the focus falls in the air it is not viſible in either caſe; but received upon any body capable of reflecting the rays, thoſe of the ſun are ſtrongly luminous, as well as thoſe of the moon. J. A.

bodies. It penetrates all with extreme facility, diſtributing itſelf uniformly through all parts of their maſſes. None is capable of reſiſting its action. When it has introduced itſelf into bodies, it dilates them, warms them, and cauſes them to occupy a greater bulk than before, without augmenting their weight:* it, however, dilates liquids and bodies of rare texture more readily than thoſe which are ſolid and very denſe.

Cold, which is only the abſence of part of this fire, produces a contrary effect; that is, the leſs bodies are penetrated by fire, the more they loſe of their bulk, without loſing any of their weight. They conſequently increaſe in ſpecific gravity and hardneſs, becauſe their particles become more cloſely joined to each other.

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* The addition of heat to a body on the ſuppoſition of its corporeal nature inſtead of increaſing ought to diminiſh the weight of that body. On the ſame principles that air added to a body would diminiſh its weight in water. So ſhould heat added to a body diminiſh its weight in air. From ſeveral experiments made on large maſſes of red hot iron, by Mr. Whitehurſt, we have every reaſon to believe that this is actually the caſe. M.

This property of fire eaſily to penetrate and dilate bodies, has been advantageouſly applied in the conſtruction of thermometers. Theſe inſtruments, perfected by the illuſtrious Reaumur, are of great ſervice in meaſuring degrees of heat and cold which could not be eſtimated by any other means.*

There is no body which is not continually penetrated by a greater or leſs quantity of this pure fire, always in proportion to the quantity contained in the ambient air. This fire perpetually flies off and re-enters, as by a kind of circulation, according to circumſtances; becauſe it is not combined with, but only interpoſed between, the particles of the ſubſtance. Thoſe bodies which excite in us ſenſations of cold, are ſtill penetrated by a large quantity of fire. One may, indeed, deprive them of part of this fire: for example, one may cauſe ice to undergo an artificial cold greater than that of its proper temperature; but hitherto it has proved impoſſible, by the greateſt degree of cold we can excite,

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* Thoſe only who are ſtrangers to Mr. de Luc's excellent Treatiſe on the Atmoſphere, will agree in this opinion of the perfection of Mr. Reaumur's Thermometer. M.

artificially to deprive bodies of all the fire they contain. The abſolute cold, or total abſence of fire, which ſome philoſophers have conceived, is as chimerical as abſolute heat: we cannot have clear ideas of theſe two extremes, ſtill leſs can we produce them.

The dilatation which fire occaſions in bodies is a beginning diſunion of their parts, and a proof of the property which fire poſſeſſes of decompoſing ſubſtances, and ſeparating their conſtituent parts. But, as there is a difference between bodies, fire will not decompoſe all with equal facility. The celebrated Boerhaave ſays, on this head, that there is in bodies a matter which is not fire, and which reſiſts the ſeparation of their principles; but we imagine this effect can only be attributed to the more or leſs intimate combination of the conſtituent parts of bodies, and their greater or leſs adheſion to each other.

The more bodies are heated, the more they dilate; but this dilatation ceaſes in bodies ſuſceptible of fuſion as ſoon as they are melted, becauſe they can then no longer retain the fire, but ſuffer it to diſſipate as faſt as they receive it.

It

It is the ſame with liquids. We may conſider them as perpetually in fuſion, ſince they are brought to a ſtate of ſolidity by cooling them ſufficiently. Ebullition is the higheſt degree of heat they can receive,* and thoſe which are with the greateſt difficulty made to boil, acquire the greateſt heat. It is from this cauſe that oil, for example, though lighter than water, admits of more heat. But mercury, although fifteen times heavier than oil, does not take a greater degree of heat when boiling, becauſe it is of a volatile nature. Thus the greateſt degree of heat that liquids can receive, is not in proportion to their ſpecific gravity, but their fixity only.

Fire has ſome adheſion to the bodies which it heats; but it is not combined with them, ſince it diſſipates as they cool; and there remains at laſt only a quantity equal to that in the ſurrounding air.†

Bodies

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* Mr. Beaumé ſhould have qualified this expreſſion, by ſaying, that the heat of ebullition is the higheſt which fluids can receive under the common preſſure of the atmoſphere. For when confined in a Papin's digeſter, even water may be heated ſo intenſely as to fuſe metallic bodies. M.

† In ſeveral caſes, there is a loſs of heat, which can be accounted for only on the ſuppoſition that it has become a conſtituent part of the body which received it e. g. An equal

weight

Bodies of the greateſt ſpecific gravity retain pure fire the longeſt.* It diſſipates quickly during the firſt moments; but when the ſubſtances are cooled to a degree approaching the temperature of the ambient air, the remains of fire which they contain are much longer in ſeparating.

It is not certain whether or no fire is weighty. There are experiments on both ſides the queſtion. Boerhaave relates that he cauſed a bar of iron which he had before weighed, to be made red hot, and that he marked no augmentation of its weight. In another part of his excellent *Treatiſe on Fire*, he obſerves that metals calcined by a burning glaſs increaſe in weight conſiderably, ſome a ſixteenth, others a tenth. But it

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weight of water at 33°. mixed with water at 212°. will aſſume the temperature of 100°; whereas a ſimilar mixture of ſnow at 32°. and water at 212°. will ſink the thermometer to 58°. In this fact the difference in the temperature of the ingredients before mixture is trifling, but after mixture it is very great; and the loſs in the laſt mixture is to be ſought for only in that abſorption of heat which was neceſſary to convert water from a ſolid to a fluid ſtate. M.

* Metallic ſubſtances muſt be excepted, which receive and part with heat quicker than other bodies.

ſeems,

ſeems, as this author remarks, that all the neceſſary precautions for aſcertaining the cauſe of this augmentation have not been taken. He ſuppoſes that it proceeds from the veſſels being deſtroyed and mingled with the calcined matter. He even aſſerts that metallic ſubſtances calcined in glaſs veſſels receive ſcarcely any addition of weight. I have repeated this experiment with care, and have obſerved that lead calcined in glaſs veſſels, under the muffle of a cupelling furnace, is augmented in weight a tenth; and I imagine this augmentation can only be attributed to the combination of the fire with the calx of lead*, eſpecially as the capſule of glaſs ſuffers no diminution in this experiment.

After having mentioned the principal properties exerted by fire on bodies, we ſhall next examine the cauſes which excite it, the means employed to collect it, and the manner in which its action is determined.

The firſt of theſe cauſes is the Sun. This luminary, though remote from us, appears to

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* By the experiments of Dr. Prieſtley and Mr. Lavoiſier it is ſatisfactorily proved that the augmentation of weight acquired in calcining metals is owing to *fixed air* imbibed from the atmoſphere. J. A.

be the common reſervoir of fire. It comes to us from the ſun in a right line, by parallel rays; and perhaps, as ſome philoſophers have conceived, but without any thing like a demonſtration, the fire detached from bodies returns thither by a kind of circulation.

The ſun's heat is mild, moderate, incapable of producing in bodies changes which might occaſion too great an alteration. It is only ſufficient to promote the generation, unfolding, and growth of all the beings which live, vegetate, or combine, on the ſurface, or within the bowels of the earth.

Natural philoſophers have diſcovered the method of uniting, and cauſing to converge to a ſingle point, a certain number of ſolar rays, by means of lenſes and concave mirrors; and thereby of producing a focus of exceſſive heat, much ſuperior to every other with which we are acquainted, and capable of inſtantly melting and vitrifying the hardeſt bodies; which we cannot effect in our hotteſt furnaces.

Another means of exciting fire, and which produces effects equally violent with thoſe we have juſt mentioned, is the ſhock of hard bodies. The colliſion of a flint and ſteel produces in an inſtant a fire as violent as that in the focus of a good concave mirror. The ſparks ſtruck from the ſteel, when collected and examined by the microſcope, appear to be particles of iron which have been melted and vitrified. The exceſſive violence of the heat neceſſary for the production of ſuch an effect in ſo ſhort a ſpace of time, may eaſily be conceived.

A third means by which fire may be excited, is the combuſtion of bodies, in the compoſition of which elementary fire has entered as a conſtituent principle, and which contain it in large quantity.

All the bodies in nature contain a portion of this fire, ſome more, others leſs. Thoſe which poſſeſs a large ſhare, as vegetable and animal ſubſtances, are called *combuſtible bodies*, or aliment of fire, becauſe they ſerve to ſuſtain it. All really terreſtrial and metallic ſubſtances do not contain enough to ſerve as aliment to fire; they can only be ignited by the aſſiſtance of the bodies which we have termed combuſtible.

The aliment of fire is that inflammable matter which detaches itſelf from bodies while burning, and which emits flame and light. This fire, brought into action, produces the ſame effects on the ſubſtances it touches, with the concentred rays of the ſun, or ſtrong friction of hard bodies; it warms, burns, and decompoſes them, and ſeparates their conſtituent parts.

During the combuſtion of bodies, the combined fire is reduced to elementary fire, and diſſipated as faſt as this takes place. The celebrated Boerhaave, however, is not of this opinion; objecting, that if this happened, the quantity of elementary fire would go on increaſing to infinity. This is not obſerved to be the caſe; on the contrary, the moſt exact obſervations ſhew that there is always the ſame proportion of elementary fire, although a great quantity of combuſtible matters are every day burned. It is eaſy, however, to reply to this objection, by ſaying, as may juſtly be preſumed, that the elementary fire detached from bodies unites in the ſame proportion with other ſubſtances, and loſes all its properties of free fire, in becoming a conſtituent principle of thoſe bodies into the compoſition of which it enters. This is Stahl's opinion;

opinion; but there are yet many *deſiderata* in our knowledge of this ſubject, and perhaps we may never be able to acquire clear ideas concerning it. In fact, it appears very difficult to determine how fire unites with and fixes itſelf in bodies; and how, in becoming one of their principles, it loſes all the properties which we had recognized in it, ſo far as not to be able to manifeſt itſelf without the contact of an actually ignited body.

Boerhaave figured to himſelf all theſe difficulties; he examined the different ſubſtances procured by the analyſes of animal and vegetable combuſtible matters, and obſerved that it was only the oily part which, in whatever ſtate it was, could be deemed the real aliment of fire. The others, as the water, earth, and ſalt, not being combuſtible, are, he alledges, more fit for the extinction than the ſuſtenance of fire. Experience is conformable to his opinion. Boerhaave further remarks, that theſe ſubſtances, though incombuſtible, ſerve nevertheleſs to augment the activity of inflammable bodies, when preſent in ſuitable proportions. He gives the name of *alcohol* to this inflammable principle when in its greateſt degree of purity; that is, when

when it will burn without emitting either ſmoke or ſoot: he alſo aſcertains the identity of this principle in all vegetable and animal ſubſtances. The principle here underſtood is the ſame that Stahl has named *phlogiſton*.

The following experiment was made by Boerhaave on this head. He received in a bell what was diſſipated by the burning of ſpirit of wine, and perceived neither ſoot nor ſmoke. The condenſed vapours were water; the inflammable matter was deſtroyed and diſſipated, and he was unable to obtain it ſeparate. He obſerves that other bodies are inflammable only by means of a ſimilar principle which they contain, and that after this is ſeparated by combuſtion, what remains of the body is not inflammable. He propoſes a queſtion to himſelf, whether, in caſe this matter were ſeparated from every foreign ſubſtance, it would burn quietly and in ſucceſſion, as happens when it is mixed with water in ſpirit of wine, or would be conſumed, like lightning, inſtantaneouſly. Without deciding the queſtion, he concludes that this matter, from whatever ſubſtance procured, would be extremely pure, ſimple, perfectly combuſtible, and would alſo yield a very pure flame, without ſoot or ſmoke. Hence he conjectures, that *this principle is a compound of fire, and a very ſubtile matter which is intimately united with it*; and that nothing in Phyſics, perhaps, is ſo difficult to come to the knowledge of, as this purely inflammable part of combuſtible bodies, which ſerves as aliment to fire; the more ſo, as when this matter burns, it is deſtroyed, and becomes ſo extremely ſubtile as not to be cognizable by our ſenſes. He adds, that to the preſent time, nothing ſatisfactory has been taught concerning the changes which this matter undergoes during its combuſtion.

I quote here the opinion of Boerhaave, in order to juſtify this eminent philoſopher from the accuſations of ignorance in this matter, which ſome chemiſts have brought againſt him, for want of having collected under one point of view the different paſſages in his *Treatiſe on Fire* which relate to this ſubject, and which unfold all his theory concerning this intereſting object. I do this the more willingly, as the reader will thereby be enabled to judge of the reſemblances and differences between the ideas of two celebrated authors, who were employed at the ſame time

time on the ſame ſubject, though in different views.

Boerhaave conſidered fire and its properties in the manner of a great natural philoſopher, and Stahl in that of a great chemiſt; and, indeed, on a more general plan than Boerhaave. They both agree, however, concerning the general and fundamental properties of the principle which Boerhaave terms alcohol, and Stahl, phlogiſton. Stahl diſcovered the exiſtence of this principle in metallic ſubſtances; whereas, Boerhaave, having had other objects in view in his examination of this principle, entirely neglected to aſcertain its exiſtence in mineral and metallic bodies.

ON THE PHLOGISTON.

From the ideas of Stahl and Boerhaave concerning the phlogiſton it follows, that we are to conſider it as a compound ſubſtance, formed from the direct union of elementary fire with a very ſimple matter, as yet unknown to us. There is reaſon to preſume that it is a very ſubtile earth which thus fixes elementary fire. It is is probably in this ſtate of combination that fire enters as a principle into the compoſition of bodies.

Fire, certainly, can only be in two ſtates, pure or combined. If it be pure, it is elementary fire, and then it acts upon all the bodies it touches, as was ſaid in my definition of fire. In this ſtate it is not phlogiſton.

Phlogiſton, on the contrary, is this ſame elementary fire combined with the leaſt poſſible ſubſtance, which cauſes it to loſe all its properties of pure fire. It is in this ſtate of combination that fire acts ſo great a part in chemiſtry, and preſents a great number of phenomena, without having the property of inflaming or heating bodies, in whatever quantity it is accumulated, unleſs inflammation be excited, either by means of the application of fire actually in action, or ſome violent fermentation produced in the mixture which contains it.

The phlogiſton ought to be regarded as a true ſecondary principle, formed by the direct union of elementary fire and ſome other ſubſtance,

ſtance, ſince it may be decompoſed, and the elementary fire ſeparated from it.*

We have already remarked the ineffectual attempts that have been made in order to obtain the phlogiſtic principle in a detached ſtate. Since the time of Boerhaave and Stahl chemiſtry is not at all advanced in this reſpect. We are ſtill only able to examine its properties. Theſe are too general to be deſcribed here: we ſhall content ourſelves at preſent with making mention of thoſe which it is neceſſary to know in order to underſtand what has juſt been ſaid; intending to ſpeak of the reſt as occaſion offers.

1. Phlogiſton is the principle of odour and colour.

2. This principle is identical, that is, of the ſame nature, from whatever ſubſtance it is drawn.

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* Since this work was written, various attempts have been made by eminent chemiſts and philoſophers to inveſtigate the nature and exiſtence of this principle; but the ſubject is, notwithſtanding, yet involved in all the darkneſs and uncertainty of ſpeculation and conjecture. M.

3. The pureſt ſtate in which we can retain it in inaction, is when it is combined with only a very ſmall number of other ſubſtances; as in charcoal, in metals, and in thoſe inflammable matters which burn without ſoot or ſmoke, ſuch as ſpirit of wine and ſulphur.

When it is in the igneous motion, it is decompoſed and diſſipated. It then, according to circumſtances, produces mortal effects. Let us examine theſe different circumſtances.

When charcoal is burned in a cloſe chamber, the organ of ſmelling is very ſenſibly affected; but this inviſible vapour affects the brain ſtill more ſtrongly, and deſtroys entirely or in part the ſpring of the air. Death preſently follows, if the perſon does not withdraw as ſoon as he begins to perceive theſe effects. But the like does not happen when ſpirit of wine is burned in the ſame manner; nor even when charcoal is burned in a chimney or a ſtove in which the external air can circulate freely.*

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* The fatal effects of burning charcoal in a cloſe room are moſt evidently produced by the depoſition of a certain quantity of fixed air, which is ſeparated from the atmoſphere by the combuſtion of the coal. If a pan of boiling water be placed

The effects which take place in the firſt caſe proceed from the vapours of the charcoal which circulate in the air of the chamber, and which are nothing elſe than a portion of the phlogiſton raiſed by the act of combuſtion, and which has not had time to burn and be reduced to elementary fire. Its effects on thoſe who are expoſed to it probably ariſe from the great diſpoſition which the phlogiſton, reduced to this ſtate, has to combine with all the bodies it meets.

It will perhaps be aſked why the vapours of burning ſpirit of wine do not produce the ſame effect. I anſwer, that there enters into the compoſition of this liquor a great quantity of air and water, which detach themſelves during its combuſtion, and ſuffice to replace theſe ſubſtances in the air as faſt as the phlogiſton of the ſpirit of wine abſorbs them while it burns.

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in the room, the ſteam will abſorb the mephitic principle as ſoon as it is formed, and will entirely prevent the inconveniences which might otherwiſe be felt.

The diſagreeable ſenſations which we experience when confined near a large ſurface of new paint, are leſſened, if not entirely removed by a ſimilar proceſs: and for the ſame reaſon the watery vapour which eſcapes during the combuſtion of ſpirits of wine will produce the effect deſcribed by this author. M.

This appears to me the more probable, as oily matters, which contain leſs water than ſpirit of wine does, produce ſimilar effects with charcoal when burned in a cloſe place, though in a leſs degree, becauſe they always contain a certain quantity of air and water, of which charcoal is entirely deprived. Theſe pernicious effects do not take place when the charcoal is burned in a chimney or ſtove where there is a free circulation of air, becauſe the phlogiſtic vapours are continually carried off by the current of air. Beſides, it is only the pure and elementary fire which filters through the pipes of the ſtove; the phlogiſtic vapour cannot do ſo.

The other properties of phlogiſton are too many to be enumerated here.

ON AIR.

AIR is an inviſible, colourleſs, inſipid, inodorous, weighty, elaſtic fluid, ſuſceptible of rarefaction and condenſation, and affecting none of our ſenſes, unleſs it be that of the touch.

This fluid environs the terreſtrial globe, and ſerves to ſuſtain the life of the animals which exiſt on its ſurface. The experiments with the air-pump have ſhewn that thoſe animals which ceaſe to breathe air immediately periſh.

Air as well as fire, is under two different ſtates.

1. Pure, detached, and not making a part of any compound body: 2. combined with other ſubſtances, and ſerving as a principle or conſtituent part of many compound bodies, particularly of the vegetable and animal kingdoms.

We ſhall firſt enumerate the moſt general properties of air in a pure and detached ſtate.

Air is always fluid, like fire; at leaſt to the preſent time, philoſophers have not been able to render it ſolid, even by the aid of the higheſt degrees of artificial cold.

The fluidity of air is abſolutely neceſſary for the ſupport of animal and vegetable life. It would be extremely melancholy if this element, like

like water, were capable of being rendered ſolid by moderate cold. Boerhaave conjectures that the fluidity of air may proceed from the particles of fire which are always mixed with it, and which are abſolutely inſeparable from it. The difficulty of producing a ſufficient degree of cold is perhaps the only cauſe why air has never been met with ſolid: it is a body which requires a very moderate degree of heat to keep it in the ſtate of fluidity in which we are accuſtomed to find it.

Air, as we have already ſaid, cannot be perceived by the organ of ſight: it is abſolutely inviſible, becauſe colourleſs. It is likewiſe abſolutely inſipid and inodorous when perfectly pure; but it very readily becomes charged both with good and bad ſcents. When it is in agitation, it carries to conſiderable diſtances the odours with which it is impregnated; it ſeems even to be the reſervoir of bodies which are in a ſtate of extreme diviſion, and reduced to particles of as great tenuity as itſelf: for this reaſon it is difficult to find air perfectly free from foreign matters. It is always loaded with moiſture, which appears even to be eſſential to its uſe in reſpiration.

Next to fire, air is the lighteſt matter with which we are acquainted. This is the cauſe of its always being on the ſurface of thoſe bodies with which it is not combined. In general, it penetrates only into thoſe places where it finds no ſubſtance heavier than itſelf. It is on this property of air that all the mechaniſm of furnaces of which we are ſoon to ſpeak is founded.

We might here enumerate a great number of experiments which prove not only the weight of the air, but its relation to the greateſt part of known bodies; but for theſe things, which appear uſeleſs in chemiſtry, we refer to the books of Natural Philoſophy.

Air is elaſtic; that is to ſay, it yields to compreſſion, and returns to its former ſtate as ſoon as the compreſſing power is removed. It loſes nothing of its elaſticity, as other ſpringy bodies do, either by being too much compreſſed, or kept too long in a ſtate of compreſſion. Air has been kept a prodigiouſly compreſſed ſtate during fifteen or twenty years, without the leaſt perceptible diminution of its elaſticity.

The effects of fire on air are to dilate or rarefy it, that is, to make it occupy a greater

ſpace

ſpace than before. The greateſt dilatation it can undergo from the moſt violent fire, is to thirteen or fourteen times its bulk. It can never be ſo far rarefied as to leave a perfect vacuum; a part of the air always remains, even when the containing veſſel is brought to a white heat. We ſhall not relate the experiments proving this point; they may be read at large in the books of Natural Philoſophy. When the air cools again, it is condenſed, that is, its particles approach each other, ſo as to occupy no greater ſpace than before.

Air, as we have ſaid, enters into the combination of many compound bodies, and even becomes one of their conſtituent principles. When thus combined, it loſes all its properties, and becomes what Dr. Hales terms *ſolid air*, that is, air rendered ſolid by aſſimilating with animal and vegetable bodies.*

Perhaps

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* The air which thus becomes a principle of bodies, not only during the time of its combination has different properties from common air, but after its ſeparation appears with different qualities. This kind of air, termed *fixed* or *fixable*, contrary to the atmoſpherical, is deſtructive to light and flame. It eaſily combines with water, and gives it an acid impregnation.

Perhaps air does not enter into the compoſition of bodies till it is united with ſome principle as yet unknown to us. In this caſe it would exiſt there under the form of a ſecondary principle, as fire under that of phlogiſton. However this be, we ought to make a proper diſtinction between this combined air, and that which is interpoſed between the particles of bodies. The latter may be ſeparated by mechanical means; whereas the former can only be expelled from bodies by decompoſing them.

Boerhaave on this ſubject ſays, that an inſulated particle of air is not elaſtic, and that it acquires this property only when it is united with others; which takes place by the union of thoſe particles of air which are detached from bodies ſubmitted to a chemical analyſis.

We ſhall not undertake at preſent to demonſtrate the exiſtence of air as performing the function of a principle in vegetable and animal bodies.

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tion. It is ſeparated from bodies in all fermentative and effervefcent proceſſes, and in ſome caſes by calcination. It ſeems not yet clearly determined whether this is a different ſpecies of air from the atmoſpherical, or only a part of it; though the latter opinion appears moſt probable, J. A.

This would engage us in details which would ſuppoſe the knowledge of a great number of things that muſt be firſt treated of. We have juſt conſidered the effects of fire upon air; let us now examine thoſe of air upon fire.

Air is the vehicle of combuſtion. Without it no combuſtible bodies can be burned: they are even extinguiſhed though well kindled when all communication with the external air is cut off. Many able philoſophers imagine that the weight and elaſticity of air are the only cauſes which render it proper for keeping up combuſtion. By means of theſe properties, it unites and aſſembles the active fire, and applies it immediately to the combuſtible matters which remain to be burned.

This theory appears inſufficient for the explanation of the following phenomenon. Black charcoal is put into a box of iron or earth exactly cloſed; this is placed in a furnace and heated to a white heat. How violent and how long continued ſoever the heat is, it is found, after the box is cooled, that the charcoal has loſt nothing of its weight, and that it has undergone no combuſtion. It is, however, certain, that the matter of fire, in its igneous motion, has continually been very intimately applied to it, and that the inflammable matter of the charcoal itſelf has been in a kindled ſtate.

It may be conjectured with a good deal of probability, that the charcoal in this experiment does not burn, becauſe it is deprived of air, and of all thoſe matters which perform the office of air in becoming conſiderably rarefied on numerous occaſions, but which cannot be volatiliſed in cloſe veſſels. The inflammable matter in charcoal is not ſuſceptible of any dilatation; it is even, as we have remarked, more fit to abſorb air during its combuſtion, than to furniſh it. The charcoal in this proceſs is penetrated with fire, but a fire foreign to it. Its own inflammable matter does not conſume, becauſe it is incapable of dilatation.

It will be urged, that neither do vegetable or animal bodies, though containing much air, with oily and aqueous matters, &c. burn during their analyſis; but this is owing to the fire being raiſed by degrees, in order to detach theſe ſubſtances in ſucceſſion. Experience has ſhewn, that when the fire is puſhed haſtily, exploſions are occaſioned, which may ariſe as well from the inflammation, as the dilatation, of theſe volatile parts.

From what has been ſaid, it evidently follows, that the concourſe of the air is abſolutely neceſſary for the combuſtion of bodies. It is upon this property that all the mechaniſm and conſtruction of furnaces is founded.

ON FURNACES.

A furnace is a machine formed ſo as to admit a current of air, and to contain, retain, and apply the fire to the veſſel in which is placed the ſubject to be operated on.

The furnace deſigned for producing the greateſt degree of heat ought to have a large aſh-hole, by which the air may enter freely; its upper part, or chimney, ought alſo to be very wide. There ſhould be no other opening; at leaſt, if it be neceſſary to make one for convenience, it ſhould be capable of being cloſely ſhut, that the current of air may not enter at many places at once.

The flame arriving at the upper part of the furnace, rarefies the air prodigiouſly, and makes a more or leſs perfect vacuum. The air, entering through the aſh-hole, paſſes acroſs the fuel with a rapidity proportioned to the completeneſs of the vacuum, which thus produces the effect of a pair of bellows.

The air cannot enter by the chimney or upper part of the furnace becauſe the flame continually expels it, and alſo becauſe that part is filled with a matter which continually tends to fly off, and oppoſes the introduction of the air. It is conſequently obliged to enter at the lower part of the furnace, where the flame does not go out.*

ON WATER.

WATER is a liquid, tranſparent, colourleſs, inodorous, inſipid ſubſtance. By a mode-

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* This fact is better explained by ſaying that the column of air which preſſes at the bottom of the furnace is heavier than that which preſſes on the top in proportion to the perfection of the vacuum in the furnace, therefore the air cannot ruſh down through the chimney, unleſs the violence of ſome deſcending wind ſhould be ſufficiently powerful to counteract the effects of gravity. M.

rate degree of cold it is converted into a ſolid tranſparent body, called *Ice*.

Water becomes rarefied by heat, is augmented in bulk, and quietly diſperſes in vapour when the degree of heat is incapable of bringing it to a ſtate of ebullition.

Water which boils with great bubbles in the open air has received the greateſt degree of heat that it can ſuſtain in open veſſels. This is demonſtrated by the thermometer, which immerſed into water in this ſtate, ſtands at from 80 to 84 degrees according to Mr. Reaumur's ſcale.* But when it is confined, and not ſuffered to evaporate, as in Papin's digeſter, it acquires heat enough to melt a piece of lead or tin ſuſpended in its centre, and to decompoſe vegetable and animal ſubſtances, nearly in the ſame manner as when they are analyſed in a retort.

When water is made ſuddenly to undergo a white heat, it is diſſipated with ſuch rapidity as to make a terrible noiſe and exploſion. It

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* The boiling point of water according to Fahrenheit's ſcale is 212. J. A.

acts like a ſpring let go, which overthrows every thing in its way.

Water, in the maſs, is neither elaſtic nor compreſſible like air. The experiment of the Florentine Academy proves that it will paſs through the pores of a metal vaſe in which it is encloſed, rather than ſuffer itſelf to be compreſſed. *

This element, in all chemical experiments, undergoes no decompoſition or alteration. At every diſtillation, indeed, a ſmall quantity of earth is ſeparated from it; but this, by every experiment appears to be a foreign matter.†

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* The Florentine experiment is by no means a proof of the abſolute incompreſſibility of water; for though the change of a ſpherical veſſel filled with water into an oblate form forced out ſome water at the ſides, yet it does not hence appear that the quantity of water forced out is adequate to the change of figure. Mr. Canton has treated this ſubject in the Philoſophical Tranſactions with his uſual clearneſs and ingenuity. M.

† The change of water into earth has been believed and maintained by many of the moſt eminent amongſt chemical philoſophers. But it is evident from the experiments of Lavoiſier, and particularly of Fontana, that by long ebullition the ſides of a glaſs veſſel are corroded by the water, and that ſiliceous particles are by this means ſuſpended in the fluid, and therefore ſeparated in the form of a fine powder, when the water is evaporated. M.

Water enters as a conſtituent principle into the compoſition of animal and vegetable bodies. It ſerves to the formation of minerals; but all enquiries that have been made to the preſent time, prove that it does not enter into their compoſition.

All the water with which we are furniſhed by nature conſtantly contains a quantity, greater or leſs, of ſaline and earthy matter. Diſtillation has the property of ſeparating theſe foreign ſubſtances.

DISTILLATION OF WATER.

River water is put in a glaſs alembic, and about two thirds of the quantity is drawn off by a moderate heat. The remainder is thrown away as uſeleſs. It is loaded with the foreign fixed matters which the water held in ſolution.

ON EARTH.

ELEMENTARY earth is not ſo eaſy to be recognized as the other elements, the principal properties of which we have aſcertained. This difficulty ariſes from the prodigious variety of ſtones and earths which nature offers us.

Many able chemiſts have made incredible efforts to inveſtigate it, but without ſucceſs. However we may regard as elementary earth that which is the pureſt, and which poſſeſſes the greateſt number of the properties of the earthy principle.

All theſe conditions are united in pure diamond, or very clean and tranſparent rock cryſtal.* If theſe ſubſtances are not elementary earth, they afford at leaſt the pureſt earthy ſubſtance with which we are acquainted.

The Chemiſts, in examining a great number of ſtones and earths, remarked that there were

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* Mr. Beaumé has very unfortunately fixed upon the diamond as a ſpecimen of the pureſt earth; for by the admirable analyſis of Bergman, it appears to conſiſt chiefly, if not wholly, of an inflammable ſubſtance, which volatilizes on expoſure to the heat of melted ſilver. See his Treatiſe on Gems, vol. II. *Opuſcul.*

The rock cryſtal likewiſe is far from any approaches to our ideas of an element; for one hundred parts of it contain ſix of argillaceous earth and one of calcareous. See *Bergman*, vol. II, p. 112, or Mr. *Kirwan's Mineral*, p. 104. M.

many which had ſimilar properties, and others which differed eſſentially among themſelves. This led them to eſtabliſh ſeveral ſpecies of ſtones and earths. The Naturaliſts, too, have given their diviſions; but as theſe do not always agree with chemical experiments, we ſhall not particularize them.

Becher, as we have ſaid above, admits three kinds of earths, viz. a vitrifiable, inflammable, and mercurial earth.

Stahl, in his amendment of Becher's ſyſtem, admits only two kinds, the vitrifiable and calcareous. He ſuppoſes that all the others are only different modifications of earth. He abſolutely rejects the mercurial earth of Becher, which, in fact, is far from being demonſtrated.

Mr. Pott receives four ſpecies of earth; the alkaline or calcareous, the gypſeous, the argillaceous, and the vitrifiable. He rejects the diviſion of Stahl, becauſe it appears to him too general; but we ſhall find, in examining the properties of Mr. Pott's four earths, that they are reduced to two. Thus we adhere to Stahl's opinion, and only acknowledge two ſpecies of earths, the vitrifiable and calcareous. The properties of theſe we ſhall now conſider, reſerving for another occaſion what we have to ſay on gypſeous and argillaceous earths.

ON VITRIFIABLE EARTHS.

Vitrifiable earths are under two different forms; in maſſes, and in duſt of greater or leſs fineneſs.

Among vitrifiable ſtones in the maſs, ſome are cryſtaliſed, tranſparent and colourleſs, as diamond and rock cryſtal, which are the pureſt of all; others are entirely or in part opake; ſome are coloured by phlogiſtic or metallic matters, as emeralds, hyacinths, rubies, garnets, &c. There are other vitrifiable ſtones which are not cryſtaliſed, but are found in irregular maſſes; as flints, quartz, grit-ſtone, &c.

The vitrifiable earths in duſt are ſands, which vary infinitely, as well in fineneſs as in colour.*

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* Pure vitrifiable earth can be gained by no other means than that of decompoſing the *liquor ſilicum* by the aid of an acid. M.

Pure vitrifiable earths have neither ſmell nor taſte ; they are not acted upon either by air, water, or earth. They are all heavier than liquids. Vitrifiable ſtones are diſtinguiſhed by being ſufficiently hard to ſtrike fire with ſteel.

Sands are as hard as vitrifiable ſtones in the maſs. They are capable of ſcratching metallic ſubſtances, and are ſucceſsfully uſed to poliſh hard bodies.

Pure vitrifiable earths and ſtones, expoſed to the violence of fire, ſuffer no alteration nor diminution of weight ; they conglutinate a little, but without entering into fuſion. It is neceſſary to add to them ſome alkaline ſalt in order to convert them into glaſs, but a leſs quantity of ſalt ſuffices than for the vitrification of calcareous earths.

We ſhall examine the other properties of vitrifiable earths as occaſion offers.

ON CALCAREOUS EARTHS.

Calcareous, *alkaline*, or *abſorbent* earths are the denominations by which thoſe we are going

going to examine are diſtinguiſhed. All calcareous ſtones and earths are tender, and eaſily receive an impreſſion from the point of a knife. The greater part imbibe water when plunged into it.

Calcareous, as well as vitrifiable ſtones, are found under different forms. Some are in irregular maſſes, compoſed of ſmall particles glued to each other, either by a kind of *gluten* unknown to us, or perhaps by the coheſion of aggregation alone. The broken ſurface of theſe ſtones is granulated, and more or leſs porous like ſugar. All the calcareous ſtones of this ſpecies imbibe water with greater or leſs facility, and retain it ſtrongly; ſuch are lime-ſtone, white and coloured marbles, chalks, &c. The more porous ſtones of this claſs ſerve for the filtration of water.

There are other calcareous ſtones which have been cryſtaliſed by water, and have all the appearance of vitrifiable ſtones. Theſe, in general, are of much greater ſpecific gravity than the preceding. They have brilliant *facets* like cryſtaliſed vitrifiable ſtones, and are almoſt as heavy. They differ from the former only in the arrangement of their parts, having, in other reſpects, all the properties mentioned in our definition. They are very compact and denſe, ſemitranſparent, and do not imbibe water. *Spars* are of this claſs.

There are other calcareous ſtones called *ſtalactites*. Theſe are formed in dripping caverns by means of the water which drains through the earth. This water contains a good deal of earth in ſolution; and as ſoon as it comes to the cavern, it evaporates, and leaves its earth attached to the roof, which generally takes a ſymmetrical arrangement.

A great quantity of calcareous earth is alſo met with in the form of finer or coarſer duſt, which has, in other reſpects, preciſely the ſame properties with thoſe kinds we have mentioned.

The ſhells of fiſh, all ſea ſhells, and thoſe of the eggs of birds, are alſo calcareous earths. They all afford the ſame phenomena in chemical operations.

Many able chemiſts have alſo ranged among calcareous earths, thoſe which are procured from vegetables

vegetables and from bones by combuſtion. But they differ from them in ſeveral eſſential properties, and more reſemble vitrifiable earths. They hold in ſome meaſure a middle nature between vitrifiable and calcareous earths. We ſhall have occaſion to ſpeak of them under the head of vegetable and animal earths.*

QUICK-LIME.

All calcareous earths and ſtones, expoſed to the violence of fire, undergo a loſs of ſubſtance generally equal to half their weight. This loſs only proceeds from the evaporation of the water interpoſed between their particles, which adheres ſo ſtrongly, as to make it neceſſary to keep them a long time in a white heat in order entirely to free them from it. By this operation, calcareous earths and ſtones are converted into quick-lime.†

LIME

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* It is now, I believe, generally admitted that bones are a compound of calcareous earth and the phoſphoric acid. M.

† By the experiments of Dr. Black, ſince repeated and confirmed by other chemiſts, it is ſufficiently proved, that beſides the *water* expelled from calcareous earths during calcination, a quantity of *fixed air*, which entered into its compoſition, and

which

LIME SLAKED IN THE AIR.

This lime, expoſed to the air, attracts the moiſture from it very ſtrongly, and is reduced to a fine powder, as light as meal. This is what is called lime ſlaked in the air.*

PASTE OF LIME.

When a certain quantity of water is poured upon quick-lime, it penetrates it, and excites a conſiderable heat, cauſed by the friction of the particles of the water againſt thoſe of the earth. The lime, during its extinction in the water, is divided into very fine particles. It retains a great quantity of water, and forms a paſte, called *paſte of lime.*

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which according to Mr. Lavoiſier's experiments amounted to near double the weight of the water, is alſo expelled. It is likewiſe demonſtrated, that from the ſeparation of this fixed air, almoſt all the properties in which quick-lime differs from native calcareous earth, proceed. J. A.

* Lime by this means recovers its water, but not its fixed air. Whence it ſtill continues (for ſome time at leaſt) in a cauſtic ſtate, and will not effervesce with acids. J. A.

MILK OF LIME.

When this paſte is mixed with a good quantity of water, it is diluted, and forms a white cloudy liquor, reſembling milk, whence it has been named *milk of lime.*

LIME-WATER.

This milk clears by being left at reſt, and the earth precipitates. If the liquor be then filtered, the product is called *lime-water.*

Lime-water has a bitter, acrid, ſaline taſte. This property depends upon a certain quantity of fixed alkali which it holds in ſolution, and which is formed during the calcination of the lime-ſtone, by the intimate combination of the phlogiſton contained in the ſtone with the calcareous earth. Lime-water has not ſo cauſtic or ſaline a taſte as a common alkaline lye, becauſe lime-ſtones do not contain phlogiſton enough to convert the whole quantity of calcareous earth into alkali, and becauſe the portion of ſalt which is produced is mixed and combined with a great quantity of earth, the ſolution of which in water is is promoted by the alkali. Thus there reſults a ſaline liquor extremely loaded with earth, which takes off conſiderably from its ſaline properties.

It follows from this theory, that the whole of a given quantity of calcareous earth ought to be converted into fixed alkali by the addition of a ſufficient quantity of phlogiſton; and this, in effect, I have been able to perform.

This reſolves one of the ſix problems which I propoſed * in the following terms; *To make fixed alkali with materials which contain nothing ſaline.*

PELLICLES OR CREAM OF LIME.

In proportion as the lime-water evaporates, † a ſalino-terreous pellicle appears on its ſurface, which is called *pellicles or cream of lime.*

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* In the *Journal de Medecine* for *October*, 1762, p. 365.

† Theſe pellicles form faſter than evaporation can be ſuppoſed to take place, and therefore are more probably, according to Dr. Black's theory, formed by the diſſolved particles of the lime near the ſurface recovering their fixed air from the atmoſphere, whereby they are rendered inſoluble in water, and thus appear in their original form of calcareous earth. It is found by experiment that ſtreams of fixed air introduced into lime-water precipitate all its diſſolved earth in the ſtate of a mild calcareous earth. J. A.

MORTAR OF LIME AND SAND.

Paſte of lime, mixed with about an equal quantity of ſand, forms the *mortar* uſed in building. This mixture dries in the air, and acquires a great ſolidity. This effect proceeds from the ſalino-terreous matter which the paſte of lime contains, and which, applying itſelf over all the ſurfaces of the grains of ſand, adheres ſtrongly to them, and binds them together. The adheſion of this matter to poliſhed bodies is ſo ſtrong, that when lime-water is ſuffered to remain for ſome time in glaſſes, the matter depoſited by it cannot poſſibly be got off, either by annealing them with ſand, or applying acids to them; becauſe it has penetrated into the very ſubſtance of the glaſs.

ON

SALINE SUBSTANCES.

SALINE ſubſtances appear to be formed directly by the intimate combination of three principles, viz. water, earth, and the inflammable principle or phlogiſton; whence reſults a compound which is ſapid and has middle properties between the three.

The antient chemiſts thought that ſalts were formed of water and earth; but they admitted a third principle, which they named *univerſal ſpirit*. They thought that different proportions of this third principle formed an acid or an alkaline ſalt.

Thoſe

Thoſe chemiſts who have made the moſt uſe of this principle in accounting for the formation of ſalts, have given us no clear ideas of its nature. But, as I have juſt ſaid, there enters alſo into the compoſition of ſalts a certain quantity of phlogiſton; and this is perhaps the principle which they have denominated univerſal ſpirit. What we have obſerved concerning the formation of the ſalino-terreous matter of lime, and its little taſte, countenances a preſumption that the different proportions of the three principles which compoſe ſalts, and their mode of arrangement, form either alkalies or acids.

The definition of ſalts in general will then be, bodies compoſed of earth, water and phlogiſton, which are ſapid, and have a diſpoſition to unite with water, earth, and inflammable matters.

The ſaline ſubſtance which we ſhall firſt examine, is the *vitriolic acid*, or as it has been called the *univerſal acid*, from its being the moſt abundantly and univerſally diſperſed through nature. This acid is never found in a native ſtate pure, on account of the great diſpoſition it has to unite and combine with all the bodies it meets. It can only, therefore, be obtained pure by decompoſing thoſe bodies with which it is combined. We ſhall, however, conſider it now in its greateſt degree of purity; reſerving to ſome other occaſion the examination of thoſe bodies which contain it, as well as thoſe whence it is extracted in great quantity.

ON THE VITRIOLIC ACID.

1. The vitriolic acid is a ſaline ſubſtance, almoſt always in a liquid ſtate; as it is extremely difficult to procure it under a concrete form. When it is pure and well concentrated, it bears the name of *concentrated* or *rectified vitriolic acid*, and improperly that of *oil of vitriol.* This laſt appellation has been given it on account of its conſiſtence, which nearly reſembles that of fluid oil olive.

2. When perfectly pure it is void of colour and ſmell.

3. It has a violently ſharp ſour taſte, ſetting the teeth on edge.

4. Its

4. Its weight is a medium between that of water and earth. A phial containing eight drams of water will contain ſixteen of this acid.

5. Expoſed to the air it ſtrongly attracts moiſture from it, and inſtead of evaporating like water, loads itſelf with humidity equal to half as much again as its own weight; thus it gains in abſolute weight while it loſes in ſpecific gravity.

SPIRIT OF VITRIOL.

6. The vitriolic acid unites with water with impetuoſity. When a mixture is made with four ounces of each of theſe liquids, a noiſe is immediately produced, accompanied with a bubbling, which cauſes vapours to riſe. The heat which this mixture acquires is equal to that of boiling water. It proceeds from the mutual friction of the particles of the two liquids as they penetrate each other. The vitriolic acid thus let down with water is called *ſpirit of vitriol.*

7. This acid readily changes into red the blue colours of ſyrup of violets, tincture of turnſole, &c.

8. It has a much greater fixity than water, that is to ſay, it ſuſtains a conſiderable degree of heat before it is diſſipated in vapours. In cloſe veſſels this degree ariſes almoſt to a white heat.

RECTIFIED OR CONCENTRATED VITRIOLIC ACID.

9. When this acid has been mixed with water, it may be ſeparated from it by diſtillation. The water being lighter and more volatile riſes firſt, and the more fixed acid remains at the bottom of the veſſel, and cannot be raiſed but by a much greater heat. This operation is called *rectification* or *concentration* of the vitriolic acid, and what remains in the retort has the name of *rectified* or *concentrated vitriolic acid.*

VITRIOLIC ACID COLOURED BY OILY MATTERS.

10. The pureſt and whiteſt vitriolic acid inſtantly receives a brown hue by the addition of oily matters. In order to produce this effect, a few ſtraws are put to ſome pure vitriolic acid in a glaſs.

VITRIOLIC ACID RENDERED SULPHUREOUS BY MEANS OF PHLOGISTON ACTUALLY KINDLED.

11. If pure vitriolic acid be put in a glaſs, and a live coal plunged in it, there immediately riſes a great quantity of white, thick vapours, which are the ſulphureous acid, and have the ſmell of burning ſulphur.

CALCAREOUS SELENITES.

12. The vitriolic acid unites with all calcareous earths and ſtones with heat and efferveſcence; but it does not ſaturate itſelf with theſe earths unleſs much weakened by water. It forms with them one kind of ſalt, which is always the ſame, whatever was the ſpecies of earth employed. This has the name of *ſelenites*. I add the term *calcareous*, in order to diſtinguiſh it from the ſelenites which has a vitrifiable earth for its baſis, the properties of which are different.

By this combination the vitriolic acid loſes the greateſt part of its ſaline properties, and communicates them to the calcareous earth; and in in return, the earth communicates part of its properties to the acid. The neutral ſalt reſulting from the mixture participates of the nature of both. It has ſcarcely more taſte than calcareous earth: it diſſolves eaſily, but in very ſmall quantity, in water; and boiling water does not diſſolve more than cold.

GYPSUM, OR PLASTER STONE.

The ſubſtances which bear this name are very abundant in nature. Thoſe called *gypſa*, *alabaſter*, and *plaſter ſtones*, are calcareous ſelenites formed by nature.

Theſe ſubſtances differ from the artificial ſelenites in being met with in very large maſſes, whereas the latter are always figured in very ſmall cryſtals. When the maſſes are irregular, they are called *alabaſter* and *plaſter ſtone*. When they are regularly cryſtaliſed and diſpoſed in flakes lying one above another, they are called *gypſum*.

The natural and artificial ſelenites are entirely of the ſame nature, and poſſeſs the ſame properties.

PREPARED GYPSUM, OR PLASTER.

When theſe ſaline ſubſtances are expoſed to the fire, they loſe their water of cryſtalization with a ſmall noiſe or crackling called *decrepitation*, and become very friable, and of a very fine opake white. Gypſum during this operation is divided into extremely ſmall plates or leaves; and when ſufficiently calcined, is called *prepared gypſum* or *plaſter*.

EFFECTS OF THE VITRIOLIC ACID UPON VITRIFIABLE EARTHS.

The vitriolic acid has no diſpoſition to unite with vitrifiable earths when in an aggregate maſs, nor even when they are divided by mechanical means. It is neceſſary to bring them into a ſtate of more minute diviſion than can be done by mechanical means in order to procure their combination with this acid. This effect is eaſily produced by the chemical operations of which we are preſently to ſpeak.

ALUM.

Nature offers us a great quantity of vitrifiable earth in a ſtate of conſiderable diviſion, and already

already combined with a certain proportion of the vitriolic acid. It is in clays that this natural combination is to be found. Clays, on account of the extreme diviſion of their particles, and the union they have already contracted with the vitriolic acid, diſſolve in great part in this acid. This ſolution not ſaturated, ſet to evaporate, forms a ſalt which cryſtaliſes, and into the compoſition of which there enters a ſuper-abundance of acid. This ſalt is perfectly ſimilar to that known under the name of *alum*. Its cryſtals are flattened triangles, the three angles of which are truncated.

Thus alum is a ſelenites the baſis of which is a vitrifiable earth, and which differs from calcareous ſelenites, 1. in its baſis being a different earth; 2. in its having a greater quantity of water in the compoſition of its cryſtals; 3. in its taſte, which is acid and very aſtringent; 4. in its being more ſoluble in water, diſſolving in much greater quantity in boiling than cold water.

ALUM SATURATED WITH EARTH.

Alum further differs from calcareous ſelenites in a very ſingular property. If earth of alum be mixed with a ſolution of alum, and the mixture warmed, a great quantity of this additional earth is diſſolved, the ſolution becomes entirely ſaturated, and the new ſalt which reſults is in very ſmall white cryſtals, flat, talky, and very ſoft to the touch. This ſalt is ſcarcely at all ſoluble in water, is inſipid, and much reſembles calcareous ſelenites. All pure vitrifiable earths and ſtones diſſolved in the vitriolic acid form an alum which has all the properties of a natural alum,* and eſpecially that ſingular one of forming a ſalt which cryſtaliſes either with a ſuperabundance of acid, or in a ſtate of perfect neutraliſation; a property which calcareous ſelenites do not poſſeſs.

ALUM DECOMPOSED BY CALCAREOUS EARTHS.

Calcareous earths have more affinity with the vitriolic acid than vitrifiable earths. If to a ſolution of alum a calcareous earth of any kind be added,

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* If Mr. Beaumé have in any inſtance procured an alum from the union of vitriolic acid with a vitrifiable earth, the production muſt have been cauſed ſolely by his uſing ſome ſpecimen of vitrifiable earth from which he had not taken proper care to remove all argillaceous particles. In experiments of this kind no earth ſhould be uſed but what is ſeparated from the *liquor ſilicum*. M.

added, it diſſolves, and precipitates the earth of alum.

Lime water and hard well waters, that is, thoſe which are loaded with calcareous ſelenites, effect the ſame decompoſition.

CALCINED ALUM.

Alum expoſed to a moderate heat liquefies and ſwells conſiderably. In this proceſs it only loſes its water of cryſtalization, of which half its weight conſiſts. There remains after the operation, a very white, light and ſpongy ſubſtance, called *calcined alum.*

PHLEGM OF ALUM.

If this operation be performed in a cloſe diſtilling veſſel, there comes over an inſipid liquor, which becomes very ſlightly acid towards the end. This is the *phlegm of alum.*

CRYSTALIZATION OF ALUM.

The alum, in all theſe operations, has not been decompoſed; it has only loſt its water of cryſtalization.

cryſtalization. If it be diſſolved in water and cryſtaliſed, it is recovered in the ſame ſtate as at firſt. There ſeparates, however, at each ſolution, a certain quantity of earth.

VITRIOLIC ACID EXTRACTED FROM ALUM.

For extracting the vitriolic acid from alum, a fire of the utmoſt violence, continued during a day and night, is neceſſary: and even then but a ſmall quantity is generally procured.

The alum met with in commerce is not prepared by the method above deſcribed. It is got in the neighbourhood of Rome after the calcination of a white argillaceous ſtone, of which we ſhall ſpeak hereafter. In this country (France) it is extracted from different, and ſometimes very compound minerals.*

ON THE CRYSTALIZATION OF SALTS.

The cryſtalization of ſalts is an operation by means of which the union of ſaline particles diſ-

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* The Yorkſhire alum ore is a bituminous ſlate of the pit-coal kind. See *Neumann's Chemiſtry*. J. A.

ſolved in water is facilitated. This union forms ſymmetrical and regular maſſes, termed *cryſtals.*

The cryſtalization of ſalts may be effected in two ways which are relative to the nature of the ſalts; viz. by the cooling, and by the evaporation of part of the liquor.

The ſalts which cryſtaliſe by cooling are thoſe which diſſolve in much greater quantity in boiling water than in cold; as, for example, alum. It is ſufficient to ſet the liquor to cool, when all the exceſs of quantity beyond what cold water can hold in ſolution cryſtaliſes in proportion as the liquor cools; and the cryſtals are much more regular when the liquor has cooled very gradually, becauſe the ſaline particles have had time better to arrange themſelves with reſpect to each other.

The ſalts which cryſtaliſe rather by evaporation than by cooling, are thoſe which diſſolve in equal quantity in boiling and cold water, as calcareous ſelenites, or gypſa, and perfectly ſaturated ſelenites with a vitrifiable baſe. It is eaſily perceived that no cryſtals will form in theſe on cooling the liquor, becauſe it contains no more than cold water can hold in ſolution.

The ſaline particles in forming cryſtals attract each other according to their ſurfaces, and according to the particular nature of theſe particles. There is reaſon to preſume that this is the mode of procedure, becauſe, if ſeveral ſalts are diſſolved in the ſame water, they are confounded and intimately blended together; but, on cryſtaliſing them, the particles of the ſame kind aſſemble, and the cryſtals of the different ſalts ſeparate and are not confounded. In the cryſtals of ſalts there enters a certain quantity of water, which is to be conſidered, relatively to the nature of the ſalts and to the cryſtals, under three different ſtates.

1. *The water which is a principle of the ſalt,* without which the ſalt would not be ſalt, and which cannot be ſeparated from it without deſtroying its nature, and decompoſing it.

2. *The water of cryſtalization.* This does not conſtitute a part of the ſalt; it only ſerves to the configuration of the cryſtals, and may be taken away without deſtroying the nature of the ſalt,

ſalt, as we have remarked in the calcination of alum. The water of cryſtalization in ſalts is abſolutely pure, becauſe ſalts in forming, do not admit any foreign matter into the compoſition of their cryſtals.

3. *The water of ſolution*, or that which holds the ſalts diſſolved. This may hold in ſolution ſaline matters foreign to the nature of the ſalt to be cryſtaliſed; but the proceſs of cryſtalization is ſuch, as not to permit theſe foreign matters to be confounded with the cryſtaliſing ſalt; and, as we have juſt obſerved, the cryſtals in forming admit only a perfectly pure water.

The cryſtals of theſe ſalts contain, it is true, a little of the ſaline matter which the water held in ſolution; but this is only through favour of the *water of ſolution*, which is ſtill interpoſed between the lamina or ſlakes of the cryſtals. Theſe foreign matters may be drawn off without diſarranging the figure, or leſſening the bulk of the cryſtals, becauſe they are not at all combined with them. It is ſufficient to put the cryſtals on blotting paper to drain, whereby the water of ſolution is pumped out from between the interſtices of the cryſtals, and abſorbed. I might here relate a great number of obſervations on the cryſtalization of ſalts; but they do not properly belong to a work of this kind.

ON THE FIXED ALKALI.

The fixed alkali is a ſaline ſubſtance extracted from the aſhes of vegetables. We ſhall here ſuppoſe it purified, and as if it were a natural product; the manner of obtaining it will be mentioned under the vegetable kingdom.

The fixed alkali is under a dry form, which ſhews that it has more earth in its compoſition than the vitriolic acid. It is colourleſs and inodorous. When deprived of all humidity it is white and affects no particular figure.

It has a ſharp, cauſtic and burning taſte, and leaves in the mouth a ſlight flavour of rotten eggs.

It turns the blue colours of vegetables green.

OIL OF TARTAR.

When the fixed alkali is very dry it unites with water with confiderable heat; it ſtrongly attracts moiſture from the air, and is thereby reſolved into a liquor. In this ſtate it is commonly called *oil of tartar per deliquium*. The name of oil is improper, as the fixed alkali has nothing of an oily nature. It has been given only on account of the conſiſtence of this liquor, which ſomewhat reſembles that of fluid oil.

Fixed alkali has a good deal more fixity than the vitriolic acid. It is capable of ſupporting the moſt violent heat in cloſe veſſels without riſing; but when it has a free communication with the air, it is entirely diſſipated by the force of fire in white, very thick vapours; and it flies off ſtill more readily when at the ſame time it has immediate contact with kindled phlogiſton.

FIXED ALKALI RENDERED MORE CAUSTIC BY QUICKLIME.

Fixed alkali is unable to contract any union with calcareous and vitrifiable earths by the moiſt way;

way; but the ſalino-terreous part of lime combines with it this way, and conſiderably augments its cauſticity.*

GLASS, OR CRYSTAL.

Fixed alkali, combining by fuſion with calcareous and vitrifiable earths, forms with them vitreous or vitriform ſubſtances, according to the proportions made uſe of.

When ſix, ſeven, or even more parts of ſand are uſed to one of alkali, the mixture, urged a long time by the utmoſt violence of fire, enters into fuſion; the alkaline ſalt facilitates the fuſion of the vitrifiable matter, combines with it, and communicates to it a part of its properties. The product reſulting is called *glaſs*, and when pure and perfect, *cryſtal*.

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* According to Dr. Black's theory, this increaſed cauſticity ariſes from the loſs of the fixed air which rendered the alkali mild, and which is taken from it by the lime, which has a greater affinity with that ſubſtance than itſelf. Alkali thus rendered cauſtic does not effervеſce with acids, becauſe it is deprived of that air the ſeparation of which cauſes the phenomena of effervеſcence. J. A.

LIQUOR OF FLINTS.

When two or three parts of alkaline ſalt are added to one of vitrifiable earth, and the degree of heat is carried no further than to melt the mixture, without giving time for the alkali to evaporate, the product obtained is a vitriform maſs, in which the earth is held in ſolution. But, as the mixture contains a great ſuper-abundance of alkali, it preſerves almoſt all the properties of alkaline ſalt: it powerfully attracts moiſture from the air, and deliqueſces. In this ſtate it is called *liquor ſilicum*, or *liquor of flints.*

EARTH SEPARATED FROM THE LIQUOR OF FLINTS.

The vitrifiable earth in this proceſs becomes ſoluble in water through the medium of the fixed alkali. If to this liquor a little vitriolic, or any other kind of acid, be added, it ſeizes the fixed alkali, and precipitates the earth.

ARTIFICIAL ALUM.

This earth, thus ſeparated from the liquor of flints, is capable, on account of its extreme diviſion,

diviſion, of being diſſolved in the vitriolic acid; and the ſolution evaporated yields cryſtals of true alum.* This proves the identity of vitrifiable earth, argillaceous earth, and the earthy baſis of common alum.

VITRIOLATED TARTAR.

Fixed alkali combines with the vitriolic acid to the point of ſaturation. This combination takes place with conſiderable heat, and, when the liquors are ſufficiently concentrated, a violent effervefcence accompanies it. In combining, each of theſe ſaline ſubſtances loſes its peculiar properties. By evaporating the liquor till a ſlight pellicle appears on the ſurface, a ſalt is obtained which forms ſmall cryſtals cut in a diamond point. This is named *vitriolated tartar*, *arcanum duplicatum*, or *ſal de duobus*.

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* If Mr. Beaumé made his *liquor ſilicum* in a common crucible, the production of alum is eaſily accounted for, becauſe the alkali abſorbs part of the argillaceous matter of which the veſſel is made. If in the experiment ſuch ſilex were uſed as may be procured from the *liquor ſilicum* made in an iron veſſel, the reſult will be very different. See *Bergman*, vol. II. Diſſ. 13. § III. M.

We may remark that neither the acid nor the alkali can cryſtaliſe by themſelves; that the taſte of each of theſe ſubſtances is very ſtrong and diſtinguiſhable, whereas the ſalt reſulting from their combination has very little taſte: it is perfectly neutral; does not alter the blue colours of vegetables; has leſs affinity with water than the two ſaline ſubſtances compoſing it; diſſolves in it in ſmall quantity, and does not attract moiſture from the air.

DECOMPOSITION OF VITRIOLIC SALTS WITH AN EARTHY BASIS, BY MEANS OF FIXED ALKALI.

Fixed alkali decompoſes all the vitriolic ſalts with an earthy baſis; ſeizing the vitriolic acid by virtue of its greater affinity with it than that of calcareous and vitrifiable earths, and precipitating the earths. Theſe earths, being waſhed in a ſufficient quantity of water, and then examined, are found in no reſpect changed as to their nature, but only more divided.

The liquors remaining after theſe decompoſitions, when ſet to evaporate, furniſh a vitriolated tartar exactly ſimilar to that formed by the direct

direct combination of fixed alkali with vitriolic acid.

ON SULPHUR.

Sulphur is a compound of vitriolic acid and phlogiſton. When pure it is of a lemon colour; it has an odour peculiar to itſelf; is ſomewhat tranſparent, dry, compact, and brittle. When caſt in cylindrical molds it is called *roll brimſtone.*

When a piece of ſulphur is held cloſe in the hand, the heat which penetrates it occaſions a dilatation within it, which cauſes a ſlight crackling, as if it were breaking in ſeveral pieces; and in fact it generally does break. This proceeds from its very electric nature.*

Air and water have no action upon ſulphur. It melts with a moderate degree of heat, ſomewhat exceeding that of boiling water. It fixes on cooling, and forms a vaſt number of points like needles. Sulphur is extremely inflammable.

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* The mere dilatation of ſo brittle a body will account for this effect without having recourſe to electricity, not one of whoſe known phenomena can be applied with the leaſt ſucceſs to our author's hypotheſis. M.

SOFT SULPHUR.

If ſulphur be melted in a crucible and poured into a baſon of water, it is found to have acquired a red colour, and a ſoft conſiſtence like that of wax; being eaſily molded between the fingers, inſtead of being dry and brittle as at firſt. This effect proceeds from the water having diſſolved a certain portion of acid during the proceſs, ſo that the remaining ſulphur contains a ſuper-abundant quantity of phlogiſton. Sulphur during the firſt moments of its fuſion runs thin; but it thickens conſiderably in an inſtant, in which ſtate it muſt be poured into water to have it ſoft. If it were poured before this thickening took place, it would be dry and brittle as at firſt.

FLOWERS OF SULPHUR.

Sulphur expoſed to the fire in cloſe veſſels undergoes no kind of decompoſition. It ſublimes entire into the upper part of the veſſel, in a kind of powder, called *flowers of ſulphur.*

SPIRIT OF SULPHUR.

If a kindled body be applied to ſulphur in the open air, it takes fire and emits an active, penetrating,

trating, ſuffocating vapour. It decompoſes during this combuſtion; the phlogiſton is diſſipated, and the acid remains detached. If the vapours are collected by proper veſſels, and their condenſation facilitated by water reduced to ſteam, the product is the *volatile ſpirit of ſulphur*, or *volatile ſulphureous vitriolic acid.*

CONCENTRATED VITRIOLIC ACID, EXTRACTED FROM SULPHUR.

This acid is watery, on account of the watery vapours employed to facilitate its condenſation; but by diſtillation the ſuper-abundant water is ſeparated, and what remains in the retort is *concentrated vitriolic acid.* It has nothing of the ſmell of the volatile ſulphureous acid.

STAHL'S SULPHUREOUS SALT.

If, by means of a proper apparatus, a linen cloth ſoaked in fixed alkali be expoſed to the vapour of burning ſulphur, the volatile ſpirit of the ſulphur combines with the alkali, and forms a peculiar ſalt, which cryſtaliſes in needles. The ſalt is ſeparated from the cloth by lotion and cryſtalization, and is the *ſulphureous ſalt of Stahl.*

DECOMPOSITION OF THE SULPHUREOUS SALT BY THE VITRIOLIC ACID.

The ſalt above-mentioned is a kind of vitriolated tartar, differing from the common only in having a greater quantity of phlogiſton in its compoſition, which renders the vitriolic acid leſs adherent to the alkali than when pure.

When pure vitriolic acid is poured upon this ſalt, it immediately raiſes penetrating vapours, which are thoſe of the ſulphureous acid, and taking the place of this acid, forms a true vitriolated tartar.

SULPHUR DISSOLVED IN THE VITRIOLIC ACID.

The vitriolic acid has a degree of action upon ſulphur, and diſſolves a ſmall quantity of it. If the acid employed on this occaſion is colourleſs, it acquires a ſlight olive tinge. This forms the ſolution of one of the ſix problems I propoſed in the *Gazette de Medicine.*

LIVER OF SULPHUR.

Sulphur unites with the fixed alkali both by the dry and the moiſt way, without ſuffering any decompoſition. This compound has the name of *liver of ſulphur*.

The proportions of this mixture when made by fuſion are equal parts of each. In the moiſt way two or three parts of alkali to one of ſulphur are employed.

MAGISTERY OF SULPHUR.

If, to liver of ſulphur diffuſed in water, the vitriolic or any other acid be added, an efferveſcence is produced, an odour of rotten eggs ariſes, and a white precipitate is thrown down. This precipitate, waſhed and dried, is called *magiſtery of ſulphur*. It is entirely the ſame with the ſulphur before mixture, which proves that it underwent no decompoſition by uniting with the alkali.

In ſpeaking of ſulphur, we obſerved that it is compoſed of the vitriolic acid and phlogiſton. Hence it ſhould follow, that by combining this acid

acid with the phlogiſton ſulphur will be formed artificially. And this really happens.

ARTIFICIAL LIVER OF SULPHUR.

Vitriolated tartar is mixed with powdered charcoal and fixed alkali. The mixture is melted, and a ſaline reddiſh-brown maſs is obtained, which is a true artificial liver of ſulphur.

During this operation, the vitriolic acid quits its alkaline baſis to unite with the phlogiſton of the charcoal. The alkaline ſalt is added to prevent the ſulphur from burning as faſt as it forms. It holds the ſulphur in ſolution, and forms an *artificial liver of ſulphur*.

ARTIFICIAL SULPHUR.

This artificial liver of ſulphur is diſſolved in water, and the liquor filtered, which is then of a greeniſh hue, owing to a part of the charcoal uſed in the preceding operation being diſſolved by the liver of ſulphur. On pouring vitriolic acid into this filtered liquor, all the phenomena mentioned under the article of magiſtery of ſulphur are obſerved. The precipitate reſulting is a true ſulphur, differing in nothing from the common, except in being leſs white, becauſe it is blackened by a little charcoal which falls down along with it.

VITRIOLATED TARTAR MADE WITH LIVER OF SULPHUR.

On expoſing liver of ſulphur to a gentle heat, the phlogiſton diſſipates in vapours without combuſtion, the vitriolic acid remains united with the alkali, and they form together a true *vitriolated tartar*.

Stahl made this experiment in order to determine the reſpective proportions of vitriolic acid and phlogiſton which enter into the compoſition of ſulphur; and he found that there were ſeven parts of acid to one of phlogiſton.

PYROPHORUS.

A mixture of ſugar and alum is kept over the fire in an iron pan till it emits no more fumes, and becomes dry enough to powder.

This is put into a matras, and calcined by a ſand bath during half an hour; when it is taken from the fire, and poured quickly into a well-ſtopped phial. A powder is thus produced, which has the property of taking fire when expoſed to the air.

This property ariſes from two cauſes.

1. During the calcination a ſulphur is formed by the combination of the vitriolic acid of the alum with the phlogiſton of the ſugar. Part of this ſulphur burns and is diſſipated during the proceſs, forming a bluiſh flame, which yields the ſmell of burning ſulphur; but a good deal remains in the pyrophorus after it is made.

2. There remains a certain quantity of alum, which does not meet with phlogiſton enough to decompoſe it. The action of the fire calcining it more and more, its earth, from the ſtate of extreme diviſion in which it before was, unites in little maſſes, which the vitriolic acid is no longer capable of diſſolving. The acid of this portion of the alum becomes therefore in ſome meaſure free, having only ſuch a ſlight adheſion to the earth as to prevent its entire ſeparation. It acquires a prodigious degree of concentration; becomes *icy*; and is diſtributed uniformly through

the pyrophorus. On expoſure to the external air, this *icy oil of vitriol* attracts the moiſture of the air, and is heated by it ſufficiently to fire the ſulphur.* The name of icy vitriolic acid is given to that which is concentrated ſo far as to appear under a concrete form, ſomewhat reſembling ice from its ſolidity and tranſparency.

ON THE NITROUS ACID.

The nitrous acid is always in a fluid ſtate; at leaſt we have not hitherto been able to procure it under a concrete form. When concentrated it is of a red-orange colour. It has a ſtrong diſagreeable ſmell, a very ſharp taſte, and continually emits red vapours. Well concentrated nitrous acid is half as heavy again as water. It changes the blue colours of vegetables to red.

When let down with a certain proportion of water it uſually bears the name of *aqua-fortis.*

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* For the full refutation of this theory we need only refer to Mr. Bewley's excellent letter publiſhed in the *Appendix to Dr. Prieſtley's third vol. on Air*, where ſeveral inſtances are produced to ſhew, that pyrophori may be made, into whoſe compoſition not one particle of vitriolic acid is admitted. M.

NITROUS ACID MIXED WITH WATER.

On mixing the ſmoking nitrous acid with water, a conſiderable heat and ebullition ariſes, and a fine green colour, bordering upon blue, is inſtantly produced. This colour proceeds from the phlogiſton with which this acid abounds, and which is ſet at liberty by means of the water, having little or no diſpoſition to unite with it.

NITRE WITH AN EARTHY BASIS.

The nitrous acid diſſolves calcareous earths with efferveſcence and heat. White marble may be taken for an example. If the ſolution is evaporated, it forms, on cooling, a ſaline maſs in which cryſtals are diſtinguiſhable. This is called *nitre with an earthy baſis*. It is a very deliqueſcent ſalt, powerfully attracting moiſture from the air.

DECOMPOSITION OF NITRE WITH AN EARTHY BASIS BY THE VITRIOLIC ACID.

On pouring vitriolic acid into a ſolution of marble in the nitrous acid, a white precipitate is thrown down, which is formed by the union of the vitriolic acid with the earth of the marble. This is a calcareous ſelenites, which appears under the form of a precipitate, becauſe it cannot be held in ſolution by the ſmall quantity of liquid contained in the mixture. This experiment proves that the vitriolic acid has more affinity with calcareous earths, than the nitrous.

NITRE WITH AN EARTHY BASIS DECOMPOSED BY FIXED ALKALI.

If, to a ſolution of white marble in the nitrous acid, fixed alkali be added, the alkali ſeizes on the acid, and throws down the earth. This precipitate, waſhed and dried, is found to be calcareous earth, unchanged in its nature, only reduced to a very fine powder.

NITRE WITH A FIXED ALKALINE BASIS.

The liquor proceeding from this decompoſition, ſet to evaporate, furniſhes needle-ſhaped cryſtals, which are called *nitre with a fixed alkaline baſis*, but more commonly, ſimply *nitre*.

REGENERATED NITRE.

Pure nitrous acid combines with fixed alkali to the point of ſaturation. This combination takes place with heat and efferveſcence. On evaporating the liquor, a true *regenerated nitre* is formed, ſimilar to that in the preceding experiment.

The nitrous acid and the alkali on combining exhauſt their properties reciprocally upon each other. The ſalt reſulting is perfectly neutral, not changing the blue colours of vegetables either to red or green.

MINERAL CRYSTAL.

Nitre expoſed to the fire melts before it becomes red hot. If, in this ſtate, it be poured into a flat veſſel, it fixes, and is then named *mineral cryſtal.*

NITRE ALKALISED WITHOUT ADDITION.

If nitre be kept long in fuſion in a heat ſomewhat ſtronger than that employed in the preceding

ceding operation, a part of its acid evaporates. What remains in the crucible is *nitre alkaliſed without addition*; but the contact of the air is neceſſary for this effect, as it does not take place in cloſe veſſels.

NITRE FIXED BY CHARCOAL.

If, to nitre melted in a crucible, powder of charcoal be added little by little, the phlogiſton of the charcoal combines with the nitrous acid, and produces a ſulphur, which takes fire as ſoon as formed. The matter remaining in the crucible is the fixed alkali which ſerved as a baſis to the nitrous acid: it is called *nitre fixed by charcoal.* It is neceſſary, in order for the inflammation of the nitre to take place, either that it ſhould be red hot, or that the phlogiſtic matter preſented to it ſhould be ignited: without theſe conditions the inflammation will not happen.

CLISSUS OF NITRE.

If this experiment be made in cloſe veſſels, the deflagration takes place as in the preceding operation, and there comes over into the receiver a great quantity of white vapours which are difficultly

ficultly condenſed into a liquor. This liquor, called *cliſſus of nitre*, is pure water; which proves that the nitrous acid during its inflammation was entirely deſtroyed. So far from being acid, the *cliſſus* almoſt always ſhews marks of alkaleſcence; but this is accidental.

The matter remaining in the retort is ſimilar to that remaining in the crucible in the preceding proceſs.

SMOKING SPIRIT OF NITRE AFTER GLAUBER'S METHOD.

To eight ounces of powdered nitre in a retort, half its weight of concentrated vitriolic acid is added, and the mixture is diſtilled. The vitriolic acid diſengages the nitrous acid, and unites with its fixed alkaline baſis. The nitrous acid paſſes over in red vapours, which are condenſed in the receiver in form of a red-orange-coloured liquor, that continually exhales red vapours.

This proceſs requires ſeveral precautions, and is, in general, very difficult to manage.

The matter remaining in the retort after the diſtillation, is a combination of the fixed alkali of the nitre with the vitriolic acid. When diſſolved in water and ſet to cryſtaliſe, it yields a true *vitriolated tartar*.

Towards the cloſe of this cryſtalization, a little *nitre* is procured which has eſcaped the action of the vitriolic acid.

NITRE DECOMPOSED BY CLAYS.

If eight or ten parts of clay be mixed with one of nitre, and the mixture diſtilled, a nitrous acid ſimilar to the preceding is procured, which alſo is ſmoking when ſufficiently *dephlegmated*.

After this proceſs there remains in the retort a vitriolated tartar mixed with clay, and adhering to it with conſiderable force. It may be ſeparated by boiling the maſs in water, and adding a little fixed alkali.

DECOMPOSITION OF VITRIOLATED TARTAR BY PURE NITROUS ACID.

We have ſeen that the vitriolic acid decompoſes nitre, and diſengages its acid; but this is by the dry way. By the moiſt way, the nitrous acid decompoſes vitriolated tartar.

In order to effect this, about equal parts of vitriolated tartar and common nitrous acid are put into a matraſs, and the mixture heated till the ſalt be diſſolved, which is eaſily done. The liquor on cooling furniſhes true cryſtals of nitre; it is therefore certain that in this proceſs the nitrous acid has expelled the vitriolic, and taken poſſeſſion of its alkaline baſis.

The cauſe of this decompoſition is, that there enters into the compoſition of vitriolated tartar a certain quantity of phlogiſton; and as the nitrous acid has more affinity with this principle than the vitriolic, it decompoſes the vitriolated tartar through favour of the phlogiſton.

It is to be remarked, that this decompoſition cannot be effected by the dry way, on account of the volatility of the nitrous acid, which eludes the action of the fire, and is diſſipated in vapours.

CHANGE OF COLOUR OF THE VAPOURS OF NITROUS ACID, BY MEANS OF THE VITRIOLIC ACID.

If ſmoking nitrous acid and vitriolic acid be mixed together, vapours ariſe, which inſtead of being red, like thoſe of pure nitrous acid, are white.

DEPHLOGISTICATION OF VITRIOLIC ACID BY THE NITROUS ACID.

The nitrous acid, mixed in very ſmall quantity with vitriolic acid which has been blackened by oily matters, very ſpeedily whitens it. This effect proves the greater affinity that the nitrous acid has with oily matters and phlogiſton, than the vitriolic.

SAL POLYCHREST OF GLASER.

If nitre and ſulphur in powder are melted together in a crucible, the phlogiſton of the ſulphur attacks the nitrous acid, and produces a very briſk inflammation; and there remains in the crucible a ſaline maſs, compoſed of the vitriolic acid of the ſulphur, and the alkaline baſis of the nitre. This ſalt is ſimilar to vitriolated tartar, although it it bears the name of *Glaſer's Sal Polychreſt.* In this proceſs all the nitrous acid is not deſtroyed, becauſe there is not phlogiſton enough in the ſulphur. If the proceſs be performed in cloſe veſſels, a great part of the nitrous acid is found in the receiver, mixed, however, with the vitriolic acid of the ſulphur.

GUN-POWDER.

An intimate and very exact mixture of ſix ounces of nitre with one of ſulphur and one of charcoal, produces *gun-powder.* The effects of this powder proceed from its ſudden inflammation, and the great quantity of nitrous ſulphur which forms as the powder fires.

DECOMPOSITION OF GUN-POWDER.

If gun-powder be boiled in water, the nitre diſſolves, and one ſometimes meets with thoſe little particles of gravel which too often occaſion the deſtruction of powder-mills. On evaporating the filtered liquor, all the nitre that was in the powder is obtained by cryſtalization.

After the filtration of the water there remains on the filter the ſulphur and the charcoal.

Theſe may be ſeparated, either by ſubliming the ſulphur in cloſe veſſels; or by expoſing the mixt to a degree of fire capable of burning the ſulphur without kindling the charcoal; which is eaſily done under a muffle.

FULMINATING POWDER.

A mixture of three parts of nitre, one of ſulphur, and two of fixed alkali, forms a powder which has the property of detonating in the open air with a conſiderable exploſion, when gently heated ſo as to liquefy it. The loud exploſion of this powder alſo proceeds from the portion of nitrous ſulphur which is formed during the liquefaction of the mixture, and which inflames as ſoon as it has acquired a certain degree of heat. If the heat be too weak, the nitrous ſulphur flies off as faſt as it is formed, and no exploſion is produced.

ON THE MARINE ACID.

The marine acid is always fluid, and cannot be procured under a concrete form. It is obtained by decompoſing ſea-ſalt by means of the vitriolic acid. When well concentrated it is of a lemon colour. It has a very ſharp taſte, and a tolerably agreeable ſmell, approaching to that of ſaffron.

It turns the blue colours of vegetables red.

The moſt concentrated marine acid weighs nine drams and a half in an ounce meaſure of water.

It continually emits white vapours, which are not, however, perceived, except when they are in immediate contact with the air. Theſe vapours occaſion a ſenſe of heat. They are very corroſive.

SEA-SALT WITH AN EARTHY BASIS.

This acid unites with calcareous earths with heat and effervеſcence, and forms with them deliqueſcent neutral ſalts, which cryſtaliſe only by cooling. This combination is called *ſea-ſalt with an earthy baſis.*

FEBRIFUGE SALT OF SILVIUS.

The marine acid unites with fixed alkali to the point of ſaturation, with heat and efferveſcence.

cence. From this combination reſults a neutral cryſtaliſable ſalt, called *regenerated ſea-ſalt*, or *febrifuge ſalt of Silvius*. This ſalt is much leſs agreeable than common ſea-ſalt, from which it differs eſſentially in its baſis; the name of regenerated ſea-ſalt is therefore improper.

ON THE BASIS OF SEA-SALT.

The baſis of ſea-ſalt is a particular alkali, which has the name of *mineral alkali*. A great quantity of it is extracted from the aſhes of marine plants, as varec, ſoda, &c.

CRYSTALS OF SODA.

The mineral alkali differs from the vegetable alkali already examined, in its property of cryſtaliſing like the neutral ſalts, which the other has not. This is owing to the greater quantity of earth which enters into its compoſition.

It differs further from the vegetable alkali in this; that when expoſed to the air, inſtead of attracting moiſture from it, it loſes its water of cryſtalization, and is reduced to very fine white powder.

It is alſo ſomewhat leſs cauſtic than the vegetable alkali.

SOAP LYE.

Five pounds of quick-lime, and fifteen pounds of ſoda in powder are boiled together in a ſufficient quantity of water; the liquor is filtered and evaporated till it is concentrated enough to weigh eleven drams in an ounce meaſure of water. This is the lye of which ſoap is made. The lime augments conſiderably the cauſticity of the marine alkali.*

CAUSTIC STONE.

Soap lye evaporated to dryneſs forms a very deliqueſcent alkaline ſalt, which melts with a moderate heat. It is caſt in ſmall plates, and then makes what is called *cauſtic-ſtone.* This is a very ſtrong cauſtic, uſed in ſurgery.

REGENERATED SEA-SALT.

The marine acid unites with cryſtals of ſoda to the point of ſaturation with heat and efferveſcence.

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* It does this, according to Dr. Black, by robbing it of its fixed air. Soap lye will not efferveſce with acids. J. A.

cence. This compound, filtered and evaporated, yields a neutral ſalt, which ſometimes cryſtaliſes in very regular cubes, and very often in triangular priſms. The cubical cryſtals are formed under the liquor; the priſmatical, at the ſurface, in contact with the air.

This ſalt is abſolutely the ſame with that obtained by the evaporation of ſea water, and is called *regenerated ſea-ſalt*.

DECREPITATED SEA-SALT.

Sea-ſalt expoſed to the fire crackles and decrepitates with violence. This effect proceeds from its water of cryſtalization, which, tending to fly off, burſts the cryſtals of the ſalt. When the crackling is over, it is removed from the fire. All ſalts which have very compact cryſtals, containing little water of cryſtalization, decrepitate in the ſame manner in the fire.

SMOKING MARINE ACID.

If twenty-four ounces of ſea-ſalt, with as much concentrated vitriolic acid, and eight ounces of water, are diſtilled in a retort, the ſalt is is decompoſed, and lets go its acid in vapours which are very difficultly condenſed, and are only perceptible in the open air. This liquor collected in the receiver, is of a lemon colour. It forms the *ſmoking marine acid*, or *Glauber's ſmoking ſpirit of ſalt.*

CAPUT MORTUUM OF SMOKING SPIRIT OF SALT.

The matter remaining in the retort after the diſtillation of ſmoking ſpirit of ſalt, is dry, compact, and attracts the moiſture of the air. It is formed by the combination of the vitriolic acid with the alkaline baſis of ſea-ſalt, and conſequently is a true Glauber's ſalt. This matter always contains a good deal of ſea-ſalt which could not be decompoſed for want of moiſture and the concourſe of the air.

GLAUBER'S SALT.

In order to obtain the Glauber's ſalt contained in this maſs, it muſt be diſſolved in water and evaporated. It furniſhes large clean cryſtals, brilliant and tranſparent, in great, pretty regular needles. This is the *Glauber's ſalt.* Towards the end of the cryſtalization, a portion of of ſea-ſalt which has not been decompoſed by the vitriolic acid, is always found.

GLAUBER'S SALT FALLEN INTO EFFLORESCENCE.

There enters into the cryſtals of Glauber's ſalt ſomewhat more than half their weight of water of cryſtalization, which adheres to them very ſlightly. When this ſalt is expoſed to the air, it loſes the greateſt part of this water, becomes opake, and is converted into a white powder. In this ſtate its nature is in no reſpect altered; and if rediſſolved and cryſtaliſed it recovers its original form.

Glauber's ſalt thus fallen into effloreſcence is as difficult to bring into fuſion as fixed alkali; but when it is in cryſtals it liquefies with a moderate heat, merely through favour of the great quantity of water of cryſtalization it contains.

SEA-SALT DECOMPOSED BY CLAY.

If ten or twelve parts of moderately dry clay are mixed with one of ſea-ſalt, and the mixture diſtilled, the acid of the ſalt paſſes over into the receiver,

receiver, where it collects under form of a lemon-coloured liquor, leſs ſtrong than the ſmoking marine acid. This is the *common ſpirit of ſalt.* What remains in the retort is a Glauber's ſalt compoſed of the alkaline baſis of ſea-ſalt, and the vitriolic acid of the clay. This ſalt adheres very ſtrongly to the clay; from which it is ſeparated by the ſame means that we pointed out in ſpeaking of the reſiduum after the decompoſition of nitre with clay.

GLAUBER'S SALT MADE BY THE DIRECT COMBINATION OF THE VITRIOLIC ACID AND THE MARINE ALKALI.

If vitriolic acid and cryſtals of ſoda (which, as we have obſerved, are nothing elſe than pure cryſtaliſed marine alkali) are combined to the point of ſaturation, and the mixture diluted with a ſufficient quantity of water, and then ſet to cryſtaliſe, a Glauber's ſalt, ſimilar to that we have already mentioned, will be obtained.

QUADRANGULAR NITRE.

A combination of the nitrous acid and cryſtals of ſoda diſſolved in water and evaporated, yields

yields brilliant tranſparent cryſtals, in form of cubes or lozenges, which deflagrate in the fire like common nitre. This is *quadrangular* or *cubic nitre.*

SEA-SALT.

The marine acid and cryſtals of ſoda combined to the point of ſaturation, yield, by cryſtalization, *ſea-ſalt.*

DECOMPOSITION OF SEA-SALT BY THE NITROUS ACID.

To two ounces of ſea-ſalt in a retort are added four ounces of nitrous acid, and the mixture is diſtilled. There paſſes into the receiver part of the nitrous acid which has not had time to decompoſe the ſea-ſalt; and then vapours ariſe, which are ſpirit of ſalt, produced by the decompoſition of the ſea-ſalt by the nitrous acid. The two acids thus united are called *aqua regia.*

The ſaline maſs remaining in the retort, diſſolved in water and cryſtaliſed, yields quadrangular nitre.

ON BORAX.

Borax is a neutral ſalt of a peculiar kind, which comes to us from the Eaſt Indies, and the origin of which is not yet known. It is uncertain whether we owe this product to art or nature. The borax which is met with in quantities as an object of commerce is purified. Some is alſo found which has only undergone a beginning purification, and is called *rough borax*.

A prejudice has long prevailed concerning the purification of borax, that it could only be performed by peculiar methods, known only to a few perſons. I was deſirous of aſcertaining by my own experience whether or no this opinion was well founded; and I found that borax was not more difficult to purify than any other ſalt. The products obtained from it during its purification throw a good deal of light on its nature.[*]

We

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[*] For a full account of the origin, manufacture, and purification of borax, ſee *Rozier*, tom. XIV. p. 437. From the ſecond vol. of the *Scelt. D'Opuſcul*, p. 23, it appears that the ſedative ſalt of borax is found in the waters of Cherchiago and of another lake near Caſtelnuovo in Italy. It has likewiſe been found in the electorate of Saxony, and in the neighbour-

hood

We ſhall now examine the properties of purified borax.

Borax is compoſed, as we ſhall find, of a peculiar neutral ſalt which ſupplies the place of an acid, and has been called *ſedative ſalt*, and an alkali abſolutely ſimilar to that which is the baſis of ſea-ſalt.

The ſedative ſalt, though perfectly neutral, acts as an acid in the borax, and neutraliſes the marine alkali, as if it were a real acid.

Borax has a ſaline neutral taſte.

It turns ſyrup of violets green, but very ſlightly ſo.

CALCINED BORAX.

There enters into the compoſition of the cryſtals of borax about half their weight of

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hood of Halberſtadt, and little doubt can be entertained of its exiſting in other parts of Europe. Hence we have reaſon to expect that borax will ſoon be copiouſly produced without the neceſſity of travelling for it to the Eaſt Indies; for when we have the ſedative ſalt, the compound is eaſily formed by the addition of the mineral alkali. M.

water of cryſtalization. When expoſed to the fire, it loſes this water, puffs up and ſwells conſiderably, and is changed into a white, dry, light, friable matter, called *calcined borax*.

GLASS OF BORAX.

Borax calcined and urged with a more violent fire in a crucible, enters into fuſion, and is converted into a vitriform, white, tranſparent ſubſtance, called *glaſs of borax*. During this calcination and fuſion the borax has loſt none of its properties. By boiling in water it is totally diſſolved. This ſolution by evaporation furniſhes cryſtals which have exactly the ſame properties with the original borax. At every proceſs, however, a ſmall quantity of a white argillaceous earth is ſeparated.

SEDATIVE SALT SEPARATED FROM BORAX BY THE VITRIOLIC ACID.

If, to a ſolution of borax, ſome vitriolic acid be added, no efferveſcence takes place; but the liquor ſet to cryſtaliſe yields a white ſhining ſalt, formed in very ſmall light ſcales. This is the *ſedative ſalt* which we have mentioned as one of of the conſtituent parts of borax. Mr. Geoffroy was the firſt who got ſedative ſalt by this proceſs, which he publiſhed in the Memoirs of the Academy of Sciences.

At the end of the cryſtalization of ſedative ſalt, Glauber's ſalt is procured, which is formed by the union of the vitriolic acid with the alkaline baſis of the borax.

SEDATIVE SALT SEPARATED FROM BORAX BY THE NITROUS ACID.

A ſolution of borax treated with the nitrous acid affords the ſame phenomena as with the vitriolic. It ſeparates in the ſame manner the ſedative ſalt from the borax.

At the end of the cryſtalization a quadrangular nitre is procured, formed by the union of the nitrous acid with the alkaline baſis of the borax.

SEDATIVE SALT SEPARATED FROM BORAX BY THE MARINE ACID.

The marine acid in like manner decompoſes borax, uniting with its alkaline baſis, and ſeparating its ſedative ſalt.

At the end of the cryſtalization a ſea-ſalt, not at all differing from the common, is procured.

SOLUTION OF SEDATIVE SALT.

Sedative ſalt has ſcarcely any taſte; it does not attract the moiſture of the air, and does not change the blue colours of vegetables. It diſſolves difficultly and in ſmall quantity, in water.

GLASS OF SEDATIVE SALT.

Sedative ſalt, urged by the fire in a crucible, does not ſwell like borax. It is converted into a vitriform white, milky, and ſemitranſparent matter.

This glaſs diſſolved in water yields, by cryſtalization, ſedative ſalt the ſame as it was before. This proves, that in all theſe proceſſes the ſedative ſalt undergoes no alteration. A part of it, however, is decompoſed; as appears from a portion of white argillaceous earth, which is ſeparated in every ſolution after its fuſion.

SEDATIVE SALT SUBLIMED.

Cryſtaliſed ſedative ſalt, expoſed to the fire in an earthen cucurbit covered with its head, ſublimes and riſes into the head under the form of ſmall cryſtals in thin flakes, extremely light and very brilliant.

Homberg was the firſt who made ſedative ſalt by ſublimation; but this was by a very different proceſs. He mixed borax with a lye of colcothar; this mixture he diſtilled in a glaſs alembic, and raiſed the fire towards the end of the diſtillation. By this method he obtained a ſublimed ſalt, ſimilar to that which we have juſt treated of. To this he gave the names of *ſedative ſalt*, and *volatile narcotic ſalt of vitriol.*

He moiſtened afreſh the matter which remained at the bottom of the cucurbit, and proceeded to a new ſublimation; and he repeated theſe ſublimations with the ſame precautions, till no more ſalt was procured.

Homberg did not well underſtand what took place in theſe operations. He thought that the ſalt

ſalt was afforded by the vitriol, and that the borax ſerved to diſengage it. But the direct contrary really happens; it is the vitriolic acid which diſengages the ſedative ſalt, and combines with the alkaline baſis of the borax. Homberg, however, had remarked that when the matter was not moiſtened with water the ſalt did not ſublime; wherefore he recommends a repetition of the moiſtening at every ſublimation.

REGENERATED BORAX.

If ſedative ſalt be combined with cryſtals of ſoda, a *regenerated borax* is produced, which in no reſpect differs from borax before its decompoſition.

ON

METALLIC SUBSTANCES.

METALLIC ſubſtances are the heavieſt bodies in nature. There is no earth, whether calcareous or vitrifiable, which is ſo heavy as the lighteſt of theſe. This truth has been abundantly proved by hydroſtatical experiments.

Metallic ſubſtances are always perfectly opake; that is, they entirely oppoſe the paſſage of the light.*

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* Newton, however, aſſerts that if gold be foliated and held between the light and the eye it will appear moſt evidently to tranſmit the blue rays. See his *Optic*, p. 11, Book I. Prop. X. M.

They

They all have a brilliancy and ſplendor peculiar to themſelves, which chemiſts have termed *metallic luſtre*.

Metallic ſubſtances expoſed to the action of the fire, enter into fuſion, and in cooling recover their former ſolid conſiſtence. When ſuffered to cool gently after a perfect fuſion, the metallic particles receive a ſymmetrical and regular arrangement with reſpect to each other, which is peculiar in every different metallic ſubſtance, and ſhews itſelf at their ſurface.

Chemiſts ſay that metallic ſubſtances take a convex form at their ſurface during fuſion. This is true when they are melted in veſſels made of a matter with which they cannot contract any union, as crucibles of earth, clay, &c. but it is not the ſame when metallic veſſels are uſed for this purpoſe. For example, if lead be melted in a copper veſſel, or tin in one of iron, theſe metals are not convex at their ſurface; on the contrary, a concavity is obſerved. This proceeds from the aſcent of the edges of the melted metal along the ſides of the metallic veſſel; which aſcent is owing to the diſpoſition the ſeveral metallic ſubſtances have to unite with each other.

Metallic ſubſtances are heated by warm air and water more ſpeedily, and cool again more quickly, than any other bodies expoſed to the ſame temperature.

It is on account of this property, that mercurial thermometers are more eſteemed than thoſe of ſpirit, in experiments where the tranſitions of heat and cold are only momentary; for mercury dilates and condenſes much more readily than any other fluid we are at preſent acquainted with.

Mr. Richmann,* who has made many very curious experiments on this ſubject, obſerved that lead cools in the air ſooner than tin, tin than iron, and iron than copper. He alſo remarked the different periods in which different metals expoſed for ſome time to froſt, afterwards regained the heat of the ſurrounding atmoſphere. This he found to be in an order exactly the reverſe of that of their cooling; that

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* Memoirs of the Academy of Peterſburg for the years 1752 and 1753.

is, lead warmed firſt, then tin, and ſo on. From theſe obſervations he concluded, that the augmentation and diminution of heat in metals, are neither in an inverſe ratio to their denſities, nor to the abſolute coheſion of their particles, nor to their hardneſs, nor in a ratio compounded of theſe two or three ratios.

Chemiſts divide metallic ſubſtances into ſeveral claſſes, and theſe diviſions are founded on general properties which are common to ſeveral metallic bodies. On this foundation, their firſt diviſion is into *metals* and *ſemimetals*; and the metals are ſubdivided into two claſſes, the *perfect* and *imperfect*.

Metals are thoſe metallic ſubſtances which beſides the general properties which we have juſt mentioned, poſſeſs ductility and malleability, and reſiſt the action of fire without being diſſipated or volatiliſed.

The PERFECT METALS are *gold*, *platina*, and *ſilver*. They have this name on account of their undergoing the utmoſt violence of fire without ſuffering any alteration.

The IMPERFECT METALS are *copper*, *tin*, *lead*, and *iron*. Theſe are ductile as well as the perfect metals; but they are deſtroyed and converted into earth by the action of fire; whence their title.

The SEMIMETALS are *regulus of antimony*, *biſmuth*, *zinc*, *regulus of cobalt*, and *regulus of arſenic*.* The name of ſemimetal is given them becauſe they are void of ductility, are volatiliſed by fire, and undergo calcination like the imperfect metals.

There is another metallic ſubſtance which chemiſts uſually range among the ſemimetals. This is *mercury* or *quickſilver*. We think however with Mr. Macquer, that it is better to make a ſeparate claſs of it.

The imperfect metals and ſemimetals have one property in common, which is to emit an

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* To this catalogue may be added, ſiderite, molybdænum, manganeſe, and nickel: the laſt of which the eminent Bergman has moſt deciſively ſhewn to be a ſeparate metal, which may be depurated from all mixtures of cobalt, arſenic, or copper, and which cannot be produced by the union of iron with any of the ingredients which are uſually ſeparated from the nickelline ores. See vol. II. *Diſſ. de Nicolo.* M.

odour

odour when rubbed, or when only warmed by the hand. This odour is different in different metals, and eaſily diſtinguiſhed. The perfect metals and mercury alone yield none.

ON GOLD.

Gold is a perfect metal; moderately hard; of a bright yellow colour; very little elaſtic and ſonorous. It is the heavieſt of all the metallic bodies, and conſequently of all the bodies in nature.

Gold acquires a ſenſible rigidity beneath the hammer, and is ſoftened by *nealing*.* Its colour is variable. It is ſometimes met with very high coloured, and ſometimes very pale; Wallerius ſays that it is even found almoſt white.

Gold weighed by the hydroſtatical balance loſes between a nineteenth and twentieth of its weight in water.

It is the moſt ductile of all metals, and likewiſe the moſt tenacious. A gold wire of a tenth

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* This is performed by heating it red hot in a furnace with charcoal, and ſuffering it to cool ſlowly; repeating the proceſs as occaſion requires. J. A.

of an inch in diameter is capable of ſupporting a weight of five hundred pounds without breaking.

Air and water have no action upon it.

FUSION OF GOLD.

Gold, expoſed to the fire, reddens long before it melts. When juſt going to melt it takes a ſea-green hue; but undergoes no alteration, or diminution of weight. Gold which has been well melted and ſuffered to cool ſlowly, has its ſurface figured in very large brilliant facets of a foliated form.

Pure acids, ſulphur, and fixed alkali, have no action upon gold, either by the dry or the moiſt way.

SOLUTION OF GOLD IN AQUA REGIA.

A mixture of the nitrous and marine acids forms a compound acid called Aqua Regia, which diſſolves gold by the aſſiſtance of heat. This ſolution is of a gold colour, and tranſparent.

CRYSTALS OF GOLD.

This ſolution ſet to evaporate and cryſtaliſe, furniſhes ſaline cryſtals, called cryſtals of gold.

ANIMAL MATTERS STAINED BY SOLUTION OF GOLD.

Solution of gold applied to bone and ivory leaves a reddiſh-purple ſtain which does not wear out. Skins are alſo ſtained in the ſame manner.

GOLD PRECIPITATED FROM ITS SOLUTION BY FIXED ALKALI.

If fixed alkali be added to a ſolution of gold, the metal is precipitated in form of a very deep yellow powder.

GOLD IN RAGS.

Clean old linen rags are plunged into a ſolution of gold, and when well ſoaked in it, are dried and burned in a crucible. There remains a coal of linen mixed with gold in a very divided ſtate. This powder is uſed, applied on the end of a phial cork, to gild delicate work which cannot be gilt in another manner.

PLATINA EXPOSED TO THE FIRE.

Platina expoſed to the greateſt heat we can produce in our furnaces, undergoes no alteration or diminution of weight, and does not melt. It is not, however, unfuſible. When expoſed to the focus of a good burning glaſs it enters into real fuſion. The portion melted is found to have a good deal of ductility, and a degree of ſpecific gravity ſimilar to that of gold.

SOLUTION OF PLATINA.

Sulphur and fixed alkali taken ſeparately do not act upon platina; no more do the mineral acids, ſingly. Like gold, it is ſoluble only by liver of ſulphur, and a mixture of the nitrous and marine acids, aſſiſted by heat.

PRECIPITATE OF PLATINA.

If fixed alkali be added to a ſolution of platina in aqua regia, a precipitate of an orange yellow colour is thrown down. When no more alkali is uſed than is neceſſary for the precipitation, the precipitate is of a pale yellow.

MEANS OF DISCOVERING WHEN GOLD IS ALLOYED WITH PLATINA.

Platina has frequently been uſed to augment the bulk of gold. This deceit was difficult to detect, on account of the ſimilarity of properties in theſe two metals. But chemiſts, in their operations on platina, ſoon diſcovered a method of detecting the ſmalleſt proportion of it mixed with gold.

On diſſolving the ſuſpected gold in aqua regia, and adding a little ſolution of ſal ammoniac, a very fine yellow precipitate immediately falls down if it really contained platina, but no precipitation enſues if it was pure.

It may, in like manner, be diſcovered when platina is alloyed with gold. For this purpoſe, the platina muſt be diſſolved in aqua regia, and ſome ſolution of martial vitriol added to it. If the platina was mixed with gold, a brown precipitate is immediately thrown down; but no precipitation take place if it was pure.

ON SILVER.

Silver is a perfect metal, of a brilliant white, without ſmell and taſte. Next to gold it is the moſt ductile of metals. It is more elaſtic and ſonorous than gold: it becomes more rigid under the hammer, and is in the ſame manner corrected by nealing: it is alſo harder than gold.

A ſilver wire one tenth of an inch in diameter ſupports a weight of 270 pounds before it breaks.

Silver weighed in water by the hydroſtatical balance, loſes between a tenth and eleventh of its weight.

Air and water have no action upon it.

Expoſed to the fire, it does not melt till long after being red; and like gold it ſuffers no alteration or diminution of weight in fuſion. Silver well melted and then gradually cooled, ſhews on its ſurface little threads in *relievo.*

SOLUTION OF SILVER IN THE NITROUS ACID.

The nitrous acid diſſolves ſilver with much effervеſcence and heat. This ſolution is clear and colourleſs.

LUNAR CRYSTALS.

Solution of ſilver, ſet to evaporate, forms, on cooling, very white cryſtals in thin flakes, called *lunar cryſtals*, or *lunar nitre*. Theſe terms are derived from the name of *Luna* given to ſilver, as that of *Sol* was to gold, by the old chemiſts.

DEFLAGRATION OF LUNAR NITRE.

This metallic ſalt is formed, as we have obſerved, by the combination of the nitrous acid and ſilver. The acid has ſufficient adheſion to the ſilver to deflagrate with the phlogiſton. If lunar cryſtals are placed upon burning coal, they melt and deflagrate like common nitre; the acid is diſſipated, and the ſilver remains in a very thin flake on the ſurface of the coal. This ſilver has no metallic brilliancy, but on rubbing it it with the blade of a knife it recovers its uſual luſtre, and has all its ductility.

LAPIS INFERNALIS.

Lunar cryſtals melted in a crucible, and then poured in a mold in ſmall cylinders of the ſize of a quill, form a powerful cauſtic called *lapis infernalis* or *lunar cauſtic.*

PRECIPITATE OF SILVER.

If, to a ſolution of ſilver in the nitrous acid, fixed alkali be added, the ſilver is precipitated in form of a white powder; while the acid uniting with the alkali produces a regenerated nitre. The precipitate, though white, is without metallic brilliancy, which perhaps is owing to its extreme diviſion.

LUNAR VITRIOL.

If vitriolic acid be added to a ſolution of ſilver in the nitrous acid, it ſeizes the ſilver, and falls down with it in form of a white powder, called *vitriol of ſilver*, or *lunar vitriol.* This new ſalt precipitates, becauſe it is vaſtly leſs ſoluble in water than lunar nitre.

LUNA CORNEA.

If, to a ſolution of ſilver in the nitrous acid, the marine acid be added, it ſeizes on the ſilver, and falls down with it in form of a thick *coagulum*, to which the name of *luna cornea* has been given. This precipitate expoſed to the fire in a crucible, eaſily melts; and in cooling fixes into a grey yellowiſh maſs, which has always been thought to be flexible like horn, but is not ſo in reality. This pretended property, however, or perhaps its colour, has acquired it the name of *luna cornea*.

ANIMAL MATTERS STAINED BY SOLUTION OF SILVER.

Solution of ſilver, applied to animal matters, gives them a black ſtain which does not wear out. This colour proceeds from the tarniſh the ſilver acquires from the phlogiſton in being precipitated on animal ſubſtances.

PRECIPITATED AQUA FORTIS.

When it is ſuſpected that the nitrous acid is adulterated by ſome other acid, it is purified by pouring

pouring in ſome ſolution of ſilver. The foreign acids ſeize on the ſilver, and fall down with it; and the pure nitrous acid ſwimming at top is called *precipitated aqua fortis.*

SILVER REVIVED FROM LUNA CORNEA.

Luna cornea expoſed to a ſufficient heat in a crucible, with ſome alkaline ſalt, enters into fuſion, and a knob of very pure ſilver is found at the bottom of the crucible. This is a method of procuring ſilver of the utmoſt purity.

SULPHURATED SILVER.

If ſilver be melted in a crucible, and ſulphur added, this attacks the ſilver, combines with it, and converts it into a black ſpongy maſs. This forms an artificial ore of ſilver, and is called *ſulphurated ſilver.*

GOLD AND SILVER FOR PARTING.

A mixture is made by melting together two parts of ſilver and one of gold; the maſs is extended under the hammer and formed into little ſpiral coils.

PARTING.

One of theſe coils is put into a matraſs with ſpirit of nitre, and the veſſel placed upon the fire. The acid acts immediately on the ſilver and diſſolves it. The gold is left untouched, in the ſame figure that the mixture had before the operation. When withdrawn it appears of a dark colour and very porous texture. It is expoſed to a gentle heat in a crucible, by which means its particles are brought together, and it recovers its ſolidity and colour. This proceſs is called *nealing of parted gold*; and the gold, which is very pure, is called *parted gold*.

SILVER TARNISHED BY PHLOGISTON.

Silver, expoſed to the vapour of phlogiſton, or ſulphur, becomes of a black or very deep brown colour. This does not happen when it is expoſed to the vapour of the volatile ſulphureous vitriolic acid.

SILVER PRECIPITATED BY LIVER OF SULPHUR.

If ſolution of ſilver be added to ſolution of liver of ſulphur, the nitrous acid of the ſolution of of ſilver ſeizes the alkali of the liver of ſulphur, and the ſilver is precipitated with the ſulphur in form of a very black powder, which colour proceeds from the tarniſhing of the ſilver by the ſulphur.

ON COPPER.

From the perfect metals, we paſs to the imperfect, and ſhall begin with copper.

Copper, named by the antient chemiſts *Venus*, is an imperfect metal of a yellow colour with a conſiderable tinge of red, brilliant, and ſhining where it is broke. When rubbed in the hands it exhales a diſagreeable odour peculiar to itſelf; and has a taſte not leſs unpleaſant.

Copper is next to gold and ſilver in ductility and malleability. It has more elaſticity and hardneſs than any of the other metals excepting iron; and is the moſt ſonorous of all.

In tenacity it comes neareſt to ſilver. A copper wire one tenth of an inch in diameter will ſupport a weight of 299 pounds four ounces without breaking.

Weighed

Weighed in the hydroſtatic balance it loſes between an eighth and a ninth of its weight.

When expoſed to the fire, it reddens long before it enters into fuſion; its ſurface becomes calcined, loſes part of its phlogiſton, and is converted into a thin pellicle which flies off in ſcales when the copper cools. This is called *ſcales* or *calx of copper*.

When copper is brought to a white heat, it enters into fuſion; and on cooling gently it takes a ſymmetrical arrangement, which declares itſelf by a peculiar luſtre, and a kind of foliage on the ſurface.

FLOWERS OF COPPER.

If copper be too long ſubmitted to the action of a violent fire, its phlogiſton burns, and forms a beautiful violet-coloured flame, which condenſes into greeniſh grey flowers, called *flowers of copper*. This property of copper to burn with a blue flame is uſed to advantage in the compoſition of fire-works.

GLASS OF COPPER.

That portion of copper which has loſt its phlogiſton in the preceding operation enters into fuſion in a violent heat, and is converted into a glaſs of a reddiſh brown colour.

REDUCTION OF CALXES OF COPPER.

The calxes of copper, ſuch as the *ſcales* which we have mentioned, are eaſily brought back to their metallic form by the addition of ſome phlogiſtic ſubſtance. For this purpoſe, ſome *black flux* and roſin is mixed with ſcales of copper, and a violent heat applied to bring the mixture into fuſion. When the crucible is cooled, a button of copper, poſſeſſing all the properties it had before calcination, is found at the bottom.

COPPER CALCINED BY THE AIR.

Air acts upon copper, tarniſhing its ſurface, and converting it into a green ruſt which is called *verdigris*.

COPPER DESTROYED BY WATER.

Water alſo corrodes copper. It brings a ruſt on its ſurface, which ruſt diſſolves in the water, and gives it a green tinge.

There is no liquor or ſolvent which has not an action upon copper. All ruſt it, and reduce it to verdigris.

SOLUTION OF COPPER IN THE VITRIOLIC ACID.

Copper is diſſolved with difficulty in the vitriolic acid: the acid muſt be boiling, and very well concentrated, for this purpoſe. The ſolution reſembles a *coagulum*. This, diluted with a large proportion of water, forms the ſolution of copper. It is of a fine blue. It depoſites a part of the copper, which has been calcined by the acid.

VITROL OF COPPER.

The ſolution of copper in the vitriolic acid ſet to evaporate furniſhes, on cooling, large rhomboidal cryſtals, of a beautiful blue.

This metallic ſalt on expoſure to the air loſes a little of its water of cryſtalization, and becomes tarniſhed on the ſurface. It has an acid, cauſtic, aſtringent, biting taſte, and a very diſagreeable metallic flavour. It is called *vitriol of copper*, *blue vitriol*, or *Cyprus Vitriol.*[*]

COPPER DISSOLVED IN THE NITROUS ACID.

The nitrous acid, even when cold, diſſolves copper very readily, with conſiderable heat and effervefcence. The ſolution exhales red vapours of the nitrous acid.[†] Its colour is as fine a blue as that of the preceding.

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[*] It is commonly called in our ſhops *Roman Vitriol*, but that name is applied by foreign writers to the vitriol of iron. Diſagreeable miſtakes have ariſen from a want of attention to this circumſtance. J. A.

[†] The vapour ariſing from the ſolution of copper, and alſo of ſome other metals, in the nitrous acid, has lately been a good deal the ſubject of inveſtigation under the name of *nitrous air*, in the curious experiments of Dr. Prieſtley. It is naturally colourleſs, and only becomes red when mixed with common air, which ſeems to produce a decompoſition in it. It has a remarkable power of diminiſhing the volume of common air, and does this in a greater degree the purer the air is. J. A.

The ſolution of copper in the nitrous acid yields only a metallic ſalt in a *magma*, which is not ſuſceptible of cryſtalization, and which ſtrongly attracts the moiſture from the air, and is reſolved into a liquor.

COPPER DISSOLVED IN THE MARINE ACID.

The marine acid does not diſſolve copper well, except when boiling. The ſolution, inſtead of the blue colour of the preceding, has a green hue.

This ſolution, ſet to evaporate, yields needled cryſtals which do not attract moiſture from the air.

COPPER DISSOLVED BY AQUA REGIA.

Aqua Regia diſſolves copper with almoſt as much eaſe as the nitrous acid. The colour of the ſolution is a blue green, of a middle hue between that made by the nitrous, and that by the marine acid.

This ſolution yields no ſaline cryſtals.

SILVER PRECIPITATED BY COPPER.

If a plate of copper be plunged into a ſolution of ſilver in the nitrous acid, it diſſolves, and precipitates the ſilver in the ſame degree. This precipitated ſilver is in powder, but has all its metallic luſtre.

The cauſe of theſe two effects, is, 1. That the nitrous acid not being able to hold in ſolution more than a determinate quantity of metallic matter, and having more affinity with copper than with ſilver, it lets fall the latter in order to take up the former. 2. The metallic luſtre of the precipitate proceeds from the large proportion of phlogiſton contained in the copper, which is transferred to the ſilver as faſt as it precipitates, and is in ſufficient quantity to give it all its uſual brilliancy.

This is the method uſed in mints to ſeparate ſilver from its ſolvent after the proceſs of parting gold from ſilver.

COPPER PRECIPITATED BY AN ABSORBENT EARTH.

If pieces of any kind of abſorbent earth are thrown into a ſolution of copper by any acid, the earth diſſolves and precipitates the copper. The liquor is found loaded with a ſalt with an earthy baſis, which is different according to the different acid employed.

COPPER PRECIPITATED BY FIXED ALKALI.

Fixed alkali, by virtue of its greater affinity with acids, precipitates copper from its ſolution in any acid. All theſe precipitates are of a fine green, and ſerve for painting in enamel and on china.

Theſe precipitates of copper are calxes ſo far deprived of their phlogiſton as to be very difficult of reduction.

COPPER CALCINED BY NITRE.

If a mixture of copper filings and nitre be heated in a crucible, the phlogiſton of the copper combines with the acid of the nitre, and they are conſumed together with a ſlight deflagration. There remains in the crucible a calx of copper with the alkali of the nitre.

This method is often uſed by ſilverſmiths to deſtroy a portion of copper with which ſilver was too highly alloyed, and bring the ſilver to its proper ſtandard.

ENS VENERIS.

If copper plates are ſtratified with ſulphur, and calcined, the ſulphur attacks the copper, and converts it into an iron-coloured, very eager and brittle matter. This is called *Ens Veneris*, or *copper calcined by ſulphur*.

ON TIN.

Tin, or Jupiter, is an imperfect metal, of a whiteneſs approaching to that of ſilver, very ſoft, very malleable, and readily extenſible under the hammer, and with little or no elaſticity.

A tin wire one tenth of an inch in diameter ſupports a weight of forty nine pounds and a half without breaking. This metal is ſcarcely at all ſonorous when pure.

It is the lighteſt of all metals. In the hydroſtatic balance it loſes about a ſeventh of its weight.

Tin, rubbed between the hands, exhales a diſagreeable odour peculiar to itſelf, and has a taſte not leſs diſagreeable. When bent, it makes a little crackling noiſe as if it were breaking.

LEAVES OF TIN.

Tin has leſs ductility than gold, ſilver, or copper; yet has enough to allow of its extenſion into very thin leaves.

TIN EXPOSED TO THE FIRE.

Tin, expoſed to the fire, melts long before it becomes red. When melted its ſurface is covered with a whitiſh grey powder, which is a portion of it calcined and deprived of its phlogiſton. This is called *calx of tin*.

PUTTY OF TIN.

On continuing the calcination for a conſiderable time, the calx acquires a white colour, and a good deal of hardneſs, and is then called *putty*. This is uſed for poliſhing glaſs, ſteel, and other hard bodies.

Theſe calxes, mixed with phlogiſtic matters, and urged by the fire, are reduced into tin in its original form.

FLOWERS OF TIN.

If very pure tin be expoſed to a ſtrong heat in a crucible, it calcines as in the preceding experiments; and a part ſublimes into the upper part of the veſſel in form of very white and brilliant needles. Theſe are the *flowers of tin.*

RED CALX OF TIN.

When the fire has been ſufficiently ſtrong in the above proceſs, there is found under the flowers of tin a purpliſh red calx, which has riſen in a vegetation, and has the form and figure of cauliflowers.

GLASS OF TIN.

Beneath this calx is found a part of the calx of tin which has entered into perfect fuſion, and forms a true glaſs of tin, pure, clean, and tranſparent, of a fine ruby or garnet colour. This proves, contrary to the common opinion, that calx of tin, like the greater part of other metallic calxes, is capable of entering into fuſion by itſelf, and forming a real glaſs. I have aſſured myſelf of this fact by repeated trials.

TIN DOSSOLVED BY THE VITRIOLIC ACID.

The vitriolic acid diſſolves tin with ſcarcely any efferveſcence, and requires the aid of heat. A ſtrong ſmell of ſulphureous acid exhales during the ſolution, and a quantity of ſulphur is even formed, which ſwims on the ſurface of the liquor. This ſulphur is produced by the union of part of the phlogiſton of the tin with the vitriolic acid. The ſolution is of a blackiſh colour. It depoſites a good deal of calx of tin which is ſo far deprived of phlogiſton as to be no longer ſoluble in the acid.

TIN CALCINED BY THE NITROUS ACID.

The nitrous acid does not ſo much diſſolve as calcine tin. It attacks the metal with conſiderable violence and impetuoſity, and excites a very great degree of heat and ebullition. The acid ſeizes with avidity upon the phlogiſton of the tin, and converts it into a very white calx, inſoluble in any acid, and very difficult of reduction.

SOLUTION OF TIN IN THE MARINE ACID.

The marine acid is the true ſolvent of tin; but it muſt be in a concentrated ſtate, and aided by heat. This ſolution exhales a very ſtrong odour of garlic or arſenic.

As ſoon as the marine acid acts upon tin, it loſes its lemon colour, and ceaſes to fume as it uſually does when concentrated.

SALT OF JUPITER, OR OF TIN.

The ſolution of tin in the marine acid, ſet to evaporate, yields needled cryſtals which do not attract moiſture from the air. They are called *Sal Jovis.*

TIN DISSOLVED IN AQUA REGIA.

Aqua Regia diſſolves tin perfectly. This ſolution affords a great number of phenomena, the detail of which cannot be entered into here. I ſhall only ſay, that it is ſometimes colourleſs; in other circumſtances, of an amber colour;

ſometimes of a dingy crimſon; and ſometimes is converted into a fine white tranſparent gelly.

PRECIPITATES OF TIN.

Abſorbent earths precipitate tin from its ſolvent. Fixed alkali does the ſame. From theſe precipitates there reſult ſo many calxes of tin, and kinds of neutral ſalts, differing from each other according to the different acid which held the tin in ſolution.

GOLDEN PRECIPITATE OF CASSIUS.

If to a ſolution of tin diluted with a good deal of water, ſome drops of ſolution of gold are added, the mixture preſently acquires a purple colour, and in the ſpace of a few days a precipitate of the ſame colour is formed. This precipitate of gold and tin is employed in painting on enamel.

Tin, or even its vapour, inſtantly deſtroys all the ductility of gold and ſilver.

TIN CALCINED BY NITRE.

Tin cauſes nitre to deflagrate, and a briſk flame ariſes during the operation. The tin by this

this proceſs is calcined, and there remains in the crucible calx of tin with the alkali of the nitre.

SULPHURATED TIN.

Tin combines with ſulphur by fuſion. It becomes, by this mixture, eager and brittle, and is diſpoſed in facets like the broken ſurface of Zinc.

BRONZE.

Copper and tin, melted together in ſuitable proportions form what is called *bronze*, or *bell-metal*.

Tin, in combining with copper, communicates to it part of its fuſibility. The mixture of theſe two metals is of greater ſpecific gravity than each had ſeparately, becauſe they mutually penetrated each other during their combination.

TINNING OF COPPER.

Tin applies very well to the ſurface of copper, and forms a coating which preſerves it from ruſt. This is the *tinning of copper.* In order, however, that the proceſs ſhould ſucceed, it is neceſſary that the ſurface of the copper ſhould be very well and newly cleaned, and that the tin ſhould not be calcined by the heat uſed in the operation. For this purpoſe, a good deal of roſin is mixed with the tin when melted.

ON IRON.

Iron, or Mars, is a metal of a livid white colour approaching to grey; it is the hardeſt, the moſt elaſtic, and next to platina, the moſt difficult of fuſion of all the metals.

It is the only metal which has the property of ſtriking fire either with a vitrifiable ſtone, or another piece of iron.

Next to gold, it is that the particles of which have the greateſt tenacity. An iron wire one tenth of an inch diameter can ſupport a weight of 450 pounds without breaking.

It loſes in water by the hydroſtatic balance between a ſeventh and an eighth of its weight.

It is ductile enough, when very pure, to be drawn out into threads as fine as hair, ſince perukes have been made of them.

It is the only known ſubſtance in nature which is attracted by the magnet, and is itſelf capable of becoming magnetic, and attracting other iron.

ZWELFER'S SAFFRON OF MARS.

Iron, expoſed to a very violent heat, enters into fuſion, but long after it has become red.

When kept in a red heat ſeveral hours without being melted, its ſurface calcines, and is converted into a reddiſh brown powder, named *Zwelfer's ſaffron of Mars.*

SAFFRON OF MARS PREPARED BY DEW.

The combined action of air and water ruſts iron; its phlogiſton is deſtroyed and diſſipated, and there remains at length a ruſt, which is called *Saffron of Mars prepared by dew.* Iron in filings is generally uſed for this purpoſe, as it preſents a larger ſurface.

MARTIAL ÆTHIOPS.

Iron filings kept under water in a veſſel, and agitated from time to time, is at length divided into particles of ſufficient tenuity to remain a while ſuſpended in water. Iron thus divided is called *martial æthiops*. It contains all its phlogiſton, becauſe it has had no contact with the external air. It is entirely attractible by the magnet, and completely ſoluble in acids.

IRON DISSOLVED BY THE VITRIOLIC ACID.

The vitriolic acid, even diluted, attacks iron with conſiderable impetuoſity. During the proceſs of ſolution, if a candle be brought to the mouth of the veſſel, an inflammation is produced which cauſes a pretty ſtrong exploſion. This exploſion is owing to the inflammation of the ſulphur which is formed by the union of the vitriolic acid with the phlogiſton of the iron, a great part of which is reduced to vapours, and ſuddenly takes fire on the approach of flame.

OCHRE.

The ſolution of iron in the vitriolic acid depoſites, when fully ſaturated, a yellow powder, which is a calx of iron totally deprived of phlogiſton, and named *ochre.*

GREEN VITRIOL, OR GREEN COPPERAS.

On evaporating this ſolution, it yields green rhomboidal cryſtals, which are called *green vitriol, martial vitriol,* or *green copperas.*

This metallic ſalt, expoſed to the air, tarniſhes, loſes its water of cryſtalization, and is reduced to a whitiſh powder.

VITRIOL CALCINED TO WHITENESS.

This vitriol, expoſed to the fire, liquefies through favour of its water of cryſtalization, and is reduced to a powder of a dirty white. When its water is entirely diſſipated, what remains is called *dried vitriol,* or *vitriol calcined to whiteneſs.*

COLCOTHAR.

If the calcination of martial vitriol be puſhed further, a part of the vitriolic acid is diſſipated in ſulphureous acid; and the iron loſes its phlogiſton, and is calcined by the vitriolic acid. What remains in the crucible is a calx of iron of a high red colour, which ſtill retains a large quantity of vitriolic acid, half combined with it. This ſubſtance is called *colcothar*.

A great part of the vitriolic acid in the colcothar is, as it were, in a ſeparated ſtate, and in a higher degree of concentration. It attracts the moiſture of the air, and reſolves into a liquor; but does not reunite with the iron, becauſe this is deprived of phlogiſton.

ICY VITRIOLIC ACID.

When martial vitriol newly calcined to redneſs is ſubmitted to diſtillation with a violent heat, a vitriolic acid is procured, which is ſo concentrated that it congeals on cooling, and on that account is named *icy vitriolic acid.* This proceſs is extremely laborious, and requires a fire

fire of the utmoſt degree of violence, and long continued.

What remains in the retort is a colcothar which retains ſo much of the vitriolic acid as could not riſe during the diſtillation on account of its too great adheſion to the earth of the iron.

SALT OF COLCOTHAR.

If colcothar be waſhed in water, and the liquor evaporated, it yields by cryſtalization a ſalt which has partly an earthy, and partly a ferruginous baſis. It is called *ſalt of colcothar.*

SWEET EARTH OF VITRIOL.

The powder which remains on the filter after ſufficient waſhings of colcothar is of a red colour like colothar. This is a calx of iron deprived of all its phlogiſton and all its acid. It is called *ſweet earth of vitriol.*

SMOKING NITROUS ACID MADE WITH COLCOTHAR.

If a mixture of colcothar and nitre be diſtilled in a retort, a nitrous acid is obtained, extraordinarily

dinarily ſmoking, and of a deep red colour. Its fumes are much more red and abundant than thoſe of Glauber's ſpirit of nitre above-mentioned. This proceſs is alſo more difficult to conduct, and requires many precautions.

The nitrous acid made with colcothar is more ſmoking than the other, becauſe it is prodigiouſly loaded with phlogiſton. When a vitriol ſlightly calcined and very dry is employed in preparing it, the nitrous acid procured is ſo far ſuperſaturated with phlogiſton, that a part of it forms a ſubſtance which ſwims above the acid, and has the appearance of an oil. I have in my poſſeſſion nitrous acid prepared in this manner and with this fluid on its ſurface, which I have kept about five years.

What remains in the retort after this diſtillation is a vitriolated tartar, formed by the alkali of the nitre, and the vitriolic acid of the colcothar. On diſſolving the maſs in water, filtrating, and evaporating, cryſtals of genuine vitriolated tartar are obtained. There remains on the filter a calx of iron deprived of all its phlogiſton. This is uſed to advantage for poliſhing glaſs.

IRON SEPARATED FROM MARTIAL VITRIOL BY FIXED ALKALI.

If to a ſolution of iron in the vitriolic acid, fixed alkali be added, the iron is precipitated under a greeniſh colour, which, however, ſoon diſappears. On drying it in the open air it acquires a reddiſh colour, becauſe it is deprived of phlogiſton.

This precipitate is not attractible by the magnet when dried ſlowly; but it is, when dried in an open veſſel, on the fire. When dried in a cloſe veſſel, without the acceſs of the air, it preſerves all its phlogiſton, is of a black colour, is perfectly attractible by the magnet, and entirely ſoluble in acids.

The liquor ſeparated from this precipitate contains a true vitriolated tartar, formed by the combination of the vitriolic acid and fixed alkali.

IRON REVIVED WITHOUT FUSION.

If a calx of iron not attractible by the magnet be put over the fire with a little oil, or ſome fatty matter, it recovers the phlogiſton it had loſt, and acquires all the properties of iron, without the neceſſity of being melted. It, conſequently, is iron revived without fuſion. This iron, however, is very little ſoluble in acids, becauſe the ſurface of each particle is coated with a coaly ſubſtance. Some phyſicians eſteem this preparation a very good medicine. We are indebted for it to M. Majault, Doctor of the faculty of phyſic at Paris.

SAFFRON OF MARS PREPARED WITH SULPHUR.

A mixture of equal parts of ſulphur and iron filings, moiſtened with a little water, ſwells, heats conſiderably, and, when the matters are in large quantity, actually inflames. If, after the heat and tumefaction are ſubſided, the fire be raiſed, the iron is found converted into a black earth, which is neither attractible by the magnet, nor ſoluble in acids.

The ſwelling and heat proceeding from this mixture are owing to the action of the ſulphur upon the iron: the phlogiſton of the ſulphur flies off; the vitriolic acid combines with the iron, and forms a true martial vitriol, which may be ſeparated from the maſs remaining after the efferveſcence is over, by lotion.

Calcination diſſipates a great part of the vitriolic acid that was united to the iron, and at the ſame time deſtroys the phlogiſton of the iron. The ferruginous earth remaining is therefore a kind of colcothar, but which contains leſs vitriolic acid than common colcothar.

IRON MELTED BY SULPHUR.

To one of the ends of an iron bar heated to a white heat, a roll of brimſtone is applied. Both of them drop in tears. In this proceſs, a part of the ſulphur is combined with the melted iron, and has reduced it to the ſtate of a pyrites. This iron is in grains. It is eager and brittle, and its particles are arranged in rays like thoſe of pyrites.

This operation is performed over a baſon full of water, that the portion of ſulphur which is not combined with the iron may be immediately extinguiſhed, and may not incommode the operator by its fumes.

The ſulphur falling into the water is figured in little drops connected by ſmall threads, like a bunch of grapes. It is in the ſame ſtate with the *ſoft ſulphur*, mentioned *page* 85.

VITRIOL OF IRON AND COPPER.

When iron and copper mixed together are diſſolved in the vitriolic acid, the ſolution furniſhes cryſtals, of a beautiful green colour and a rhomboidal figure, which loſe part of their water of cryſtalization in the open air. This is a bad quality of vitriol, and is found in that which comes from Germany.

IRON DISSOLVED IN THE NITROUS ACID.

The nitrous acid diſſolves iron with a good deal of effervеſcence and heat. When this ſolution is not completely ſaturated, it is of a greeniſh colour, but when perfect ſo, it is of a fine orange red.

IRON PRECIPITATED BY ITSELF.

When freſh iron is added to a ſolution of the ſame metal in the nitrous acid, it diſſolves, and precipitates that which was before held in ſolution.

The cauſe of this is, that the freſh iron being provided with all its phlogiſton, the nitrous acid ſeizes on it with avidity, and calcines the iron as it diſſolves it, letting fall that which it before held, in proportion as it takes up this.

STAHL'S MARTIAL ALKALINE TINCTURE.

If to fixed alkali diſſolved in water, a ſolution of iron be added, a precipitate is immediately formed, which, however, preſently diſappears on agitating the mixture, and diſſolves in the alkali. This liquor is of a fine red colour. This experiment does not ſucceed well but with a ſolution of iron not ſaturated, and a very pure alkali. If the alkali contains never ſo little earth,

earth, the ferruginous precipitate only diſſolves in very ſmall quantity.

STAHL'S APERIENT SAFFRON OF MARS.

If an acid be poured to the alkaline tincture of Stahl, it combines with the fixed alkali, and precipitates the iron, which preſerves a fine red colour.

SAFFRON OF MARS DISSOLVED IN THE NITROUS ACID.

Although this ſaffron of Mars has been highly calcined by the nitrous acid, it is ſtill ſoluble in acids; for which reaſon Stahl prefers it to other martial ſaffrons for medicinal uſes.

SOLUTION OF IRON BY THE MARINE ACID.

The marine acid diſſolves iron with a good deal of facility, but with leſs effervеſcence than the other acids. This ſolution is ſomewhat greeniſh.

IRON DISSOLVED BY AQUA REGIA.

Aqua Regia diſſolves iron with the ſame phenomena as thoſe of the fore-mentioned acids.

COPPER PRECIPITATED BY IRON.

Into a ſolution of copper in any acid a very clean bar of iron is plunged. The iron diſſolves, and in the ſame degree precipitates the copper, which appears with all its metallic luſtre. This experiment proves that copper has leſs affinity with acids than iron has.

This method is uſed in mints to ſeparate the copper which has ſerved for the precipitation of ſilver.

IRON CALCINED BY NITRE.

A mixture of iron and nitre, expoſed to the fire in a crucible, detonates, and throws out a great number of very brilliant ſparks. This mixture is the baſis of ſparkling fireworks. The matter remaining in the crucible, waſhed and dried, forms a calx of iron.

ON STEEL.

The pureſt iron always contains a certain portion of ferruginous earth, which is not completely metaliſed, and wants a ſufficient proportion of phlogiſton to become good iron. This earth is interpoſed between the very particles of the iron, acts there as a foreign body, and prevents it from having all the ſoftneſs and flexibility of which very pure iron is ſuſceptible.

In converting iron to ſteel, all the buſineſs conſiſts in giving phlogiſton to this ferruginous earth which is intermixed with the ſubſtance of the iron, and rendering it itſelf true iron. This is effected by expoſing to the fire in a covered crucible iron bars along with a mixture of animal earth and powdered charcoal. The phlogiſton of the coal penetrates the iron, revives its ferruginous earth into true iron, and thus makes what is called *ſteel.*

TEMPERING OF STEEL.

If a bar of this ſteel be made red hot, and then quenched in cold water, the particles of the iron are fixed by the ſudden cold, and have not time to arrange themſelves in the manner they uſually do when iron is cooled gradually.

The iron thus tempered is by ſo much the more hard, eager and brittle, as it was hotter when quenched. When the ſteel is too brittle, it is ſoftened by rubbing it dry upon a hard body ſo as to heat it a little, or by warming it in hot aſhes.

WHITE IRON.

If a thin and well ſcraped iron plate be plunged in melted tin, the ſurface of which is covered with ſuet, the iron comes out coated with tin, and is then called *white iron.* The manufacturers in this branch expoſe the iron well cleaned to the vapour of ſal ammoniac, that the tin may apply better to its ſurface.

PRUSSIAN BLUE.

This is iron coloured blue by a phlogiſtic matter. The proceſs by which it is made requires ſeveral previous preparations, which we ſhall firſt mention.

PHLOGISTICATED ALKALI.

Fixed alkali and ox's blood, or ſome other animal matter which contains no more earth than this, are calcined together in a crucible. The veſſel is kept on the fire till the matter no longer emits fumes; it is then removed, and when cooled the product is *phlogiſticated alkali*, proper for making Pruſſian blue.

LYE OF PHLOGISTICATED ALKALI.

The alkali thus prepared is put into boiling water, to diſſolve all its ſaline matter. The liquor is filtred, and a phlogiſtic alkaline lye is obtained, of an amber colour, and with a ſlight ſcent of peach bloſſoms when well charged with phlogiſtic matter.

PREPARATION OF THE BLUE.

A ſolution of martial vitriol, and a ſolution of alum are put together in a large glaſs, and the phlogiſtic alkaline lye is poured to them. An efferveſcence immediately ariſes, and a greeniſh

iſh precipitate is thrown down. The liquor is filtered in order to get the precipitate by itſelf, which is collected and put into a glaſs cup.

On pouring marine acid to the precipitate thus obtained, it immediately acquires a fine blue colour. This is called the *brightening* of Pruſſian blue. After ſtanding four and twenty hours it is diffuſed in a large quantity of water to waſh off the ſaline particles, and then dried. This is the *Pruſſian blue.*

THEORY OF PRUSSIAN BLUE.

During the calcination of the fixed alkali with the blood, the alkali becomes loaded with a great quantity of phlogiſtic matter. All the alkali, however, is not ſaturated with it; a part ſtill remains in a pure ſtate.

The alum is not at all neceſſary in making Pruſſian blue. It only ſerves, by the whiteneſs of its earth, to diminiſh the intenſeneſs of the colour; as will preſently be proved.

When the phlogiſtic alkaline lye is mixed with the ſolutions of alum and martial vitriol, the precipitate reſulting is of three kinds; 1. The earth of the alum precipitated by that portion of alkali which is not phlogiſticated; 2. A portion of the iron of the vitriol, not converted into Pruſſian blue, and which is alſo precipitated by the unphlogiſticated part of the alkali; 3. A true Pruſſian blue, formed by a portion of the iron of the vitriol, precipitated by the phlogiſtic matter contained in the alkali.

This latter precipitate does not appear of a blue colour as ſoon as it is formed, becauſe it is mixed and confounded with the other above-mentioned precipitates; but it becomes ſenſible on the addition of the marine acid, which diſſolves that portion of precipitated iron which is not converted into Pruſſian blue. This acid has little or no effect on the earth of the alum; and does not diſſolve the leaſt particle of the Pruſſian blue already formed, which is not acted upon by acids.

During this proceſs, two decompoſitions and two new combinations are effected. It is therefore an example of the double affinities which we mentioned as being produced by the mixture of four bodies.

Neither the vitriolic, nor any other acid, ſingly, has any action on the phlogiſtic or colouring matter combined with the alkali; neither has iron, ſingly, any action on it, nor is more capable of ſeparating it than an acid. But the united affinities of the iron and acid act together on the compound of alkali and phlogiſton: the iron ſeizes the colouring matter, with which it forms Pruſſian blue: the vitriolic acid, ſet at liberty, combines with the fixed alkali, and forms with it a vitriolated tartar. This is the theory of Pruſſian blue given by M. Macquer in a paper printed among the Memoirs of the Academy. His reſearches on this ſubject, and the theory he has deduced from them, may be regarded as a maſter-piece in their kind.*

It follows from what we have juſt ſaid, that without alum a Pruſſian blue may be made which ſhall not require *brightening*. This happens

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* It is rather ſurprizing that the abſolute neceſſity of ſome animal ſubſtance for the production of Pruſſian blue, did not lead M. Macquer to ſuſpect the fallacy of his theory. Some of the firſt chemiſts at preſent conſider Pruſſian blue as conſiſting of a phlogiſticated calx of iron united with an acid which Scheele and others have procured in a ſeparate ſtate, and to which they give the name of the *Pruſſian Acid*. M.

when that portion of alkali which is not phlogiſticated is ſaturated with an acid. For this curious experiment we are alſo indebted to M. Macquer's Memoir.

PRUSSIAN BLUE WITHOUT ALUM, WHICH DOES NOT REQUIRE BRIGHTENING.

Some phlogiſtic alkaline lye is put in a glaſs, and an acid of any kind is dropt in till no further effervеſcence is produced; and the liquor is then poured on a ſolution of martial vitriol. A fine Pruſſian blue that needs no brightening is inſtantly formed. The cauſe of this is that the phlogiſtic lye does not now contain a ſuperabundant alkali which may throw down a yellow precipitate of iron from the vitriol. The precipitate is now a pure Pruſſian blue.

DECOMPOSITION OF PRUSSIAN BLUE.

Acids have no action upon Pruſſian blue; but alkalies decompoſe it, by attacking its colouring matter. Fixed alkali loads itſelf with this matter to the point of ſaturation, and then does not act any longer on Pruſſian blue, or or affect its colour. What remains after the extraction of the blue colour is iron deprived of its colouring matter.

EXAMINATION OF ALKALI SATURATED WITH THE COLOURING MATTER OF PRUSSIAN BLUE.

This liquor has not the alkaline taſte.

It does not efferveſce with acids.

It does not change the blue juices of vegetables to green.

It does not precipitate the earth from ſalts with an earthy baſis.

It precipitates iron from a ſolution in any acid in form of a very fine Pruſſian blue.

It precipitates all metallic ſubſtances from their ſolutions in any acid, under different colours, which are peculiar to each of them.

We are indebted to Mr. Macquer for all theſe experiments and diſcoveries concerning the nature of Pruſſian blue.

ON LEAD.

Lead, or *Saturn*, is an imperfect metal, of a white colour with a bluiſh tinge. It has a taſte and ſmell peculiar to itſelf. Weighed in water it loſes between an eleventh and a twelfth of its weight. A leaden wire of a tenth of an inch diameter is only capable of ſupporting a weight of twenty-nine pounds and a quarter without breaking.

Lead is the ſofteſt of all the metals. It is not ſenſibly elaſtic. It extends eaſily under the hammer, and is beat into thin leaves.

Air and water act upon lead and tarniſh it. Its ſurface becomes covered with a whitiſh powder, which is nothing but the lead itſelf calcined by the air and water.

CALX OF LEAD.

Lead, expoſed to the fire, enters into fuſion long before it is red hot. When melted, its ſurface acquires a pellicle which is reproduced as faſt as it is taken off. This pellicle is the *calx of lead.*

MASSICOT.

Calx of lead, expoſed to a red heat, is more and more calcined, acquires at firſt a pale yellow colour, and at length becomes of a deep *aurora* yellow. In this ſtate it is called *Maſſicot.*

MINIUM.

Maſſicot, calcined in a reverberatory furnace with a heat not ſufficient to melt it, has its colour continually heightened, and acquires at length a fine red, approaching to that of vermilion. It is then called *read lead* or *minium.*

LITHARGE.

Maſſicot expoſed to a more intenſe heat ſuffers a ſemi-vitrification; its particles concrete into ſmall thin ſcales which ſtill preſerve their red colour; and it then bears the name of *litharge.*

GLASS OF LEAD.

Litharge or minium, expoſed to the fire in a crucible, enter into fuſion, and are converted into glaſs; but this glaſs has ſo much action upon earthy ſubſtances that it penetrates the crucible, and eaſily eſcapes through its pores.

To obviate this inconvenience, the calx of lead is mixed with vitrifiable earths, on which it exerts its action, facilitating their vitrification. The mixture brought into perfect fuſion forms a every tranſparent glaſs, called *glaſs of lead.*

REDUCTION OF CALX AND GLASS OF LEAD.

All the calxes, and even glaſs of lead, melted in a crucible with ſome fatty matter, reſume the phlogiſton which they had loſt, and are revived into lead.

SOLUTION OF LEAD IN THE NITROUS ACID.

The nitrous acid diluted with water, diſſolves lead very eaſily. The ſolution is clear, limpid and colourleſs.

SATURNINE NITRE.

The ſolution of lead in the nitrous acid, furniſhes, on cryſtalization, a ſalt of a dead white, called *ſaturnine nitre.* This ſalt decrepitates violently, and inflames, when expoſed to the fire in a crucible, without requiring the immediate contact of phlogiſton. The cauſe of this is, that the lead, although combined with the nitrous acid, ſtill retains a conſiderable portion of phlogiſton; which promotes the inflammation of the nitrous acid.

VITRIOL OF LEAD.

If to a ſolution of lead in the nitrous acid, the vitriolic acid, or any ſalt containing it, (vitriolated tartar, or Glauber's ſalt, for example,) be added, this acid diſpoſſeſſes the nitrous acid, and ſeizes the lead, falling down with it in form of a white powder, which is called *vitriol of lead.* This ſalt precipitates, becauſe it is little ſoluble in water.

PLUMBUM CORNEUM.

If to a ſolution of lead in the nitrous acid, marine acid, or any neutral containing it, be added, a white precipitate in form of a coagulum is immediately produced. This has the name of *Plumbum Corneum*, becauſe, when melted in a crucible, it acquires on cooling the tranſparency of horn. It is entirely ſoluble in water, and the liquor on evaporation yields little needled cryſtals.

MAGISTERY OF LEAD.

If to a ſolution of lead fixed alkali be added, it ſeizes on the acid, taking the place of the lead, which falls down in a white powder, named *magiſtery of lead.*

Some chemiſts aſſert that water by itſelf will precipitate lead diſſolved in the nitrous acid; but this only happens when the water employed is loaded with ſelenites, in which caſe it is the vitriolic acid, and not the water, that effects the precipitation.

ARTIFICIAL ORE OF LEAD.

Lead and ſulphur, melted together in a crucible, unite, and form a black, eager, brittle, flaky ſubſtance, which does not melt till after it is red hot. This is called *ſulphurated lead*, or *artificial lead ore.*

ANOTHER COMBINATION OF SULPHUR WITH LEAD.

When ſulphur in powder is thrown upon melted lead, and the mixture ſtrongly agitated, it forms a black, ſomewhat ſcaly powder, called *plumbum uſtum*, or *lead mineraliſed by ſulphur.*

LEAD CALCINED BY NITRE.

If lead and nitre are melted together in a crucible, a ſmall obſcure detonation takes place, and the lead is reduced to a reddiſh calx.

WHITE ENAMEL.

A mixture of calx of lead, calx of tin, ſand and alkaline ſalt, brought into fuſion by a ſtrong heat,

heat, forms a glaſs of an opake white, which is called *enamel.*

The white colour of this kind of glaſs proceeds from the calx of tin, which being very refractory, and not fuſible even by a violent heat, is only interpoſed in form of a fine powder between the particles of the glaſs.

CUPELLATION OF SILVER BY LEAD.

The facility with which lead is reduced to a calx or glaſs, cauſes it to be uſed as a medium for promoting the calcination and vitrification of the imperfect metals which happen to be mixed with gold and ſilver.

For example; when ſilver is alloyed with copper, it is melted with lead in a flat ſhallow crucible, made with the powder of calcined bones, which is called a *cupel.* A fire is made ſtrong enough to calcine and vitrify the lead. In this ſtate it vitrifies the foreign metal mixed with the ſilver, and cauſes it to be imbibed with itſelf by the cupel.

The

The cupel appears as if it were wet while in the furnace. During the time of the proceſs, a rotatory motion is obſerved proceeding from the centre to the circumference of the melted metal. This motion ceaſes when there is no more lead to be calcined; and at the ſame inſtant the ſilver appears more brilliant and ſhining. This inſtant is called the *lightning* or *fulguration*. The cupel is then taken from the fire, and the ſilver in it is called *cupelled ſilver*.

SILVER EXTRACTED FROM LEAD.

There is very little lead which does not contain a minute portion of ſilver, and ſometimes of gold.

To aſcertain this, a certain quantity of lead is ſubmitted to the cupel, and there remains, after every operation, from the thirtieth of a grain to a grain of the precious metals, to the ounce of lead. The Aſſayers of gold and ſilver term this product from lead the *witneſs*; becauſe, in their operations, it is put into the ſcale on the ſide of the weight, in weighing cupelled ſilver, in order to ſubſtract with exactneſs what the lead has left in cupelling the ſilver.

ON MERCURY.

Mercury, or *Quickſilver*, is a metallic matter always fluid, or at leaſt not loſing its fluidity without an exceſſive degree of cold. Although fluid, it does not wet or moiſten like other liquids; it only moiſtens and adheres to thoſe metals with which it is capable of uniting.

Mercury, by reaſon of its fluidity, forms a ſeparate claſs among metallic ſubſtances. It has all their general properties, and differs from them only in reſpect to ſome of its peculiar properties.

Mercury has the whiteneſs and brilliancy of ſilver.

It admits of being divided with extreme facility. Its globules always affect a convex figure when it is not applied to ſome metallic ſubſtance with which it can unite. It has the metallic opacity.

When weighed in water, it loſes about a thirteenth of its weight.

Mercury ſeems to attract duſt. When left in the open air its ſurface is inſtantly covered with the little bodies that float in the atmoſphere.

On January 6, 1760, there was a cold at Peterſburg which cauſed Reaumur's thermometer to deſcend about 33 degrees below the freezing point.* The opportunity of this natural cold was taken to excite a greater artificial cold; and by means of a mixture of ſmoking ſpirit of nitre, and pounded ice, which was of the temperature of the place, the thermometer was brought down to 186 degrees below the freezing point.† After this it was perceived not to vary. The thermometer was broke, and the mercury was found fixed. Several ſtrokes of the hammer were given to its convexity, by which it was flattened like a piece of lead without ſplitting or cracking; but as ſoon as it began to loſe its intenſe cold, it returned to its uſual fluidity.‡

This

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* Equal to about 60 degrees below the freezing point, or 28 below 0, of Fahrenheit's.

† Equal to about 338 below the freezing point, or 306 below 0, of Fahrenheit's.

‡ By Mr. Hutchinſon's experiments, it is demonſtrated, that quickſilver congeals and becomes ſolid at 40 below 0; and that the

This is a very intereſting diſcovery both with reſpect to Phyſics and Chemiſtry; but ſtill more ſo to Alchemy. The artiſts in this branch have a fine field opened for attempts to take away from mercury this ſuperabundant central fire, (if I may uſe the expreſſion) which gives it its fluidity by keeping it always in fuſion.

MERCURY PRECIPITATED PER SE.

Air and water have no action upon mercury.

If it be expoſed in a flat veſſel to a very long continued heat, its ſurface calcines, and is converted into a red, ſhining, ſcaly powder, called *mercury precipitated per ſe*.

This operation is very tedious, laſting even for years. Only a ſmall quantity can be put into a ſingle veſſel; on which account it is proper to multiply them when we want to get a good deal.

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the ſudden contraction of the mercury at that point (which led other philoſophers into an error in marking its freezing temperature) is not owing to an increaſe of cold proportional to that which cauſed its progreſſive contraction before it had arrived at congelation. M.

VITRIOL OF MERCURY FOR MAKING TURBITH MINERAL.

To mercury in a retort double its weight of oil of vitriol is added, and the mixture diſtilled. There paſſes over a little vitriolic acid, which is become ſulphureous by combining with the phlogiſton of the mercury. The ſaline maſs remaining in the retort is cryſtaline and very white. It is a compound of mercury and vitriolic acid; and is called *vitriol of mercury.*

TURBITH MINERAL.

If vitriol of mercury be diffuſed in a large quantity of boiling water, a very heavy precipitate is immediately formed, of a fine bright yellow colour. This precipitate waſhed and dried bears the name of *yellow precipitate* or *turbith mineral.*

YELLOW PRECIPITATE OF MERCURY MADE BY FIXED ALKALI.

During the lotion of the vitriol of mercury, a part of the ſaline maſs diſſolves in the water. If

If fixed alkali be added to this liquor it ſeizes the vitriolic acid which held the mercury in ſolution, and throws down a precipitate of a yellow colour, but a good deal paler than the preceding.

TURBITH MINERAL CRYSTALISED.

If, inſtead of pouring fixed alkali into the water which has waſhed vitriol of mercury, it be evaporated and cryſtaliſed, it furniſhes a ſalt in little needled cryſtals.

MERCURY DISSOLVED IN THE NITROUS ACID.

The nitrous acid diſſolves mercury with efferveſcence and heat. The ſolution is almoſt colourleſs.

MERCURIAL NITRE.

On cryſtaliſing this ſolution, it yields a ſalt figured in long needles, which melts on burning coals, much in the ſame manner as lunar cryſtals.

COPPER WHITENED BY MERCURY.

When a piece of copper is plunged into a ſolution of mercury in the nitrous acid, the copper diſſolves, and precipitates the mercury, which fixes upon its ſurface, and forms a kind of ſilvering, of conſiderable brilliancy, but not very durable.

RED PRECIPITATE.

The ſolution of mercury, or the ſalt to which we have given the name of mercurial nitre, after being dried and calcined in a matraſs, loſes almoſt all its acid. The remaining maſs takes at firſt a yellow colour, and then a pretty deep fine red. In this ſtate it is called *red precipitate.* This preparation always retains a certain portion of nitrous acid.

TURBITH MINERAL OBTAINED BY THE MIXTURE OF VITRIOLIC SALTS WITH A SOLUTION OF MERCURY IN THE NITROUS ACID.

If ſolution of mercury in the nitrous acid be poured to a ſolution of Glauber's ſalt, vitriolated tartar,

tartar, or any vitriolic ſalt with an earthy baſis, a white precipitate is immediately produced, which, however, becomes of a very fine yellow on waſhing it in water.

In this experiment, two decompoſitions and two new combinations are effected. The nitrous acid quits the mercury to unite with the alkaline baſis of the Glauber's ſalt or vitriolated tartar, or the earthy baſis of the earthy vitriolic ſalts. The vitriolic acid of theſe ſalts unites with the mercury, and forms a vitriol of mercury, which precipitates, becauſe it is ſoluble only in a large proportion of water. When the mixture is diffuſed in a ſmall quantity of water, the precipitate is white, becauſe the vitriolic acid is ſtill united to the mercury. But when the precipitation is made in a large quantity of water, or the precipitate is waſhed, it appears of a yellow colour, becauſe the vitriolic acid quits the mercury to unite with the water.

The liquor that ſwims above retains, however, a ſmall quantity of mercury in ſolution. By evaporation and cryſtalization it yields cryſtals of mercurial vitriol, which are diſpoſed in needles. Theſe cryſtals, waſhed in a good deal of of water, loſe more and more of their acid, and furniſh a turbith mineral ſimilar to the preceding.

MERCURY PRECIPITATED FROM THE NITROUS ACID BY FIXED ALKALI.

If fixed alkali be added to a ſolution of mercury in the nitrous acid, the mercury is precipitated in form of a brick-duſt coloured powder. The powder is waſhed and dried. Its red colour proceeds from the great quantity of phlogiſton which the alkali contains, and which paſſes to the mercury.

WHITE PRECIPITATE OF MERCURY.

When marine acid, or a ſolution of ſea-ſalt, is poured into a ſolution of mercury in the nitrous acid, a white precipitate is immediately thrown down in form of a coagulum.

This precipitate is a ſalt of little ſolubility in water, compoſed of the marine acid and mercury. On this occaſion, the mercury quits the nitrous acid to unite with the marine, with which it has a greater affinity. If ſea-ſalt be uſed inſtead of its acid, the nitrous acid unites with the marine alkali, and forms with it quadrangular nitre.

CORROSIVE SUBLIMATE.

A powder compoſed of equal parts of martial vitriol, ſea-ſalt, and mercurial nitre is put in a matraſs, and expoſed to the heat of a ſand bath. Several decompoſitions take place. The nitrous acid of the mercurial nitre evaporates: the vitriolic acid of the martial vitriol decompoſes the ſea-ſalt: the acid of the ſea-ſalt attacks the mercury, and ſublimes with it to the upper part of the matraſs in form of a white ſemi-tranſparent ſalt. This ſalt is in long needles when the fire has been moderate, but in a very white maſs when it has been ſomewhat ſtronger. The maſs, which is a compound of marine acid and mercury, is called *corroſive ſublimate*, and is one of the moſt violent poiſons.

CAPUT MORTUUM OF CORROSIVE SUBLIMATE.

There remains at the bottom of the matraſs after the ſublimation of corroſive ſublimate a reddiſh brown, very compact maſs, which contains

tains the iron of the martial vitriol, and Glauber's ſalt.

After waſhing the reſiduum in water, the Glauber's ſalt is obtained by cryſtalization.

During the lotion, a reddiſh brown powder is ſeparated, which is the iron of the vitriol deprived of all acid and phlogiſton. It is of the ſame nature as that which we have named *ſweet earth of vitriol.*

MERCURIUS DULCIS.

Corroſive ſublimate is a metallic ſalt with a ſuperabundance of acid: it does not attract moiſture from the air; it diſſolves entirely, but difficultly, in water; it turns red the blue juices of vegetables, which proves its having a ſuperabundance of acid. It is in a ſtate capable of receiving an additional quantity of mercury, which it does in the proceſs for *mercurius dulcis.*

If four parts of corroſive ſublimate are triturated with three of running mercury, the ſuperabundant acid attacks and facilitates the extinction of the mercury, and the mixture acquires a grey colour. This mixture is ſublimed in the ſame manner as in the firſt operation. The product is ſimilar to corroſive ſublimate, but perfectly neutral, containing a much greater quantity of mercury. It is ſublimed twice more, after which it forms what is called *mercurius dulcis*, or *aquila alba.*

MERCURIAL PANACEA.

Mercurius dulcis, pulveriſed and ſublimed nine times more, is called *mercurial panacea.* Mercurius dulcis and panacea are much leſs ſoluble in water than corroſive ſublimate. They have neither taſte, nor any corroſive quality, becauſe, in theſe compounds, the marine acid is perfectly ſaturated with mercury.

PHAGÆDENIC WATER.

If a little ſolution of corroſive ſublimate be poured into lime water, a precipitate of a yellow colour is thrown down. This is not ſeparated from the liquor, which is called *phagædenic water.* The precipitate is formed by the alkaline

alkaline ſubſtance in lime water; and it is yellow, becauſe of a little phlogiſton which the lime water contains.

CORROSIVE SUBLIMATE DECOMPOSED BY FIXED ALKALI.

If fixed alkali be added to a ſolution of corroſive ſublimate, the mercury is precipitated in form of a brick-duſt coloured powder.

ÆTHIOPS MINERAL MADE WITHOUT FIRE.

Two parts of ſulphur and one of mercury, triturated together in a glaſs mortar, combine, and form a black powder, called *æthiops mineral.*

ÆTHIOPS MINERAL PREPARED BY FIRE.

To melted ſulphur an equal weight of mercury is added: a combination between them is preſently effected; the mixture is ſtirred, and there reſults a black maſs, which is afterwards reduced to powder. This is a ſecond manner of preparing the *æthiops.* Some authors recommend ſetting the mixture on fire with a view of conſuming part of the ſulphur; but by this means a great part of the mercury is alſo diſſipated.

ARTIFICIAL CINNABAR.

If either of the æthiops above-mentioned be expoſed to the fire in a matraſs, a more intimate combination takes place; the mixture ſublimes to the upper part of the veſſel in form of a very deep reddiſh-brown maſs. I have remarked that this matter requires one or two more ſublimations to be made perfect *cinnabar*.

VERMILION.

Cinnabar ground upon a porphyry loſes a good deal of the intenſeneſs of its colour, and becomes of a fine ſcarlet. It is then uſed by painters under the name of *vermilion*.

MERCURY REVIVED FROM CINNABAR.

If a mixture of iron filings and cinnabar in powder be urged by the fire in a retort, the mercury

cury of the cinnabar comes over into the receiver in its original form.

There remains at the bottom of the retort, in this proceſs, a *ſulphurated iron*, formed by a combination of the iron with the ſulphur of the cinnabar.

SMOKING LIQUOR OF LIBAVIUS.

Corroſive ſublimate is capable of being decompoſed by tin. If a mixture of theſe two ſubſtances be ſubmitted to diſtillation, the marine acid of the corroſive ſublimate quits the mercury to unite with the tin. The liquor that comes over is a very concentrated marine acid, which condenſes difficultly in the receiver. It contains a little tin in ſolution; and emits very thick white vapours. It is called the *ſmoking liquor of Libavius*.

SOLID BUTTER OF TIN.

Towards the cloſe of the diſtillation of the ſmoking liquor of Libavius, there ariſes to the vault of the retort a ſolid ſublimate, compoſed of tin and marine acid, which does not emit fumes. This may be named *ſolid butter of tin.*

MERCURY REVIVED FROM CORROSIVE SUBLIMATE.

The fire employed in the foregoing proceſs, being very gentle, is not capable of bringing over the mercury. It is found at the bottom of the retort, under its natural form, but mixed with ſome portions of tin, from which it may be ſeparated, and obtained very pure by diſtillation.

AMALGAM OF MERCURY AND GOLD.

Mercury unites with gold with great facility, and forms with it a compound called an amalgam. This is uſed for the gilding called *or moulu* [*ground gold.*]

AMALGAM OF MERCURY AND SILVER.

Mercury amalgamates with ſilver in the ſame manner, and their union ſerves to make the ſilvering called *argent haché* [*minced ſilver.*]

AMALGAM OF MERCURY AND TIN.

Mercury and tin combine in all kinds of proportions. Of this mixture, balls are made for purifying water. An amalgam of the ſame kind is alſo the matter uſed for ſilvering looking-glaſſes. The method of doing this, is to lay tin leaf upon a very clean piece of poliſhed glaſs, placed exactly horizontally; over which mercury is poured to the height of about half an inch. The whole is left in this ſtate for a certain time; after which one ſide of the glaſs is raiſed ſo that the greateſt part of the mercury, which is not converted into an amalgam with the tin, may run off. The glaſs is then diſpoſed ſo as to finiſh the draining of the mercury. The amalgam remains adherent to the glaſs by immediate contact.

ARBOR DIANÆ, OR THE PHILOSOPHICAL TREE.

If a ſmall piece of amalgam of mercury and ſilver be put into a ſolution of mercury and ſilver mixed and diluted in water, there ſprings, ſome time after, from the amalgam, a little ſilver ſhrub, which is not always of the ſame form. This vegetation is a mixed cryſtalization of ſilver and mercury, which appear with their metallic luſtre.

ON REGULUS OF ANTIMONY.

Regulus of antimony is a ſemi-metal of a brilliant white like that of ſilver. It has the opacity, weight, and fuſibility of metals; but it wants ductility, malleability and fixity: it conſequently is of the number of the bodies that we have named *ſemi-metals*.

Weighed in water it loſes a ſeventh of its weight.

It does not melt till a little time after being red-hot.

SILVERY FLOWERS OF REGULUS OF ANTIMONY.

When regulus of antimony is ſubmitted to a violent heat in a pretty deep crucible, it is reduced to a calx. This calx becomes more and more calcined by the action of the fire, and ſublimes

limes in needled, ſilvery white flowers. Theſe are called *ſilvery flowers*, or, *ſnow of regulus of antimony*.

All the regulus is thus converted into flowers. Theſe are ſoluble in boiling water, but in very ſmall quantity, and very difficultly.

Theſe flowers ſhould be conſidered as a calx of this ſemi-metal. They are reducible into regulus by the addition of phlogiſton.

ON ANTIMONY.

Antimony is a mineral compoſed of nearly equal parts of ſulphur and regulus. It is ſeldom that this combination is made artificially, as nature furniſhes it abundantly ready formed. This mineral is the ore of regulus of antimony. It is of a grey ſlate colour, approaching to that of lead. It is diſpoſed in long ſhining needles, eaſy to break.

FLOWERS OF ANTIMONY.

Antimony, expoſed ſingly to the fire in half-cloſed veſſels, as, for example, in aludels, ſublimes entire, and is converted into differently coloured flowers. Theſe are what is called *flowers of antimony*. They have more or leſs of an emetic quality, in proportion to the degree of heat by which they have been raiſed. Their colour proceeds from the ſulphur, which ſublimes with the flowers of the reguline part.

REGULUS OF ANTIMONY, SEPARATED FROM ANTIMONY.

A mixture of antimony, tartar and nitre is thrown by ſpoonfuls into a crucible previouſly made red hot. A great detonation takes place each time. This muſt be ſuffered to ceaſe before freſh matter is added. When the whole is put into the crucible, the fire is raiſed in order to bring the matter into fuſion. The crucible is then taken from the fire, and broken when grown cool. A metallic button is found at the bottom, which preſents a ſtarry ſurface when the regulus has been well melted.

This regulus is covered with *ſcoriæ*, of which we ſhall preſently take notice.

The

The nitre, in this proceſs, detonates with the tartar and the ſulphur of the antimony. The tartar, in burning, yields a coaly matter, which gives phlogiſton to the regulus, and facilitates its union into a maſs. The tartar and nitre, after their deflagration, furniſh a fixed alkali, which diſſolves a little of the ſulphur of the antimony, and forms a true liver of ſulphur.

This liver of ſulphur holds in ſolution a certain quantity of regulus; and it is this mixture which forms the ſcoriæ that ſwim above the regulus. The ſtar upon the ſurface of the regulus proceeds from the ſymmetrical arrangement which the metallic particles take during their union.

GOLDEN SULPHUR OF ANTIMONY, EXTRACTED FROM THE SCORIÆ OF REGULUS OF ANTIMONY.

The ſcoriæ of regulus of antimony contain, as we have already obſerved, liver of ſulphur, which holds ſome regulus in ſolution. If this matter be boiled in water, and after filtration of the liquor, an acid of any kind be poured to it, an efferveſcence is produced, and an odour of rotten

rotten eggs ariſes, as on the precipitation of common liver of ſulphur. At the ſame time a red precipitate is thrown down, which, after waſhing and drying, forms what is called *golden ſulphur of antimony.*

MARTIAL REGULUS OF ANTIMONY.

Several metallic ſubſtances have a greater affinity with ſulphur than regulus of antimony has; and by means of this property are very fit for ſeparating the regulus from the ſulphur. Theſe metals are copper, tin, lead, ſilver, and iron; but iron is commonly made uſe of.

The practice then is to melt together crude antimony and points of iron nails. The iron ſeizes the ſulphur of the antimony, and forms a mixture of leſs ſpecific gravity than the regulus; which laſt therefore occupies the lower part of the crucible, while the ſcoriæ ſwim at top. The regulus thus procured is called *martial regulus of antimony.*

When well prepared it ought not to contain a particle of iron, and is abſolutely the ſame with that prepared without iron.

The proceſs by which the martial regulus is uſually prepared, conſiſts in adding to the iron and antimony while in fuſion, a mixture of tartar and nitre. The regulus thus procured is afterwards purified by repeated fuſions, but the method is tedious. By the proceſs I have pointed out, a ſingle fuſion only is neceſſary, provided a ſufficient degree of heat be given to melt the matter completely.*

Stahl gives the name of *ſuccinated ſcoriæ* to thoſe which ſwim above the martial regulus prepared with nitre and tartar, becauſe their colour approaches to that of amber.

STAHL'S APERIENT ANTIMONIATED SAFFRON OF MARS.

On boiling in water theſe ſuccinated ſcoriæ reduced to powder, they become conſiderably di-

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* The particular nature and advantages of Mr. Beaumé's method cannot be underſtood without referring to the detail in his larger work. We there find, that the fault of the common proceſs is in adding a proportion of iron, greater than is neceſſary to ſaturate the ſulphur of the antimony. The ſuperabundant part is therefore united with the regulus of antimony. Mr. Beaumé employs no more iron than is juſt requiſite for abſorbing the ſulphur, and puſhes the mixture with a ſudden and violent heat. J. A.

vided. The liquor is decanted after the groſſer parts of the powder have ſubſided; theſe groſſer parts are triturated and waſhed over again. The decanted liquors are united and filtered; the powder remaining on the filter is dried and detonated in a crucible with thrice its weight of nitre; the calcined matter is then waſhed and dried. This is *the antimoniated ſaffron of Mars, of Stahl.*

This preparation may be conſidered as iron calcined and deprived of all its phlogiſton, containing a little antimony reduced to a white calx by the nitre.

PURIFICATION OF GOLD BY ANTIMONY.

This practice is founded upon that juſt mentioned. The ſulphur of the antimony unites with the metals with which gold may be alloyed, and does not act upon the gold. A regulus of antimony is therefore formed, which precipitates with the gold, and occupies the bottom of the crucible.

The ſcoriæ which ſwim at top are ſeparated, and the operation is repeated twice more, that it may be certain no foreign metals remain.

The regulus of antimony united to the gold is ſeparated by keeping the mixture in a red heat long enough to diſſipate the regulus, when the gold is left behind pure. This proceſs cannot be performed without the loſs of a little gold; a ſmall quantity of which always remains in the ſcoriæ; beſides that the regulus, during its diſſipation, volatiliſes a part.

GREY CALX OF ANTIMONY.

On calcining antimony with a moderate heat, the ſulphur which it contains is diſſipated; and there remains a calx of the reguline part, which, on account of its greyiſh aſh colour, is called *grey calx of antimony.*

REGULUS OF ANTIMONY MADE WITH THE CALX.

This grey calx, brought into fuſion with phlogiſtic matters, yields a regulus of antimony.

GLASS OF ANTIMONY.

The grey calx of antimony, expoſed ſingly to an intenſe heat in a crucible, is converted into a tranſparent glaſs, of a brown colour more or leſs deep. This glaſs is a powerful emetic.

LIVER OF ANTIMONY.

If a mixture of equal parts of nitre and crude antimony be expoſed to the fire in a crucible, a ſtrong detonation enſues, the matter enters into fuſion, and, on breaking the crucible, there is found at the bottom a brown, opake, very brilliant maſs, which eaſily breaks. This is the *liver of antimony*.

It is covered with ſcoriæ almoſt ſimilar to thoſe of regulus of antimony. Theſe are ſeparated and thrown away as uſeleſs.

LIVER OF ANTIMONY WITHOUT ADDITION.

Liver of antimony may be made by ſlightly calcining crude antimony, and then melting it in a crucible; when it is turned into a vitriform maſs, ſimilar to the preceding, but of a deeper colour, and a ſomewhat different nature.

KERMES MINERAL, MADE BY FUSION.

If alkaline ſalt and crude antimony are melted together in a crucible, the ſulphur of the antimony combines with the alkali, and forms a liver of ſulphur, which diſſolves all the reguline part of the antimony. This mixture is of a deep red colour. It diſſolves entirely in a ſufficient quantity of boiling water, and paſſes with it through filtering paper. When the liquor cools, it becomes turbid, and lets fall a red powder, which is *kermes mineral made by fuſion*. It is waſhed and dried.

KERMES MINERAL MADE THE MOIST WAY.

Small bits of crude antimony are boiled in an alkaline lye. The ſulphur combines with the fixed alkali, and diſſolves a portion of the reguline part; which makes a true *antimoniated ſulphur of antimony*. The liquor while boiling is clear and tranſparent; but as ſoon as it cools, it becomes

becomes turbid, and depoſites a red powder which, waſhed and dried, is *kermes mineral.*

This is the common method of preparing kermes mineral, but the proceſs is tedious. It is better to uſe antimony reduced to an impalpable powder, and throw it by ſmall quantities into the boiling alkaline liquor. The kermes forms in an inſtant; the liquor is filtered; and the ſame proceſs is repeated for the reſt. After the antimony has given, by this means, all the kermes it is able to furniſh, there remains a heavy powder, which is nothing elſe but that portion of regulus which is more than the liver of ſulphur, formed in this proceſs, can diſſolve.

ROTROU'S SOLVENT.

Crude antimony mixed with three parts of nitre, and expoſed to the fire in a crucible, loſes all its phlogiſton by the action of the nitre. The mixture enters into a paſte-like fuſion; it is then poured on a marble, pulveriſed, and kept in a bottle. This is *Rotrou's Solvent.*

DIAPHORETIC ANTIMONY.

The maſs remaining on the marble is white and opake. It attracts moiſture from the air. The ſalts which it contains diſſolve in water, and a white powder falls down, which, well waſhed and dried, bears the name of *diaphoretic antimony*.

ANTIMONIATED NITRE.

The liquor which has ſerved to waſh the diaphoretic antimony contains a portion of the fixed alkaline baſis of nitre, proceeding from the nitre which has been decompoſed by the ſulphur of the antimony: it alſo contains vitriolated tartar, formed by the vitriolic acid of the ſulphur united to the alkali of the nitre; and likewiſe ſome nitre which has not been decompoſed. On evaporating this liquor, thoſe ſalts are obtained by cryſtalization which are capable of cryſtaliſing. The nitre thus procured is called *antimoniated* or *ſtibiated nitre.* There remains a liquor which yields no more cryſtals. This is the alkali of the nitre, charged with a certain quantity of calx of antimony held in ſolution.

MATERIA PERLATA.

If, inſtead of cryſtaliſing the ſalts contained in the liquor ſeparated from diaphoretic antimony, an acid be poured into it, a white precipitate is formed, which is nothing elſe but a very refractory calx of antimony. This is called *materia perlata*, or *ceruſſe of antimony*. It reſembles diaphoretic antimony.

REGULUS OF ANTIMONY DISSOLVED BY AQUA REGIA.

The ſimple mineral acids do not diſſolve antimony: aqua regia alone is capable of attacking it. If pieces of crude antimony are thrown into aqua regia, it diſſolves the reguline part, but muſt be aſſiſted by heat.

SULPHUR SEPARATED FROM ANTIMONY BY AQUA REGIA.

If crude antimony reduced to a groſs powder be put into aqua regia, the reguline part diſſolves, and the ſulphur ſeparates and falls down under its uſual colour. This is abſolutely ſimilar to common ſulphur.

BUTTER OF ANTIMONY.

Common marine acid does not attack regulus of antimony; but if ſix ounces of regulus of antimony are mixed with ſixteen ounces of corroſive ſublimate, and the mixture diſtilled in a retort with a gentle fire, the marine acid of the corroſive ſublimate ſeizes the regulus, ſublimes with it, and condenſes in the receiver into a matter which cryſtaliſes on cooling. This is the *butter of antimony.*

MERCURY EXTRACTED FROM CORROSIVE SUBLIMATE AFTER THE DISTILLATION OF BUTTER OF ANTIMONY.

The mercury of the corroſive ſublimate is ſet free after the diſtillation of the butter of antimony. It remains at the bottom of the retort, becauſe it is leſs volatile than the butter of antimony; but, on raiſing the fire ſufficiently, it is brought over in its turn. After the diſtillation of the mercury, there is found, in the retort, a button of regulus of antimony, which is the portion

portion exceeding that which is taken up by the marine acid.

CINNABAR OF ANTIMONY.

If, inſtead of employing regulus of antimony for the preparation of the butter, one part of crude antimony and two of corroſive ſublimate be uſed, the butter is equally obtained, but the mercury is not ſet free as in the preceding proceſs; it is united to the ſulphur of the antimony. On augmenting the fire, a compound of mercury and ſulphur ſublimes to the neck of the retort, which is called *cinnabar of antimony*.

POWDER OF ALGAROTH.

Butter of antimony attracts the moiſture of the air, and reſolves into a liquor. If it be diluted in a large quantity of water, a white powder precipitates, which is waſhed and dried. This powder is the reguline part of the antimony deprived of all acid and almoſt all its phlogiſton. A ſmall portion of phlogiſton which it ſtill contains ought to be conſidered as the cauſe of its emetic quality, and not a pretended portion

tion of acid, which ſome perſons imagine to be left in it. This preparation has the name of *powder of algaroth.*

MARINE ACID GOT FROM POWDER OF ALGAROTH.

The liquor from whence powder of algaroth has been precipitated, contains the marine acid of the butter of antimony, and this acid holds in ſolution a little of the reguline part of the antimony. This liquor, on evaporation, furniſhes cryſtals of a ſalt of the ſame nature with butter of antimony.

BUTTER OF ANTIMONY DISSOLVED IN THE MARINE ACID.

In order to have a clear and limpid ſolution of regulus of antimony in the marine acid, butter of antimony is diſſolved in this acid.

BUTTER OF ANTIMONY DISSOLVED IN THE NITROUS ACID.

If nitrous acid be poured upon butter of antimony, the mixture heats conſiderably. A very briſk efferveſcence, accompanied by a great quantity of red vapours, enſues. The ſolution is of an amber colour. It remains clear during ſome time, and then forms a ſolution of regulus of antimony in aqua regia; but by degrees the nitrous acid acts upon the phlogiſton of the reguline part, calcines it, and it precipitates in a few days under the form of a white powder.

BEZOAR MINERAL.

A mixture of butter of antimony and nitrous acid is evaporated in a ſand heat, till nothing remains but a white powder. It is calcined three times ſucceſſively, adding each time ſome nitrous acid, in order to deprive it entirely of marine acid and phlogiſton. The product is called *bezoar mineral.*

ON BISMUTH.

Biſmuth is a white ſemi-metal, with a yellowiſh tinge, eager, brittle, moderately hard. Its broken ſurface preſents facets nearly reſembling thoſe of regulus of antimony.

Weighed in water, it loſes a tenth of its weight.

Air and water have no action upon it.

It eaſily melts. When vitrified, it is imbibed into the pores of the cupel, and may ſerve, as well as lead, to purify the perfect metals by the proceſs of cupelation. Expoſed to the fire in cloſe veſſels, it ſublimes entire, without loſing any of its properties.

SOLUTION OF BISMUTH IN THE NITROUS ACID.

The nitrous acid has a conſiderable action upon biſmuth. It diſſolves it with a briſk efferveſcence and conſiderable heat. The ſolution is of a dirty crimſon.

CRYSTALS OF BISMUTH.

This ſolution, ſet to evaporate and cryſtaliſe, yields a very ſhining white ſalt, but which eaſily loſes this quality when expoſed to phlogiſtic vapours.

MAGISTERY OF BISMUTH.

The ſolution of biſmuth, diluted with water, lets fall the biſmuth in form of a very fine white powder, which is the *magiſtery of biſmuth.* The nitrous acid leaves the ſemi-metal to unite with the water. This precipitate, waſhed and dried, is the *Spaniſh white.*

ON ZINC.

Zinc is a white ſemi-metal, with a caſt of blue, almoſt malleable, and very difficult to break, becauſe it has a degree of ductility. Weighed in water it loſes a ſeventh of its weight.

FLOWERS OF ZINC.

Zinc, expoſed to a ſtrong heat, enters into fuſion at the ſame time that it becomes red. When thoroughly penetrated by the fire, it inflames. Its flame is lively, bright, and yellowiſh. During its inflammation a great quantity of white, ſnowy, very light flakes eſcape from it, and riſe above the crucible. Theſe are called

called *philoſophical wool*, *pompholix*, or *flowers of zinc.*

Flowers of zinc, although they riſe in this manner, are not volatile. They are to be conſidered as the calx of this ſemi-metal. This calx is very refractory, and in the higheſt degree fixed.

ZINC DISSOLVED IN THE VITRIOLIC ACID.

The vitriolic acid diſſolves zinc with conſiderable effervecence. The ſolution has little colour. Set to evaporate, it furniſhes ſhining, tranſparent cryſtals, nearly reſembling thoſe of Glauber's ſalt. Theſe have the name of *vitriol of zinc*, *white vitriol*, or *white copperas.*

PURIFIED ZINC.

Sulphur does not combine with zinc; it ſerves as a medium for its purification. When it is ſuſpected that zinc is alloyed with other metals, it is melted with ſulphur, when the ſulphur unites with the foreign metals which have an affinity with it, and the zinc is found ſeparate at the bottom of the crucible.

BRASS.

Copper, melted with zinc, loſes its red and acquires a yellow colour, without loſing much of its ductility. This forms a compound metal, named *braſs* or *latten.*

SIMILOR TOMBAC, OR PRINCE'S METAL.

Different proportions of zinc and copper give mixtures of deeper or paler colours, approaching to that of gold. Theſe form the compounds called *pinchbeck*, *Prince Rupert's metal*, or *ſimilor.*

ON ARSENIC.

Arſenic is the calx of a ſemi-metal. It is in a white, cryſtaline, brilliant, tranſparent maſs, but ſoon becoming opake, yet without loſing its whiteneſs. Weighed in water it loſes a fifth of its weight. It has ſome properties in common with ſalts.

ARSENIC DISSOLVED IN WATER.

Arſenic diſſolves in almoſt all oily, ſpirituous, and watery liquors.

Its ſolution in water, on evaporation, yields red and irregular cryſtals.

REGULUS OF ARSENIC.

Arſenic, expoſed to the fire in cloſe veſſels, ſublimes entire, and preſerves its whiteneſs. It combines eaſily with phlogiſtic matters; and in that ſtate ſublimes in a ſcaly, brilliant, friable ſubſtance, which has the metallic opacity, weight and luſtre. This ſubſtance is called *regulus of arſenic.*

Regulus of arſenic is heavier than arſenic. It loſes an eighth of its weight in water.

EFFECT OF THE MINERAL ACIDS ON ARSENIC.

The mineral acids attack arſenic, or its regulus; but they make a bad ſolution.

ORPIMENT.

Sulphur combines with arſenic; and from their union there reſults a ſemi-tranſparent, very weighty maſs, of a yellow or red colour according to the proportion of ſulphur.

RED ORPIMENT, REAGAL, OR REALGAR.

If the proportion of ſulphur to arſenic be augmented, there reſults a red, ſhining, brittle ſubſtance, named *reagal*, or *riſigal*.

DECOMPOSITION OF NITRE BY ARSENIC.

If a mixture of equal parts of nitre and arſenic be diſtilled in a retort, the nitrous acid paſſes over in red vapours and condenſes. It carries over a little arſenic along with it, which gives it a ſmell of garlic.

NEUTRAL ARSENICAL SALT.

The ſaline maſs remaining in the retort is formed by the combination of the arſenic with the alkaline baſis of the nitre. This ſubſtance diſſolves

diſſolves entirely in water, and yields cryſtals of a regular form, which Mr. Macquer firſt obſerved, and named *neutral arſenical ſalt.*

NITRE ALKALISED BY ARSENIC IN THE OPEN AIR.

If nitre and arſenic mixed are thrown together into a red hot crucible, a ſmall detonation enſues, and the nitrous acid evaporates. The ſaline matter remaining in the crucible attracts the moiſture of the air, and diſſolves in water, but does not cryſtaliſe like that in the preceding proceſs.

SILVER PRECIPITATED BY NEUTRAL ARSENICAL SALT.

If ſolution of arſenical ſalt be poured into ſolution of ſilver, this metal precipitates as it unites with the arſenic. This precipitate is of a brick-duſt colour.

WHITE TOMBAC.

A mixture of copper and arſenic, melted together in a crucible, gives a compound metal, which is eager, brittle, and of a white colour. This is *white Tombac.*

MIXTURE OF ARSENIC AND TIN.

Arſenic renders all metals eager and brittle. When melted with tin, it gives it a good deal of ſtiffneſs and hardneſs, and the tin is diſpoſed in facets, like regulus of antimony. It is of an extremely brilliant ſilvery white.

After having thus examined each ſubſtance in particular, and in their ſtate of purity, we ſhall next examine the more compound minerals, beginning with thoſe which furniſh the ſaline mineral ſubſtances.

ON PYRITES.

Pyrites are bodies compoſed of a great quantity of ſulphur, a very ſmall portion of metallic matter, a greater or leſs quantity of argillaceous earth, and a little calcareous earth. There are pyrites which, beſides theſe ſubſtances, contain a greater or leſs proportion of arſenic.

All pyrites appear to be formed by a kind of cryſtalization; and, for the moſt part, have ſymmetrical figures. Some Naturaliſts have given

given the name of *marcaſites* to thoſe pyrites which are regularly cryſtaliſed; but theſe diſtinctions are too little eſſential to deſerve regard. We conſider as pyrites all minerals which have the general properties above-mentioned, and which are compoſed of the ſubſtances we have enumerated.

The figure of pyrites varies remarkably. There are ſome, globular, hemiſpherical, oblong, in cluſters, in cakes, quadrangular, in regular cubes, in hexahedras, in rhomboids, in octahedras, &c.

The colour of pyrites varies leſs than their figures. There are ſome, brown, reddiſh, white and ſhining like ſilver; which laſt always contain arſenic. Others are of a fine black, which takes a beautiful poliſh; theſe are ſometimes uſed for making buttons.

Pyrites are hard or tender. The firſt emit fire freely when ſtruck againſt ſteel: the ſparks are briſk, ſhining, and exhale a ſtrong ſmell of burning ſulphur.

PYRITES FALLEN INTO EFFLORESCENCE.

All pyrites fall into efflореſcence, and are reduced into powder, when expoſed alternately to air and moiſture. Thoſe which are very hard, undergo this change with difficulty; but their efflореſcence is haſtened by calcining them a little, and then moiſtening them with water, when they fall into powder.

VITRIOL EXTRACTED FROM PYRITES.

During the above proceſs, the ſulphur of the pyrites decompoſes, the phlogiſton is diſſipated, and the vitriolic acid, ſet free, diſſolves the metallic and earthy matters contained in the pyrites. This acid, united to metallic ſubſtances, forms ſo many vitriols, which are named from the metal that ſerves them for a baſis. Thus when the pyrite contains iron, it forms *martial vitriol*; when it contains copper, it forms *vitriol of copper*. Theſe are the only two metals which are mineraliſed in pyrites; and it is almoſt always theſe two ſpecies of vitriols which pyrites furniſh.

ALUM EXTRACTED FROM PYRITES.

A part of the vitriolic acid of the pyrites unites with the argillaceous earth which they contain, and forms alum.

SELENITES EXTRACTED FROM PYRITES.

When pyrites contain calcareous earth, a part of the vitriolic acid combines with this earth, and forms ſelenites.

Arſenical pyrites are not uſually worked for their arſenic, becauſe this ſubſtance is occaſionally got from minerals which furniſh metallic matters.

FLOWERS OF SULPHUR.

Pyrites which have not fallen into effloreſcence, diſtilled in a retort with a ſtrong heat, yield flowers of ſulphur, which ſublime to the vault of the retort.

The *caput mortuum* remaining in the retort is called *burnings of ſulphur*.

ROLL SULPHUR.

In works in the great, the ſulphur got by the diſtillation of pyrites is melted, and caſt into wooden moulds, where it fixes. During its fixing it takes the cryſtaline arrangement obſerved in the inſide of rolls of brimſtone, which is that of needles going from the centre to the circumference.

ON ORES.

What are called *ores* are mineral ſubſtances, in which metals are mineraliſed always by ſulphur or arſenic, and moſt frequently by both together. Gold muſt be excepted, which is never mineraliſed in mines, but only diſperſed through the *gangue*; platina is, perhaps, another exception.

The gangue, or matrix, is the ſtony matter, cryſtaliſed or uncryſtaliſed, calcareous or vitrifiable, which does not mineraliſe the metal, but is only interpoſed between the metallic particles, whether mineraliſed or not.

ORES* OF GOLD.

Gold is found in the bowels of the earth under an infinite number of different forms; but, as we have juſt obſerved, it is never mineraliſed by ſulphur or arſenic like the other metals; it is only diſperſed in earthy matters, without being combined: thus it is always in a *virgin* ſtate. When alloyed, it is commonly with metallic matters, ſuch as ſilver, copper, iron and lead. Peru contains the richeſt gold mines hitherto diſcovered.

Many rivers waſh down little particles of gold. Theſe are ſuch as flow through beds of gold ore.

ORES OF SILVER.

Unmineraliſed virgin ſilver is often met with in the bowels of the earth, under a great variety of forms. Some is in grains, ſome has a reſemblance of lace, of hair, of feathers, &c. But ſilver is uſually mineraliſed by ſulphur and arſenic, and often by both together.

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* The term *ore* is here improperly uſed, according to the preceding definition of it. J. A.

There are very few ores of ſilver, properly ſo called, that is, which do not contain other metals. Silver is moſt frequently found in lead ores; and ſome of theſe are even called ſilver ores by the workmen, becauſe the profit upon the ſilver is greater than upon the lead, although the product, in quantity, of the latter is greateſt. But chemiſts diſtinguiſh ores by the name of the metal which they yield in greateſt abundance, without regard to the value of metals. Thus, for example, when the weight of lead extracted from an ore exceeds that of ſilver, they call it a *lead ore containing ſilver*; and ſo of the reſt.

ORES OF LEAD.

Virgin lead is very rare; lead is almoſt always mineraliſed, like ſilver. Lead ores are generally formed in cubes heaped upon one another, and preſenting very large facets.

Lead ores in very ſmall cubes uſually contain more ſilver than the former.

There are many varieties of lead ore.

ORES OF COPPER.

Copper is pretty frequently met with in a virgin ſtate, but it is moſt commonly mineraliſed. It is often mixed and confounded with other ores. Copper ores are eaſily diſtinguiſhed, becauſe they have always ſomewhat of a blue colour on their ſurface, which is owing to a portion of the copper calcined and reduced to verdigris.

ORES OF TIN.

Virgin tin is very rare; it is even doubted whether it is ever met with. Tin is always mineraliſed by ſulphur and arſenic, and is ſeldom mixed with other metallic ſubſtances.

ORES OF IRON.

Virgin iron is not uncommon; but it is very ſeldom met with perfectly pure, and poſſeſſing the ſame properties with wrought iron. It is always impure and eager.

Iron

Iron ores are pretty generally of a brown or yellowiſh colour, and almoſt always ruſted on their ſurface.

ORES OF ZINC.

Ores of zinc are leſs numerous than other ores. The true ore of zinc is *lapis calaminaris.* Zinc is found mixed with ſeveral other ores, particularly thoſe of iron, whence it is extracted in very great quantity in the neighbourhood of Goſlar.

ORES OF BISMUTH.

Ores of biſmuth a good deal reſemble thoſe of lead. They are, like them, diſpoſed in facets; but have a yellowiſh caſt. Ores of biſmuth are frequently mixed with cobalt.

ORES OF ANTIMONY.

Ores of antimony are common. They are diſpoſed in needles or little cubes. Theſe ores are mixed with a good deal of ſulphur, and ſometimes with arſenic. They often contain other metals, as gold, ſilver, and lead.

In 1748, virgin regulus of antimony was found for the firſt time, in Sweden.

ORES OF MERCURY.

Virgin mercury is not uncommon. It is ſometimes found running; ſometimes mixed with earths, without being mineraliſed.

Mercury is uſually mineraliſed by ſulphur. Theſe mercurial ores are of a more or leſs vivid red colour; they bear the name of *native cinnabar.* This cinnabar is ſometimes mixed with arſenical matters.

ORES OF COBALT.

Ores of cobalt reſemble thoſe of antimony. Their ſurface is almoſt always covered with an efflореſcence of a dingy ſcarlet.

Theſe ores contain a good deal of arſenic, and it is from them that arſenic is uſually got. They alſo frequently contain a portion of biſmuth. Thoſe which contain cobalt alone are very rare.

Cobalt mines bring in a conſiderable revenue to Saxony, where the ores are worked with a good deal of intelligence. We ſhall give a brief account of the proceſſes.

ARSENIC EXTRACTED FROM COBALT ORE.

Cobalt ore is pounded, and expoſed to be calcined or torrefied in a furnace. During this operation it emits a great quantity of white ſmoke, which is condenſed in a very large horizontal chimney, placed on one ſide of the furnace. Theſe vapours, in condenſing, form a hard, half vitrified, ſemi-tranſparent maſs, white in certain ſpots, called *arſenic.*

REAGAL.

In other parts of the ſame chimney, theſe condenſed vapours are of a yellow or red colour, which proceeds from the greater or leſs proportion of ſulphur with which the arſenic is combined. The yellower part is called *yellow reagal*; the redder, *red reagal.*

CALCINATION OF COBALT ORE.

Cobalt ore which has been torrefied in the fire, has loſt all the ſulphur and arſenic it contained. When it ceaſes to fume, it is removed from the fire; and is then called *calcined cobalt ore.*

ZAFFRE.

Ore of cobalt thus torrefied, reduced to powder, and mixed with twice its weight of flints or quartz alſo powdered, forms the ſubſtance named zaffre. This is much uſed in painting blue on porcelain or delft ware.

AZURE BLUE.

Zaffre, mixed with fixed alkali, and brought into fuſion by an intenſe heat, is charged into a glaſs of a very deep blue. This is reduced to powder by means of an iron peſtle, and diſtributed in commerce under the name of *azure, enamel blue, azure blue, &c.*

SPEISS.

During the fuſion of the blue glaſs abovementioned, a ſubſtance ſeparates which is only half vitrified, and precipitates under the glaſs. This has the name of *ſpeiſs*. It is a compound of arſenic, of biſmuth in grains, of regulus of cobalt alſo in grains, and of a certain portion of the ore itſelf, which has not been able to vitrify completely, for want of being ſufficiently calcined. Great care is taken to ſeparate the ſpeiſs from the vitrified matter, becauſe it ſpoils its colour.

REGULUS OF COBALT EXTRACTED FROM ITS ORE.

If calcined cobalt ore be mixed with alkaline and phlogiſtic matters, and the mixture expoſed to a heat ſufficient to melt it, the metallic part ſubſides to the bottom of the crucible, and ſcoriæ ſwim above it.

BISMUTH EXTRACTED FROM COBALT ORE.

When a heat of ſufficient intenſeneſs is given to the above mixture, the button of metal at the bottom

bottom of the crucible is ſeparated into two parts, which are eaſily diſtinguiſhed. The upper part is the true cobalt; the lower biſmuth.

Theſe two ſemi-metals, though mixed and confounded in the groſs mineral, have no diſpoſition to unite; on the contrary, they ſeparate from each other during the fuſion of the ore, and arrange themſelves according to the order of their ſpecific gravity; the biſmuth, as the heavieſt, occupying the loweſt place.

ON REGULUS OF COBALT.

Regulus of cobalt is a ſemi-metal of a ſilvery white, very brilliant when newly produced, but ſoon tarniſhing in the air.

When well melted, its ſurface, like that of regulus of antimony, preſents a ſymmetrical arrangement of chaſed work, as if done with the graver.

This regulus is eager, brittle, of a moderate hardneſs, nearly the ſame with that of regulus of antimony.

Weighed

REGULUS OF COBALT COMBINED WITH LIVER OF SULPHUR.

Regulus of cobalt is incapable of contracting directly any union with ſulphur, but by the medium of a fixed alkali it unites with it ſo intimately, as not to be ſeparable except by ſolution in acids.

A KIND OF DECOMPOSITION OF REGULUS OF COBALT.

I melted together in a crucible, cobalt ore, alkaline ſalt, gypſum, and roſin. By this proceſs I obtained the metallic matter furniſhed by this ore in two different ſtates. 1. The greateſt part was combined with the liver of ſulphur formed during the fuſion, and ſwam above the ſcoriæ. This kind of regulus of cobalt is of a bronze colour, with large facets like biſmuth. 2. At the bottom of the crucible was found a ſemi-metallic, white, ſilvery regulus, a ſolution of which in the nitrous acid had a ſlight blue tinge. It did not form a ſympathetic ink with the marine acid, nor give a blue on vitrification

fication like common regulus of cobalt.* This reſolves one of the ſix problems which I propoſed in the *Gazette de Medicine*, and of which no ſolution has been given.

REGULUS OF COBALT CALCINED BY NITRE.

Regulus of cobalt and nitre, mixed and expoſed to the fire in a crucible, detonate ſlightly, after which the regulus remains calcined and mixed with the alkali of the nitre. This maſs is waſhed in water, and the liquor filtered. The powder remaining on the paper is a calx of cobalt.

REGULUS OF COBALT DISSOLVED BY THE VITRIOLIC ACID.

The vitriolic acid acts upon cobalt with difficulty. The ſolution is made in a retort, and the proceſs carried on as if for diſtillation. It is of a deep reddiſh colour.

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* It is this ſecond kind of regulus which Mr. Beaumé ſuſpects to be the *nickel* which is treated of as a new ſemi-metal by Cronſtedt, and has ever ſince been uſually added to the number. J. A.

SOLUTION OF REGULUS OF COBALT IN THE NITROUS ACID.

The nitrous acid attacks regulus of cobalt with impetuoſity. The colour of the ſolution is a dingy crimſon.

COBALTIC NITRE.

If a ſolution of cobalt in the nitrous acid be evaporated, it yields olive coloured cryſtals, which are deliqueſcent, and melt with the ſmalleſt degree of heat.

COBALT PRECIPITATED FROM THE NITROUS ACID BY FIXED ALKALI.

If a fixed alkali be added to ſolution of cobalt in the nitrous acid, the metal precipitates under the form of a powder of a purpliſh colour. This precipitate, waſhed and dried, and afterwards expoſed to a vitrifying heat with fuſible matters, gives a very fine blue.

COBALT DISSOLVED IN THE MARINE ACID.

The marine acid acts difficultly upon regulus of cobalt. In order to effect a ſolution it is neceſſary to uſe a diſtilling apparatus, and to return the acid upon the regulus. This ſolution appears of a pale green colour when cold, and a fine ſea green when hot. It makes a true *ſympathetic ink of cobalt.*

COBALT DISSOLVED IN AQUA REGIA.

Regulus of cobalt diſſolves eaſily in aqua regia. The ſolution is clear, and of a peach-bloſſom colour. It alſo makes a ſympathetic ink, but only in conſequence of the marine acid of the aqua regia.

SYMPATHETIC INK OF COBALT.

If a ſolution of cobalt in aqua regia be diluted with about four times its weight of ſoft water, and this liquor uſed to write with inſtead of ink, on good paper, the writing does not appear till the paper is warmed, when the traces of the pen are viſible under a fine ſea-green colour. This colour diſappears as the paper cools, and is renewed on warming it again; and thus alternately vaniſhes and re-appears for an indeterminate number of times.

It is very difficult to explain the cauſe of this phenomenon. The diſappearance of the colour does not proceed, as has been aſſerted, from the moiſture which it attracts during the cooling of the paper; ſince, if a paper written upon with this ink be expoſed to the vapour of boiling water in a cloſe veſſel, the characters become viſible as readily as if a dry heat had been employed. Further, if ſuch a paper be encloſed in a well-corked bottle, either dry or moiſt, and the bottle be heated by plunging it in boiling water, the writing appears and diſappears in the ſame manner as when heated in the common way.

In fine, I have made a ſtill more deciſive experiment than thoſe above-mentioned. I plunged a paper impregnated with this liquor in boiling water: it inſtantly took the colour proper to it in a heated ſtate. It muſt, however, be obſerved, that this colour is only momentary, as the boiling water diſſolves and carries away the ſympathetic ink from the paper.

Another phenomenon, not leſs difficult of explanation, is the ſingular property which regulus of cobalt has, not to form this ſympathetic ink except with the marine acid, or this acid in conjunction with the nitrous. Solutions of cobalt in the vitriolic and nitrous acids ſeparately, or theſe acids in conjunction, or mixed ſolutions of the ſeparate acids, do not form the ſympathetic ink. But if to each of theſe ſolutions marine acid be added, the liquor immediately acquires the property of giving a ſea-green colour by the aſſiſtance of heat.

It is then to the marine acid alone that this property is due; and it is the ſolution of cobalt in this acid only which yields this kind of ſympathetic ink, the traces of which on paper appear more vivid and deep without the mixture of nitrous acid. On the other hand, when made by the marine acid ſingly, it has the inconvenience of being leſs durable; the colour growing fainter every time the paper is warmed, and vaniſhing entirely after a certain period, which does not happen when the nitrous acid is added. All theſe phenomena appear to me very difficult of ſolution.

O N

EARTHY SUBSTANCES.

THE greater part of Naturaliſts have thrown a good deal of obſcurity on the nature of ſtones and earths, becauſe they have attended more to the external figure of theſe ſubſtances, in their attempts to claſs them, than to their true ſpecific characters. Since chemiſtry has occupied itſelf with this object, it has greatly elucidated this part of natural hiſtory. Mr. Pott is one of the chemiſts who has laboured moſt in this matter. He divides earthy ſubſtances into four ſpecies; the *vitrifiable*, *argillaceous*, *gypſeous*, and *calcareous*.

Before Mr. Pott, Stahl had admitted two kinds of earth only. The numerous experiments I have made on this ſubject will ſerve to confirm the opinion of Stahl, and to prove that there are only two ſpecies of earths, the *vitrifiable* and *calcareous.**

Upon the foundation of theſe experiments, I think myſelf authoriſed to advance that argillaceous earth is only a very divided vitrifiable earth, combined with the vitriolic acid, and reduced to a ſaline ſtate.

Gypſeous earth is only a calcareous earth combined with the ſame acid, and likewiſe reduced to a ſaline ſtate. Theſe two ſubſtances, clay and gypſum, conſequently are not pure earths, but ſalts with an earthy baſis, formed by nature. We ſhall firſt examine the properties of theſe four ſubſtances ſeparately; and then their effects with reſpect to each other.

ON VITRIFIABLE EARTHS.

Vitrifiable earths are the heavieſt and hardeſt of the ſimple earths. They are either in

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* Mr. Bergman, whoſe mineralogical authority at preſent is ſuperior to all other, has divided the ſimple earths into five, viz. 1. The calcareous: 2. The argillaceous: 3. Magneſia, or the Muriatic: 4. Terra Ponderoſa, or the Barytic earth: And 5. The ſiliceous, or vitrifiable earth. M.

regular cryſtaliſed maſſes, or in irregular uncryſtaliſed ones. They are alſo found in duſt of different fineneſs, when they bear the name of ſand.

Vitrifiable earths are not acted upon by acids or alkalies in the moiſt way:* they are all hard enough to ſtrike fire with ſteel: they do not imbibe moiſture from air or water: expoſed to the moſt intenſe fire they do not enter into fuſion; their particles only conglutinate a little, without having conſiſtence.

ON CLAYS.

I conſider clays, as I have above remarked, as vitrifiable earths in a very divided ſtate, and combined with a good deal of vitriolic acid. Theſe earths are ſometimes white; but are alſo found of all ſorts of colours. The pureſt clays are thoſe which are whiteſt.

Clays diffuſe themſelves in water: they adhere to the tongue; are ſoft to the touch; have

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* Vitrifiable earth is ſoluble in an acid which has been lately diſcovered, and which Bergman and Scheele have named the *fluor acid*. M.

a good deal of coheſion, and are eaſily formed by the wheel. When not perfectly dry, and expoſed too ſuddenly to the fire, they crack with a loud exploſion, and are reduced into powder. When mixed with water, and formed into a ſoft paſte, they ſwell by the fire, inſtead of cracking. They grow hard in the fire, acquire a good deal of body and ſolidity, and become capable of ſtriking fire with ſteel.

Theſe earths, expoſed to an intenſe heat, do not enter into fuſion when pure. They partly diſſolve in acids, and with the vitriolic acid form true alum; but by the moiſt way they are not acted upon by alkalies. They all contain vitriolic acid, on which account it is that they decompoſe nitre and ſea-ſalt; but I have remarked that they are not all equally furniſhed with this acid, thoſe which are perfectly white containing leſs than the others.

ON CALCAREOUS EARTHS.

Calcareous earths are the lighteſt of all the earthy bodies. All the ſpecies of it which are not formed by cryſtalization imbibe water when plunged into it, and thereby become conſiderably heavier

heavier than before. They are ſoluble in acids, are all very tender, and are worn by friction againſt hard bodies. Expoſed to an intenſe heat, they do not enter into fuſion, but are converted into quicklime.

ON GYPSUM.

What chemiſts name gypſeous earth, is a true vitriolic ſalt with an earthy baſis formed by nature.

It is found in irregular uncryſtaliſed maſſes, ſuch, for example, as gypſeous alabaſter, and plaſter ſtone. Cryſtaliſed maſſes are alſo met with, ſuch as common gypſum. Theſe ſubſtances being compoſed of calcareous earth and vitriolic acid, ought to be conſidered as of the ſame nature with what is called ſelenites.

The cryſtals of gypſum are formed by a great number of flakes, extremely ſmall, and applied upon each other. Their figure is a very acute angle, terminated at the baſe by a returning angle.

Theſe ſubſtances are tender, and eaſy to be ſcratched. When expoſed to a fire capable only of making them red, they loſe their water of cryſtalization, and become opake and friable; but when calcined by a ſtronger heat, the calcareous earth they contain is reduced to quicklime. In this ſtate, if they are pulveriſed and mixed with water, they form a paſte which hardens as they recover the water which they had loſt by calcination, and makes what is called *plaſter.*

Gypſeous earths expoſed to an extremely intenſe heat do not enter into fuſion, but loſe a great part of the vitriolic acid which they contained, and then approach nearer to the character of quicklime. This forms what the workmen call *burnt plaſter.*

Gypſeous earths before their calcination are not acted upon by acids; they diſſolve in water, in greater quantity only, but without undergoing any alteration. If they are boiled with fixed alkali, this ſalt ſeizes upon the vitriolic acid which they contain, forming a vitriolated tartar, and the remaining earth is now no more than a pure calcareous earth.

Gypſum diſſolves in water, but in very ſmall quantity; and it is this which ſpoils the well water of Paris, and of all the countries which abound in plaſter-ſtone.

The four kinds of earth, the general properties of which we have thus enumerated, are abſolutely unfuſible by the ſtrongeſt heat we can produce, when taken ſingly; but when combined two by two, there are mixtures which enter into fuſion, and are converted into a clear tranſparent glaſs.

A mixture of vitrifiable earth and chalk, of vitrifiable earth and gypſum, of vitrifiable earth and clay, and of chalk and gypſum, does not enter into fuſion.

FUSION OF EARTHS BY ONE ANOTHER.

Clay and chalk, and clay and gypſum, melt one another, and form a glaſs which is hard enough to ſtrike fire with ſteel.

This curious phenomenon was diſcovered by Mr. Pott, but no explanation of it is given by this able chemiſt. When I treat fundamentally on this ſubject, I propoſe to demonſtrate that this fuſibility ought to be attributed to the calcareous earth which is reduced to quicklime during the proceſs. The ſaline alkaline matter which forms during this calcination, becomes the flux of the vitrifiable earth, obliges it to enter into fuſion, and occaſions at the ſame time the vitrification of that portion of calcareous earth which has not become ſaline. The vitriolic acid contained in the clay and gypſum further facilitates this reciprocal fuſibility.

STONE-WARE.

A mixture of crude and of baked clay, reduced to a fine powder, and diluted with water to the conſiſtence of a paſte, forms a maſs capable of being turned by the wheel, and figured into veſſels of various ſhapes. Theſe veſſels dried and afterwards baked in a very ſtrong heat acquire a conſiderable hardneſs, on account of which property they have acquired the name of *ſtone-ware.*

In ſome places ſtone-ware is made with crude clay that is ſomewhat ſandy. Veſſels of this kind are as good as thoſe made with the above-mentioned mixture.

DELFT-WARE.

Common clay, mixed with ſand and diluted with water, may be turned by the wheel like the preceding mixture; and being afterwards baked with a moderate heat, it forms the *biſcuit* for delft-ware. Theſe pieces of biſcuit are covered with a coating of white enamel, made with vitreſcent matters and calx of tin. The pieces are put a ſecond time into the fire in order to melt the coating, which applies itſelf completely over the biſcuit. It then makes *delft-ware.*

GLAZED EARTH.

The pottery called glazed earth is made of a biſcuit ſimilar to that for delft-ware, but inſtead of a coating of enamel, it has one of calx of lead. The pieces are put into the fire in order to melt this coating, which thus forms a glaſs of lead, that applies itſelf to the biſcuit. This forms the *glazed earth*, which is the kind of pottery moſt in uſe for the table.*

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* The elegant pottery called *Queen's ware* is of this kind. Its biſcuit is compoſed of tobacco-pipe clay and ground flints. J. A.

ON PORCELAIN.

Porcelain [or china] is a ſemi-vitrified matter, made with clay and vitrifiable earths. Fine porcelain ought to have a perfectly white ſemi-tranſparency. Its body ſhould be very white; of a ſhining grain; a little granulated, and not ſmooth like glaſs, on its broken ſurface; and of hardneſs ſufficient to ſtrike fire with ſteel as well as a flint.

The coating of porcelain is a cryſtal glaſs. This ſhould be hard, perfectly clean and tranſparent, and applied very uniformly upon the porcelain.

MATERIALS OF FURNACES OF BAKED EARTH.

Furnaces for chemical purpoſes are alſo made with clay and ſand. Some workmen inſtead of ſand make uſe of ſtone ware reduced to a groſs powder, which anſwers better.

GLASS OF WINE BOTTLES.

Vitrifiable earth mixed with alkaline ſalts and a ſmall quantity of calcareous earth, forms the mixture which is the baſis of bottle glaſs. The metallic calxes which are commonly met with in the materials uſed in the compoſition of this kind of glaſs, are the cauſe of the colour met with in all wine bottles. The glaſs of Seve is coloured by a little iron. In ſome manufactories a very ſmall quantity of azure blue is mixed with the glaſs in fuſion, in order to give it a more agreeable colour.

GLASS ACTED UPON BY ACIDS.

If too great a quantity of calcareous earth be admitted into the compoſition of glaſs, it preſerves part of the properties of this ſpecies of earth. This forms a bad kind of glaſs, which is acted upon by the mineral acids. The wine bottles which come from Lorraine have this defect.

REAUMUR'S PORCELAIN.

Common bottle glaſs cemented with gypſum in powder, and made red hot, loſes a good deal of its tranſparence. It becomes of a milky white, and has a degree of tranſparency nearly the ſame with that of porcelain.

I attribute this change to the action of the vitriolic acid of the gypſum, which attacks the calcareous earth of the glaſs, and cauſes its particles to take another arrangement.

It is remarked that the broken ſurface of this glaſs is diſpoſed in threads, inſtead of being ſmooth and united. This glaſs reſiſts the fire nearly as well as glazed earth, and may ſerve for the ſame purpoſes in warming water quickly. We are indebted for this diſcovery to the late Mr. Reaumur.

WHITE GLASS, OR CRYSTAL.

The moſt beautiful glaſſes are thoſe made with ſand and fixed alkalies, both very pure. The

The longer they remain in a ſtate of fuſion, and the leſs alkali they contain, the harder, whiter and more ſolid they are. This forms the fine glaſs known by the name of *cryſtal*; into the compoſition of which calxes of lead are alſo ſometimes admitted, which vitrify during the fuſion, and give ſolidity to theſe kinds of glaſs.

FALSE TOPAZ.

A mixture of ſand and ceruſs, urged with an intenſe heat, and kept a long time in fuſion, forms a glaſs of lead, which is very hard, tranſparent, and of a yellow colour reſembling topaz when a little phlogiſton remains in it, but colourleſs when the phlogiſton is all conſumed.

STRAS.

A yellow glaſs of lead, mixed with a ſufficient quantity of white cryſtal glaſs, forms a leſs coloured, pretty hard glaſs, which is ſold under the name of *ſtras*.

FALSE RUBIES AND GARNETS.

All ſorts of colours are given to ſtras by means of metallic calxes. The calx of gold, known under the name of *purple powder of Caſſius*, gives it a lively red colour, and forms *falſe rubies* and *garnets*.

FALSE EMERALDS.

Calx of copper gives a green tinge to ſtras, and forms *falſe emeralds*.

FALSE HYACINTHS.

The different ſaffrons of Mars give red or aurora colours, more or leſs deep, according to the degree of calcination. This forms the *falſe hyacinths*.

FALSE SAPPHIRE.

The calxes of cobalt, eſpecially that which is precipitated from the nitrous acid by fixed alkali,

alkali, communicates to ſtras a fine blue colour, indeſtructible in the fire, and forms the *falſe ſapphire.*

FALSE AMETHYST.

Calxes of gold and cobalt mixed, give to glaſs a beautiful violet tinge, and form the *falſe amethyſt.*

FALSE OPAL AND VENETIAN GIRASOLE.

If a ſmall quantity of calx of tin be added to the compoſition of ſtras, it forms a brilliant, but ſomewhat opake glaſs. This is what, according to the proportions of the calx of tin, makes the *falſe opal*, and the *Venetian giraſole.*

WHITE ENAMEL.

Calx of tin, *minium* and ſand, mixed and melted together by an intenſe fire, form a white, opake, milky maſs, known under the name of *enamel.* It is this enamel which forms the coating of delft-ware.

COLOURED ENAMELS.

All ſorts of colours may be given to enamel by means of the metallic calxes above-mentioned; by augmenting or diminiſhing the doſes of which, varieties of all kinds are produced.

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MINERAL AND SALT-WATERS, AND ON NITRE.

ON MINERAL WATERS.

THE pureſt water that is found in the bowels, or on the ſurface of the earth, is always loaded either with a little earth in a divided ſtate which it holds in ſolution, or with ſelenitic matters. When the water contains only a ſmall quantity of theſe ſubſtances, it is not rendered unfit for drinking or culinary uſes.

When water in its courſe meets with veins of mineral matters which it is capable of diſſolving, it loads itſelf with a certain quantity of them,

them, and acquires taſte, colour, and often odour. It is then called a *mineral water*.

Some mineral waters are warm, when they have the name of *thermal waters*.

Some are cold; that is, are conſtantly ſome degrees colder than the temperature of the place where they are found.

Laſtly, ſome are neither hot nor cold.

The metallic matters moſt commonly met with in mineral waters, are iron and copper. Other metallic ſubſtances are very rarely contained in them; and there are no inſtances of gold and ſilver being found in any mineral water, although this is not abſolutely impoſſible.

Among the ſaline matters that are found in mineral waters, the vitriolic acid is always that which is met with in greateſt quantity, and next the marine acid: the nitrous acid is ſcarcely ever contained in them. Theſe acids, in general, are not in a detached ſtate in mineral waters, but almoſt always combined with the metallic

tallic matters above-mentioned. They are likewiſe combined with earths both of the vitrifiable and calcareous kind, and form ſo many ſpecies of ſalts with an earthy baſis.

Neutral ſalts with a fixed alkaline baſis are alſo very frequently contained in mineral waters; ſuch as vitriolated tartar, Glauber's ſalt, and ſea-ſalt. Nitre is rarely met with, and always in ſmall quantity.

There are ſome mineral waters, the acids of which are not perfectly ſaturated, and which have an acidulous taſte. They are called, on this account, *acidulous mineral waters.**

Other mineral waters have the common fixed alkali, or the marine alkali, for one of their predominant principles. Theſe waters, by means of their alkali, hold oily matters in ſolution. They are ſaponaceous, and lather like ſoap ſuds. For this reaſon they are called *ſaponaceous mineral waters.*

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* It has ſince been ſufficiently proved, that the acidulous taſte of theſe waters is owing to the *gas* or fixed air with which they are impregnated. J. A.

Sulphur is one of the principles of mineral waters. It is held in ſolution in them, ſeveral different ways.

1. By diviſion only. When theſe waters are expoſed to the air, their ſulphur precipitates almoſt totally, after a certain time, in form of a white powder.

2. When ſulphur is contained in the acidulous waters it is in a better ſtate of ſolution, and is therefore much longer in ſeparating from them when they are expoſed to the air.

3. In ſaponaceous mineral waters this ſubſtance is preſent in form of liver of ſulphur. Theſe mineral waters have an odour of rotten eggs, which acids render ſtill more ſenſible.

Certain mineral waters contain a volatile principle which appears of a ſpirituous nature. This principle is named *gas*. Experiments have ſhewn that this is only air intimately mixed with the water.* This gives to certain waters which are charged with mineral matters the pungent odour and taſte of ſparkling Champagne wine.

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* Not the common or atmoſpherical air, but fixable or mephitic air, J. A.

wine. Theſe mineral waters froth, ſparkle, and if ſhaken too briſkly, break the bottles. They inebriate like Champagne, but this effect is only momentary.

Theſe general facts are all that we can mention in a work like this. It would take up too much room to enter into details in order to ſhew how the principles contained in mineral waters are united to each other. We ſhall alſo excuſe ourſelves from giving the details of their analyſes.

ON SEA-WATER, AND THE WATER OF SALT PITS AND SPRINGS.

The ſalt waters of which we are now to ſpeak, all contain a little detached uncombined earth; a little calcareous ſelenites; a good deal of ſea ſalt which is uſed for ſalting proviſions; marine ſalt with an earthy baſis; and Glauber's ſalt.

The practices employed with reſpect to all theſe waters, have for their purpoſe the extraction of the ſea-ſalt ſeparate from all foreign matters. This is effected in different manners.

The methods uſed at different ſalt works are ſomewhat different, although tending to the ſame purpoſe: they turn upon certain circumſtances which cannot be entered upon at preſent. We ſhall only ſpeak of one of theſe methods, becauſe all theſe waters may be treated in the ſame manner in order to obtain their ſea-ſalt.

SCHLOT.

The brine is evaporated in large iron pans. At the beginning of the evaporation the detached earth and the ſelenites ſeparate and precipitate; and the ſelenites carries with it a great quantity of Glauber's ſalt. This precipitate forms a matter which has an earthy appearance, and is called *ſchlot* or *ſcratch* by the workmen. It is ſeparated with a good deal of care, becauſe it injures the goodneſs and purity of the ſalt.

SEA-SALT.

When no more ſchlot precipitates, the ſurface of the liquor, when the evaporation is carried to a certain point, is ſeen covered with a great number of little cryſtals of ſea-ſalt. The evaporation

poration is continued by a ſtrong fire when the ſea-ſalt is wanted only in very ſmall cryſtals; but it is managed ſlowly when large cryſtals are to be procured. Theſe are taken off as faſt as they form, and ſet to drain.

There remains at laſt a large quantity of liquor which refuſes to yield any cryſtals. Theſe liquors are called by chemiſts *mother-waters*; but that we are now ſpeaking of is called *bittern* in the ſalt works. Sea-ſalt cryſtaliſes in cubes and triangular pyramids.

BITTERN.

The bittern, or mother-water of ſea-ſalt, contains a great quantity of ſea-ſalt with an earthy baſis, and a little Glauber's ſalt.

MAGNESIA OF SEA-SALT.

On pouring fixed alkali into bittern, a white earthy precipitate is immediately thrown down, which is the *magneſia* of ſea-ſalt. The alkali unites with the marine acid which held the earth in ſolution, and forms with it a regenerated ſea-ſalt.

ſalt. Towards the end of the cryſtalizations the Glauber's ſalt which was contained in the bittern is procured.

SCALES.

During the evaporation of ſalt waters, a part of the ſchlot adheres to the bottom of the pan, along with a good deal of ſea-ſalt with an earthy baſis, a little common ſalt, and a good deal of Glauber's ſalt. All theſe ſubſtances are mixed and confounded. They are from time to time ſeparated from the bottom of the pans with chiſſels. Theſe are called *ſcales* by the workmen.

GLAUBER'S SALT PROCURED FROM SCHLOT.

The ſchlot is lixiviated with a good deal of cold water, in which the Glauber's ſalt, as being very ſoluble, diſſolves. By evaporation and cryſtalization large cryſtals of Glauber's ſalt are obtained.

EPSOM SALT.

When the cryſtalization of the Glauber's ſalt is interrupted by agitating the liquor when the cryſtals are about to form, it yields only ſmall irregular cryſtals, which bear the name of *Epſom ſalt*.

Glauber's and Epſom ſalt are therefore abſolutely one and the ſame ſalt, ſince they contain the ſame principles, and the former may be made with the latter. For this purpoſe, nothing more need be done than diſſolving the Epſom ſalt, and re-cryſtaliſing it. On the other hand, by interrupting the cryſtalization of Glauber's ſalt, Epſom ſalt may be made. This is all the difference between the two ſalts.*

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* This is only true with reſpect to the ſalt called *Epſom ſalt* in France. That which goes under this name (and alſo that of *ſal catharticus amarus)* in England, and which is obtained from the bittern of ſea-ſalt, differs from Glauber's ſalt in having for its baſis the earth ſo well known in medicine under the name of *magneſia*; whereas that of Glauber's ſalt is the foſſil alkali. The acid of both is the vitriolic. The addition of fixed alkali ſerves at once to diſtinguiſh the Epſom from the Glauber's ſalt; occaſioning a copious precipitation with the former, but producing no change with the latter. J. A.

OBSERVATIONS ON SEA-SALT.

Before we quit the ſubject of ſea-ſalt, it may be proper to make ſome further obſervations upon it, and on the matters which are contained in the waters which furniſh it.

1. The cryſtals of ſea-ſalt are always figured in cubes or triangular pyramids.

Thoſe which are cubical, are formed in the interior part of the liquor, where the air has no acceſs. Theſe cryſtals repreſent one cube enchaſed within another. That which forms the centre is of a milky white, and almoſt opake; it is a maſs of a vaſt number of ſmall cubes, heaped upon one another. The great cube is formed of ſaline laminæ or layers, tranſparent, incumbent one upon another. They are as it were ſeparated by diagonal lines, which terminate at each angle of the little central cube.

The cryſtals which are triangular, have been formed at the ſurface of the liquor.

2. Sea-ſalt is a perfect neutral, which cannot be decompoſed by the action of fire. Some perſons, however, ſuppoſe the contrary. They imagine that it ſuffers a part of its acid to eſcape when diſtilled *per ſe*, or when calcined in the open air, as is done in ſome ſalt works, in order to form the large maſſes called *loaves of ſalt*. It is true that common ſea-ſalt exhales a portion of marine acid when expoſed to the action of the fire, but this acid proceeds from the decompoſition of the ſea-ſalt with an earthy baſis, from which common ſalt is never free; and not from the ſea-ſalt with an alkaline baſis. Thoſe chemiſts who have ſuppoſed that common ſalt was decompoſed by the action of the fire, have entirely overlooked the exiſtence of this ſea-ſalt with an earthy baſis, which is mixed in more or leſs quantity with all the different kinds of ſalt in common uſe. I have ſeveral times made theſe experiments on ſea-ſalt perfectly freed from this earthy ſalt, and it never yielded an atom of acid, to whatſoever degree of heat it was expoſed.

3. The ſea-ſalt with an earthy baſis, although it cryſtaliſes with difficulty, yet mixes in cryſtalization along with that which has an alkaline baſis, and is even the cauſe why cubical cryſtals

are obtained vaſtly larger than when the ſea-ſalt is very pure.

SEA-SALT PURIFIED.

Common ſea-ſalt is diſſolved in water, the liquor filtered, and cryſtals of ſoda added, a few at a time. Theſe unite to the acid of the ſea-ſalt with an earthy baſis, and precipitate its abſorbent earth. When the precipitation ceaſes no more is added; the liquor is filtered, evaporated, and cryſtaliſed. The ſea-ſalt obtained by this method is of the moſt perfect purity, and does not give out any acid by the action of fire, without a medium.

ON SCHLOT.

The ſchlot ſeparated from brines in ſalt works, contains the ſelenites, and almoſt all the Glauber's ſalt. This laſt, though very ſoluble in water, nevertheleſs precipitates with the ſelenites during the evaporation; which proceeds from the great affinity which ſelenites, Glauber's ſalt, and ſea-ſalt with an earthy baſis have to each other.

ON NITRE.

Nitre, or *ſaltpetre* is a ſalt extracted from old rubbiſh.* In this rubbiſh is contained a good deal of nitre with an earthy baſis, and ſea-ſalt. In order to procure nitre with a fixed alkaline baſis, the following method is practiſed.

NITRE EXTRACTED FROM RUBBISH.

The rubbiſh of old plaſter is reduced to a groſs powder, and lixiviated with cold water. The liquor is paſſed through freſh wood aſhes, and then evaporated to a pellicle. During this proceſs a great quantity of ſea-ſalt is precipitated, which is taken away as uſeleſs. When the liquor is ſufficiently evaporated, it is carried into a cool place to cryſtaliſe. The cryſtals that form are called *nitre of the firſt boiling*. This is produced from the combination of the fixed alkali of the aſhes with the nitrous acid. The

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* Nitre is alſo got from the common ſoil, or vegetable mould, impregnated with putrefactive ſubſtances, and expoſed to the air. J. A.

NITRE OF TWO BOILINGS.

The aſhes through which the lye of the rubbiſh is paſſed, furniſh a fixed alkali, which decompoſes a part of the ſea-ſalt and of the nitre with earthy baſes.

We have remarked that a large quantity of ſea-ſalt is ſeparated, which precipitates during the evaporation of the liquor. There ſtill remains, however, a good deal, which cryſtaliſes indiſtinguiſhably with the nitre.

This nitre of the firſt boiling is diſſolved in a ſmall quantity of water. The nitre is more ſoluble than the ſea-ſalt, diſſolves the firſt, and in the greateſt quantity. The undiſſolved ſea-ſalt is ſeparated, and the liquor evaporated. It yields a nitre purer than the former, ſince it is freed from the greateſt part of its ſea-ſalt: it ſtill, however, contains ſome. This is called *nitre of two boilings.*

NITRE OF THREE BOILINGS, OR REFINED SALTPETRE.

The proceſs above-mentioned is repeated on the nitre of the ſecond boiling. The ſaltpetre is now procured in a vaſtly purer ſtate, and without any ſea-ſalt, when the operation has been well conducted. It is called *purified or refined nitre*, or *nitre of three boilings*. Among the nitre cryſtaliſed in great works there are very often met with large beautiful cryſtals of nitre, in long needles, which the workmen call *nitre in ſticks*.

Nitre of three boilings is ſufficiently pure for gunpowder, and for the other uſes to which it is applied in the arts; but for medical purpoſes it is made to undergo another purification.

ON THE VEGETABLE KINGDOM.

VEGETABLES are organiſed bodies, which extract from the earth the juices proper to their nature. Vegetable ſubſtances are much more compound than mineral. Their analyſis is conſequently more difficult: certain principles, of too great tenuity or volatility, eſcape us entirely.

The action of menſtrua, of fire, and of the other means uſed for the analyſis of vegetable ſubſtances, often produce ſuch conſiderable alterations in them, as entirely to change their nature.

The order we ſhall follow in theſe analyſes or decompoſitions, will be firſt to examine the ſubſtances extracted from vegetables by means which do not occaſion any alteration in them.

ON THE JUICES OF PLANTS.

In order to extract the juices of plants, they are pounded, while recent, in a marble mortar with a wooden peſtle, and then put to the preſs. By this method a liquor is extracted which contains the principles of the vegetable, without having undergone any change.

CLARIFICATION OF JUICES.

Theſe juices, immediately after their ſeparation, are turbid, on account of a part of the bruiſed plant which they contain, and of the reſinous matter which is in a ſtate of imperfect ſolution. In order to clear them, the white of one or more eggs is beat up with them, and they are juſt brought to boil over the fire. During this proceſs, the white of egg involves and brings with it to the top in form of a ſcum all the matter that was not perfectly diſſolved in the juice.

In this manner the greater part of juices are clarified, which are then called *depurated juices.*

ESSENTIAL SALTS EXTRACTED FROM THE JUICES OF VEGETABLES.

On evaporating great part of the ſuper-abundant moiſture of theſe juices, they yield, after a certain time, cryſtals of ſalts which differ in their nature according to the different ſpecies of the vegetables. The greater number of theſe juices contain all the mineral ſalts with a fixed alkaline baſis; as Glauber's ſalt, vitriolated tartar, and nitre; but theſe are not the true eſſential ſalts of vegetables.

Thoſe which more properly bear this name are of a different nature. They are ſuch as preſerve ſome of the properties of the vegetable, and in the compoſition of which there enters a certain quantity of oil; whereas no oily matter enters into the compoſition of the mineral ſalts.

EXPRESSED OILS.

The ſeeds termed oily or *emulſive* yield by contuſion and expreſſion an unctuous inflammable juice, called *fatty oil.* All theſe oils are mild and inodorous, thoſe excepted which are extracted from the ſeeds of umbelliferous plants, which

which yields oils of another nature, to be ſpoken of under the article of eſſential oils.

Among the mild oils extracted in this manner, ſome are fluid, as thoſe of ſweet almonds, of nuts, &c. others very thick, and even ſolid, as the oil or butter of cacao, oil of nutmegs, &c.

COMBINATION OF FATTY OILS WITH VITRIOLIC ACID.

The vitriolic acid unites with fatty oils with heat and effervefcence, and a ſtrong odour of ſulphureous acid. The mixture becomes black, and of a reſinous conſiſtence, ſimilar to turpentine.

ANALYSIS OF ARTIFICIAL RESINOUS MATTER.

This artificial reſin, ſubmitted to diſtillation, yields a ſulphureous acid, a little ſulphur which ſublimes at the cloſe of the diſtillation, and oil, according to the proportions that have been employed.

INFLAMMATION OF FATTY OILS BY THE NITROUS ACID.

The ſmoking nitrous acid unites to fatty oils with prodigious activity. On mixing them, ſo conſiderable

conſiderable a heat is produced, that many of them inflame. After the inflammation the coaly matter of the oil remains.

All the fatty oils do not inflame with the nitrous acid ſingly. The concurrence of the vitriolic acid is neceſſary to ſeveral. The oils of this kind are oil of olives, oil of ben-nuts, oil of pinks, &c. The chemiſts who appear to have laboured moſt on this ſubject, have given nothing ſufficiently accurate, either on the theory of the inflammation of theſe oils by nitrous acid alone, or on the effect of the vitriolic acid in thoſe caſes where its concurrence is neceſſary for the inflammation.

It has been aſſerted that the effect of the vitriolic acid is to dephlegmate the nitrous acid, and give it more ſtrength; but in order to reaſon well upon an operation, we muſt begin with ſtudying the nature of the ſubſtances that concur in it.

The fatty oils all reſemble each other in their general properties, as unctuoſity, inflammability, &c. but they differ in ſome particular properties which, however, are common to a number of individual kinds. It is to theſe different properties of fatty oils that we ought to attribute the different facility with which they inflame, either with the nitrous acid ſingly, or with this acid joined with the vitriolic.

After a great variety of experiments made upon oils, I have found that there are ſeveral which poſſeſs the property of drying in the air, or of being converted in time to a thick, truly reſinous matter. Thoſe of this claſs are known to the painters by the name of *drying oils*. All theſe readily inflame with the nitrous acid ſingly; and thoſe of this kind which dry the ſooneſt, inflame the moſt eaſily. Linſeed oil may be placed at the head; and of all the fatty oils it is that which is moſt frequently and ſucceſsfully uſed for the experiment. Eſſential oils, which, it is well known, ſooner evaporate and thicken in the air, are for this reaſon more readily inflamed by the nitrous acid ſingly, than any of the fatty oils.

I think myſelf ſufficiently authoriſed to aſſert, that the effect which the vitriolic acid produces on thoſe fatty oils which cannot be inflamed without its aſſiſtance, is to change their nature

nature, and make them reſemble reſins. It ſeparates their mucilaginous principle, and ſeizes the water which is a principle of theſe oils; in fine, it reduces them to the ſtate of the drying oils which inflame with the nitrous acid ſingly.

I have mixed olive oil with the vitriolic acid, and when the effervеſcence was over, have waſhed in water the reſin-like matter, in order as much as poſſible to take out the acid. This matter, mixed afterwards with ſmoking ſpirit of nitre, inflamed as eaſily as pure linſeed oil. Thus, in this experiment, it is certain that the nitrous acid is not dephlegmated by the vitriolic. When a mixture of theſe two acids is poured upon oil olive to inflame it in the common method, the ſame thing takes place; that is, the oil is converted into a reſinous maſs: but this is done inſtantaneouſly, and the inflammation uſually follows very ſpeedily.

With reſpect to the theory that has been given of the inflammation of oils by the nitrous acid, it ſeems to me defective. It is pretended, 1. that the fungus formed during the tumefaction of the oil with the mineral acids is charcoal; 2. that

2. that this coal forms an aſh which produces nitre with the nitrous acid.

But it is very certain that the fungus in queſtion, whether produced by the vitriolic acid, the nitrous acid, or both in conjunction, has nothing of the nature of a coal. When ſubmitted to diſtillation it yields all the principles that oil affords.

As to the ſuppoſed production of nitre from the combination of the nitrous acid with the fixed alkali of this pretended coal, this is alſo an error. In order to effect this combination, a complete combuſtion of part of the oil would be previouſly neceſſary; which does not happen: beſides, it is known that oils yield little or no alkali by combuſtion.

I imagine the inflammation of fatty oils with the nitrous acid is owing to a portion of nitrous ſulphur, which is formed by the combination of the nitrous acid with phlogiſton. This nitrous ſulphur is very inflammable; and the heat excited by the mixture is more than ſufficient to inflame it.

WHITE SOAP.

Fixed alkali of ſoda, rendered more cauſtic by quicklime, and then put to olive oil, forms a mixture which in the ſpace of ſome days acquires a good deal of conſiſtence, and is then called *ſoap*. In order to prepare it, a pound of ſoap lye is mixed with two pounds of olive oil, and the mixture triturated with a wooden peſtle till it has acquired the conſiſtence of a very thick ſoup. It is then poured into moulds of the form required. In the ſpace of ſome days it acquires a ſolid conſiſtence; it is then taken out of the moulds, and expoſed to a dry air, which completely hardens it.

DECOMPOSITION OF SOAP BY ACIDS.

If an acid be put into ſoap-water, it decompoſes the ſoap. The acid unites to the alkali, and ſeparates the oil from it, which ſwims at top. Well waters loaded with ſelenites produce the ſame effect by means of the vitriolic acid they contain. On this account they will not lather with ſoap.

BALSAM OF SULPHUR, MADE WITH FATTY OILS.

Fatty oils diſſolve ſulphur with the aſſiſtance of heat. This compound bears the name of *Ruland's balſam of ſulphur*, when oil of nuts has been employed. Oils when hot hold more ſulphur in ſolution than when cold; hence theſe balſams in cooling depoſite a part of their ſulphur.

EMULSIONS.

The ſeeds which we have called oily or emulſive, ground in a marble mortar with water, form a liquor as white as milk. This has the name of an *emulſion.*

In this mixture, the oil is united to the water, by favour of the mucilaginous matter contained in the oily ſeeds. It is this oil, prodigiouſly divided, which produces the milky whiteneſs of emulſions.

ON MUCILAGES.

The greater part of the oily ſeeds contain a good deal of mucilage which diſſolves in water. Linſeed is of this number: boiled in water it gives

gives out a very ſoft mucilage, which has only a ſlight maukiſh taſte, and reſembles glue.

PLASTERS.

Fatty oils by the aſſiſtance of heat combine with certain metallic calxes. When combined with calxes of lead, a ſpecies of *metallic ſoaps* are formed, which bear the name of *plaſters*.

SPIRITUS RECTOR OF PLANTS.

When an aromatic plant is diſtilled along with water in a water-bath, there riſes, with a degree of heat leſs than that of boiling water, a very ſmall quantity of an extremely odorous liquor named *ſpiritus rector*. This liquor contains almoſt all the odour of the vegetable; is not inflammable; and loſes its ſmell in a ſhort time in the open air, without any loſs of weight.

ESSENTIAL OILS.

If an aromatic plant be diſtilled along with water by a naked fire, there riſes, at the boiling heat, *ſpiritus rector*, and water charged with an oil which either ſinks to the bottom, or ſwims on the ſurface. This oil is called an *eſſential oil*.

The eſſential oils of foreign aromatics are almoſt all heavier than water; but thoſe extracted from all the vegetables of this country, are lighter than water, and ſwim on its ſurface.

EXTRACTS OF VEGETABLES.

The decoction of the plant which remains in the alembic after the diſtillation of its eſſential oil, is loaded with the ſaline extractive parts of the plant. On evaporating this liquor ſufficiently, there remains a honey-like matter, which is called an *extract.*

EXHAUSTED PLANTS.

The plant remaining in the alembic, on being repeatedly boiled with freſh water, gives out all the ſoluble matter it contains. There is left at laſt only the ſkeleton or ligneous part of the vegetable.

RECTIFICATION OF ESSENTIAL OILS.

Eſſential oils, on long keeping, loſe a great part of their odour, and are conſiderably thickened. They ſometimes even entirely loſe their odour.

When their odour is not quite gone, they are rectified in a retort, in order to ſeparate the reſinous

reſinous matter that thickens them, which is formed by the diſſipation of the more fluid part of the oils.

When their odour is entirely loſt, they are put into an alembic with freſh plants of the ſame kind, in order perfectly to renew them. This is the beſt method of rectifying them in ſuch a caſe.

INFLAMMATION OF ESSENTIAL OILS.

The nitrous acid mixed with eſſential oils, inflames them with much greater facility than it does the fatty oils.

STARKEY'S SOAP.

Eſſential oils do not eaſily combine with fixed alkali. A compound of this kind, made with oil of turpentine and fixed alkali, bears the name of *Starkey's ſoap*.

Starkey's ſoap is a compoſition very difficult to be made, and requiring a conſiderable time. Few perſons well underſtand what it really is.

My experiments have ſhewn me that this ſoap is compoſed of the reſinous part of the oil of turpentine and fixed alkali. The more fluid and rectified the oil of turpentine is, the leſs of this ſoap is obtained; and on adding turpentine to the mixture, the preparation is conſiderably accelerated. By repeated trials I have aſſured myſelf, that all the fluid and ſpirituous part of the eſſential oil is diſſipated when Starkey's ſoap is made. Thus, it evidently muſt be very difficult to determine the proportion of the oil of turpentine to the alkali, ſince that depends upon the ſtate of the oil. When common eſſence of turpentine is employed, eight parts are requiſite to one of alkali.

To be certain of my theory, I have attempted to make this ſoap with oil of turpentine rectified in a water-bath with lime ſlaked in the air. This oil was of extreme tenuity; and forty, or even fifty parts of it to one of alkali were neceſſary to form a very little of Starkey's ſoap. On evaporation, this oil left ſcarcely any reſinous matter.

The ſhorteſt method of making Starkey's ſoap was, I found, to grind the alkaline ſalt with the oil of turpentine upon a porphyry. The oil thus preſenting a larger ſurface, ſooner evapo-

rates,

rates, and the ſoap is more ſpeedily made. This reſolves another of the ſix problems propoſed in the *Journal de Medecine.*

NEUTRAL SALT FORMED BY THE ACID OF THE OIL OF TURPENTINE, AND FIXED ALKALI.

Starkey's ſoap is commonly filled with little cryſtals of a ſalt formed by the combination of the acid of the oil of turpentine with the fixed alkali.

This ſalt is alſo obtained by digeſting oil of turpentine with alkaline ſalt. By means of filtration the Starkey's ſoap that forms is ſeparated from the aqueous ſaline liquor, which, on evaporation, yields cryſtals, generally in little needles, but ſometimes in very large ones, figured in parallelopepids, eſpecially when the liquor is ſuffered to evaporate in the open air.

BALSAM OF SULPHUR, MADE WITH ESSENTIAL OILS.

Eſſential oils diſſolve ſulphur as well as fatty oils. Theſe compounds bear the name of balſams of ſulphur. That in which oil of turpentine is employed is called *terebinthinated balſam of ſulphur*; that with oil of aniſeeds, *aniſated balſam*, &c. Like the fatty oils, the eſſential diſſolve more ſulphur by the aid of heat than they can retain when cold. They, therefore, in cooling depoſite the ſuper-abundant ſulphur in a cryſtaline form.

ANALYSIS OF WOOD.

Guaiacum wood is generally taken as an example of this analyſis. This wood is hard, compact, reſinous, and ſo heavy as not to ſwim on water. It yields a good deal of oil by diſtillation. The ſubſtances procured by an analyſis of guiacum are,

1. Phlegm, which riſes with a heat a little ſuperior to that of boiling water.

2. An acid ſpirit, which comes over with a higher degree of heat.

3. A light, ſomewhat coloured oil, which ſwims upon the ſpirit.

4. A black, heavy, thick oil, which ſinks to the bottom of the ſpirit.

5. There remains in the retort a true charcoal.

6. During the analyſis a conſiderable quantity of air is detached, equal in volume to three hundred times the bulk of the guaiacum.

7. Guaiacum yields alſo a little volatile alkali, but combined with the acid ſpirit, and conſequently in the ſtate of a neutral, which may be termed a *vegetable ammoniacal ſalt*. The volatile alkali is produced by the volatilization of part of the fixed alkali, effected by the oily matters of the wood.

FIXED ALKALINE SALT OF VEGETABLES.

The fixed alkali uſed in the above recited experiments is extracted from the aſhes of vegetables.

In order to obtain it, any plant judged fit for the purpoſe is burned in the open air; the aſhes are lixiviated with a ſufficient quantity of water; and the lye is evaporated to a certain point in order to ſeparate by cryſtalization the neutral ſalts mixed with the alkali. For in the aſhes of the greateſt part of vegetables, ſome of the mineral ſalts, as Glauber's ſalt, vitriolated tartar, and ſea-ſalt, are contained; but never nitre, on account of its combuſtibility with phlogiſtic matters.

matters. When theſe neutral ſalts have been ſeparated by cryſtalization, nothing remains but the alkali.

Alkaline ſalt, perfectly purified, is always the ſame from whatever plant it be obtained; but as the ſeparation of the neutral ſalts is very difficult to effect with all the requiſite exactneſs, the alkalies extracted from different vegetables are not uſed indifferently. That got from tartar is very pure, and does not contain any foreign ſaline matters; it is therefore generally preferred to other vegetable fixed alkalies.

FIXED SALT EXTRACTED FROM PLANTS BY THE METHOD OF TACHENIUS.

Tachenius, a phyſician, deſirous of obtaining fixed ſalts from plants for medical purpoſes, which ſhould be milder than thoſe procured in the common way, thought of a new method. This conſiſted in reverberating the ſmoke and flame upon plants during their combuſtion, in order that the phlogiſtic matter might be combined with the alkali. The ſalts obtained by this method are brown, but they have the properties intended to be given them. They are loaded

loaded with phlogiſton, and approach to the nature of the alkaline liquor impregnated with the colouring matter of Pruſſian blue.

SALT OF SODA.

Varec and ſoda are plants growing on the ſea-coaſt. Theſe, with ſeveral others of the ſame ſpecies, are burned in great cavities made in the earth. The heat excited during this operation occaſions a kind of fuſion of the aſhes which are left behind. They cohere in maſſes of conſiderable bulk; and are afterwards broken into lumps, in which ſtate we get the ſoda.

In order to extract the marine or mineral alkali which it contains, the ſoda is reduced to powder, and boiled in water. The filtered lye yields a fixed alkali which cryſtaliſes, and the properties of which we have already examined.

POTASH.

Potaſh is an alkaline ſalt proceeding from the combuſtion of certain woods, and from the fluid which exudes from green wood when burned to charcoal. Pans are placed round the heaps of wood to receive the moiſture which the heat expels from both ends. This water is evaporated, and the reſiduum calcined. It yields a very large quantity of alkaline ſalt, which is mixed with wood aſhes, and forms *potaſh*.

SALT OF POTASH.

The ſalt of potaſh is extracted by diſſolving it in water, filtering the liquor, and evaporating it to dryneſs. This is called *purified potaſh*, or *ſalt of potaſh*.

The alkaline of potaſh is not pure. It is very often mixed with ſea-ſalt, vitriolated tartar, ſometimes Glauber's ſalt, and generally contains a good deal of marine alkali.

ANALYSIS OF BALSAMS, TAKING TURPENTINE FOR AN EXAMPLE.

Turpentine, in a degree of heat inferior to that of boiling water, yields an eſſential oil, called *eſſence*, or *oil of turpentine*. It is clear and colourleſs. Along with this oil, a little colourleſs acid phlegm comes over.

BOILED TURPENTINE.

After this diſtillation, there remains at the bottom of the veſſel the reſinous part of the turpentine, which is called *boiled turpentine.*

On urging this reſiduum with a degree of heat ſuperior to that of boiling water, there comes over a red oil, much leſs fluid than that obtained at the beginning of the analyſis. It is accompanied with an aqueous liquor, more acid than the former. When the diſtillation is only carried ſo far as to obtain theſe products, what remains in the veſſel is dry, brittle, and has ſcarcely any of the turpentine ſmell. It is called *colophony.*

BALSAM OF TURPENTINE.

Colophony, urged with a ſtill greater fire, yields an oily matter, as thick as turpentine, called *balſam of turpentine.*

COAL OF TURPENTINE.

There remains in the retort a very ſmall quantity of coaly matter.

PITCH AND TAR.

Pitch is a reſinous half-burnt ſubſtance, formed by the exudations which proceed from both ends of pieces of old fir wood burned in the middle. The more liquid part forms what is called *tar*.

LAMP-BLACK.

The reſiduums of turpentine, pitch and tar, which can be applied to no other uſe, are burned, and the ſmoke is received into apartments conſtructed for the purpoſe. It forms a ſoot in very light flakes, which is called *lamp-black*.

ANALYSIS OF BENZOIN.

FLOWERS OF BENZOIN.

Benzoin is a pure, very fragrant reſin. It yields, by ſublimation, with a degree of heat a little ſuperior to that of boiling water, a fragrant volatile ſalt, cryſtaliſed in little needles, called *flowers of benzoin*.

OIL, SPIRIT AND COAL OF BENZOIN.

The reſiduum after the ſublimation of flowers of benzoin, ſubmitted to diſtillation with a

ſomewhat

ſomewhat ſtronger heat, yields a clear, fluid, fragrant oil, with very little colour; but which continually acquires more and more colour and thickneſs. At the ſame time a little liquor paſſes over in white vapours, which is acid, and has the name of *ſpirit* or *acid of benzoin*. A true charcoal is left in the retort.

ON CAMPHOR.

Camphor is a concrete eſſential oil, always ſolid, of a ſtrong and penetrating odour. It is of a particular nature, and is not ſuſceptible of decompoſition by rectification, like oils. Camphor riſes entire in cloſe veſſels, without ſuffering any decompoſition. It is very inflammable, like the eſſential oils.

OIL OF CAMPHOR.

The moſt concentrated acids have no ſenſible action upon camphor. They unite with it, and cauſe it to take a liquid form. Camphor liquefied by the nitrous acid bears the name of *oil of camphor*.

If oil of camphor be poured into water, the nitrous acid which held the camphor in a liquid form

form unites with the water, and the camphor is collected in a white maſs which ſwims on the ſurface. It is found not to have undergone any alteration.

ON BITUMENS.

Bitumens are oily concretions, which belong originally to the vegetable kingdom, and are found in the bowels of the earth. They are under two different ſtates: ſome are liquid, as *naphtha*, *petroleum*, &c. others ſolid, as *Jew's pitch*, *amber*, *pit coal*, &c.

ANALYSIS OF PETROLEUM.

Petroleum, called alſo *oleum petræ*, in a degree of heat a little ſuperior to that of boiling water yields a very thin oil, colourleſs and very inflammable. This has the name of *artificial naphtha*, or *rectified oil of petroleum*.

By a ſomewhat ſtronger fire a red oil is obtained, which becomes more and more thick. Along with theſe oils an acid liquor comes over in white vapours, which is called *acid of petroleum*. There remains in the veſſel a true coal.

ANALYSIS OF AMBER.

Amber furniſhes on an analyſis the following matters; 1. phlegm; 2. ſpirit; 3. volatile ſalt; 4. a white oil; 5. a red oil; 6. a thick oil. The reſiduum is a true coal.

DETONATION OF NITRE BY AMBER.

If a mixture of nitre and amber be heated in a crucible, a detonation takes place; the oil of the amber burns and is diſſipated; the acid of the amber unites with the alkali of the nitre, and forms a neutral ſalt which cryſtaliſes.

AMBER VARNISH.

Clean amber, after being torrefied by a moderate heat in order to free it from the firſt principles which riſe at the beginning of diſtillation, is in a ſtate fit for ſolution in fatty oils. This is the foundation of the beautiful varniſh for coaches.

ANALYSIS OF WAX.

Wax is a ſubſtance of a middle nature between oils and reſins. On an analyſis it yields a ſmall a ſmall quantity of fluid oil, and then an oil which appears as fluid as the firſt, but which on cooling acquires almoſt as much conſiſtence as wax itſelf. With theſe oils a ſmall quantity of acid liquor comes over, which proceeds from the decompoſition of the wax.

By a great number of ſucceſſive diſtillations, the oil of wax is rendered fluid like the eſſential oils; and it does not grow thick through age, as they do.

BLEACHING OF WAX.

Wax, in its uſual ſtate, is yellow. This colour is diſcharged, and it is rendered white, by the combined action of air and water. This action occaſions the ſeparation of a part of its acid, which operates like the ſulphureous acid, and deſtroys the colour of the wax.

In order to facilitate the deſtruction of the colour, the wax is melted, and poured into water round a cylinder of wood, which reduces it into very thin ribbons. In this ſtate it is expoſed to the air and dew; and when whitened on its ſurface, it is melted again to give it a freſh

freſh ſurface, and again expoſed to the air. This proceſs is repeated till the wax becomes ſufficiently white throughout.

ON GUMS.

Gums are only thickened mucilages, which are preciſely of the ſame nature as the mucilages of which we have ſpoken. In their analyſis they furniſh the ſame ſubſtances, and in the ſame proportions.

Gums are diſtinguiſhed by the following properties.

1. They are of a compact texture.

2. They are inſipid and inodorous.

3. They diſſolve in water, without injuring its tranſparence, and are then converted into mucilages.

4. They are inſoluble in oil, and ſpirit of wine.

5. When well dried they do not liquefy on the fire, but puff up and burn.

6. Gums, in burning, do not flame till they are almoſt reduced to a coal.

All theſe properties ſhew that very little oil enters into the compoſition of mucilages and gums.

ANALYSIS OF GUMS.

Gum Arabic is uſually taken as an example of this analyſis. It yields a good deal of ſlightly acid phlegm, and ſome drops of oil.

There remains at the bottom of the veſſel a coaly matter which is rarefied, and occupies a good deal of room.

ON GUMMY RESINS.

Gummy reſins are mixtures of gum and reſin preſented to us by nature in this ſtate of combination. They, conſequently, participate of the properties of both gums and reſins.

They are leſs friable than pure reſins, and leſs hard than gums. They are ſapid and odorous.

They whiten water in which they are diffuſed, and form emulſions; which is owing to the reſinous

reſinous part which, being in a very divided ſtate, remains ſuſpended in the water.

Gummy reſins do not totally diſſolve in ſpirit of wine. The purely reſinous part alone diſſolves in this liquor; the purely gummy part precipitates.

They rarefy leſs in the fire than gums, and burn more readily.

ANALYSIS OF GUMMY RESINS.

Gummy reſins in their analyſis yield leſs oil than reſins, but a good deal more than ſimple gums; and the ſame is true with reſpect to the quantity of acid they give out.

ON SACCHARINE JUICES.

The ſubſtances called *ſaccharine juices*, are ſuch as have a ſweet agreeable taſte, approaching to that of ſugar, and which are capable of producing a ſpirituous liquor by fermentation. Subſtances of this kind are ſugar; manna; honey; the juices of ſeveral vegetables, as pears, apples, grapes; the ſmall portion of ſap in a green ear of corn; the honey-like juice in the flower cup of pinks, jeſſamine, &c.

All theſe matters are of the ſame nature, and give out the ſame principles on an analyſis. We ſhall take honey for an example.

ANALYSIS OF HONEY.

DEW OF HONEY.

Honey, with the heat of boiling water, yields a liquor which has all the odour of honey, and is called *dew of honey*. It is without taſte.

ACID OF HONEY.

With a ſtronger heat, honey gives out a very large quantity of a pretty ſtrong acid, which has an empyreumatic ſmell, on account of a ſmall portion of burned oil which comes over with it. Honey, like the reſt of the ſaccharine juices, yields little oil during its analyſis. The acid of honey effervefces and combines to the point of ſaturation with alkali, forming a neutral ſalt which cryſtaliſes.

COAL OF HONEY.

After the analyſis of honey, there remains at the bottom of the veſſel a light ſpongy coal.

ON FERMENTATION.

Chemiſts diſtinguiſh fermentation into three periods; to wit, that of the *ſpirituous*, of the *acid* or *acetous*, and of the *putrid* or *alkaleſcent fermentation*. We ſhall give an idea of theſe three ſtates of fermentation, in proportion as the train of ſubjects will lead us to them; and we ſhall now begin with the ſpirituous.

ON THE SPIRITUOUS FERMENTATION.

The ſpirituous fermentation is an inteſtine motion, accompanied with heat, which diſunites the principles of a fermentible juice; combines them in a different manner, in changing their nature; and ſeparates them into two parts, one named *wine*, the other *dregs* or *lees*.

All ſaccharine and farinaceous ſubſtances are ſuſceptible of the ſpirituous fermentation, and capable of forming wine. The buſineſs of fermen-

fermentation is too extenſive to allow us in this place to enter into a larger detail on the ſubject: we ſhall proceed to examine the wine which is its product.

DISTILLATION ON WINE---BRANDY.

Wine diſtilled by a leſs heat than that of boiling water, yields a ſpirituous and very inflammable liquor, which is the ſubſtance called *brandy*.

EXTRACT OF WINE.

What remains at the bottom of the veſſel is an acid liquor, loaded with extractive principles; which, when evaporate to the conſiſtence of a conſerve, forms what is called *extract of wine*. We ſhall examine it hereafter.

SPIRIT OF WINE.

On diſtilling brandy with a water-bath it is freed from a great part of its phlegm and groſs oil, and becomes *ſpirit of wine*. On re-diſtilling this ſpirit ſeveral times, the *rectified ſpirit of wine* is procured.

WATER OF RABEL.

Rectified ſpirit of wine digeſted with vitriolic acid forms a combination called *water of Rabel.* The proportions are one part of concentrated acid to three of ſpirit of wine.

VITRIOLIC ÆTHER.

A mixture of equal parts of rectified ſpirit of wine and concentrated vitriolic acid, ſubmitted to diſtillation, yields a ſpirituous very inflammable liquor, named *æther*. The detail of this proceſs may be ſeen in my diſſertation on æther.

VOLATILE SULPHUREOUS VITRIOLIC ACID OBTAINED BY THE DISTILLATION OF VITRIOLIC ÆTHER.

When the æther ceaſes to come over, there riſes an aqueous acid liquor, of an active penetrating and ſuffocating odour. This is ſulphureous acid, which is formed by a portion of the vitriolic acid volatiliſed by the oily and phlogiſtic ſubſtance of the ſpirit of wine.

OIL OF WINE.

With this ſulphureous acid there paſſes over a certain quantity of oil which ſwims on the ſurface of the acid liquor. This oil is that which was one of the conſtituent principles of the ſpirit of wine. Chemiſts have named it *ſweet oil of vitriol*, but improperly. It is the eſſential oil of the ſpirit of wine.

RESIDUUM OF ÆTHER.

After the diſtillation of theſe products, there remains in the retort a black vitriolic acid, with a ſtrong ſmell of burning ſulphur. This, by rectification, may be purified from all the foreign matters it contains, and made to re-appear with all the properties it had before being uſed in this proceſs.

RECTIFICATION OF ÆTHER.

The æther, obtained by the proceſs above deſcribed, is mixed with a certain portion of ſpirit of wine, which roſe in the beginning of the operation, and had not time to be converted into æther. This is ſeparated by a ſecond diſtillation, which is termed *rectification*.

The æther, as more volatile, riſes firſt, and the ſpirit of wine remains at the bottom of the veſſel.

EXAMINATION OF THE PROPERTIES OF RECTIFIED VITRIOLIC ÆTHER.

Æther has a ſtrong, penetrating, tolerably agreeable ſmell. It heats a little on mixture with water, but much leſs than ſpirit of wine.

It is vaſtly more inflammable than ſpirit of wine; it gives a lively brilliant flame, and yields a little ſoot, which ſpirit of wine does not.

It diſſolves all eſſential and fatty oils in all proportions; which is not the caſe with ſpirit of wine.

It inſtantly ſeizes upon gold diſſolved in aqua regia, as eſſential oils do; a property not poſſeſſed by ſpirit of wine.

All theſe properties of æther prove that it approaches to the nature of eſſential oils, by ſo much as it recedes from that of ſpirit of wine.

It holds, in ſome meaſure, the middle rank between theſe ſubſtances.

One of the curious properties of æther, which proceeds from its great evaporability, is that of producing a cold ſufficient to ſink the liquor of Reaumur's thermometer 25 degrees* below its uſual temperature, and 41 or 42 degrees when the experiment is tried *in vacuo*.

DULCIFIED SPIRIT OF NITRE.

A mixture of two parts of ſpirit of wine and one of common ſpirit of nitre, digeſted in the cold during ſome days, forms a liquor in which the properties of the nitrous acid are very much deadened. This is the *dulcified ſpirit of nitre*.

NITROUS ÆTHER.

A mixture of ſix ounces of ſpirit of wine, and four ounces of ſmoking ſpirit of nitre, digeſted in a glaſs veſſel ſurrounded with ice, forms, at the end of ſome days, a liquor which ſeparates from the mixture, and ſwims above

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* A degree of Reaumur's thermometer is ſomewhat more than two of Fahrenheit's. J. A.

the acid part. This is called *nitrous æther*. My diſſertation on æther may be conſulted for the precautions neceſſary in this proceſs.

The action of nitrous acid on ſpirit of wine is ſo ſtrong, that it is neceſſary to repreſs it by cooling the mixture with ice, without which conſiderable exploſions would happen. For this reaſon the operation cannot be performed by diſtillation, as is done with reſpect to vitriolic æther.

RESIDUUM OF NITROUS ÆTHER.

The liquor above which the nitrous æther ſwims, is very acid. It contains a ſmall portion of æther in ſolution.

EXAMINATION OF THE PROPERTIES OF NITROUS ÆTHER.

This æther is of a light lemon colour, which is owing to a part of the oil of the ſpirit of wine, that has been a little burned by the nitrous acid.

It has an acid taſte, owing to a portion of nitrous acid which it contains.

It mixes with water in certain proportions, like vitriolic æther: ſome drops of oil ſwim on the ſurface, which is called *ſweet oil of nitre.*

On evaporating, it produces almoſt as much cold as vitriolic æther.

It burns with a ſoot, and leaves behind it a coaly matter. Its flame is yellowiſh.

DULCIFIED SPIRIT OF SALT.

Spirit of wine and marine acid digeſted together form *dulcified ſpirit of ſalt.*

The marine acid does not combine with ſpirit of wine ſo readily as the other mineral acids; which proceeds from the little diſpoſition we have obſerved it to have for uniting with the phlogiſton. Nevertheleſs, when this acid has been freed from certain principles, by the aſſiſtance of ſome metallic ſubſtances, it combines with ſpirit of wine nearly as well as the vitriolic acid; and, in this ſtate, preſents ſimilar phenomena.

MARINE ÆTHER.

Equal parts of ſpirit of wine and the ſmoking liquor of Libavius are mixed together, and the mixture

mixture diſtilled. An ætherial liquor is procured, ſimilar to vitriolic æther, and with all its properties. This proceſs was diſcovered ſome years ago by the Marquis de Courtanveaux.

TINCTURE OF SALT OF TARTAR.

Spirit of wine, digeſted on very dry ſalt of tartar, acquires in a few days an amber tinge. This colour is produced by the action of the alkali upon the oily principles of the ſpirit of wine. The alkali in ſome meaſure burns the oil of the ſpirit of wine, in part combines with it, and forms with it a ſort of reddiſh ſoap, which diſſolves in the ſpirit of wine, and tinges it.

LILIUM OF PARACELSUS, OR TINCTURE OF METALS.

A mixture of copper and antimony, another of regulus of antimony and tin, and regulus of antimony, nitre and tartar, are melted together in a crucible, and then poured into a mortar. They are introduced as hot as poſſible into a matraſs, and ſpirit of wine is poured upon them. The mixture is digeſted till the ſpirit has acquired a red colour. This is the *lilium* or *tincture of metals*

Part of the metallic ſubſtances calcines during their fuſion, by means of the nitre: the tartar and nitre alkaliſe together: the ſmall portion of metallic calx augments the cauſticity of the alkali, which thereby becomes more able to act upon the oily principles of the ſpirit of wine. It is for this reaſon that this tincture is a little more coloured than the tincture of ſalt of tartar.

ON VEGETABLE SPIRITUOUS TINCTURE.

Spirit of wine diſſolves the reſin contained in vegetables, and forms ſo many mixtures which bear the name of tinctures. We ſhall take for example tincture of jalap, becauſe this root furniſhes a good deal of reſin.

TINCTURE OF JALAP.

Jalap in groſs powder is put into a matraſs, and ſpirit of wine poured upon it. The mixture is digeſted till the ſpirit has acquired a reddiſh tinge. The liquor is then filtered, and is the *tincture of jalap*.

RESIN OF JALAP.

On pouring tincture of jalap into water, a white milky mixture is inſtantly formed. The ſpirit of wine unites with the water and quits the reſin, which, being in an extremely divided ſtate, makes the water white; but by degrees the reſin precipitates, and the water clears. The reſin when collected has a liquid conſiſtence like turpentine. It is dried by a gentle heat.

GUMMY EXTRACT OF JALAP.

The jalap, from which all the reſin that ſpirit of wine would diſſolve has been ſeparated, yields by decoction in water an extractive matter which has a good deal of the nature of gums.

EXHAUSTED JALAP.

There remains at laſt, after all theſe operations, the exhauſted jalap, which will give out nothing more either to water or ſpirit of wine.

SOAP DISSOLVED IN SPIRIT OF WINE.

Spirit of wine, as we have already obſerved, does not well diſſolve fatty oils, and has ſcarcely any action upon alkalies; but when theſe ſubſtances are combined in form of a ſoap, ſpirit of wine diſſolves them with ſufficient facility, and in large quantity.

SPIRIT VARNISH.

Spirit of wine, loaded with reſinous matters, forms *varniſh*. When theſe ſolutions are applied on a body, the ſpirit evaporates, and leaves the reſinous ſubſtances under the form of a ſhining coating, like ice. But theſe varniſhes dry conſiderably in the air, and ſplit or crack; an inconvenience to which oil varniſhes, that is, ſolutions of reſins in fatty oils, are not ſubject.

ON SPIRITUOUS OR AROMATIC WATERS.

We have remarked that ſpirit of wine perfectly diſſolves eſſential oils. If aromatic plants, therefore, are ſubmitted to diſtillation in a water-bath with ſpirit of wine, this liquor comes over, and carries with it the eſſential oils of the vegetables, and holds them in ſolution. This is the method in which all ſimple ſpirituous aromatic liquors are made; as ſpirit of lavender, of thyme, of citron, &c. By the ſame method, alſo, compound ſpirituous aromatic liquors, in which ſeveral vegetable ſubſtances enter, are made.

MIXTURE OF SPIRITUOUS WATERS WITH WATER.

When theſe ſpirituous aromatic liquors are mixed with water, the ſpirit of wine unites with the water, and the oil ſeparates; which, being in an extremely divided ſtate, renders the waters milky.

GUM DISSOLVED IN WATER, AND PRECIPITATED BY SPIRIT OF WINE.

When ſpirit of wine is added to a ſolution of gum arabic in water, it ſeizes on the water, and throws down the gum under the form of a white powder, becauſe, as we have ſeen, gum will not diſſolve in ſpirit of wine.

EFFECTS OF SPIRIT OF WINE ON SALTS.

Spirit of wine diſſolves neutral ſalts with difficulty; on the contrary, it facilitates their cryſtalization. If, to a ſolution of nitre, ſpirit

rit of wine be added, it ſeizes the water, and cryſtaliſes the ſalt in an inſtant.

SEDATIVE SALT DISSOLVED IN SPIRIT OF WINE.

Sedative ſalt diſſolves in ſmall quantity in ſpirit of wine, but only through favour of the water the ſpirit contains.

If this ſolution be ſet on fire, the flame appears of a greeniſh yellow, which colour is owing to the combination of the ſedative ſalt with the phlogiſton of the ſpirit of wine.

ON TARTAR.

Tartar is the eſſential ſalt of wine. It is found adhering to the ſides of caſks. There is a red and a white ſort.

CREAM OF TARTAR.

Tartar is purified at Montpellier. For this purpoſe, it is boiled in water with argillaceous earths, on which tartar has no effect. Theſe earths are employed to free the tartar from its ſuperabundant oil. The liquor filtered and ſet to to cryſtaliſe, yields cryſtals which are called *cryſtals of tartar*, *purified tartar*, or *cream of tartar*.

ANALYSIS OF TARTAR.

Tartar, or cryſtals of tartar, ſubmitted to diſtillation, yield the following ſubſtances: 1. an acid ſpirit; 2. an empyreumatic oil; 3. a coaly alkaline ſalt.

Tartar is almoſt the only ſubſtance which furniſhes a pretty large quantity of fixed alkali by combuſtion in cloſe veſſels. Stahl attributes this effect to the great quantity of air which is detached from tartar during its analyſis. According to the experiments of Hales in his Vegetable Statics, this amounts to a third of the weight of the tartar.

CRUDE OR WHITE FLUX.

One part of nitre and two of tartar form what is called the *crude or white flux*. This mixture is uſed for the fuſion and reduction of ores and metallic calxes.

BLACK FLUX.

The crude flux above-mentioned detonates briſkly by means of kindled charcoal, and the nitre and tartar mutually alkaliſe each other. If this inflammation be effected in a mortar ſlightly covered, part of the ſmoke that riſes from the tartar combines with the alkali which is the product of the inflammation, and renders it black and phlogiſtic. This forms a very good reductive of metals.

NITRE FIXED BY TARTAR.

A mixture of equal parts of nitre and tartar detonates more briſkly than the preceding mixture. As a greater quantity of nitre enters into this latter, there is enough entirely to deſtroy the coaly matter which the tartar might form. This *nitre fixed by tartar* is a white, pretty pure alkaline ſalt.

SOLUBLE TARTAR, OR VEGETABLE SALT.

Cream of tartar unites with fixed alkali with effervefcence, to the point of ſaturation. From this combination there reſults a neutral ſalt which cryſtaliſes difficultly, when the liquor is made perfectly neutral; but eaſily, when there is a ſuperabundance of alkali.

SOLUBLE TARTAR MADE WITH ABSORBENT EARTHS.

Cream of tartar unites with abſorbent earths with effervefcence. This combination furniſhes cryſtals ſimilar to the preceding, but which differ in their baſis.

SALT OF SEIGNETTE.

Cream of tartar combines with effervefcence to the point of ſaturation with the marine alkali. From this combination reſults a ſalt which forms larger cryſtals than the preceding. This is the *ſal polychreſt of Rochelle*, or *ſalt of Seignette.*

PRUSSIAN BLUE, MADE WITH THE MOTHER-WATER OF SALT OF SEIGNETTE.

If vitriolic acid be poured into the mother-water of ſalt of Seignette, a Pruſſian blue is inſtantly produced. The reaſon of this is, that the marine alkali always holds a little iron in ſolution, through favour of its phlogiſton.

TINCTURE OF MARS.

Tartar unites with iron with efferveſcence. This combination forms a deliqueſcent neutral ſalt, which does not cryſtaliſe. It is kept in a liquid form, with a little ſpirit of wine added, to prevent it from growing mouldy. This is the *tincture of Mars.*

BALLS OF MARS.

Two parts of tartar and one of iron filings, moiſtened with a little water, combine, and form a reſin-like extractive maſs, with which balls are made, called *balls of Mars*, or *balls of Nancy.*

EMETIC TARTAR.

Cream of tartar combines with glaſs of antimony to the point of ſaturation. This forms *tartar emetic*, *ſtibiated tartar*, or *ſal Mochlitis.*

In this proceſs, the tartar only combines with the reguline part of the antimony which is deprived of a ſufficient quantity of phlogiſton. On this account, it cannot form a combination with regulus

regulus of antimony itſelf, becauſe it poſſeſſes all its phlogiſton.

ON THE ACID FERMENTATION.

The acid fermentation is the ſecond degree of the ſpirituous fermentation: it tends to combine in a different manner the principles which are formed and ſeparated in the firſt fermentation.

We ſhall define the acid fermentation, an inteſtine motion, which continues, or which is artificially renewed, among the particles of a liquor that has undergone the vinous fermentation, and the effect of which is to convert the wine into an acid liquor named *vinegar*, by combining the ſpirituous part of the wine with the other principles, more intimately than before.

Spirit of wine is a principle eſſential to vinegar: it remains in it combined with the other principles ſo intimately that it cannot be ſeparated by diſtillation. Nevertheleſs, it manifeſts itſelf in the operations that we are preſently to mention.

All liquors that have undergone the ſpirituous fermentation, are capable of being converted into vinegar by paſſing through the ſecond degree of fermentation. Such are beer, cyder, wine, made wines, &c.

DISTILLED VINEGAR.

Vinegar ſubmitted to diſtillation, yields a clear acid liquor, which has all the properties of the vinegar before diſtillation, except that it is without colour, which it loſes from being deprived of its extractive parts.

When vinegar is newly made, the firſt portion of liquor that diſtills is inflammable, containing a good deal of ſpirit of wine; but when it is old, this portion of ſpirit is ſo combined with the other principles of the vinegar, that it is no longer perceptible in diſtillation. All the liquors which have undergone the ſpirituous and acid fermentation are alone capable of giving out an acid liquor by diſtillation with the heat of boiling water. On the contrary, all the vegetable acid juices, ſuch as that of lemons, or barberries, verjuice, &c. only yield an abſolutely inſipid water: their acid is not attenuated by a ſpirituous

uniting with the acid of the vinegar, and precipitating the earth. Theſe precipitates are called *magiſteries:* that proceeding from the decompoſition of ſalt of crab's-eyes is the *magiſtery of crab's-eyes*; and ſo of the reſt. The precipitates are waſhed in ſeveral waters and dried. The filtered liquor on evaporation yields *terra foliata*.

VERDEGRIS OR VERDET.

Vinegar combines alſo with different metallic ſubſtances.

Verdegris is the ruſt of copper, the formation of which is facilitated by means of wine and grape ſtalks. Copper plates are alternately ſtratified with the huſks and ſtalks of grapes moiſtened with wine: when the copper is ſufficiently ruſted, the verdegris is collected, and formed into maſſes, which are uſually wrapt in ſheep-ſkin bags.

CRYSTALS OF VERDEGRIS.

Verdegris, as we have juſt obſerved, is ruſted copper. Part of it is in a ſaline ſtate, but the greater part is purely a metallic calx.

If verdegris be digeſted with diſtilled vinegar, the vinegar becomes loaded with it to the point of ſaturation. This forms a green ſolution, which, by cryſtalization, yields very beautiful blue cryſtals, called *cryſtals of Venus*; and, by the painters, *diſtilled verdegris*. Theſe have an acid metallic taſte. They do not attract moiſture from the air, but rather grow drier in it.

RADICAL VINEGAR.

All the vegetable ſalts compoſed of vinegar and abſorbent earths, fixed alkalies, or metallic matters, are capable of decompoſition by the action of fire. The acid procured from them is very concentrated. It has an extremely penetrating odour of vinegar, and is inflammable. This acid is called *radical vinegar*; and when got from the cryſtals of Venus, *ſpirit of Venus*.

There remains in the retort (in the laſt caſe) a calx of copper, which may be reduced by melting in a crucible with a little alkali and phlogiſtic matter.

Moſt chemiſts have ſaid that radical vinegar contains an inflammable ſubſtance, and is itſelf partly

partly inflammable: but the Count de Lauragais has ſhewn, 1. that radical vinegar is totally inflammable; 2. that in order to inflame it either totally or impartially it muſt be kept in a boiling heat. It is in this that his diſcovery principally conſiſts, which has been unjuſtly conteſted with him.

The inflammable part of the acid obtained from the cryſtals of Venus, is the portion of ſpirit of wine that was combined in the vinegar, and which is diſengaged from the other principles by a kind of decompoſition which the vinegar undergoes during theſe operations.

On rectifying theſe acids, they all yield, at the beginning of the diſtillation, an ætherial liquor ſimilar to that we are going to mention.

ACETOUS ÆTHER.

A mixture of equal parts of ſpirit of Venus and ſpirit of wine, yields, on diſtillation, an ætherial liquor, very ſimilar to vitriolic æther, which is called *acetous æther*. We are indebted ed to the Count de Lauragais for this diſcovery.

WHITE LEAD.

Lead, expoſed to the ſteams of vinegar, has its ſurface converted into a kind of white ruſt. This is collected in the form of flakes of a line or a line and a half in thickneſs, which are hard and very compact. They have the name of *white lead* or *flake white.*

White lead may be reſembled to verdegris with reſpect to the ſtate in which it is procured; part being in a ſaline ſtate, and a greater part in that of a white calx.

CERUSS.

White lead is triturated with a third or thereabouts of white chalk, and a ſufficient quantity of water. The mixture is put into funnels in order to be formed into little conical loaves. Theſe are the *ceruſs.**

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* We generally conſider *white lead* and *ceruſs* as the ſame, and reckon the mixture of chalk an adulteration. J. A.

VINEGAR OF SATURN.

Diſtilled vinegar diſſolves white lead readily to the point of ſaturation. This combination has a ſweet ſaccharine taſte. It is called *vinegar of Saturn.*

SALT OF SATURN.

Vinegar of Saturn, ſet to evaporate, yields a ſalt cryſtaliſed in little needles, which is called *ſalt*, or *ſugar*, *of Saturn.* Its name of *ſugar* is given on account of its ſaccharine taſte.

DECOMPOSITION OF GLAUBER'S SALT BY SALT OF SATURN.

If Glauber's ſalt and ſalt of Saturn are ground together on a porphyry, the mixture is reduced to a paſte, and two decompoſitions and two new combinations are formed. The vitriolic acid unites with the lead, forming a vitriol of lead; the vinegar unites with the marine alkali, and forms the cryſtaliſed *terra foliata* of which we have ſpoken above.

SPIRIT OF SATURN.

Salt of Saturn ſubmitted to diſtillation yields an acid ſimilar to that procured from the cryſtals of Venus, and like it inflammable.

There remains at the bottom of the veſſel a calx of lead, which may be reduced by the addition of phlogiſton.

SOLUTION OF MERCURY IN DISTILLED VINEGAR.

Diſtilled vinegar has no action upon mercury while in an aggregate form; but if mercury precipitated from the nitrous acid by fixed alkali be taken, the vinegar diſſolves it thus divided, and they form together a neutral ſalt, which cryſtaliſes very readily. Theſe cryſtals are very brilliant, ſilvery, and in thin flakes like ſedative ſalt; but they unite in drying, and form thin extremely light little plates. This ſalt has of late years been employed for the cure of venereal complaints.

ON PUTREFACTION.

Putrefaction may, I conceive, be conſidered as a ſpontaneous analyſis, without heat; or a ſubſidence and laceration of the particles of bodies, by the weight of their maſs, and by the dilatation

dilatation of the fluids they contain, but aided by the external heat of the atmoſphere. This ſpontaneous analyſis diſengages the aqueous, oily and ſaline principles of which the bodies conſiſted.

The ſaline ſubſtance which purified bodies furniſh, is always the volatile alkali, whether they are of the animal or vegetable kingdom: hence has ariſen the name of *alkaleſcent fermentation.*

In order to render plants putrid, any quantity of them is put into a veſſel, and cruſhed, with the addition of a little water if the plants are dry. After a time they heat conſiderably; but this heat is only occaſioned by the two firſt degrees of fermentation which precede putrefaction: when they are really in a putrid ſtate, they produce neither heat nor tumefaction. They are left till they are thoroughly putrefied, and exhale the ſmell of fecal matters.

ANALYSIS OF PUTREFIED PLANTS.

Putrefied plants give out, with the heat of boiling water, a fetid liquor, which contains a little volatile alkali, and turns ſyrup of violets green.

With a ſtronger degree of heat they yield an empyreumatic oil, a concrete volatile alkali, and water loaded with volatile alkali. At the bottom of the veſſel there remains a true coal, containing fixed alkali, which may be extracted by lixiviation, without any other combuſtion.

EXAMINATION OF THE PROPERTIES OF VOLATILE ALKALI.

Volatile alkali is met with both in a dry and in a liquid form.

Theſe alkalies have an urinous, ſtrong, and penetrating odour.

They are very volatile, and are diſſipated in the air with extreme facility. As they riſe entire in the heat of the boiling water, they are rectified by ſublimation.

They turn ſyrup of violets green.

VITRIOLIC AMMONIACAL SALT.

The volatile alkali unites with the vitriolic acid to the point of ſaturation, with heat and effer-

efferveſcence. This combination furniſhes a ſalt in needled cryſtals, named *vitriolic ammoniac*, or *ſecret ſalt of Glauber*.

NITROUS AMMONIACAL SALT.

The volatile alkali and nitrous acid unite with the ſame phenomena, and yield a neutral ſalt which cryſtaliſes in needles.

This ſalt detonates and inflames like common nitre; with this difference, however, that as a good deal of phlogiſton enters into its compoſition, it inflames ſingly, without requiring the aid of foreign phlogiſton. It is ſufficient to put it into a crucible previouſly made red hot.

SAL AMMONIAC.

The marine acid combined with the volatile alkali yields *common ſal ammoniac*. It is in cryſtals reſembling the feather of a quill.

DECOMPOSITION OF SAL AMMONIAC BY THE VITRIOLIC ACID.

The vitriolic acid decompoſes ſal ammoniac by diſengaging the marine acid, and uniting with the volatile alkali, with which it forms vitriolic ammoniac.

AQUA REGIA MADE WITH NITROUS ACID AND SAL AMMONIAC.

The nitrous acid unites with ſal ammoniac with conſiderable heat and effervefcence, on account of the phlogiſton contained in the ſal ammoniac: this forms an aqua regia which diſſolves gold very well. Some chemiſts have imprudently adviſed diſtilling this mixture to dryneſs, in order to form a more intimate combination of the nitrous acid with the ſal ammoniac; but they ſeem to be ignorant that the nitrous acid in this mixture combines with the volatile alkali, and that thence reſults a nitrous ammoniac which detonates in the retort, and produces an exploſion, whenever it is ſufficiently heated.

DECOMPOSITION OF AMMONIACAL SALTS BY FIXED ALKALI.

Fixed alkali decompoſes all ammoniacal ſalts, by uniting with their acid, and diſengaging their

their volatile alkali, which is obtained in its proper form.

There remains in the retort after the decompoſition of vitriolic ammoniac, a vitriolated tartar; after that of nitrous ammoniac, common nitre. In the decompoſition of the latter a good deal of caution is requiſite, on account of the facility with which it inflames in cloſe veſſels.

After the decompoſition of common ammoniac, there remains a regenerated ſea-ſalt, or febrifuge ſalt of Silvius, which ſome improperly called *fixed ſalt*, and *fixed ſal ammoniac*.

DECOMPOSITION OF AMMONIACAL SALTS BY ABSORBENT EARTHS.

Abſorbent earths decompoſe all the ammoniacal ſalts, uniting with their acid, and diſengaging the volatile alkali, which is generally in a concrete form. The reſiduums are neutral ſalts with an earthy baſis; viz. ſelenites, after the decompoſition of vitriolic ammoniac; nitre with an earthy baſis, after that of nitrous ammoniac;

niac; and ſea-ſalt with an earthy baſis, after that of common ammoniac.

DECOMPOSITION OF AMMONIACAL SALTS BY QUICKLIME.

Quicklime, as well as abſorbent earths, decompoſes ammoniacal ſalts, but with different phenomena. The volatile alkali obtained by its means is always under a fluid form. The cauſe of this is, that the lime ſeizes a certain quantity of the oil which is one of the ſubſtances eſſential to the concrete form of the volatile alkali.

This is what Mr. Duhamel of the Academy of Sciences has demonſtrated in a ſatisfactory manner, as may be ſeen in the Memoirs of the Academy for the year 1735. This writer ſhews, that when the lime is impregnated with phlogiſtic matters, it decompoſes ſal ammoniac in the ſame manner as pure abſorbent earths, that is, the volatile alkali is obtained under a concrete form.

Some perſons, who probably were not acquainted with Mr. Duhamel's Memoirs, have

propoſed

propoſed a problem* on this ſubject, in which they aſſert "that by means of quicklime the "volatile alkali of ſal ammoniac may be ob"tained either in a concrete or fluid form ac"cording to the will of the artiſt." But we may preſume that theſe perſons did not know the alterations that pure quicklime occaſions in the volatile alkali; otherwiſe they would not have ſaid that neither preparation nor the addition of foreign matters was neceſſary to the lime.

I have repeated all thoſe of Mr. Duhamel's experiments which ſupport his theory, and which relate to the object in queſtion; and I am fully convinced that the author of the problem is evidently miſtaken. The following experiment appears deciſive to the point.

I powdered three ounces of quicklime, and mixed it with an equal weight of dried oxes blood. I calcined the mixture till it ceaſed to flame. I powdered it again, and added the ſame quantity of dried blood. I calcined this matter in a covered crucible, and kept it in a

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* *Journal de Medicine* for October 1762, p. 366.

white heat for more than an hour. I then took out the matter, which was very black. The lime had loſt all the properties of quicklime, no longer producing heat with water, as it does when pure.

I made uſe of this lime to decompoſe ſal ammoniac, and obtained only a concrete volatile alkali, with very little liquor. I lixiviated with water the matter remaining in the retort; it yielded marine ſalt with a fixed alkaline baſis, and a very little marine ſalt with an earthy baſis.

The lime in this calcination conſequently changed its nature. The added phlogiſtic matter converted a great portion of the calcareous earth into quicklime; whence it follows, 1. that in order to obtain concrete volatile alkali from ſal ammoniac decompoſed by lime, the lime muſt be overcharged with phlogiſtic matter: 2. that fixed alkali is compoſed, as I have formerly obſerved, of earth, phlogiſton, and water.*

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* According to Dr. Black's theory, confirmed by the moſt accurate experiments, it appears that the ſole cauſe of the different

OIL OF LIME.

The reſiduum after the decompoſition of ſal ammoniac by means of pure quicklime, contains a ſea-ſalt with an earthy baſis. This matter is lixiviated in a ſufficient quantity of water, the liquor filtered, and evaporated to the conſiſtence of a ſyrup. It yields on cooling a cryſtaline maſs, in which cryſtals are diſtinguiſhed. This ſalt diſſolved in water and filtered, forms a liquor named *oil of lime.*

DECOMPOSITION OF SALTS WITH AN EARTHY BASIS BY THE VOLATILE ALKALI.

The volatile alkali obtained in decompoſing ſal ammoniac by fixed alkali or abſorbent earths, decompoſes all the ſelenites, and nitre and ſea-ſalt with earthy baſes.

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ent ſtates in which volatile alkali is procured, is the preſence or abſence of fixed air in the ſubſtance effecting the decompoſition. Thus, chalk and mild fixed alkali always detach the volatile alkali of ſal ammoniac in a concrete form; quicklime and cauſtic alkali, in a fluid form. J. A.

But the fluid volatile alkali obtained by means of quicklime, ſcarcely at all decompoſes the ſalts with an earthy baſis; it only precipitates a very ſmall quantity of earth.

Theſe phenomena ſhew that the quicklime has conſiderably altered the nature of the volatile alkali.

DECOMPOSITION OF SAL AMMONIAC BY CALX OF LEAD. PLUMBUM CORNEUM.

Calx of lead decompoſes ſal ammoniac like earthy calxes. It detaches the volatile alkali, which has conſiderable ſtrength, and is always in a liquid form.

The marine acid of the ſalt unites with the lead, and forms with it the *plumbum corneum*, which is uſed in the proceſs for making phoſphorus.

FULMINATING GOLD.

The volatile alkali precipitates gold from its ſolvent. The precipitate collected is of a yellow colour. It fulminates and detonates in a very moderate

moderate heat, with very conſiderable noiſe and exploſion. I imagine this effect to proceed from a portion of the nitrous ſulphur, formed by the union of the phlogiſton with the nitrous acid which has fallen down along with the gold.*

DECOMPOSITION OF SAL AMMONIAC BY IRON.

Iron decompoſes ſal ammoniac, and detaches its volatile alkali. If a mixture of iron and well-dried ſal ammoniac be ſublimed, the ſal ammoniac, for want of moiſture, riſes in ſubſtance with a little iron. This ſublimate is of a yellow colour, and forms what is called *Ens Martis*, or *martial flowers of ſal ammoniac.*

DECOMPOSITION OF SAL AMMONIAC BY COPPER.

Copper decompoſes ſal ammoniac, and detaches its volatile alkali. This mixture, well-dried and ſublimed, forms *Ens Veneris*, or *coppery flowers of ſal ammoniac.*

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* Bergman has refuted this theory by proving that it may be made by the marine acid alone. M.

AQUA COELESTIS.

Lime water and ſal ammoniac, ſuffered to ſtand together in a copper baſon, acquire a fine blue colour. This is called *aqua cæleſtis.*

BLUE COLOUR WHICH DISAPPEARS FOR WANT OF AIR.

If volatile alkali and copper filings are put into a phial, a fine blue tincture is produced. On ſtopping the phial cloſely the colour diſappears ſome time after, but appears again on opening it; and this phenomenon may be renewed a great number of times.

WHITE PRECIPITATE OF MERCURY.

If corroſive ſublimate and ſal ammoniac are diſſolved together in water, on the addition of fixed alkali a mercurial precipitate of a very fine white is directly thrown down.

In this proceſs, the fixed alkali unites with the marine acid of the corroſive ſublimate, and with the marine acid of the ſal ammoniac; the volatile alkali of the ſal ammoniac is diſengaged; and the mercury, deprived of acid, is obliged to precipitate.

EAU DE LUCE.

The volatile alkali unites with oily matters, and forms with them kinds of ſoap. The liquor named *Eau de Luce* is made with rectified oil of amber and fluid volatile alkali obtained by means of quicklime.

Eau de Luce, to be fine, ſhould be of a milky white ; and there ſhould be no ſeparation of the ſaponaceous matter, but it ſhould remain united to the volatile alkali.

ANALYSIS OF SOOT.

Soot on its analyſis furniſhes a phlegm ſomewhat acid, a little empyreumatic oil, and then volatile alkali both concrete and liquid. There remains in the retort a coaly, light, and ſpongy matter.

ANALYSIS OF CRUCIFORM PLANTS.

There is a claſs of plants called *cruciform*, becauſe their flowers are diſpoſed in a croſs. Theſe on an analyſis furniſh ſubſtances ſimilar to to thoſe yielded by animal matters. Of this kind are creſs, radiſh, ſcurvy-graſs, muſtard, and the other antiſcorbutic plants.

Theſe plants, diſtilled in a retort, give out a volatile alkali both concrete and liquid, and an empyreumatic oil. The reſiduum is a coaly matter.

Chemiſts are not yet agreed concerning the nature of the acrid principle of the antiſcorbutic plants. It is certain that this principle, when obtained by a degree of heat inferior or equal to that of boiling water, is neither acid nor alkaline; at leaſt nothing is perceived that indicates its partaking of the nature of either of theſe.

I am inclined to think that this principle is nothing elſe than phlogiſton, which is in a ſtate approaching to that in which it exiſts in the oily ſubſtance that compoſes the *ſpiritus rector* of odorous vegetables.

My conjecture is founded on the ſingular property which the antiſcorbutic plants have of tarniſhing ſilver veſſels extremely, in the ſame manner as thoſe ſaline matters do which contain a ſuperabundance of phlogiſton. Silver veſſels tarniſhed by theſe plants are alſo as difficult to clean, or more ſo, than when tarniſhed by ſaline matters.

ON THE

ANIMAL KINGDOM.

ANIMAL ſubſtances are much more compound than thoſe we have hitherto examined. Several of the ſubſtances furniſhed by animals ſtill preſerve many of the properties of the vegetables by which they are nouriſhed.

ON MILK.

Milk is a white liquor which may be compared to emulſions, and is, in fact, an animal emulſion. Milk is compounded of butter, cheeſe, and phlegm which holds in ſolution a certain quantity of ſalts of different natures. This phlegm is termed *whey*.

Cheeſe acts as a mucilage in milk: it ſerves as a medium to unite the butter with the whey. The

The butter contained in milk is in a ſtate of extreme diviſion, and gives it its white colour.

Acids coagulate milk, and ſeparate it into two parts: one, which is the *curd* or cheeſe, is named the *caſeous* part; the other, which is the *whey*, is named the *ſerous* part.

Fixed alkali divides the caſeous part of milk, and ſeems to diſſolve it; but in little while, it is found to coagulate it, as acids do.

FRANGIPANE.

Milk, diſtilled in a water-bath, yields a great quantity of inſipid water. There remains at the bottom of the alembic the caſeous part dried, which is the ſubſtance named *frangipane.*

ANALYSIS OF MILK.

When milk is ſet to reſt, there forms at the ſurface a thick pellicle called *cream:* it is this that contains the butter.

Milk from which the cream is ſeparated is leſs white and thick. When left quiet, it grows ſour and curdles in a ſhort time. The caſeous part of this ſkimmed milk is cheeſe, which is ſeparated from the whey by means of a cloth.

ANALYSIS OF CREAM.

Cream contains all the principles of milk, but in different proportions. It contains leſs water and leſs cheeſe than an equal meaſure of milk, but more butter. The cheeſe contained in cream is not in ſufficient quantity to keep the butter ſuſpended in the water; for which reaſon the butter ſeparates from the other parts on agitating the cream.

The butter of cream may equally be ſeparated by warming it in a water-bath; but the butter thus procured has the taſte of melted butter, and is not ſo good as that got by agitation.

ANALYSIS OF BUTTER.

Butter yields, on diſtillation, a ſmall quantity of an aqueous, acid, volatile, very penetrating liquor; and an oil in great abundance, which is of a ſomewhat thinner conſiſtence than the

the butter itſelf. The reſiduum is a very ſmall quantity of coaly matter.

From this analyſis it appears, that butter contains the ſame principles as vegetable oils, and that it is itſelf an oily vegetable ſubſtance, which has not changed its nature in paſſing into an animal body.

ANALYSIS OF CHEESE.

The cheeſe that ought to be the ſubject of an analyſis, is that made from ſkimmed milk, which ſhould alſo be boiled in water in order entirely to deprive it of butter. Theſe precautions are neceſſary for an exact analyſis. Cheeſe, thus prepared, yields a good deal of concrete volatile alkali, and of empyreumatic oil. There remains in the retort a conſiderable portion of a very rarefied coaly matter.

From this analyſis it appears that cheeſe is a ſubſtance perfectly animaliſed, ſince it furniſhes the ſame principles as really animal matters.

ANALYSIS OF WHEY, TAKING THAT OF COW'S MILK FOR AN EXAMPLE.

Whey, after three fourths of it are evaporated, yields at firſt a ſalt which has a ſweet ſugary

ſugary taſte, and is therefore called *ſalt* or *ſugar of milk*. This ſalt is obtained by the firſt cryſtalization. The moſt concentrated acids have no action upon it. It is, however, of a ſaponaceous nature. If it be expoſed to the action of fire in a retort, an empyreumatic oil is expelled from it, and a fixed alkaline ſalt remains in the retort. Sugar of milk has many properties in common with cream of tartar, but differs from it in not being acid.*

On evporating the remaining liquor afreſh, it yields by cryſtalization a ſalt nearly ſimilar to the preceding, but which is decompoſed by the mineral acids. A third evaporation gives cryſtals of common ſea-ſalt.

There remains at laſt a liquor which refuſes to cryſtaliſe. It contains fixed alkali and a little extractive matter. The alkali is procured without combuſtion.

Every quart of cow's whey contains about ſeven or eight drams of the above- mentioned ſalts.

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* Mr. Scheele has extracted from milk two kinds of acids; the one he calls the acid of milk, and the other the ſaccharine acid of milk. M.

It may reaſonably be conjectured that all theſe ſalts come originally from the vegetables on which the animal feeds, and which have not been changed in their paſſage through the animal body.

ANALYSIS OF FLESH, TAKING BEEF FOR AN EXAMPLE.

Beef, ſubmitted to diſtillation, yields, in the heat of boiling water, an inſipid phlegm, which has a ſlight ſmell of meat. In a ſtronger heat it gives out a volatile alkali both concrete and fluid, and finally a very fetid empyreumatic oil. The reſiduum is a light ſpongy coal, which occupies a great ſpace.

All kinds of fleſh afford the ſame products, as well as all really animaliſed matters.

ANALYSIS OF SUET.

Mutton ſuet, ſubmitted to diſtillation, yields a little of a very ſharp penetrating acid liquor, and then an oil which congeals on cooling, and which has nearly the ſame conſiſtence that the ſuet had before. A great number of repeated diſtillations are neceſſary for obtaining a fluid oil. After the diſtillation and rectification of ſuet,

ſuet, there remains a ſmall quantity of coaly matter.

From this analyſis it appears, that ſuet and all fatty animal matters afford the ſame principles with vegetable oils.

ANALYSIS OF OSSEOUS MATTERS, TAKING HARTSHORN FOR AN EXAMPLE.

Hartſhorn, with a heat a little greater than that of boiling water, gives out a large quantity of an inſipid phlegm, with a faint very diſagreeable ſmell. In a ſtronger fire it yields a phlegm charged with volatile alkali, which is called *volatile ſpirit of hartſhorn*; then a little of a light but fetid oil, a concrete volatile alkali, a red oil, and an oil as thick as turpentine. Theſe three oils are confounded together, and are extremely fetid.

There remains in the retort the pieces of hartſhorn, which are black, and in a coaly ſtate, but have preſerved their form.

Bones and oſſeous matters are compoſed of a good deal of earth, and a gelatinous perfectly animaliſed

animaliſed matter, which ſerves as a glue to bind together the oſſeous particles, and give conſiſtence to the bones. It is this ſubſtance alone which yields the products above-mentioned on an analyſis.

The products are rectified, in order to have them in their greateſt purity.

VOLATILE SPIRIT OF HARTSHORN RECTIFIED.

Volatile ſpirit of hartſhorn is of a red colour, owing to a little oil that it holds in ſolution. On diſtilling it, there riſes, with a heat much below that of boiling water, volatile alkali in a concrete form. This ſalt is clean and tranſparent: it lines the upper part of the veſſel. It diſſolves in the liquor which riſes after it; and this forms *rectified volatile ſpirit of hartſhorn.*

When about half the liquor is come over, what remains in the retort is a phlegm of a bad ſmell, which contains no more volatile alkali. It is thrown away as uſeleſs.

RECTIFICATION OF VOLATILE SALT OF HARTSHORN.

Volatile ſalt of hartſhorn is of a black colour, owing to a portion of fetid oil with which it it is impregnated. It is ſubmitted to diſtillation ſeveral times ſucceſſively, mixing it with abſorbent earths and ſand, in order to retain the oily matter.

RECTIFICATION OF OIL OF HARTSHORN.

DIPPEL'S ANIMAL OIL.

On ſubmitting the fetid oil of hartſhorn to diſtillation, it is rectified, becomes white and fluid like ſpirit of wine, and loſes almoſt all its bad ſmell. This is what is called *Dippel's animal oil.* The fetid oil muſt be diſtilled three or four times for this purpoſe. A good deal of coaly matter remains after each diſtillation.

CALCINED HARTSHORN.

The hartſhorn remaining in the retort after the firſt operation is black, on account of the coal of the gelatinous part which it contains.

This is burned in the open air in order to deſtroy the coaly matter. After that there remains only a white earth, which has ſome properties in common with vitrifiable and calcareous earths :

earths: it in ſome meaſure holds the middle place between theſe earths, but is not a calcareous earth, as ſome chemiſts have thought. It is not converted into quicklime by calcination.*

HARTSHORN PREPARED PHILOSOPHICALLY WITH WATER.

When hartſhorn cut in pieces is boiled in a good quantity of water, the cartilaginous part diſſolves in great meaſure in the water, but the earthy part preſerves its form. Theſe pieces have not near the ſame ſolidity they before had, becauſe there remains only, in a manner, the pure earth, deprived of the gelatinous part. In the following experiment the inverſe of this is performed, that is, the earth of bones is ſeparated, and the cartilage preſerved by itſelf.

DECOMPOSITION OF BONES BY ACIDS.

A flat piece of ivory or hartſhorn is plunged into diluted nitrous acid. The acid diſſolves

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* By numberleſs experiments, it has lately been proved, in conſequence of ſome diſputes amongſt the French chemiſts, that the earthy baſis of hartſhorn and other bony ſubſtances is almoſt wholly calcareous. M.

all the earth, but does not touch the cartilage; and the piece preſerves its form entire. It is waſhed in a ſomewhat alkaline liquor, in order to carry off all the acid. In drying it becomes tranſparent and flexible like horn.

PRECIPITATION OF THE EARTH OF BONES BY FIXED ALKALI.

On pouring fixed alkali into the acid in which bone has been infuſed, it unites with the acid, and throws down the earth.

ON EGGS.

Eggs are compoſed of an earthy covering, which is the *ſhell*; a mucilage within it called the *white*; and a yellow globe in the centre of the white, named the *yolk*. Theſe three ſubſtances differ much in their nature.

The yolk is the part which is to form the chick; the white is the part which is to ſerve it for nouriſhment during incubation, and in proportion as the chick diſcloſes itſelf.

The

The ſhell is a calcareous earth, which diſſolves in acids with a briſk efferveſcence, and is converted into quicklime by calcination.

ANALYSIS OF WHITE OF EGG.

White of egg, in the heat of boiling water, yields a great quantity of inſipid water. The dry reſiduum is tranſparent as horn.

This matter, ſubmitted to diſtillation with a ſuperior degree of heat, yields a good deal of concrete volatile alkali, and a little empyreumatic oil.

ANALYSIS OF YOLK OF EGG.

Yolk of egg is compoſed of a very ſoft oil, and a mucilaginous matter which may be conſidered as deſtined to form the ſolid parts of the chick. Theſe two ſubſtances are of a different nature, as we ſhall preſently ſee.

EMULSION OF YOLK OF EGG.

Yolk of egg diffuſes in water, and forms a white liquor reſembling an emulſion; or rather which is a real animal emulſion.

The mucilaginous matter ſerves as a medium to unite the oil with the water.

OIL OF YOLK OF EGG.

When yolks of eggs are dried, they liquefy after loſing their humidity. If in this ſtate they are ſubmitted to the preſs, a very ſoft yellow oil is procured, called *oil of eggs*.

Oil of eggs ſubmitted to diſtillation, yields a very volatile, very penetrating acid, and an oil of the ſame nature, that is, acid.

From this analyſis it appears, that yolk of egg preſerves all the properties of the vegetable oils to which it owes its origin.

The reſiduum after the expreſſion of oil of eggs is of a very different nature. It is a perfectly animaliſed ſubſtance. It yields, on an analyſis, volatile alkali, as the fleſh of animals does, and a good deal of empyreumatic oil.

COAGULATION OF WHITE OF EGG BY SPIRIT OF WINE.

White of egg diffuſes in water like mucilaginous matters. If ſpirit of wine be added to this mixture, it unites to the water, and the white of egg coagulates and ſeparates.

ANALYSIS OF FAT.

The fat of animals is abſolutely of the ſame nature with their ſuet. It yields the ſame principles on an analyſis; that is, a very volatile and penetrating acid, and a thick oil, which fixes on cooling.

ANALYSIS OF URINE.

Urine is an excrementitious liquor, charged with the ſuperabundant ſalts of the animal œconomy.

The freſh urine of perſons in good health neither efferveſces with acids nor alkalies.

Fixed alkali cauſes it to exhale an odour of volatile alkali.

The urine of ſome perſons in perfect health turns ſyrup of violets green; and the urine of others turns the tincture of turnſole red: thoſe who make urine of this latter quality are leſs ſubject to the ſtone and gravel, but it is always a ſign of bad digeſtion, ſince it ſhews that the vegetable acids have not been ſufficiently elaborated.

DISTILLATION OF URINE.

Urine, in a heat below that of boiling water, yields a clear liquor, of a very diſagreeable ſmell, and which is found to contain nothing ſaline.

In the heat of boiling water, the fluid that comes over is charged with a little volatile ſalt, and turns ſyrup of violets green.

FUSIBLE SALT OF URINE.

Urine evaporated two thirds, yields, on cooling, a ſalt of a particular nature, which is called *native ſalt*, or *fuſible ſalt of urine.* This is the only kind of ſalt in urine proper for making the phoſphorus of which we are ſoon to ſpeak.

SEA-SALT EXTRACTED FROM URINE.

On continuing the evaporations and cryſtalizations of urine, ſea-ſalt is procured, and the other mineral neutral ſalts which men ſometimes make uſe of, or are contained in the ſubſtances which compoſe their food.

EXTRACT OF URINE.

After the cryſtalization of the ſalts of urine, there remains a red thick liquor, which evaporated to dryneſs, yields the *extract of urine.*

EXAMINATION OF THE FUSIBLE SALT OF URINE.

This ſalt impreſſes the tongue with a ſaline, ſomewhat cool taſte.

It does not loſe its water of cryſtalization in the air. It froths in the fire, and by a ſufficient degree of heat is reduced to a tranſparent glaſs, as borax is.

The fuſible ſalt of urine is an ammoniacal ſalt of a particular nature. It is compoſed of volatile alkali and an acid named *phoſphoric acid.* This acid is in the higheſt degree fixed in the fire.

The fuſible ſalt of urine ſubmitted to diſtillation ſuffers the volatile alkali to eſcape: the acid is left behind in the retort, not being capable of riſing.

This acid has all the general properties of acids. When united to the phlogiſton it forms a kind of ſulphur, named *phoſphorus.*

This phoſphorus is generally made in the following manner.

PHOSPHORUS.

A mixture is made of plumbum corneum, of urine dried to the conſiſtence of an extract (from which the fuſible ſalt has not been ſeparated,) and of charcoal in powder. This is ſubmitted to diſtillation with a gradual heat.

There firſt riſes volatile alkali, partly concrete, and partly fluid, and a very fetid empyreumatic oil. The fire is raiſed till the retort becomes red, and nothing more comes over. The receiver is then changed; water is put into the new one, and the fire is increaſed till the retort is brought to a white heat. The phoſphorus paſſes over in vapours, and manifeſts itſelf by the

the light which ſpreads through the inſide of the receiver, and which iſſues through the little hole made in its body.

When the operation is finiſhed, the veſſels are ſuffered to cool during forty-eight hours. At the bottom of the receiver there is found a black coaly powder which contains the phoſphorus.

The above proceſs is that of Mr. Margraff. It has always ſucceeded with me, not failing once in twenty times that I have tried it. Some perſons would inſinuate that the plumbum corneum cauſes the retorts to melt during the operation; but I can affirm the contrary. This mixture is ſo refractory that it does not even enter into fuſion in a crucible, on account of the charcoal, which prevents the re-union of the lead that revives in extremely minute grains.*

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* The chemical world is much obliged to Mr. Scheele for the ſimple method by which this ſingular body is now procured. The bones of all quadrupeds, of birds, and fiſhes, by long digeſtion in the vitriolic acid yield microcoſmic ſalt in great abundance; and the union of this ſalt with an equal weight of charcoal, affords by diſtillation a conſiderable quantity of phoſphorus. M.

RECTIFICATION OF PHOSPHORUS.

The coaly powder above-mentioned is ſubmitted to diſtillation. The phoſphorus, which exiſts in it ready formed, riſes with a moderate heat. Water muſt be put into the receiver to prevent the phoſphorus from burning as it comes over.

In order to form the phoſphorus into ſticks, it is melted in tubes of glaſs filled with water and ſtopped with a cork at the lower end. Theſe tubes are plunged into hot water, when the phoſphorus melts and ſettles into the lower part of the tubes. When it has cooled and fixed it is drawn from the tubes, and kept in bottles filled with water, becauſe it decompoſes in the air.

Phoſphorus ſmokes in a warm air: the phlogiſton flies off, and the acid remains.

It inflames with a very moderate degree of heat; for this purpoſe it is ſufficient to rub it between two papers. When melted in water heated to 50 degrees above the freezing point by

Reaumur's thermometer, it ſwims and inflames on the ſurface of the water.

ANALYSIS OF ANTS.

Ants, common flies, bees, and many other inſects of this kind, ſubmitted to diſtillation, yield an acid and an empyreumatic oil, like vegetable matters. After theſe ſubſtances are extracted, a volatile alkali and an empyreumatic oil of the ſame nature, that is, ſimilar to thoſe procured from perfectly animaliſed matters, come over. There remains in the retort a light ſpongy coal.

ANALYSIS OF SPONGES.

Sponges, madrepores, corals, and other receptacles of marine inſects, yield, on diſtillation, the ſame products as animaliſed matters; that is, volatile alkali and a fetid oil of the ſame nature.

ON

DYING.

THE art of dying is entirely founded on chemiſtry. To dye a ſubſtance is to combine it with one or more ſubſtances of an abſolutely different nature. The operations by which theſe combinations are made afford an infinite number of very ſingular and intereſting chemical phenomena. This it was that engaged Mr. Macquer to occupy himſelf with this object, and to make it the ſubject of one of our chemical lectures. An abſtract will probably be acceptable to the reader.

All the art of dying conſiſts, in extracting the colouring matters from the different bodies that contain them, making them paſs into the

ſubſtances

ſubſtances that are to be dyed, and fixing them there as firmly as poſſible.

The colouring matters made uſe of in dying are extracted from vegetables and animals. Mr. Macquer, in conſequence of the experiments he has made relative to this ſubject, has ranged them all in three claſſes; viz. 1. dyes of a gummy nature; 2. thoſe which are gummy-reſinous; 3. thoſe which are purely reſinous.

Among theſe ſubſtances there are ſome which ſerve for dying without any preparation or *corroſive.* Theſe are thoſe the dying principle of which is of the nature of gummy-reſins.

Thoſe ſubſtances the dying principle of which is reſinous, require a preparation, in order to facilitate its ſolution in water, and exalt its colour. They, however, require no particular preparation of the ſtuff to be dyed.

Thoſe, the colouring principle of which is of a gummy nature, require a corroſive, in order to make the colour adhere better, and to exalt it. Among the dyes of this claſs, there are ſome the corroſive of which is put into the ſtuff before the application of the colouring matter, and others where it is put into the vat containing the dye.

The matters to be dyed afford particular phenomena, which are relative to their ſpecific nature and character. Wool, ſilk, cotton and thread are not equally ſuſceptible of receiving the ſame dyes. Wool and animal matters are thoſe which are the moſt eaſily dyed, and the colours of which are the fineſt and moſt durable: cotton, thread and all vegetable matters, on the other hand, are more difficult to be dyed. Silk holds the middle rank, not being ſo eaſily dyed as animal, nor ſo difficultly as vegetable matters. We ſhall give ſome examples of the different claſſes we have juſt eſtabliſhed.

ON GUMMY-RESINOUS DYES, WHICH REQUIRE NO PREPARATION NOR CORROSIVE.

Any quantity deſired of green walnut ſhells is boiled in water, and the decoction ſtrained. Into this liquor, which is called a *bath*, is plunged a ſkain of wool, and it is left there till ſufficiently dyed. The wool is then waſhed ſeveral times, in order to take off all the dye which is not incorporated with the ſtuff.

The *proof* of this dye is a ſolution of cream of tartar in water.

By the term proof, is meant the experiment made to try the firmneſs of a dye applied to any ſtuff. This experiment conſiſts in boiling the dyed ſtuff, for a certain time, in water charged with ſubſtances, the action of which that dye ought to reſiſt. The proof is therefore different, according to the nature of ſtuffs and dyes.

On Reſinous Dyes which require being prepared, but need no Preparation of the Stuff.

ROSE-COLOURED DYE, GOT FROM CARTHAMUS.

Two drams of carthamus waſhed and dried* are mixed with eighteen grains of alkaline ſalt, and

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* The flower of carthamus, or baſtard ſaffron, contains a great quantity of yellow extractive matter, ſoluble in water, which

and ſeven drams of ſpirit of wine. This mixture is macerated in the cold for two hours: two ounces of cold water are then added, and it is macerated two hours more. The liquor is paſſed through a cloth, and a ſufficient quantity of lemon juice or diſtilled vinegar is put to it, till it becomes of a cherry colour. This *bath* is uſed for dying ſilk.

which muſt be taken out before the flower is uſed for a red dye. Flowers of carthamus are waſhed in the following manner. Some pounds of it are put into a cloth ſack, moderately tight. This is put in water, and worked about with the hands, to facilitate the ſolution of the extractive matter. The water is changed in proportion as it becomes impregnated, and thrown away as uſeleſs. The operation is continued, till the water is no longer diſcoloured. The dyers are accuſtomed to uſe it while it is moiſt, as they have remarked that it does not afford colour enough when ſuffered to dry. But this lotion would be very inconvenient in operating in the ſmall way, becauſe freſh carthamus muſt be waſhed as often as it was wanted. I have remarked that it may be dried, and yet uſed at pleaſure, on moiſtening it with a little ſpirit of wine, which diſſolves the reſinous colouring part. Carthamus, thus dried, gives out its dye copiouſly enough for ſmall operations.

ANOTHER EXAMPLE.

SAXON BLUE.

Three drams of indigo and an ounce and a half of concentrated vitriolic acid are digeſted together with a gentle heat. To this mixture a ſmall quantity of water is added.

When this indigo is wanted for uſe, a little of it is diffuſed in a good deal of boiling water. Into this liquor the ſtuff to be dyed is plunged, and kept in till it has acquired ſufficient colour.

The proof of this dye is vinegar.

On Gummy Dyes, which require a Corroſive of Alum.

YELLOW OF YELLOW WOOD.

Three drams of yellow wood cut in ſmall pieces are boiled in eight ounces of water, and the decoction ſtrained. Into this a ſkain of alumed * ſilk is plunged, while it is very hot, and is left in till ſufficiently coloured.

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* To alum, is to impregnate a ſtuff with alum. For this purpoſe, alum is diſſolved in water, and the ſtuffs are plunged in the ſolution, where they are kept for a certain time. They are then waſhed to take off all the ſuperfluous alum.

It is neceſſary that the alumed ſilk ſhould be well waſhed before it is dipped into the liquor, otherwiſe the ſuperabundant portion of alum which is not combined with the ſilk, will precipitate all the colour of the dye in clots.

ANOTHER EXAMPLE.

FINE CRIMSON.

A decoction is made of a dram of cochineal in four ounces of water, and ſix drops of ſolution of tin in aqua regia are added. Into this a ſkain of alumed ſilk is dipped, which in a ſhort time is dyed a fine crimſon.

The proof of this dye is ſoap-water.

On Gummy Dyes, the Corroſive of which is put into the Liquor.

SCARLET ON WOOL.

Half a dram of cochineal is boiled in eight ounces of water, and to this is added a dram of ſolution of tin in aqua regia, let down with as much water. A piece of woollen ſtuff is plunged into this bath, and boiled till it is ſufficiently coloured.

The proof of this dye is ſolution of alum.

Thread, cotton and ſilk do not take this dye.

After theſe proceſſes for dying, I ſhall give a receipt for a very good writing ink, which, it is well known, is the baſis of the black dye; and I ſhall conclude with a proceſs for making *painter's lake.*

INK.

Take of galls, a pound; gum Arabic, ſix ounces; green vitriol, ſix ounces; water, ſeven pints.

The galls and gum Arabic are to be groſsly pounded, and macerated in the water, upon warm aſhes, for twelve hours, ſtirring the matter from time to time with a ſtick. The green vitriol is then to be added; and, while the mixture is pretty hot, the whole is to be ſtirred, without putting it again on the fire. When the liquor is cooled, the ink is made. It is paſſed through a hair ſieve, and ſuffered to ſettle till the next day. It is then put into well-ſtopped bottles.

Galls contain an aſtringent principle, and developed phlogiſton. Theſe principles decompoſe the vitriol. The phlogiſtic matter attacks the iron, precipitates it, and converts it into a matter very analogous to Pruſſian blue, but differing from it in being entirely ſoluble in acids, which the other is not. This ferruginous precipitate is very fine. It would fall down after ſome time, if it were not ſupported by the mucilage of the gum Arabic, which gives the liquor ſufficient conſiſtence to retain it.

RED LAKE OF COCHINEAL.

Half an ounce of cochineal and five ounces of alum are boiled together in a ſufficient quantity of water. The liquor is filtered, and ſome drops of ſolution of tin are poured into it. Some fixed alkali in ſolution is then added. This decompoſes the alum, and precipitates its earth; which, as it falls down, collects and carries with it all the red colour. The liquor is filtered; the fluid is thrown away, and the precipitate is waſhed to carry off the ſaline particles, and then dried.

All the other lakes may be prepared in the ſame manner. The ſolution of tin may be left out if it be thought proper.

INDEX.

I N D E X.

Copper,

Luna

THE END.

ERRATUM.

Page 71, line 22, for *alum ſaturated with earth* read *alum ſaturated with its earth.*

Printed for J. JOHNSON, No. 72,
St. Paul's Church-Yard.

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