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AN

ESSAY

ON THE

BATH WATERS.

In Four Parts.

CONTAINING

A Prefatory Introduction on the Study of Mineral Waters in General.

Part I. An Account of their poſſible Impregnations.

II. The moſt approved Means to be uſed for the Diſcovery of their Contents.

III. Experiments on the Bath Waters, with an Application of the foregoing Rules, to the Diſcovery of their Contents.

IV. An Application of the Whole to the Practice of Pharmacy and Medicine.

By William Falconer, of Bath, M.D.

Neque vero inficiantur Experimenta quoque eſſe neceſſaria; ne ad hæc quidem aditum fieri potuiſſe, niſi ab aliquâ ratione, contendunt. Celsus.

LONDON,
Printed for T. Lowndes, in Fleet Street.
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TO

JOHN FOTHERGILL, M.D.

DEDICATIONS are generally offered to rank and fortune alone, though when theſe are united with learning and abilities, they have certainly a ſtronger claim to our regard. For this reaſon I chuſe to deviate from the uſual courſe, and addreſs the following treatiſe to one of the firſt Names in the ſcience and practice of medicine; as, whatever may be the fate of the work itſelf, the public muſt approve my choice of a Patron. Not but I muſt confeſs I was partly ſwayed by a private motive, wherein my ſilence might juſtly be deemed ingratitude. Your kind concern for my welfare, and the intereſt you took in recommending me

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INTRODUCTION.

On the STUDY *of* MINERAL WATERS *in general.*

IN the preſent improved ſtate of medical knowledge, it ſeems remarkable, that ſo little progreſs ſhould have been made in ſo important a branch of it, as that of the inveſtigation of the Nature and Qualities of Mineral Waters. Books, indeed, have not been wanting, as upwards of two hundred volumes have been written on this ſubject only. The accounts, however, tranſmitted to us, by the generality of theſe Writers, are very little to be depended on, as they are moſtly filled with inſtances of the groſſeſt ignorance, or

miſrepreſentation. Bold, however, as this aſſertion may appear, we ſtill think that, on examination, it will appear well founded, and believe that in the future part of our Work, ſuch inſtances of this will be produced, as will leave the Reader little reaſon to doubt its truth.

We would not have it here underſtood, that we mean this as a reflection on all the books, without exception, that have been written on the ſubject; we are willing and ready to acknowledge ſeveral uſeful and important diſcoveries, which are to be found in works of this kind. It muſt, nevertheleſs, be owned, that, conſidering the great advances made in the other branches of the ſcience of phyſic, and in that eſpecially which would moſt aſſiſt diſcoveries of this kind, this in particular has not been improved in proportion with the reſt. A certain ingenious Writer, a native of a neighbouring kingdom, who has included in his work a Diſſertation on the celebrated Waters

which

which we propoſe as the ſubject of the enſuing pages, has carried his reflections on this ſubject to a great length, and made many ſevere obſervations on the Faculty reſident there, for their ignorance of the principal remedy in their Materia Medica. How far this may be true, does not become us to determine; certain it is, however, that a decency of language impeaches no truth; and had the Author kept to that, his work would, probably, have found that reception in the world, which the ingenious diſcoveries it contains entitle it to. We hope, however, that our Work will be as little obvious to objections of this kind as the nature of the thing will admit of. Opinions, indeed, and ſome of thoſe, perhaps, of a pretty general nature, will be found diſputed; but we hope it will be done in ſuch a manner, as not to give offence to thoſe who have written in ſupport of them.—When opinions alone are controverted, it may be alledged, that no apology is neceſſary, as a certain degree of candour

ought to be the inſeparable attendant on learning; and that no man of ſcience ſhould be aſhamed to receive information from whatever channel it may be derived.— Specious, however, as this argument may ſeem, the practice of the world is widely different. Diſputes of this nature have been generally managed with great acrimony, and have not infrequently degenerated from mere literary controverſies into perſonal ſatyr and invective. This obſervation, though particularly true in this inſtance, is not confined to phyſic, it having been an old general remark, that men are at leaſt as tenacious of their opinions as their property. We are too well ſatisfied of our own imperfections, to deſire to enter into diſputes of this nature, and are ready to own, that, however probable our Theory may ſeem, it is by no means, even in our own opinion, free from objections. A conſciouſneſs of this will, we hope, make us ready to receive any information, or acknowledge any error, we have made.

One

One merit, however, we hope we may pretend to, which is, that we have falſified no fact in favour of, nor ſuppreſſed any circumſtance in our experiments, that might make againſt our opinions. When any ſuch have occurred, we have related them faithfully, and, as far as reaſon, or a juſt probability would ſupport us, endeavoured to reconcile them with our Theory.

We have not, likewiſe, taken any experiment on the credit of others, but have repeatedly made all thoſe here related. How far we have ſucceeded, the world muſt judge; we hope, however, for ſome indulgence, as our Work is compoſed, in a great meaſure, on a new plan.

We ſhall now proceed to ſpeak of the cauſes which have prevented, or at leaſt retarded, the improvements we might have expected to have ſeen in this branch of ſcience. The principal of which are the following.

1. The want of chemical knowledge. That a certain degree of chemical knowledge is neceſſary to thoſe who propoſe to inveſtigate the impregnations and qualities of Mineral Waters, will ſcarce be denied. As a proof, however, of it, if we look into the books written on this ſubject, while that branch of knowledge was little cultivated, and, of courſe, few improvements made; or into thoſe of later date, whoſe Authors were defective in that ſcience, we ſhall be abundantly convinced of the truth of this aſſertion.

We there read of impregnations of Waters with ſubſtances, which we know are (in the ſtate they are preſented to us by nature, and, of courſe, the ſtate in which they are generally expoſed to the action of the Waters) indiſſoluble in a watery fluid; or elſe of ſuch ſubſtances which, although ſoluble in water, we know to be mere creatures of Art only, and, of courſe, not to be expected to be met with among the operations of Nature.

Expe-

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ples of phyſic, what reaſon have we to deſpair that the remainder will, in time, be rendered equally clear?

To aſſert the contrary, would, were it applied equally to every branch of learning, preclude all ſearch whatever; and, had it been formerly obſerved, would have hindered us of many of the uſeful and important diſcoveries we now enjoy.

An accurate knowledge of chemiſtry is likewiſe requiſite in the examination of waters, to diſtinguiſh their original contents from thoſe which are only the product of the experiments. From inattention to this circumſtance, many miſtakes have been committed, and many ſuppoſed diſcoveries have been made, of impregnations which never had any exiſtence in the water before theſe were made.

2dly, Abuſe and confuſion of terms. This cauſe is nearly connected with the former, and proceeds, in a great meaſure, from the ſame origin; it having been an old

obſervation, that no ſcience ever arrives at any conſiderable degree of perfection until its terms are accurately defined. If this rule holds general, we may pronounce this branch of knowledge to be at an exceeding low ebb, as there are ſcarcely two Writers on the ſubject of Mineral Waters, who have applied the ſame ſignification to ſimilar expreſſions. It is, indeed, greatly to be doubted, if the Authors themſelves had any poſitive ideas affixed to many of their terms, as they ſeem to be more frequently drawn from ſome poſſible, or, as their fancy might ſuggeſt, probable production, than from experiment tending to prove that ſuch facts had really happened. This imperfection is juſtly charged on moſt of the antient Writers, and, indeed, was more pardonable in them than in many of their ſucceſſors the moderns, who, notwithſtanding they have wrote ſince more accurate, and explicit ideas were affixed to chemical terms, have ſtill purſued the ſame unintelligible path with their predeceſſors. A late Writer of a voluminous

Treatiſe

Treatiſe on this ſubject has been grievouſly faulty in this reſpect, as many of his terms are inexplicable, others contradictory, and no ſmall ſhare of the remainder ſcarcely differing more from one another, than they do from thoſe things which, from a view of their name, we ſhould imagine they were intended to expreſs.

Many of theſe Writers, like the Alchemiſts of old, have made a notable uſe of theſe confuſed and unintelligible terms, in order to cover their own ignorance; juſtly ſuppoſing that no one could object to terms, however unintelligible, which the cuſtom of their predeceſſors had eſtabliſhed, the very obſcurity of which would lead many to believe implicitly in the ſagacity and learning of the Author, while the means of its detection muſt be in the hands of few, and thoſe, perhaps, too deeply intereſted to make the diſcovery.

Had this been properly attended to formerly, we ſhould, in all probability, have ſeen many of the unmeaning and unintel-

intelligible terms, which now diſgrace this branch of learning, exploded, and new and explicit ones ſubſtituted in their place.

3dly, Want of method has been likewiſe a principal ſource of this obſcurity, as that neceſſarily produces circumlocution, and not infrequently confuſion.

For want of this, many of our Authors ideas appear ſo dark and unintelligible, and, probably, from a conſciouſneſs of it, were unwilling to part with terms ſo well adapted to them, being deſirous, like the Painter of old, to cover with a veil what they were unable to expreſs.

4thly, Lucre of gain, likewiſe, has been the occaſion of much ignorance, as well as falſhood and miſrepreſentation on this ſubject. The Practitioners from whom they might be chiefly expected, have been fearful of making, and ſtill more of diſcloſing, the event of experiments made on the Mineral Waters which they attended, left

their

their impregnations ſhould be diſcovered to be ſuch as might be eaſily imitable in equal perfection by the hand of art, and by that means deprive themſelves of many of their lucrative ſources, by preventing the reſort of people to a place for a thing ſo eaſily procurable at home.

Another reaſon, and perhaps a more juſtifiable one, is, that ſince a patient's good opinion of the efficacy of his medicines, is, in many caſes, neceſſary, and at all times favourable to his cure, by keeping up his ſpirits, and ſecuring his obſervation of the Phyſician's directions; ſhould many of theſe boaſted arcana, however efficacious in practice, be at once laid open, and diſcovered to be no more than the moſt common and ſimple ſubſtances, it might diminiſh his confidence in the remedy, and by that means deprive him of many of the advantages otherwiſe to be expected from it. They were, therefore, unwilling to encourage ſcrutinies of this kind, being con-

contented with a few practical obſervations on the effects of the Waters, and deſirous that the chemical diſcovery of their contents ſhould, like the Roman Palladium, remain locked up in the moſt ſecret part of the Temple, ſcarce to be looked on even by the Prieſts themſelves.

A celebrated Writer on this ſubject, has carried his arguments on this head much farther, and has brought ſeveral grievous accuſations againſt the faculty of Phyſic; as having, for lucrative motives, ſo miſrepreſented or falſified the qualities of the Waters where they reſided, as to adapt them to every diſorder, or ſtate of it, incident to the human body. Were this charge true in its full extent, grievous indeed would be the imputation; as it would be reducing the principles of their profeſſion to the ſtandard of the loweſt empyriciſm; and, what is of ſtill more conſequence, how melancholy muſt be the ſituation of the generality of thoſe who apply to ſuch practitioners for relief! To

ſuch

ſuch, indeed, the advice of a late great and worthy Phyſician might be well applied—To peruſe the Sixth Commandment. We are, however, fully ſatisfied that this Author has carried his reflections to a very unjuſtifiable length. Some few might perhaps be found, to whom ſuch an imputation might be applicable, as it can never be expected that the profeſſors of medicine ſhould, more than other men, be uniformly, and without exception, juſt and honeſt. But we are well ſatisfied, that the number of theſe is very ſmall, in compariſon with thoſe who would even ſhudder at the thought.—Some prejudice, perhaps, is inſeparable from our nature; it is not therefore to be expected, that our profeſſion alone ſhould be diveſted of it. Many practitioners, ſeeing the good effects of the Waters at which they reſided, might be tempted to extend their uſe to more caſes than their unprejudiced reaſoning might fully juſtify. But is not this the caſe with the profeſſion in general? What practitioner can ſafely aſſert he has not ſome partiality

for

for a particular medicine above the reſt? I believe few can avow it; and, if they ſhould be ſo blind to their own prejudices, thoſe who would examine their practice would ſoon make the diſcovery for them.

Prejudice of opinion, likewiſe, in favour of ſome particular theory, has miſled many of the Writers on this ſubject. Many had formed their opinions before they made their experiments. It is probable, therefore, that many of thoſe which ſeemed contrary to their opinion were ſuppreſſed, or miſrepreſented; while others, that ſeemed to favour it, were carefully remarked.

It is a common complaint, likewiſe, of books of this kind, that they ſeem to be written to the learned only; their meaning being ſo enveloped in terms of art, as to render them unintelligible to the reſt of the world. This evil is, in ſome meaſure, a neceſſary one, as every ſcience has peculiar technical terms belonging to it, without which we ſhould not be able to give a clear idea of what we mean

to

to expreſs, without much circumlocution and tautology. This, however, by the antient Writers was carried to a very extravagant length, inſomuch that they could ſcarce expreſs the moſt ſimple idea, without the uſe of ſome abſtruſe technical term. Later improvements have, however, greatly diminiſhed this formidable hoſt, whereby the avenues to this branch of learning were formerly ſo ſtrongly barricadoed, and has reduced them to a few, and thoſe ſimple, expreſſive, and eaſily underſtood.

The uſe of an accurate chemical examination of the Waters, will, we hope, want no proof with men of learning and candour. Some cavils have, however, been frequently raiſed againſt any attempts of this kind, as being impoſſible to be brought to the deſired degree of perfection, and therefore more apt to miſlead, by ſubſtituting an uncertain or falſe theory, in room of an approved method, which time and experience had confirmed. The firſt of theſe objections has been, as we hope,

hope, already removed: And we would farther aſk, Whether a ſearch into the cauſes of effects, is unworthy the Phyſician, or Philoſopher?

To the ſecond we would anſwer, that no attempt is made to overthrow the good effects of the Waters in thoſe caſes which experience has juſtified, nor to extol their uſe in others which it has condemned. We are far from wiſhing to ſee a ſyſtem of phyſic, or indeed the application of any particular medicine, founded on theory only, independent of practice. But is not a ſearch into the cauſes of effects conſiſtent with a due regard to practical knowledge? Do they not mutually illuſtrate one another? But we hope it is needleſs to purſue this argument farther. We will venture, however, to point out a few of the advantages which might accrue to the publick from a work of this kind, if accurately performed.

Were the contents of the Waters aſcertained, it would enable the Phyſician to form a better judgment of their uſe in phyſic,

phyſic, from a compariſon of the effects on the human body, of the ſame, or ſimilar ſubſtances, uſed as articles of medicine, with which the Water is impregnated, with the Waters themſelves.—Might not this extend their uſe to many caſes in which their efficacy is at preſent unknown, and inſtruct us in a better method of adminiſtring them in others, in which their good effects are acknowledged? Would it not be of ſervice to thoſe practitioners, who reſide in diſtant places, who have had no opportunity of making experiments on, or of ſeeing the effects of, the Waters? Would they not then be enabled to judge of the proper application of theſe Waters in certain diſorders, from analogy of the effects of the ſame, or ſimilar ſubſtances with which they are acquainted? It is needleſs to expatiate on the uſe of this. A perfect knowledge of the chemical contents of the Waters would be of great ſervice likewiſe to the practiſing Phyſician at the place.

Moſt of the Mineral Waters are very apt to have their component parts ſeparated, (which deſtroys their original effect,) on admixture of any foreign body. As it is often judged neceſſary to take ſome medicines along with, and frequently in, the Waters, a knowledge of this kind would inſtruct us in the choice of theſe, either to ſelect ſuch as would leaſt alter their original nature, or elſe, from a knowledge of the compound formed by the medicine and the waters, to enable us to form ſome judgment of the effects likely to be produced by ſuch a combination.

We ſhall now proceed to give the plan of our work; and, firſt, we ſhall premiſe an account of Mineral Waters in general, and of thoſe ſubſtances with which they are capable of being impregnated.

Secondly, We ſhall give an account of the moſt approved means to be uſed for diſcovering theſe impregnations.

Thirdly, We ſhall relate our experiments made on the Bath Waters, and endeavour to

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PART I.

WATER has been divided by the Chemical Writers into two kinds, but this is not quite correct, as we know but one kind of Water. Whether this Water be an element, or a compound, is not at preſent to our purpoſe to enquire. It ſeems, however, to have as good a title to the epithet of elementary as moſt bodies. It is a body that has fluidity and firmneſs in different circumſtances, and is particularly diſpoſed with reſpect to oily bodies.

Water, as it is capable of diſſolving many ſubſtances, may, from a perfectly pure ſtate to that of the greateſt impurity, undergo various degrees of impregnation. Hence it is divided into *ſimple*, or *common*, and *compound*, or *mineral*.

This diviſion muſt be rather imperfect: Firſt, becauſe we know no Water perfectly free of ſome degree of impregnation; and, ſecondly, as this diviſion is only from different degrees of the ſame quality, it muſt, conſequently, be inaccurate.

But by Common Water they would underſtand ſuch, whoſe impregnation is not obvious to the taſte or ſmell, and which has no ſenſible action on the human body.

By Mineral, where it has the contrary properties.

Even in Common Water, according to this diviſion, there are various impregnations, which may be chemically diſcovered; from the waters of the atmoſphere, from whence all the reſt proceed, to that of ſprings, rivers, and lakes.

Of

Of MINERAL WATERS, *ſtrictly ſo called.*

WERE we to attend to the various characters and analyſes that have been given in books, of the different Mineral Waters, we ſhould, at firſt ſight, be led to imagine there was a great diverſity of them; but, on examination, the contrary appears evident.

It has been before obſerved, that theſe facts have been, in general, groſly miſrepreſented, and, as ſuch, can never be the foundation of rational concluſions. In ſuch a complicate caſe, therefore, to reaſon *a priori* will be the only certain method, and then ſee if the concluſions we draw from thence are compatible with ſuch facts as we can depend upon.

1ſt. Spring Waters are chiefly impregnated with foſſil ſubſtances; for if ever they contain vegetable or animal matters,

it is in ſo ſmall quantities as to bring them under our firſt diviſion of Common Water.

2dly. As to foſſil matters, they may contain, in ſolution, every thing that water is capable of diſſolving, but no other.

But here, however, we muſt be cautious of aſſuming principles; for argillaceous and chryſtalline earths have been found diſſolved in water, but then the impregnation is extremely ſlight.

But in order to determine accurately all the poſſible impregnations of Waters, we ſhall take a view of the different forms of bodies, and ſee in what circumſtances they are ſoluble in water *.

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* Water is capable, likewiſe, of containing many bodies ſubtilely divided in a diffuſed ſtate. This ſeems to be the caſe with many oily bodies, ſulphur per ſe, and perhaps ſome earths, which are not capable of being united with water, except in this manner.

Of

Of the Saline MINERAL WATERS.

ALL Saline Bodies we know to be ſoluble in water; but notwithſtanding this general ſolubility, only the proper foſſil matters, and not thoſe of artificial production, can be admitted of. Hence the nitrous and vegetable acids are to be rejected, and the acid of ſea ſalt, though a foſſil production, yet as it is never known to be found in a ſeparate ſtate, ſo it never can, by itſelf, impregnate a Mineral Water. The vitriolic acid, from its almoſt univerſal diſtribution through the bowels of the earth, has been more generally ſuppoſed to do ſo. But then its attractions are ſo general, and ſo potent, as prevent its remaining long unaſſociated. The ſuppoſition of its being in a ſeparate ſtate in the bowels of the earth, proceeded

Simple Saline Bodies.

Acids.

Nitrous, muriatic, and vegetable, not contained in Mineral Waters.

Vitriolic acid.

from the notion of its giving riſe to the inflammable damps in mines, and from the acidulous tartneſs in ſome waters. The firſt of theſe is a mephitic air, and the ſecond a decompoſition; for the ſulphureous pyrites that contain iron, are very ſubject to deliqueſcence on expoſure to the air. Hence if they are expoſed in any ſubterraneous cavern, the vitriolic acid may be thus ſeparated, and if this decompoſition takes place not far diſtant from the ſurface, it may impregnate the ſpring before it be prevented by any freſh attraction.

The celebrated Dr. Lucas *, in his Diſſertation on the Bath Waters, ridicules the notion of ſulphur ſubſiſting in any water, together with a ſuperabundant acid. Had he conſidered the laſt mentioned circumſtance, which ſo frequently happens, he would have found nothing abſurd in ſuch a ſuppoſition. In all waters impregnated with ſimple ſulphur in a diffuſed ſtate, this

* Lucas, Vol. III. p. 252.

may

may happen from a decompoſition of the ſulphur when expoſed to the air.

This may be illuſtrated by a familiar inſtance. It is well known that flowers of ſulphur, when kept, contract an acidulous taſte, from the flying off of the phlogiſton, and leaving the acid ſeparate, though adhering to the remaining ſulphur. For this reaſon, the London College directs them to be waſhed with warm water, in order to clear them of their ſuperabundant acid.

It is well known, likewiſe, that ſulphur is more liable to decompoſition when kept in a moiſt, than in a dry ſtate.

There is another fact which ſupports the poſſibility of an acid in water. The vitriolic acid, as combined with iron, is generally in its volatile ſtate, and, when diffuſed in water, ſoon ſeparates from the iron, and lets it fall in the form of ochre.

This has been obſerved in ſeveral chalybeates, where the acid has been ſo obvi-

ous as to change the colour of ſyrup of violets. But as the firſt circumſtance is rare, and could furniſh only a temporary impregnation, and as the latter is only the decompoſition of a chalybeate, we cannot admit of a Mineral Water originally impregnated with the vitriolic acid.

Muriatic acid. 2dly. The Muriatic acid, or acid of ſea ſalt, is the only other foſſil acid. This is contained in fewer foſſil productions than has been imagined, and is not, in like manner, ſubject to decompoſition; therefore we exclude it.

3dly. The other two acids, as we ſaid before, are never found native. The ingenious and learned Dr. Heberden, in his Remarks on the pump-water of London, has, however, mentioned the nitrous acid *per ſe*, as the predominant impregnation in moſt of the waters he examined. We would willingly pay all due deference to the authority and judgment of this learned Gentleman, but, as he has not recited the methods he took in

Nitrous acid.

in detecting this ſubſtance, we cannot help ſuſpecting it to be either a miſtake of this for the volatile vitriolic acid, which, in ſome circumſtances, ſuch as its decompoſition by the fixed vitriolic acid, its exhaling a powerful odour, &c. much reſembles the nitrous, or elſe the decompoſition of ſome ſubſtance containing the nitrous acid uſed in the experiment.

We have, ourſelves, made ſeveral experiments to this purpoſe, and have added a fixed vegetable alkaline ſalt to a great number of pump waters, but never could diſcover the ſmalleſt particle of nitre, on evaporation, which muſt have been the caſe, had the water contained the nitrous acid in ſubſtance.

Dr. Cullen likewiſe, the late ingenious Profeſſor of Chemiſtry at Edinburgh, has made many experiments to the ſame purpoſe, but without diſcovery of any traces of ſuch an impregnation. We would not, however, from any reaſoning *a priori*, deny the exiſtence of any fact ſupported by

the authority of ſo competent a judge as Dr. Heberden.

We will venture, however, to ſuggeſt a thought, which, perhaps, may reconcile both theſe opinions. The ſpring water of London, which was the ſubject of the Doctor's experiments, was, as he obſerves, "liable to many impurities from cellars, "burying-grounds, ſewers, and many o-"ther offenſive places, with which they "undoubtedly often communicate."

Nitre we know to be the produce of putrefaction, and gained in largeſt quantity by a lixiviation of thoſe earths which have had the greateſt proportion of animal or vegetable ſubſtances left to putrefy in them. Is it not very probable that theſe ſprings may be impregnated in this manner? This is farther illuſtrated by what the Doctor ſays afterwards, "that a cer-"tain ſpring in the City never fails to "yield a portion of volatile alkali in diſ-"tillation, which is always the product of "putrefaction, and, probably, owing to "ſome

" ſome animal ſubſtances with which it is " tainted in its paſſage under ground."

In the nitre manufactories, the ſubſtance procured on waſhing the earth, is ſaid to be a nitrous ammoniac, or the nitrous acid combined with a volatile alkali, which is changed into nitre by lixiviating it with pot-aſhes. In all probability, the wells the Doctor examined contained the nitrous ammoniac likewiſe, which, if any fixed alkaline ſubſtance was uſed in making the experiment, would be decompoſed, raiſe an effervescence, and, on evaporation, leave a perfect nitre, in the ſame manner as if the nitrous acid had been preſent in the water uncombined with any other body.

It is poſſible, likewiſe, though we never before heard it aſſerted, to ſuppoſe a method by which a ſpring might be impregnated with the nitrous acid in its ſeparate ſtate. Should any of the ſprings which contain the nitrous ammoniac, communicate with any which, from ſome of the circumſtances before mentioned, contained the

vitriolic acid in a ſeparate ſtate, a decompoſition might happen, by which the * nitrous acid might be diſengaged from the volatile alkali, and, thus left by itſelf, diffuſed through the water. Here, however, another difficulty occurs. The vitriolic acid is always found, when native, in a volatile ſtate, in which it will not decompoſe any neutral ſalt formed by the other acids. To this, however, we may anſwer, that the volatile vitriolic acid, on being largely diluted with water, is in part reſtored to its fixed ſtate, which may ſerve to account for this appearance †.

* A great reaſon to lead us to believe, that the nitrous acid is never found native, is, that the ſmalleſt portion of cubic nitre was never yet found in any analyſis of ſprings. As common ſalt is accumulated in ſo great quantities in the earth, it muſt often be changed into cubic nitre, were the nitrous acid preſent there.

† This ſeems true with reſpect to the volatile vitriolic acid *per ſe*, but will not hold of it when united with iron, as, in that caſe, it ſeems to be entirely diſſipated on its communication with the atmoſphere. This metal ſeems to have a power of rendering even the fixed vitriolic acid in ſome degree volatile, as we ſee in ſolutions of green vitriol, which, on ſtanding expoſed to the air, ſuffer a decompoſition, owing to the acids flying off; which occaſions the precipitation of the iron in a flaky ochrous form.

A ſtill greater difficulty occurs, in accounting for the preſence of the muriatic acid alone, in ſprings; the exiſtence of which has the authority of the ſame learned Gentleman to confirm it. When combined with the foſſil alkali, in form of ſea ſalt, it is the moſt frequent impregnation we meet with; but we have not found any Author who has mentioned this ſubſtance uncombined, as being preſent in any Mineral Water.

It is poſſible, however, to account for this, in the ſame manner as the laſt mentioned.

Should any of the ſprings, which are accidentally impregnated with the volatile alkali, communicate with any that contain the vitriolic acid, either pure, or united with iron, in form of a chalybeate, a vitriolic ammoniac would be formed. Should this afterwards communicate with any ſource containing common ſalt, a double decompoſition would enſue, and a Glauber's ſalt, and ſal ammoniac, would be reſpectively

ſpectively formed in place of the others. If to this ſhould be added, in the courſe of experiment, a fixed alkaline ſalt, a decompoſition, attended with efferveſcence, would happen, and a common ſalt, or ſal digeſtivum, would be found on vaporation; in the ſame manner as if the water had originally contained the pure muriatic acid.

Several Chemiſts have aſſerted the exiſtence of ſal ammoniac in ſprings. Dr. Cullen allows the poſſibility of it, but reſtrains it to ſuch places as it might have been produced in by inflammation, ſuch as adhering to the lava of volcanos, &c. That it is often produced by inflammation is an undoubted fact, but there are reaſons to believe that this is not the only method by which it may be formed. Many great Chemiſts have been of opinion, that both nitre and common ſalt owe their origin to putrefaction, and that they may be reſpectively produced, by a ſlight variation in

that

that proceſs *. If this be probable of common ſalt, we ſhall find † it much more ſo of ſal ammoniac, as one of its component parts, viz. the volatile alkali, is conſtantly produced, in ſo large proportion, in every putrefying ſubſtance. If this be true, we may ſuppoſe the ſal ammoniac at once formed and communicated to the water by the means above mentioned. We beg leave to acquaint our reader, that what we have here laid down, we offer only as matter of conjecture, and that, even in our own opinion, rather a diſtant one.

Granting, however, that Water has been found combined with ſuch ſubſtances, as this happens only in accidental circumſtances, we cannot admit them into our liſt of native impregnations of Mineral Waters.

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* This is, by moſt, attributed to the different proportions of moiſture in the putrefying ſubſtance; a ſmaller producing nitrous ammoniac, or nitre, and a larger common ammoniac, or common ſalt.

† The convertibility of the fixed and volatile alkalies into one another, render this more probable.

The

Vegetable acid. The vegetable acid we know to be a purely artificial production, and never found native in the bowels of the earth.

Vegetable alkali. With reſpect to the fixed alkalis, we may exclude the vegetable one, as being entirely artificial, and which can never be accidentally waſhed down in ſufficient quantity to impregnate a running water.

Foſſil alkali. This, however, is by no means the caſe with the foſſil alkali, ſince we know it is preſent in the Mineral kingdom, both in a compound ſtate, and *per ſe*. The firſt perſon who obſerved its preſence in Mineral Waters was the celebrated * Dr. Stahl. It is, however, far from being a common impregnation, nor have we ſeen any thing wrote ſatisfactorily on this ſubject.

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* Dr. Hoffman, likewiſe, purſued this ſubject farther, and has adduced ſeveral arguments in proof of it.

The

Volatile alkali.

The volatile alkali comes next in order. This is contained in vegetable and animal ſubſtances, eſpecially ſuch as approach towards putrefaction, when it is copiouſly generated. It is generally, however, believed, that the foſſil kingdom never affords it native. Some ſtones, indeed, have been found, which, on being broken, or rubbed againſt each other, give out an odour reſembling the volatile alkali, from whence the name is taken, *Lapis Suillus*.

Dr. Cullen, however, accounts for this, from ſome vegetable or animal ſubſtances being waſhed down, when in a putrid ſtate, and theſe incruſtations forming round them. It is, however, here, in a ſtate of too firm concretion to be waſhed out by waters. When ſprings, in their courſe under ground, have acceſs to any putrid ſubſtances, they may, by this means, be impregnated with the volatile alkali. An inſtance of this was given above, which is related by Dr. Heberden.

Sal

Sal ammoniac, as was before obſerved, may accidentally be a foſſil ſubſtance, as adhering to the lava of volcanos, &c. It is found ſometimes, likewiſe, in this country, in fiſſures of the earth, from whence the ſmoak of burning coal pits iſſues, and the volatile alkali might be waſhed out from thence by a decompoſition. This caſe is certainly poſſible, but we have no fair experiments adduced in proof of it.

Henckel, indeed, in his *Bethesda Potuosa*, tells us, that he found a volatile alkali in ſome waters, on diſtillation; but in his experiments he formed a *hepar ſulphuris*, and the fixed alkali, when decompoſed from it, appears in a volatile form *.

Having finiſhed what we have to ſay on the Impregnation of Waters with ſimple ſaline bodies, we now proceed to the compound ones.

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* The convertibility of the fixed and volatile alkalies into each other, was firſt obſerved by my late worthy and ingenious friend, Dr. Butt.

Here,

Here, however, we muſt keep to the rule before laid down, to admit thoſe only which are formed by the foſſil neutral ſalts, and, of conſequence, we muſt exclude thoſe formed by the vegetable and volatile alkali, with the vegetable and nitrous acids. With reſpect to the laſt, indeed, the caſe is not ſo clear. Margraaf, in his Analyſis of Common or Snow Water, found a portion of nitre, but then it was in ſo ſmall a proportion as one grain in a hundred quarts; and as this impregnation could have no influence in practice, it would be needleſs to conſider it.

Compound ſaline bodies.

Neutral ſalts.

Nitre.

If it be true, as ſome ſay, that nitre is directly got, by lixiviating the ſoil, or ſtaple of the earth, it will be eaſy to conceive how a ſmall portion of nitre might be accidentally waſhed down, eſpecially after great rain, ſo as to give a ſlight impregnation to ſome ſprings. What ſeems to have miſled many in this reſpect is, the reſemblance in form between

between the chryſtals of nitre, and thoſe of Glauber's ſalt and the ſal cathartic. amarus.

The proper method of diſtinguiſhing them, would be to obſerve, whether any of the chryſtals, (which are in both of them hexagonal priſms) terminate at one end in a ſix ſided pyramid. Theſe, we may be aſſured, are nitre; as the chryſtals of that ſalt, when perfect, are always in that form; whilſt thoſe of the other two have their extremities always truncated. Even nitre itſelf, by too haſty a chryſtallization, will often put on that appearance *.

We ſhall now proceed to ſpeak of the moſt common impregnation of Mineral Waters, and from which, indeed, ſcarce any are entirely free, viz *common ſalt*, and this is found from

Common ſalt.

* Although the chryſtals of nitre by this management may be made to put on this form, yet no art can make thoſe of Glauber's ſalt, or ſal cath. amar. reſemble thoſe of nitre, when regularly formed.

quantities

quantities imperceptible to the ſenſes, to that of a ſaturated ſolution.

Though we do not allow the vitriolic acid to be found originally native in any Mineral Waters, we are ready to own, that, in a compound ſtate, it is one of the moſt frequent impregnations we meet with. It is, however, found combined only with the foſſil, among the alkalies, in the form of the true Glauber's ſalt. Though we believe this to be a native ſubſtance, we have the utmoſt reaſon to think it not to be a common one. There are, however, ſome accounts of its being found native in hot climates, as about Smyrna, &c. *Glauber's ſalt.*

The Gentlemen of the French Academy, indeed, gave out, that it was plentifully found in their country; but it afterwards proved to be the ſal cathartic. amarus, whoſe baſis is magneſia, which indeed ſo nearly reſembles the true Glauber's ſalt, as not to be eaſily detected by a bare inſpection.

The

The above-mentioned are the only proper ſaline impregnations we know of. As for the metallic, and earthy ſalts, they ſhall be ſeparately treated of under their reſpective heads. It is proper, however, to caution thoſe, who read Authors who have wrote on this ſubject, that they be not miſled by terms. In Dr. Short's Treatiſe he frequently makes mention of nitre, as an impregnation of Mineral Waters. What he means here, however, is not what we mean by nitre, but the foſſil alkali, which was called nitrum, or natron, by the ancients. He probably borrowed this miſtake from Dr. Liſter, who likewiſe uſed that term. A late Writer on the Bath and Briſtol waters, has made a diſcovery that one of them contains ſalts, and the other a neutral ſalt. Surely the diſcovery might have been carried ſo far as to determine of what nature theſe ſalts were; as otherwiſe the world is but little inſtructed.

Authors,

Authors, likewiſe, who have written on this ſubject, while chemiſtry was yet in its infancy, and, indeed, ſome of later date, imagined that a ſalt might be formed, partaking of the nature of ſeveral others. Thus we read of vitriolico nitrous ſalts, &c. which we now know to be miſtaken notions, as ſalts are capable of no farther union than that of being diſſolved together in the ſame menſtruum, but always chryſtallize diſtinct.

It muſt be owned, however, that native ſea ſalt, and, perhaps, Glauber's ſalt, and the ſal. cathartic. amarus may ſometimes be found united by nature with ſome metallic bodies, and from ſome admixture of this kind, probably proceeds the various colours obſerved in ſal. gemmæ or rock ſalt.

Of WATERS *impregnated with* INFLAMMABLE SUBSTANCES.

Inflammables. THE only foſſil inflammable ſubſtances we are acquainted with, are ſulphur, and the foſſil oil, which, from its different degrees of concretion from the moſt fluid ſtate, to a firm ſolidity, is named *naptha* and *pitcoal.* The celebrated Profeſſor at Edinburgh is of opinion, that the two laſt mentioned only differed in firmneſs of coheſion, owing, as he thought, to the preſence of ſome foreign body, which he, with great appearance of probability, imagined to be the vitriolic acid. It is obſervable, that no inflammable ſubſtance, reſembling the animal and vegetable oil, are ever found below the ſurface of the earth; and there is ſome reaſon to believe, that the earth is capable of converting theſe into the form of a foſſil oil. Both theſe ſubſtances, however, refuſe a combination with water, though they may be

be carried along with it, and ſo minutely diffuſed, as to have the appearance of a ſolution. We cannot, here, help obſerving, that the learned Dr. Lewis has carried his arguments *a priori*, in this caſe, to a great exceſs; and, from a preconceived opinion of the impoſſibility of their union, takes no notice of their diffuſion through waters, though their preſence is very often obvious to the ſmell and taſte.

Sulphur per ſe.

Sulphur is ſometimes an ingredient in Mineral Waters, in a diffuſed ſtate. The pipes that convey the Waters of Aix-la-Chapelle, are incruſted with it, to a conſiderable thickneſs. Sulphur, when thus diffuſed in water, has been thought to have acquired new properties, but, on examination, this is found to be a miſtake. Many Writers on this ſubject, have talked much in praiſe of a volatile ſulphur, to which they attributed great virtues. This, however, is now found not to be poſſible, as it proved undeniably, that there is but one kind of ſul-

phur, and that not volatile. Probably the volatile vitriolic acid was miſtaken for it. Both oil and ſulphur may be combined with water, by the mediation of an alkali.

Foſſil oil, united with water, by mediation of an alkali.

The foſſil oil, naptha, forms a kind ſoap, with alkalies. This, indeed, we can perform, but by a method we can ſcarce expect nature to imitate. This, however, is one of the caſes in which, as was obſerved in the firſt part of our work, we muſt not ſet bounds to her operations, and we certainly have accounts of ſuch waters from accurate and good Chemiſts, though the inſtances are very few.

Hep. ſulph. c. alk.

Hepar ſulph. is, however, a very frequent impregnation. The learned Dr. Lewis has rather incautiouſly rejected this from his catalogue of impregnations of Mineral Waters, from his not being able to procure it by a chemical analyſis. The reaſon of which is, that the hepar ſulph. is decompoſed, in

ſome

ſome degree, in the air, and by ſolution in water. The taſte, however, odour, and blueiſh white colour, on addition of acids, are ſufficient evidences of its preſence.

Calcareous earths, likewiſe, in form of quick lime, form a kind of hepar ſulph. with ſulphur, which is miſcible with water, in like manner with that formed by an alkali, though not near ſo copiouſly. This has been ſometimes ſuſpected in Mineral Waters, but never clearly proved. Its ſenſible qualities, and chemical effects, differ, in ſeveral reſpects, from that made with an alkali. It is nearly inodorous, and the ſulphureous taſte, which is by many compared to that of a rotten egg, is ſcarce perceptible. Its chemical qualities vary much likewiſe; it is not precipitated from an aqueous ſolution by acids, as that is which is formed by an alkali.

Hep. ſulp. c. calce vivâ.

The learned Dr. Lucas has aſſerted, that ſulphur, and a ſuperabundant acid, cannot ſubſiſt together in the ſame ſolution. This

is undoubtedly true of the ſolution of ſulphur in water, by the mediation of an alkali, but does not hold with reſpect to that made with quick lime *. This was taken notice of in a late Treatiſe, intitled, *A Reply to Dr. Lucas's curſory Remarks on Dr. Sutherland's Work on the Bath Waters.* The fact, thus related, is undoubtedly true; yet the Author has no great reaſon to triumph over Dr. Lucas, in the manner he does, on account of his pretence to a ſuperior degree of chemical knowledge; ſince the firſt experiments he brings in proof of his aſſertion, proves nothing more than his ignorance of the ſubject. He aſſerts, that water, added to quicklime, and ſulphur, *calcined* together, acquired a *vitrioline* acid from the lime. The Doctor has here found a new matrix for the vitriolic acid, in which it was never before ſup-

* We may judge, from hence, how dangerous it is to take theſe things on truſt, from theory, without making the experiments to confirm them.

poſed

poſed to exiſt in a ſeparate ſtate. Had he conſulted ſo common a book as *Neumann's Chemiſtry*, he would have found, that the vitriolic acid, joined to quick lime, or a mild calcareous earth, forms the earthy ſalt called Selenites, of very ſparing ſolution in water, and from which the vitriolic acid is ſcarce ſeparable by mere force of fire. It is probable, by the Doctor's account of his experiment, unleſs his calcination of the ſulphur was performed in a cloſe veſſel, (in which caſe it could be of no uſe,) that it would be diſſipated; and what he took for a ſolution of ſulphur, would be no more than the water impregnated with a ſalt reſembling Selenites, compoſed of the vitriolic acid, in a volatile ſtate, as ſeparated from the ſulphur and the quick lime*. The Doctor, however, ſeems to have derived his notion of the vi-

* If the heat was very ſtrong, both the acid and phlogiſton would be diſſipated together, and nothing but a calcareous earth left behind.

triolic acid being contained in quick lime, from his obſervation of the generation of heat, on addition of water to quick lime, as well as to the vitriolic acid. That the ſame effect is produced in both theſe caſes we readily acknowledge; but that they are owing to the ſame cauſe, we cannot ſo eaſily agree to; ſince alkaline ſalts in a cauſtic ſtate, which we can ſcarce ſuppoſe to contain an acid, and neutral ſalts, when calcined, generate heat with water in greater proportion than quick lime. The true reaſon, however, may be explained on that univerſal maxim in Chemiſtry, that ſolution produces cold, and concretion heat. Quick lime, in this reſpect, reſembles ſaline bodies, in requiring a certain quantity of water to be united with it, in order to its concretion. The Doctor, however, ſeems not to have been acquainted with this, as he aſſerts, ſoon after, that alkaline ſalts render water colder; which is, indeed, true of them, when united with water in a chryſtallized ſtate, as they then generate cold

cold by ſolution. But neutral ſalts have alſo this effect in like manner.

Perhaps ſome apology may be thought neceſſary, for having made the aforeſaid obſervations, as we promiſed, in the Introduction to our Work, to keep clear of all perſonal reflections. We do not mean this as ſuch, nor ſhould we have animadverted upon this opinion of Dr. Linden's, had it not been unneceſſarily introduced into his Work, in order to caſt a very ſevere reflection on a very reſpectable character in our profeſſion, ſome time deceaſed, of which he brings not the leaſt proof, and to which neither the character of Dr. Whytt, nor the works he left behind, authorize any credit to be paid.

Of IMPREGNATIONS *of* WATERS *with* METALLIC SUBSTANCES.

THE metallic impregnations of Mineral Waters are very few. Many metals are not ſoluble in the foſſil acids, and ſeveral, that are ſoluble in the vitriolic acid, are only ſo in a boiling heat. Moreover, they are generally in a ſtate of ore, and thus protected from their action by the ſulphur.

Iron. Iron is, therefore, the moſt frequent impregnation we meet with, from the univerſality of its preſence, and ſuperior ſtrength of attraction.

Notwithſtanding the great variety of chalybeats, mentioned by ſome authors, we are inclined to believe, that, conſidered as ſuch, they do not vary, except in the degree of ſaturation, as the vitriolic acid is the only native ſubſtance with which iron has hitherto been found united. Many writers have uſed the terms of fine and coarſe

coarſe chalybeats, which have no foundation in truth, and which ſeem to have been drawn rather from the degree, than the nature of the impregnation. Though all the chalybeats, hitherto diſcovered, have been of this kind, yet we might ſuppoſe, that it might be found in waters impregnated with ſome of the foſſil neutrals. I have ſeen pieces of ſal gemmæ, which contained an admixture of iron in their chryſtals, which might impregnate any ſpring it might meet with, in its paſſage through the earth. Probably it would not hold the iron in ſolution when diſſolved in water.

Even when we are certain of the vitriolic acid and iron in a water, we can ſeldom get it in a chryſtallized form *, as the vitriolic acid ſeems here to have been extracted from pyrites, which contains it in a vola-

* There are ſome inſtances of green vitriol being got, in a chryſtallized form, from the waters at Hartſell, in Scotland. Eſſ. Phyſ. and Lit. vol. I. p. 346.

tile ſtate; it is therefore decompoſed on expoſure to the air, the iron falls down, in form of ochre, and the water loſes its chalybeate taſte and qualities. This gave riſe to the opinion of many writers of the volatility of the vitriol itſelf, whereas nothing but the pure volatile acid ſeems to eſcape. This explains the appearance of a volatile ſpirit in them, called, abſurdly, *Spiritus Mundi.* A late Writer has called the iron, thus ſeparated from the acid, a *Mucilagium Ferri*; but what he means by this, he himſelf is beſt able to explain. The waters that contain this volatile impregnation, do not bear tranſportation, except corked up as ſoon as taken from the ſpring.

Copper. Copper is frequently found in the earth, and from its being ſo eaſily corroded and diſſolved by acids, and ſaline ſubſtances, we might imagine it to be a common impregnation of Mineral Waters. Accordingly we ſometimes find it combined with water, but not

not ſo common as we might expect, on account of the frequency of iron which precipitates it.

In this ſtate it is (like iron) united with the vitriolic acid, which, on its combination with copper, ſeems to be, in ſome degree, reſtored to its fixed ſtate, as no ſpontaneous precipitation of the metal happens in the cupreous, as does in the ferrugineous waters, on being expoſed to the air. We might expect, from what has been before ſaid of iron, to ſee the Mineral Waters impregnated with copper, combined with a neutral ſalt, as many chryſtals of ſal gemmæ are found tinged of a beautiful blue colour, which undoubtedly proceeds from ſome admixture of copper. Probably, however, the ſame reaſon ſubſiſts with regard to copper, as does to iron.

Zinck.

Zinck is not infrequent in the bowels of the earth, and, ſince it precipitates every other metal, even iron, from their ſolutions, it would ſeem remarkable that we do not meet with it oftner in Mineral Waters.

A great Chemiſt is of opinion, that in its moſt frequent ſtate, as the *Pſeudo-Galena*, it is not acted on by acids.

Zinck, however, is ſometimes found in a chryſtallized ſtate, in form of white vitriol. It is certainly a poſſible impregnation of Mineral Waters, though we have not ſeen any proofs brought of its exiſtence as ſuch. Probably its not having been taken much notice of by the Chemiſts, was not ſo much owing to its abſence, as to their never having had it in view. Neumann, indeed, mentions ſome as contained in waters, but brings no particular experiments to prove* it.

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* Arſenic has, of late, been ſaid to be found in ſeveral Mineral Waters, particularly thoſe of Chevron or Bru, in France; but we have not ſeen any accounts that incline us to pay any credit to it. Dr. Linden, who is ſo anxious for the credit of the Bath Waters, pretends to have diſcovered this Mineral in them; but gives no reaſons that ſupport his allegation.

WATER *impregnated with* EARTHS.

EArthy bodies, in their ſimple ſtate, we know not to be ſoluble in water. Here, however, we muſt not truſt too much to general principles; for earths are undoubtedly ſo largely ſuſpended in water, as to bring them under our definition of Mineral Waters. It is aſſerted, that chryſtalline and argillaceous earths have been diſcovered in ſolution in waters. *Calcareous Earth.* Theſe impregnations are, however, very ſlight; but the calcareous earth is frequently contained in them in large quantity, and is procured not only by evaporation, but by depoſition on the ſurface, where it frequently appears in form of ſtalactites, and even through the pores of ſome bodies, ſo as perfectly to petrify them. This plentiful diffuſion of earth is difficult to account for, unleſs we

ſuppoſe

ſuppoſe it in form of quick lime, and that, on its acquiring its mephitic air, it is again depoſited. Dr. Cullen is of opinion, that the difference of taſte in theſe waters, is owing to the different manner in which the earths are previouſly deprived of their water and air; ours is done by calcination, the other by means we are ignorant of.

The ſaline earthy impregnations are the vitriolic acid, united with a calcareous earth, in form of Selenites, with magneſia in form of ſal cath. amar. and with earth of alumn, in form of alumn. The muriatic acid is never found native, combined with an abſorbent earth.

Selenites. The firſt of the above-mentioned ſubſtances is the moſt common impregnation of ſprings, though very ſparingly ſoluble in water. To this is generally owing, that quality of waters, which we call hardneſs, though other ſubſtances, ſuch as the vitriolic acid, ſeparate; the ſal. cath. amarus, aluminous waters, and the common chalybeates, have all this effect.

Sal

Sal cath. amar. is very frequently a native ſubſtance; accordingly we ſee it preſent in many ſprings. It is very largely ſoluble in water, ſo that we meet with many more degrees of this, than the foregoing impregnation. *Sal cath. amar.*

The laſt ſaline earthy body that comes under our conſideration, is alumn; of this there are great diſputes among the learned, if ever it is found impregnating a Mineral Water. Neumann ſays, he never ſaw any water that yielded a perfect alumn on bare evaporation. Dr. Lewis ſeems to be of opinion, that the vitriolic acid is capable of changing the argillaceous earth into earth of alumn, in ſupport of which he brings a very ſatisfactory experiment. By this, however, it appears, that acceſs to the air was neceſſary to the production of the alumn. It has been moreover obſerved, that the aluminous pyritæ, and ſeveral other ſubſtances from which alumn is procured, *Alumn.*

cured, betray no marks of containing it, until they have been dug up for ſome time, and expoſed to the air.

If the laſt mentioned circumſtance was neceſſary to the production of alumn, we could ſcarce imagine it could poſſibly be a native foſſil. We have, however, great reaſon to believe it to be ſo, as we have very good authority for aſſerting it to be found in Mineral Waters. Moreover, ſeveral kinds of ſlate have been found, which have an aluminous taſte when newly dug, and from which alumn is directly elixated, without a previous expoſure to the atmoſphere. It is certain, however, that the communication with the air is neceſſary to the procuring of alumn from ſeveral bodies; and ſome circumſtances, relative to the manner in which it is found native, make us believe this to be univerſally neceſſary to its production. It is moſtly found in the interſtices of the laminæ, of which the ſtone is compoſed, (which are ſometimes at ſome diſtance from

from each other,) but never in the body of the ſtone. This might give occaſion to the decompoſition of the pyrites *, by which means the vitriolic acid is ſet looſe, and at liberty to unite with the aluminous earth. Should any ſpring interfere with any of theſe cavities, it might receive an impregnation of this kind. Any ſpring, likewiſe, containing the vitriolic acid in ſubſtance, running through a bed of argillaceous earth, might gain from that an aluminous impregnation.

Argillaceous earths have been ſaid to contain a perfect alumn. That ſomething of that kind is preſent in clays, that have been ſubjected to the action of the fire, is well known, for which reaſon a † late ingenious Writer has cautioned againſt lin-

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* N. B. A circumſtance of this kind was mentioned before, in order to account for the vitriolic acid alone in ſprings.

† Dr. Perceval, on Water.

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ing the inſides of deep wells with brick; and, indeed, it is probable, that the aluminous taſte, diſcoverable in many of our ſprings, may be owing to this circumſtance.

WATER *united with aërial* BODIES.

WE now come to the laſt, though not the leaſt important Impregnation of Mineral Waters, viz. that of aërial Bodies. The preſence of air in water is frequently obvious to our ſenſes, and at all times diſcoverable by the experiment of the exhauſted receiver. Whether the air, thus ſeparated, be the ſame of the air of the atmoſphere, which we breathe, or of the mephitic kind, affords room for a curious queſtion. An eminent Chemiſt is of opinion, that the air which iſſues from water, under an exhauſted receiver, is of the latter kind; and, indeed, there are very good reaſons to be brought in defence of that opinion. He urges, that the air which is diſcharged from water under the receiver, is of the ſame nature with that ſeparated by freezing, of which the following is offered as a proof: Water, in its common ſtate, ſuffers

Common Air, or mephitic Air, Qu.

fers a large expanſion from the ſeparation of its air, in conſequence of which, many bubbles are formed, which ſometimes occupy a conſiderable ſpace. But water, when deprived of its air by the receiver, freezes without any increaſe (but rather diminution) of bulk, or ſeparation of air. In order to determine the quality of the air thus diſcharged, he obſerves, that the freezing of water bears a ſtriking analogy to the chryſtallization of neutral ſalts, previous to which, the ſeparation of the air is always neceſſary; which we know to be of the mephitic kind, or fixed air reſtored to its elaſtic ſtate.

On the other hand, reaſons are not wanting to induce us to think the air, thus diſcharged from water, not to be of the fixed kind. Calcareous earths are obſerved to have the greateſt affinity with fixed air of any known body, ſome metallic ſubſtances excepted; inſomuch that when in their cauſtic ſtate, or deprived of it, they abſorb it from every other body they are united

nited with that contains it, and thus become mild and inſoluble in water *. From this we ſhould be led to conjecture, that a ſolution of theſe earths in water could contain no air of this kind. Nevertheleſs lime-water, placed under a receiver, ſhews evident marks of its containing an aërial fluid, by the bubbles it exhibits on exhauſting the air. We frankly own, we are not able to reconcile theſe contradictory appearances, but leave them for ſome abler judge to determine. A certain quantity of air, of whatever kind this may be, ſeems neceſſary to be united to common water, in order to render it fit for the purpoſes of diet, as water that has been frozen, viz. *ſnow* or *ice-water*, which makes a great part of the drink of the inhabitants of

* This is proved by conveying the air from an efferveſcent mixture, into a veſſel containing lime-water, by means of a communicating tube, which immediately cauſes a film on the ſurface, and a turbidneſs and precipitation through the body of the water. The precipitation is found to be a mild calcareous earth.

moun-

mountainous countries, is productive of ſeveral diſorders, as glandular obſtructions, &c. This was formerly attributed to the nitre contained in it; but, as we before obſerved, this is in exceeding ſmall quantity, and, moreover, an innocent impregnation. Dr. Percival, however, in his ingenious Treatiſe on Water, has, with great probability, referred it to the ſeparation of the air. However, notwithſtanding the doubts concerning the nature of the air with which common water is united, we can have no doubt that many mineral ſprings are impregnated with fixed air, in large quantity. This is ſufficiently determined by chemical experiments. Cauſtic alkalies become mild, and the lime is precipitated from lime-water, by the air, ariſing from Mineral Waters being united with it. The effects, too, of many of them on the human body, ſimilar to thoſe of fermenting liquors, and which, if drank plentifully at the ſpring, it is ſaid, in ſome, will even

Fixed air preſent in Mineral Waters.

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which is obſerved in many Mineral Waters *.

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* *Neumann's Chem.* p. 176. If equal quantities of green vitriol, and the mineral alk. ſalt, or baſis of ſea ſalt, be dropped into a ſtrong bottle, filled with ſpring water, and the mouth inſtantly cloſed, ſo as to leave no vacuity in the veſſel, the two ſalts will be ſlowly diſſolved, and ſubſiſt quietly together, as long the veſſel is kept cloſely ſtopped; there being no room for the extrication of the air, which all acids expel from alkalies, on uniting with them, and, without the expulſion of which, they cannot unite with them. As ſoon as the bottle is opened, the ſalts begin to act upon one another, and the liquor exhibits the ſame remarkable phænomena, as the chalybeate waters do when brought up into the open air: It ſparkles or emits bubbles of air, taſtes briſk and ſpirituous, as it is called, gives marks both of acidity and alkaleſcence, ſtrikes with galls, not the black that vitriol does by itſelf, but a fine purple: On ſtanding for a little time, it loſes theſe qualities; the vitriol is deſtroyed; its iron falls to the bottom, in form of ochre, its acid being abſorbed by the alkali. The remaining liquor, evaporated, leaves only a little cathartic ſalt, and a part of the alkali unneutralized; together with a portion of marine ſalt and different earths which the ſpring water contained before.

The learned Dr. Lewis has related an experiment which ſtrongly confirms the above theory, and proves that, by a proceſs of this kind, water may be artificially impregnated with fixed air, ſo as to exhibit all the appearances of the natural impregnations *.

This experiment of Dr. Lewis, however, only tends to ſhew, that water may be impregnated with air, by means of a mild, alkaline ſalt.

The ſame appearances, however, would happen on the addition of a mild, abſorbent earth, or metallic ſubſtance, as iron, to a dilute ſolution of the vitriolic acid; provided the veſſels were filled, and immediately cloſed, as in the former experiment.

Dr. Lewis has, by this experiment, ingeniouſly ſuggeſted a method by which a chalybeate water might be formed naturally, which ſhould exhibit the ſame appearances, which we find they generally do, on

* See the foregoing page.

exami-

examination. The natural chalybeates, however, are by no means of this kind; ſince, if that were the caſe, every chalybeate water muſt be impregnated with Glauber's ſalt, if the precipitation was made by the foſſil alkali, or by decompoſition of common ſalt; or with ſal cath. amarus, or ſelenites, if the iron were precipitated by an abſorbent earth, which we find by no means to be the caſe; and the common chalybeates have, in general, no impregnation of the two former kinds. What proves this, moreover, is, that common ſalt is often found in chalybeate ſprings, which could not be the caſe, if the ſpring contained the vitriolic acid in a fixed ſtate, as it would ſuffer a decompoſition, and be changed into Glauber's ſalt. The vitriolic acid, however, in its volatile ſtate, as it is found united with iron in chalybeates, is weaker in its attraction to alkalies, than the other foſſil acid, the muriatic, on which account, no decompoſition of the ſea ſalt happens.

Notwithſtanding, however, the ſpecioufneſs of this theory, it labours under many objections. Were it true in its full extent, we might expect to ſee waters impregnated with fixed air, in proportion as they contained a greater quantity of ſaline matter, from which the air had been diſcharged, as in the formation of a neutral by an acid and an alkali.

Notwithſtanding this, we ſee ſeveral ſprings that contain neutral ſaline matter in great abundance, and ſome even to a ſaturated ſolution, very lightly, if at all impregnated with fixed air. This would ſeem at once to overturn our theory, but perhaps even this admits of an explanation. The ſalts that are found thus, are, common ſalt, Glauber's ſalt, and the earthy ſalt called ſal cath. amar. The firſt of theſe we have great reaſon to believe to be an original ſubſtance, and that its component parts never exiſted, native, ſeparately in the earth, but that they were originally produced combined in the form we ſee them,

them, viz. common ſalt; and there are ſome reaſons to induce us to think this not improbable of the ſal cath. amar. and Glauber's ſalt.

On ſuppoſition, however, that it might be formed in the earth, by the union of an acid with an alkali, the air thus generated might be abſorbed by other foſſil bodies, many of which attract it, before the ſpring had acceſs to it, or, at leaſt, by ſome ſubſtances it might meet with in its paſſage to the ſurface. Were this true, it would account for this circumſtance, as we could not expect to ſee ſprings thus impregnated with air, unleſs ſome new ſaline combination was directly formed by ſome of the means above mentioned, in the waters. It is probable, that, on this account, we ſee the Chalybeate Waters have, in general, more or leſs impregnation of air, as we have great reaſon to believe the ſolution of the iron is performed in the water by the vitriolic acid united with it, by the means above mention-

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together, by means we are ignorant of *.

From the aforesaid review of the Impregnations of Mineral Waters, we find that they all may be divided into

- Those impregnated with saline bodies.
  - Simple
    - Acid
      - 1. Vitriolic acid, *per se. Quer.?*
    - Alkali
      - 2. Fossil alkali, *per se.*
  - Compound
    - 3. Glauber's salt.
    - 4. Common salt.
- Inflammable bodies.
  - Oils.
    - Simple
      - 5. Oil fossil, *per se.*
    - Compound
      - 6. Oil in form of soap. *Quer.?*
  - Sulphur
    - Simple
      - 7. Sulphur, *per se.*
    - Compound
      - 8. Hepar. Sulph. with an alkali.
      - 9. Hep. Sulp. with quick lime.
- Metallic bodies.
  - Simple
  - Compound with vitriolic acid
    - 10. Copper.
    - 11. Iron.
    - 12. Zinck, dubious.
- Earthy bodies.
  - Simple
    - 13. All earths diffused.
  - Compound
    - 14. Selenites.
    - 15. Magnesia Glauber's salt.
    - 16. Alumn.
- Aërial bodies.
  - \- - -
    - 17. Common air, dubious.
  - \- - -
    - 18. Mephitic air.

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* The ingenious Mr. Cavendish has invented a machine by which water may be mechanically impregnated with fixed air.

Beſides the differences that ariſe from Impregnations, we make a diviſion of Mineral Waters, from their difference of temperature, into the *acidulæ* and *thermæ*.

The laſt have been the ſubject of much enquiry among the Philoſophers, and are ſtill very indifferently accounted for. Naturaliſts finding that the pyrites, on being moiſtened with water, acquired a conſiderable degree of heat, have been willing, from this admixture, to account for both the impregnation and heat together.

Sulphur and iron filings generate a heat ſtill more conſiderable, and to this cauſe they would attribute earthquakes and volcanoes. But there are many objections that will deſtroy or ſuperſede the firſt theory; for we have accounts of thermæ without any degree of impregnation. But even ſuppoſing the heat to be communicated to a neighbouring ſtream that is unimpregnated, we cannot imagine that ſuch a cauſe ſhould act with ſuch uninterrupted uni-

uniformity *, for ſuch a length of time as theſe ſeem to do, ſince even Ætna and Veſuvius have long intervals of ſeeming quietude. For theſe reaſons, a celebrated Profeſſor at Edinburgh ſeems to think, that they owe their origin to a different cauſe, viz. to an internal ſubterraneous heat and fire, ſo much ſpoken of by Philoſophers. This circumſtance, he thinks, favours that opinion; and, could its exiſtence be abſolutely proved, we might then account for the production of many foſſils, which we perceive to be ſtrongly marked with evidences of ſuch a forming cauſe.

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* As far as we are able to judge, there ſeems to be great reaſon to think, that the Bath Waters have not varied the moſt minute degree in their heat, ſince its firſt riſe.

PART II.

HAVING thus determined the nature and qualities of the ſeveral ſubſtances contained in Mineral Waters, we ſhall now give a ſhort ſketch of the moſt approved means to be uſed for diſcovering theſe impregnations.

And here we do not propoſe to give an account of the effects of every experiment uſed on theſe occaſions, with each of the impregnations; but to ſelect ſuch only, as may moſt effectually ſerve to diſcover their contents.

We ſhall take theſe in the order they are preſented in the foregoing table.

The firſt of theſe that occurs is,

I. *The*

I. *The vitriolic Acid per ſe.*

WATERS of this kind are ſometimes ſo ſtrongly impregnated, as to be diſcoverable to the taſte by their acidulous tartneſs. They change the colour of the vegetable blues to red, effervesce with all the alkaline ſalts, or calcareous earths, in their mild ſtate, and with magneſia, and on evaporation leave a neutral, or earthy ſalt, according to the ſubſtance with which they were combined. *Saline ſubſtances. Simple.*

They precipitate all ſolutions made in alkalines, curdle ſoap, or render a ſolution of it in vinous ſpirits milky. A ſolution of ſulphur in water, made by means of alkalies, is precipitated, and rendered milky by theſe waters, and emits at the ſame time a ſtrong fœtor.

Dr. Lewis ſays, they do the ſame by thoſe made with lime water. We have repeatedly made this experiment, but find it otherwiſe.

They produce a ſlight milky cloudineſs, with the ſolutions of ſilver, lead, and mercury, in the nitrous acid; and with lime water, cauſe a precipitation in form of ſelenites. Such are the general characters of theſe waters. Many of them, however, are not peculiar. Waters containing ſelenites, and alumn, effervesce with alkaline ſalts; and the latter ſhews the ſame effect on the vegetable juices.

In order to ſupply this defect, the learned Dr. Lewis recommends to diſtil the water whilſt freſh, and then examine, if what comes over in diſtillation, has this effect on the vegetable blues. He alledges, that if this be the caſe, we may be aſſured of the preſence of an acid unneutralized, as the neutral, or earthy ſalts, which produce this effect, do not riſe in diſtillation. This theory of the Doctor's is very ingenious, and we wiſh we could pay an entire credit to it, as it would afford us an eaſy method of diſcovering the preſence of this ſubſtance in waters.

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We will venture, however, to ſuggeſt a circumſtance, which makes us doubt if this be ſo clear a teſt as the Doctor ſeems to imagine. The ingenious Dr. Percival, in his *Eſſay on Water*, has demonſtrated, that the vitriolic acid, when the ſalt containing it is in a ſtate of ſolution in water, as in this caſe might often happen with ſo common an impregnation as ſelenites, is ſeparable by a boiling heat; and that by this means the hardeſt waters, that owe this quality to that ſubſtance, might be rendered ſoft. It is probable, therefore, that this would happen in diſtillation, and the vitriolic acid be thus * forced over into the receiver, and impregnate the diſtilled liquor, in ſufficient quantity to produce this effect on the vegetable blues, although

* This opinion is confirmed, by the appearances obſerved on the diſtillation of ſea water, where a ſmall quantity of the vitriolic acid, (which is always preſent in it,) comes over into the receiver, unleſs a quantity of fixed alk. or calc. earth be added to it, previous to its being committed to diſtillation.

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it had never exiſted originally in a ſeparate ſtate in the ſpring. It is doubtful, if the vitriolic acid does not ariſe in a volatile form from ſelenites, which would render this ſtill more probable.

We offer this, however, only as matter of conjecture; and, poſſibly, the circumſtances may not be exactly ſimilar, as a communication with the air may be neceſſary for the ſeparation of the vitriolic acid from the ſelenites, which, from the conſtruction of the veſſels uſed in diſtillation, could not happen.

We will venture, however, to give ſome of the more certain ſigns by which the preſence of this ſubſtance may be determined.

Firſt, To obſerve if the effervescence cauſed on the addition of mild alkaline, or earthy ſubſtances, and eſpecially the change of vegetable blues to red, does not ceaſe to be produced on the Waters ſtanding ſome time expoſed to the air.

Secondly,

Secondly, To obſerve if any precipitation happens on addition of a fixed alkaline ſubſtance. The firſt of theſe is a pretty certain mark of the preſence of an acid unneutralized, as the vitriolic acid, when in its ſeparate ſtate in Mineral Waters, is always in its volatile form. Were theſe effects produced by alumn, or any other neutral or earthy ſalt diſſolved in the Waters, they would be more permanent in them. If no precipitation happens on addition of a mild alkali, but an effervescence enſues, without any change of colour, we may take it for granted, from theſe two circumſtances, that an acid is preſent in its ſeparate ſtate; as, were it united with an earth, or metal, ſome precipitation, or change of colour, would happen on addition of the alkali *.

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* If the fixed vegetable alkali is uſed, care ſhould be taken not to make the experiment with too large a quantity, as the ſalt formed by it, and the vitriolic acid, is very ſparingly ſoluble in water, which might give the appearance of a precipitation.

II. *The foſſil Alkali.*

WATERS containing the foſſil alkali effervesce with all the acids, and form thus neutral ſalts, according to the different acids added to them, change the vegetable blues to green, and precipitate the ſolutions of calcareous earths, or magneſia, in any of the acids, and of the ammoniacal ſalts and alumn in water. They render milky the ſolutions of ſilver, lead, and mercury in the nitrous acid, and precipitate the iron from the vitriolic and nitrous, in form of a yellow ochre. Dr. Lewis recommends, as the moſt certain mark of this ſubſtance, to obſerve if the water containing it effervesces with the muriatic or vegetable acids. This is certainly a good criterion with reſpect to thoſe ſaline bodies into whoſe compoſition the vitriolic acid enters, as theſe would not be decompoſed by addition of the muriatic or vegetable acids, but will not hold univerſally, as ſome waters, containing calcareous earths,

ſeparate

ſeparate in a diffuſed ſtate, would exhibit the ſame appearance, although they contain no alkali. Perhaps the beſt method would be to examine the reſiduum left by ſuch waters on evaporation, and the neutrals formed by it with the ſeveral acids. Theſe might be diſtinguiſhed from thoſe formed by calcareous earths, aluminous earth, and magneſia; from the firſt, by their eaſier ſolution in water; from aluminous, by its larger ſolubility, and not poſſeſſing the ſtyptic taſte of the earth of alumn; and from all by no precipitation happening on addition of fixed alkaline ſalts to the ſolution; which would be the caſe with abſorbent earths.

* A precipitation is occaſioned in waters of this kind on addition of a ſolution of

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* Dr. Lewis has aſſerted, that ſolutions of calcareous earths in water, lime water, for inſtance, decompoſes neutral ſalts formed by an acid and alkali, *e. g.* Glauber's ſalt. I have repeated this experiment, but always found the contrary effect; as the alkali, added to an earthy ſalt, produced a decompoſition, but

chalk, or magneſia in the nitrous or muriatic acids. This circumſtance, joined to that mentioned by Lewis, afford a reaſonable preſumption of the preſence of an alkali, as the calcareous earth beforementioned would cauſe no precipitation.

III. *Glauber's Salt.*

Compound ſaline ſubſtances. WATERS, containing Glauber's ſalt in large proportion, are eaſily diſtinguiſhed from thoſe that poſſeſs other impregnations, by the bitteriſh ſaline taſte that accompanies them. It is, however, ſometimes preſent in too ſmall a proportion to be obvious to the taſte. On evaporation, however, it is

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but an earth, added to a neutral, produced no change. Glauber's ſalt, or vitriolic tartar, cannot be decompoſed by any ſimple ſubſtance, but only by a double elective attraction, as in the caſe of ſolution of ſilver in the nitrous acid, and of earths in the nitrous, or muriatic.

The Dr. himſelf, in another part of his Work, has confirmed what is here laid down. Vide Neuman's Chemiſtry, p. 252.

diſcover-

diſcoverable by its chryſtals, which are large and well formed, of an hexagonal priſmatic form, when perfect, and truncated at both ends. They are of very eaſy ſolubility in water, and calcine in a dry air. On evaporation, however, it manifeſts itſelf to the taſte, though, when largely diluted, it was not perceptible. Theſe waters cauſe no change on the colour of vegetable blues, and afford no precipitation on addition of alkaline, or acid ſubſtances, in which they differ from thoſe waters impregnated with ſal cath. amarus *; which ſhews a precipitation on addition of an alkali, though in other reſpects, as taſte, ſhape of chryſtals, and eaſy ſolubility, it much reſembles this. Solutions of lead and ſilver, in the nitrous acid, are precipitated in form of a yellowiſh white cloud; and that of mercury, in the ſame acid, in an orange-coloured one.

* The Author of the Pharm. Medici has laid it down as a diſtinction between theſe ſubſtances, that the Glauber's ſalt melts eaſily in the fire, whereas the other can ſcarce be fuſed by the moſt extreme heat.

IV. *Com-*

IV. *Common Salt.*

THE brackiſh taſte of many waters frequently diſcovers the preſence of this ſubſtance. It is indeed preſent native in moſt ſprings, though not in quantity ſufficient to be thus detected. It differs from the former by its not having the bitter taſte, which accompanies the Glauber's ſalt, and ſal cath. amar. The ſureſt teſt of it, however, is, to examine the ſhape of the chryſtals yielded on evaporation: Theſe are always cubical, which diſtinguiſhes them from all other native ſubſtances found in Mineral Waters, as none of them aſſume that form on chryſtallization. It is not affected by alkaline ſubſtances; but on addition of the nitrous, or vitriolic acids, a decompoſition takes place, and the ſalt loſes its native taſte and qualities, and aſſumes thoſe of Glauber's ſalt, or cubic nitre. It precipitates the ſolutions of ſilver, lead, and mercury, (as above,) the moſt ſuddenly and largely

of

of any ſubſtance, in form of a white cloud, which ſoon falls to the bottom, and may be collected by itſelf, and proves to be the muriatic acid of the ſea ſalt, ſeparated from its alkaline baſis, and united with the ſilver. It does not affect the colour of vegetable blues.

V. OILS *per ſe.*

THESE come next in order, and are eaſily diſtinguiſhed by the taſte and ſmell of the waters that contain them; which are both very acrid, and peculiar to this ſubſtance only. When in this ſtate, they are diſtinguiſhable to the eye, as not being mixed with the water, but floating on its ſurface. They are generally, when thus found, of a browniſh colour, and thick conſiſtence, when it is called Petroleum, though ſometimes it appears clear and colourleſs, when it is termed Naptha. Thoſe wells are of this kind that take fire on application of a burning body to their ſurface. *Inflammables.*

VI. *Oils*

VI. *Oils mixed with Water in Form of Soap.*

THESE poſſeſs the ſame qualities with the above-mentioned, except that here the foſſil oil is more intimately united with the water by mediation of an alkali. It is diſcovered by addition of acids, which immediately ſeparate the oil, and leave the water clear.

VII. *Sulphur per ſe.*

THIS is diſcoverable by the taſte and ſmell of the waters that contain it; by examination of the precipitate it lets fall on ſtanding; which ſometimes, as at Aix la Chapelle, lines the pipes that convey it. This, if ſulphur, may be eaſily diſtinguiſhed by its taſte, ſmell, and inflammability; by the waters ſtriking a black colour with ſacch. Saturn. and ſolutions of lead in the nitrous acid; by their ſudden tarniſhing of ſilver; by the fœtid ſmell, reſembling a rot-

a rotten egg, or ſcowering of a foul gun-barrel; on addition of alkalies; by the taſte attending this addition; all which circumſtances point out this ſubſtance very clearly.

VIII. *Hepar Sulph. with an Alkali.*

THE taſte and ſmell of theſe waters are ſo remarkable, as ſcarce to leave any room to doubt the impregnation when they are preſent. They reſemble, as was ſaid before, a rotten egg, or ſcowring of a gun-barrel: In the latter of theſe, this ſubſtance is always generated on the inflammation of the gunpowder, the acid of the nitre being diſſipated, and the vitriolic acid of the ſulphur, joined to the phlogiſton acquired from the charcoal, uniting with its alkaline baſis, and forming this ſubſtance. Waters, impregnated thus, ſtrike a black colour with ſolution of lead in the nitrous acid; and with a ſolution of ſacch. Saturn. in water; from whence the ſympathetic ink is derived. They tarniſh

ſilver

ſilver ſuddenly and deeply; become milky, and emit a ſtrong fœtor on addition of acids; by which they differ from the laſt mentioned, as the ſulphur, being there in a diffuſed ſtate, is not affected by acids. The former too is not diſtinguiſhed by the taſte and odour above-mentioned, which is peculiar to this.

It differs likewiſe, that this, though in part decompoſed by expoſure to the air, and, as Dr. Cullen thinks, by ſolution in water, yet retains its qualities in a great degree, when kept from the air, a conſiderable time; whereas the other ſoon ſuffers a precipitation of all its contents of this kind.

IX. *Hepar Sulph. with Quick-Lime.*

THIS, though nearly allied to the former, exhibits very different appearances on experiment. It is not affected by addition of acids like the other, is altogether inodorous, and in taſte, though diſagreeable in a ſtrong ſolution, yet, when largely diluted,

diluted, is not unpalatable, having nothing of that peculiar ſmell and taſte reſembling a putrid egg, or ſcowring of a gun, which ſo eminently diſtinguiſhes the other. It is decompoſed by expoſure to the air, and ſolution in water, as the hepar ſulph. with alkali is, and on ſtanding, even ſhut from the air, ſuffers a precipitation. It ſtrikes no black colour with ſolution of lead in the nitrous acid, or of ſacch. ſaturni in water, and ſcarce even precipitates them, or the ſolution of ſilver. It is precipitated by all the alkalies, both fixed and volatile, which the former is not. It has no effect in tarniſhing ſilver.

X. *Copper.*

Metallic Impregnations.

WATERS of this ſort are ſometimes obvious to the taſte, which is, indeed, able to diſcover a very ſlight impregnation of this kind. Thus we ſee waters, that have ſtood in copper or braſs veſſels, gain what is called a braſſy taſte, though the quantity diſſolved can ſcarce be meaſured. The moſt

certain teſt, however, of the preſence of this metal, is, the addition of the cauſtic volatile alkali, as ſp. ſal. amm. cum calce vivâ. This, if the ſmalleſt particle of copper be diſſolved, cauſes the whole of the fluid to aſſume a beautiful blue colour. Iron alſo precipitates this metal; on addition, therefore, of a plate of iron, to any waters containing copper in ſolution, it will ſoon be covered with a cruſt of this metal; and if it be laid in the current of the ſpring, will, in time, be entirely changed into it. This has given room for ſome, who did not underſtand the nature of precipitation, to imagine that the iron was really tranſmuted into copper; whereas no more happens than the ſimple precipitation of the copper, occaſioned by the vitriolic acid, that held it diſſolved, having a greater affinity with iron than the copper. A proportionable quantity of iron is, therefore, diſſolved in place of the copper precipitated, which always happens on the ſurface of the precipitant, ſo that, in time, the whole is diſſolved,

ved, and a portion of copper ſubſtituted in its place. It is obſervable of metals, that they always precipitate one another in their metallic form. If waters contain copper in conſiderable quantity, it may be diſcovered by chryſtallization.

XI. *Iron.*

CHALYBEATE Waters are generally diſcoverable to the taſte by their peculiar aſtringency. Where the quantity diſſolved is very ſmall, this, however, is not perceptible. Springs of this kind are eaſily diſtinguiſhed by the ochrous ſediment which is conſtantly precipitating from them, and which gives a yellow colour to all the ſubſtances expoſed to their current. The principal and beſt known teſt of them, however, is, the black colour they ſtrike with the vegetable aſtringents, and the purple one when an alkaline ſalt, or lime-water, is added to the aſtringent. Dr. Percival has aſſerted, that the ferruginous Waters will not ſtrike a black, or purple, with many of

the vegetable aſtringents, without the addition of lime-water, and has, indeed, brought ſeveral experiments in proof of what he has alledged. The addition, however, of theſe ſubſtances, makes this experiment tolerably ſatisfactory, and enables us to diſcover a very minute portion of iron in the water. Some of the mineral aſtringents, as alumn, likewiſe precipitate this metal, in form of a reddiſh, yellow, ochrous ſediment, which, on addition of an inflammable body, and a ſmall degree of heat, may, like the foregoing precipitation, be again reduced into iron.

Of the metallic kind, Zinc is the only one that precipitates iron, which it does in form of a browniſh powder.

Care muſt be taken to make theſe experiments with the waters when freſh from the ſpring, as on ſtanding they loſe theſe qualities.

XII. *Zinc.*

THIS ſubſtance has hitherto been ſo little ſuſpected to be preſent in Mineral Waters,

ters, that we have had very few experiments made on the appearances it aſſumes on addition of other bodies. It is always found in Mineral Waters diſſolved by the vitriolic acid, in form of white vitriol. It may be eaſily diſcovered on chryſtallization, by its taſte, which is nauſeous, ſweetiſh, and ſtyptic, and, by the form and colour of its chryſtals, which are pyramidal parallelopipeds, and ſometimes tranſparent, though generally of a duſky yellowiſh hue, from the ochre of iron they contain in the ſtate we find them.

XIII. *Earths in their native Form united with Water.*

THE calcareous earth is the only one we find united with water in its native ſtate, and in ſufficient quantity to bring it under our definition of Mineral Waters, and it is doubtful if even this be not in a ſtate of ſolution in form of quicklime. Waters of this kind *Earthy Impregnations.*

are not diſcoverable by the common teſts of diffuſed bodies, (viz. their refuſing to paſs the filtre,) as theſe may be filtred without the leaſt ſeparation of their contents. Earths, thus united with water, are precipitated in large proportion by any body containing fixed air in large quantity, as mild alkaline ſalts, *&c.* and ſcarce at all by cauſtic alkali. Theſe Waters are obſerved to depoſit their contents on the ſurface of, and even to pervade the ſubſtance of, ſeveral bodies over which they run, ſo as perfectly to petrify them. They likewiſe let fall a large ſediment on boiling, and it is probable, that the incruſtation of many of our tea-kettles may be owing to this, though that may be produced alſo by the decompoſition of ſelenites. Theſe are diſtinguiſhed from thoſe impregnated with the following ſubſtance, in that they lather well with ſoap, and let fall a ſediment, neither of which is the caſe with the ſelenitic waters.

XIV. *Se-*

XIV. *Selenites.*

THIS, as we before obſerved, is a very frequent impregnation. It is diſcovered by the refuſal of theſe waters to unite with ſoap, and by their throwing down a large earthy precipitate, on addition of a mild or cauſtic alkaline ſalt. When the former is uſed, it is attended with effervescence. On evaporation likewiſe it is diſtinguiſhable by the form in which it chryſtallizes, being in thin laminæ, which form a pellicle on the ſurface of the liquor; by the taſte of the ſalts, and water containing them after a pellicle is formed, which is lightly ſaline and auſtere. We ſhould, however, be cautious not to miſtake the waters impregnated thus, for thoſe containing calcareous earths in ſubſtance, as they leave nearly the ſame reſiduum on boiling, by the decompoſition of the ſelenites. The method of diſtinguiſhing them is given above.

XV. *Spurious Glauber's Salt.*

THIS is not liable to be confounded with any other ſubſtance, except the true Glauber's ſalt. The method of diſtinguiſhing them is given above, in our account of that ſubſtance.

XVI. *Alumn.*

WATERS containing alumn diſcover themſelves on evaporation, by their auſtere aſtringency. * They change vegetable blues red, and coagulate milk.

The taſte of ſelenites, though rather auſtere, is very diſtinguiſhable from alumn

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* Dr. Percival, in his *Eſſay on Water*, has blamed Dr. Lewis for ſaying, that alumn changes vegetable blues red. He himſelf made the experiment with only one native vegetable juice, viz. that of radiſhes, which anſwered to Dr. Lewis's aſſertion. He alledges, that the ſyrup of violets was changed green by it. The common ſyrup of violets is much ſophiſticated, and the generality of what we have ſeen has been ſcarce altered by acids or alkalies, but always turned

by its inferiority in ſtrength, as the former is very ſparingly ſoluble in water. We have, however, a more certain method of diſcovering the preſence of alumn, which is, to evaporate the water until it becomes perceptibly ſaline, when, if we add a few drops of lix. tart. or any other fixed alkaline ſalt, the earth of alumn will be precipitated, not as other earths are, (in a powdery form,) but in flocculi. If but a ſmall quantity of alkali is uſed, theſe will be rediſſolved, which ariſes from the nature of alumn, which is the only ſalt we know that has a ſuperabundant portion of acid adhering to it, which rediſſolves the earth of alumn precipitated by the alkali. If too much alkali is uſed, the ſuperabundant acid will be ſaturated, and the earth not re-

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turned green on dilution with water. Probably its blue colour was not owing to any vegetable ſubſtance. We have repeated the experiment with freſh violets, which were always changed to red by alumn. The proof here offered, of alumn's containing a ſuperabundant acid, ſtrongly confirms the probability of this.

diſſolved. Dr. Lewis recommends to us to examine the precipitates of waters, thrown down by addition of alkali, with vitriolic acid. This, if the water contained alumn, will unite with the earth thus precipitated, into a highly aſtringent ſalt; if magneſia, into a ſaline bitter one; and if a calcareous earth, into one lightly ſaline and aſtringent, and ſcarcely ſoluble in water.

XVII. *Air.*

Aërial Impregnations.

THE preſence of aërial bodies in water, has been mentioned in the former part of our Work, where it was alſo remarked, that it was doubtful in what form they exiſted there. The experiment with lime-water, mentioned above, in our opinion proves, that common air is the ſubſtance ſeparated by the exhauſted receiver, and which is probably united, in a certain degree, with all water it has acceſs to. Mephitic air is likewiſe combined, in large quantities, with many waters. This is proved by their

their ſparkling appearance, pungent taſte, and ſmell, by their precipitation of the lime, when added to lime-water, when freſh; which effects are all loſt, on their ſtanding expoſed to the air. Theſe Waters, likewiſe, are ſometimes diſcoverable by their effects on the human body, as being, if drank in large quantity, heating, and even inebriating as fermented liquors.

The air ariſing from theſe Waters, when conveyed by a bended tube on the ſurface of lime-water, will render it turbid, and cauſe a film on its ſurface, owing to the ſeparation of the lime from the water.

It now remains to make ſome application of theſe rules to our experiments on the Bath Waters.

N. B. The enſuing Experiments are all made with the King's Bath Water.

PART III.

EXPERIMENTS *on the* BATH WATERS.

Senſible qualities.

BEFORE we enter upon our chemical experiments, we ſhall premiſe a few words concerning the ſenſible qualities of theſe waters, and, firſt, of their external appearance.

External appearance.

The Bath water, when drawn freſh from its ſource, appears quite colourleſs, and pellucid. Notwithſtanding this, as Dr. Lucas has remarked, that ſome minute white moleculæ may be obſerved on a cloſer examination. It ſparkles in the glaſs like the Spa water, occaſioned by the air bubbles riſing through the body of it, and flying off. On ſtanding, it is ſaid to abate of its pellucidity, and becomes of a whey

whey like colour, and then it depoſits a light yellow ochrous ſediment, obſervable round the ſides of the Baths. If kept ſtopped cloſe from the air, it does not ſenſibly abate of its clearneſs.

Odour.

Theſe waters have no peculiar ſmell, nor has their vapour; though we have ſometimes imagined ſomething reſembling that ariſing from fermented liquors, and which, without giving a ſenſation of any particular odour, impreſſes a kind of pungency of the organs of ſmell. This ſeems to be that mentioned by Dr. Lucas, which he attributes to the pyrites.

Touch.

The heat of theſe waters is very obvious, inſomuch, that at ſome of the ſources it is ſcarce tolerable to the human body. Dr. Lucas ſays, the water drawn at the pump of the King's Bath is, when the pump has been heated by long pumping, 119 gr. of Farenheit's thermometer; and to this our own, and, indeed, moſt other experiments, ſeem nearly

nearly to agree. The water in the King's Bath, as applied to the human body, does not ſeem to exceed 105 or 106 degrees, by any obſervations we could make, occaſioned by the waters being cooled, by a large expoſure of its ſurface to the air. The heat of the water, at its ſource, is, however probably, much greater than any of the above-mentioned. It is ſenſibly hotter to the touch, and, I was once informed, by a judicious and accurate obſerver, who made the trial, when the ſource of the King's Bath was opened, that it raiſed the thermometer to 130 gr. of Farenheit's ſcale.

Taſte. They are ſlightly ſaline, accompanied with an agreeable pungency, added to a light chalybeate taſte. The two latter, however, go off entirely on the waters cooling, when it becomes much leſs agreeable, the ſaline taſte is more manifeſt, and ſeems to be accompanied with another different from the taſte of any ſaline body we are acquainted with.

What

What this probably is, ſhall be conſidered in the following part of our work.

Specific gravity.

The ſpecific gravity of equal bulks of the Bath water and rain water, is as follows.

	oz.	*dr.*	*gr.*
King's Bath,	28	4	3
Rain water,	28	4	42

N. B. During the time this experiment was making, the water ſunk near half an inch in the neck of the flaſk. They were weighed at the loweſt mark, this is therefore their greateſt ſpecific gravity.

Chemical Analyſis of the BATH WATERS.

Contents on Evaporation.

ABOUT ſix gallons of the King's Bath Water was evaporated to about a quart: Before this, a conſiderable quantity of a whitiſh powdery ſubſtance, in part chryſtallized, was * de-

* Dr. Sutherland, in an experiment of this kind, has denied that any pellicle was formed on evaporation, and endeavours to invalidate thoſe experiments

poſited round the edges of the veſſel joining the fluid; and ſeveral pellicles were formed, which ſucceſſively precipitated in a laminated form. The remaining liquor taſted evidently ſaline, but not ſo ſtrongly as might have been imagined, as it was proved to be at leaſt a ſaturated ſolution, from the chryſtallization of the ſaline matter. On evaporation to dryneſs, which was done with a very gentle heat, there remained about ʒvij. of a powdery ſubſtance of a light duſky yellowiſh colour, adhering ſtrongly to the bottom of the veſſel.

Examination of the Reſiduum.

This reſiduum had no perceptible odour, but to the taſte was apparently ſaline, and ſeemingly more ſo than the reſiduum left by thoſe waters that contain only ſelenites.

-ments in which this appearance is related. When the water was diſtilled in the manner he performed it, no pellicle would be formed, as the ſelenites would then chryſtallize at the bottom of the veſſel, as the communication with the air was obſtructed.

The

The greateſt part of it was in a powdery form, and the remainder conſiſting of chryſtallized ſubſtances, which, on examination with the microſcope, appeared as Dr. Charleton, in the Plate prefixed to his work on this ſubject, has deſcribed them, to be made up of hexagonal and cubical chryſtals.

Chemical Analyſis of the Reſiduum.

EXPERIMENT I. *Vitriolic Acid to Part of the Reſiduum.*

About ten grains of the cubical ſalts were carefully ſeparated from the reſt by chryſtallization. To theſe were added a few drops of the vitriolic acid. Immediately the ſmell of the ſpirit of ſalt became perceptible.

EXP. II. *Solution of Silver.*

To ʒij of diſtilled water, was added five drops of ſolution of ſilver in the nitrous acid, which produced no change of colour.

To

To this was added one grain of the cubical ſalt above-mentioned. Immediately the whole aſſumed a white, milky appearance.

EXP. III. *Vegetable Blues.*

To ʒij of water, was added four grains of the cubical ſalt, carefully ſeparated from the powdery reſiduum. Into this ſolution were put ſome ſlips of paper, rubbed with the flowers of freſh violets and polyanthus. No change of colour happened, although the taſte of the ſolution was manifeſtly ſaline.

EXP. IV. *With the groſs Reſiduum, Mineral and Vegetable Acids.*

To a ſmall quantity of the groſs reſiduum, was added a few drops of the vitriolic, nitrous, marine, and vegetable acids. It effervеſced with each, and, with the vitriolic, formed a ſalt of little taſte, but that rather auſtere and aſtringent, and of difficult ſolution in water. The other acids formed with it, each of them ſaline com-

compounds, more ſoluble in water, and, of conſequence, more ſapid.

EXP. V. *Lix. Tartar. with the Salts formed in* EXP. IV.

To each of the ſaline compounds thus formed, ſeparately diſſolved in water, was added a few drops of lixiv. tart. A white precipitation enſued *.

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*EXPERIMENT I.

A few grains of the reſiduum we laid on a red hot iron; a crackling noiſe was produced, owing to the ſaline particles which decrepitated, but no detonation was obſerved, nor did any part ſeem diſpoſed to fuſion; no flame appeared, nor was any ſmell of ſulphur perceived.

EXPERIMENT II.

To ℥ij of the reſiduum, was added an equal weight of powdered charcoal, and the whole was made into a paſte with oil, and put into a crucible, where it was kept half an hour. On taking it out, we found ſeveral granules of its contents vigorouſly attracted by the artificial magnet.

N. B. The magnet had no effect on the groſs reſiduum *per ſe*.

Che-

Chemical Analyſis of the WATER.

EXP. VI. *Alkalies.* — *Cauſtic.* — *Vegetable.*

To ℥ij of Bath water, freſh from the pump, was added gutt. x. of lixiv. ſapon. This cauſed a conſiderable milkineſs through the body of the fluid.

EXPERIMENT VII.

To ℥ij of Bath water, that had ſtood corked about half an hour, was added a like quantity of lixiv. ſapon. A ſlight milky colour, much leſs than in EXP. VI. was produced, which ſoon ſubſided to the bottom, in form of a white precipitation, and the fluid above, recovered its tranſparency.

N. B. The ſame experiment was tried with the water which had ſtood open twenty-four hours, when the effect was ſcarce perceivable.

EXP. VIII. *Alkali mild.*

To ℥ij of Bath water, was added gutt. x. of lixiv. tartari. This cauſed a copious, ſudden, and flaky precipitation, much more conſider-

conſiderable than in EXP. VI. and VII. of a reddiſh, white colour, extending through the body of the fluid, which, on ſtanding, fell to the bottom, in a powdery form, and the liquor above appeared clear.

EXP. IX. *Volatile Alkali, cauſtic:*

To ℥ij of Bath water, was added gutt. xl of ſp. ſal. ammon. c. calce vivâ, which produced the ſmalleſt degree of milkineſs poſſible, but no ſenſible precipitation happened on ſtanding.

EXP. X. *Volatile Alkali, mild.*

To ℥ij of Bath water, was added gutt. xl of ſp. ſal. ammon. comm. This cauſed a milky appearance, and flaky precipitation, but not ſo conſiderable as in EXP. VIII.

EXP. XI. *Calcareous Earths in their cauſtic State.*

To ℥ij of Bath water, freſh pumped, was added ℥ſs of lime-water, which cauſed a ſudden flaky precipitation, which remained at the bottom in form of ſnow, and not in a white powder, as in EXP. VIII.

The

The water in the glaſs above the precipitated matter, became as tranſparent as before the addition of the lime-water.

EXPERIMENT XII.

To ℥ij of Bath water, which had ſtood open ſome time, was added ℥ſs of lime water, without producing any change.

N. B. No efferveſcence was perceived on the addition of any of the above ſubſtances. Probably, what gave riſe to the common opinion of the Bath waters efferveſcing with alkalies was, that this experiment was tried with alkaline ſalts in their ſolid form, and the air bubbles formed in the ſolution were miſtaken for an efferveſcence.

EXPERIMENT XIII.

To each of the liquors precipitated, a in EXPERIMENTS VII, VIII, IX, X, an XI, was added ſpirit of vitriol, gutt. w which reſtored them all to their tran parency.

Ex

EXP. XIV. *Acids.—Vitriolic.*

To ʒij of Bath water was added gutt. v of vitriolic acid, without producing any change.

EXP. XV.—*Nitrous.*

To ʒij of the Bath water was added gutt. v of the ſpirit of nitre, without producing any effect.

EXP. XVI.—*Muriatic.*

To ʒij of Bath water was added gutt. v of ſpirit of ſalt, without producing any effect.

EXP. XVII.—*Vegetable.*

To ʒij of the Bath water was added a tea ſpoonful of lemon juice, and of vinegar, without producing any effect.

EXP. XVIII. *Solution of Metals. Silver in the nitr. Acid.*

To ʒij of the Bath water was added gutt. v of ſol. of ſilver, which produced an appearance like equal parts of milk and water, but on adding xv gutt. more, a large precipitation enſued of white powdery par-

particles, cohering together in maſſes of different ſizes, and the fluid above became more tranſparent.

EXP. XIX. *Lead in the ſame.*

To ℥ij of Bath water was added thirty drops of ſol. of lead, which produced an appearance like equal parts of milk and water, and gave a precipitation of ſmall white particles, cohering together, as in EXP. XVIII, but not ſo copious.

EXP. XX. *Copper. In the ſame.*

To ℥ij of Bath water was added five drops of a ſol. of copper in the nitrous acid, which gave a light blue tinge to the water, and cauſed a precipitation of ſmall flaky particles adhering to the ſides and bottom of the glaſs, but the fluid did not appear turbid *.

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* To two ounces of Bath water was added fifteen drops of a ſol. of mercury in the nitrous acid. This cauſed a ſlight reddiſh yellow precipitation, which remained in the middle of the liquor, but did not ſubſide.

EXP.

EXP. XXI. *Solution of Sacch. Sat. in Water.*

To ℥ij. of Bath water was added xxx drops of a ſol. of ſacch. ſat. which cauſed a whitiſh cloudy precipitation of a reddiſh tinge, which on ſtanding ſubſided.

EXP. XXII. *Solution of Galls in Water.*

To ℥ij of Bath water was added xx gutt. of a ſol. of galls, which gave a ſlight purple tinge, but no precipitation. This effect ceaſed on the water's ſtanding open a quarter of an hour.

EXPERIMENT XXIII.

To ℥ij of rain water was added gutt. i. of ſol. of ſal martis in water. This ſtruck a black colour with ſol. of galls, ſome ſhades darker than in EXP. XXII.

EXP. XXIV. *Sol. of Corroſ. Sub. in Water.*

To ℥ij of Bath water was added gutt. x of a ſol. of corroſ. ſubl. This cauſed ſcarce any change at the time. On ſtanding, however, a blueiſh white cloud was precipitated, and a thin film floated on the

top. The intermediate liquor remained clear. On ſtanding, a yellowiſh ſediment precipitated.

EXP. XXV. *Sol. of white Vitriol in Water.*

To ℥ij of Bath water was added gutt. x of a ſol. of white vitriol. This cauſed no change.

EXP. XXVI. *Vegetable Blues.*

Several ſlips of paper, rubbed with the flowers of freſh violets and polyanthus, were immerſed in the Bath water. The purple colour ſeemed to be heightened by the water freſh drawn. On ſtanding, however, they acquired a greeniſh caſt.

EXP. XXVII. *Soap.*

Two ounces of Bath water were agitated with ʒſs. of Caſtile ſoap. The fluid appeared turbid and flaky; on letting it ſtand, a curdled oily ſubſtance floated on the ſurface, and the water beneath, in a great degree, recovered its tranſparency.

EXPERIMENT XXVIII.

The like appearance happened, on dropping a ſolution of ſoft ſoap in ſp. vin. rect. into the Bath water.

EXP.

EXP. XXIX. *Coagulation of Milk.*

To ʒij of milk, boiling hot, was added ʒiv of Bath water. This immediately cauſed a precipitation of a light curd, but not an entire ſeparation of the cheeſy parts.

EXP. XXX. *Fixed Air.*

We conveyed the ſteam of Bath water, freſh pumped, by means of a ſyphon, into lime water. No turbidneſs appeared for ſome time; but a thin film was formed on the ſurface of the lime water; and, on ſtanding ſome time, though ſecured from any communication with the outward air, it loſt its tranſparency towards the upper part of it.

N. B. This Experiment did not ſucceed with water that ſtood, even corked up, a quarter of an hour.

EXPERIMENT XXXI.

Inſtead of the ſteam of the Bath water, we conveyed, by means of the foregoing apparatus, that which aroſe from mixing a ſol. of ſalt of tart. with the vitr. acid.

This produced an evident, and immediate decompoſition of the lime water; a film ſwimming on the top, and a portion of the water below the film appeared turbid.

Chemical Analyſis of the Sand depoſited by the Bath Water.

EXP. XXXII. ACIDS. *Vitr. Acids.*

A drachm of the vitriolic acid, diluted with four times its quantity of water, was added to ℥ſs of the King's Bath ſand; a ſharp efferveſcence enſued, and many air bubbles were formed.

EXP. XXXIII. *Nitrous, muriatic, and Veget. Acids.*

The like happened on addition of the nitrous, muriatic, and vegetable acids; with the laſt, however, in a very ſmall degree.

EXPERIMENT XXXIV.

This ſand, ſprinkled on a red hot iron, gives a blue flame, and emits a highly acid vapour, in ſmell like that diſcharged from burning ſulphur.

EXPE-

EXPERIMENT XXXV.

About ʒij of the Bath ſand were put into a crucible, with an equal weight of powdered charcoal. When the matter was thoroughly heated red hot, it was poured out; ſeveral particles of it were then vigorouſly attracted by the magnet.

EXPERIMENT XXXVI.

To the taſte the Bath ſand is not in the leaſt ſaline, but impreſſes, on being kept in the mouth ſome time, a ſtrong chalybeate taſte.

EXPERIMENT XXXVII.

Two ounces of water were infuſed on ʒij of Bath ſand, in a vial, which was kept in a moderate heat about an hour. The taſte of the liquor was then highly chalybeate. On addition, however, of a ſmall quantity (about gutt. xii.) of powdered galls, little change was produced, except a ſlight purple tinge. By dropping in, however, gutt. iv. of lix. tart. the whole turned to a deep purple, nearly approaching to black.

EXPERIMENT XXXVIII.

About ℥ij of the yellow powdery ſubſtance, that concretes round the edges of the Bath, was collected. To this was added an equal weight of powdered charcoal, and the whole was made into a paſte with oil. This was put into a crucible, and kept in a red heat near half an hour. On pouring it out, a large proportion of it ſeemed revived into iron, the granules of which were vigorouſly attracted by the magnet.

EXPERIMENT XXXIX.

The like happened with the concretions formed on the baſons, that hold the water glaſſes at the Pump-room.

Application of the Experiments.

We ſhall now endeavour to apply theſe Experiments to the diſcovery of the impregnation of the waters.

And here we ſhall take another view of the ſubſtances we have before mentioned, as poſſible impregnations of Mineral Waters,

Waters, in the order they are there placed; and endeavour to ſhew of each, what proof or probability there may be that it has, or has not, a ſhare in the compoſition of the Bath Waters. The firſt of theſe that occurs is

The Vitriolic Acid per ſe.

Simple Salts. Acids. Vitriolic Acid per ſe.

THE exiſtence of this ſubſtance in its ſeparate ſtate in the waters, has been much diſputed. Even their ſenſible qualities, with reſpect to this impregnation, have not been clearly aſcertained.

Dr. Lucas * has ſaid, that "it flies off in a ſubtile vapour, ſenſible to the organs of ſmell, and ſo as to affect the lungs of thoſe inclined to phthiſical complaints."

We cannot ſay we have ever had an opportunity of obſerving its effects in ſo ſenſible a degree, yet we are inclined to pay

* Vol. iii. p. 277.

credit to it, as this acid is undoubtedly preſent in the waters in its volatile ſtate, united with iron, which it quits as ſoon as it communicates with the open air. This is ſufficiently proved by EXP. XXII. with ſolution of galls, by the ochrous incruſtations depoſited round the ſurface and ſides of the Baths, and on the baſons at the Pump-room, which were ſhewn, by EXP. XXXVIII. and XXXIX. to be reducible into iron. Arguments, however, ſufficiently plauſible, are not wanting to contradict the exiſtence of an unneutralized acid in theſe waters, even though it was granted that their vapour were ſo. The vitriolic acid in theſe caſes, it is alledged, flies off as it is diſunited from the iron, and does not remain in the water in its ſeparate ſtate. The ſenſible qualities of the waters ſeem to favour this opinion: No acidity has been ever aſſerted by any perſon, whoſe writings we have examined, to be perceptible to the taſte; and the trite Experiment of ſyrup of violets being turned green by it, has been brought as a

proof

proof of a very different impregnation, and ſuch a one as could not poſſibly ſubſiſt with the other. It has, however, been urged, that the Bath water curdles milk, decompoſes ſoap, and effervesces with alkaline ſalts, which are all properties belonging to acid bodies. That waters containing an acid would produce theſe effects we readily acknowlege, but the two former of theſe we ſhall prove, in the future part of our Work, not to be qualities peculiar to acids only, but to be producible by means of other ſubſtances, and the laſt we cannot help believing a miſtake. By EXP. VIII. it did not appear that any effervesence was perceived, or, at leaſt, ſuch as was ſcarce perceptible, and by no means adequate to the accounts given of it by other Writers on ſuch admixture, although the lixiv. tartari, which we uſed, is the mildeſt ſtate of alkaline ſalts we know of, and of conſequence moſt favourable to a diſcovery of this kind. Probably this miſtake was produced by

the cauſe mentioned in our Experiments *.

Notwithſtanding, however, theſe arguments, we are inclined to believe, that the volatile vitriolic acid is preſent in theſe waters, even in its ſeparate ſtate, either as combined with them by the method related in our account of this ſubſtance, Part I. or in the interval between its being diſunited from the iron, and its diſſipation in the air. By our Experiments, the water, when freſh, appeared to heighten the colour of the vegetable purples, though afterwards on ſtanding it ſeemed to exert contrary effects, and to partake, in ſome meaſure, of an alkaline nature.

Dr. Sutherland ſays, that the Bath Waters turn ſyrup of violets to a ſea green colour, immediately; but he ſeems here to have fallen into the ſame miſtake with many others, who have made uſe of ſyrup of violets in their experiments. The ſy-

* Vide EXP. XII.

rup

rup commonly uſed, is very ſeldom genuine, and ſtill leſs frequently (which is of equal import in experiments of this nature) freſh and well made, as it loſes its diſtinguiſhing colour by keeping, and acquires that brown, duſky one, we generally ſee it to have when genuine. When of a fine bright colour, it is generally adulterated with ſome ſubſtances that will not anſwer the teſts here required.

We made ſeveral experiments with different ſyrups of violets, and they * all in-

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* Dr. Sutherland has quoted ſome paſſages from Dr. Linden, extraordinary, indeed, in their kind, on this ſubject. That Gentleman has attributed the green colour, which the Bath Water is ſaid to ſtrike with ſyrup of violets, to the ſyrup of violets ſetting the acid free from the *mucilagium ferri*, and at liberty to work on the iron. Were this the caſe, a ſolution of green vitriol, where the iron is actually diſſolved, would be green, which we find it not to be, even when ſaturated; and by our Experiment, N°. XXIII. it appears, that one drop of a ſaturated ſolution of green vitriol, renders two ounces of diſtilled water more ſtrongly chalybeate than the Bath Waters are. As to the aſſertion, that the quantity of alk. requiſite to produce this effect, would render the water

deed, as Dr. Sutherland has related, ſtruck a green colour, on admixture with the Bath Water; but on the ſame experiment being tried with rain and diſtilled water, the ſame effect was produced; and the colour ſeemed more owing to the dilution of the ſyrup, than any ſtrictly chemical effect.

In general, the purple or blue flowers of vegetables, when freſh, or their expreſſed juices, anſwer this purpoſe better than when made into ſyrup. On the whole, if this acid be preſent here, it is in exceeding ſmall quantity, and which, pro-

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as *cauſtic* as ſoap lees, we beg leave to inform him, that one drop of a ſolution of a mild alkali, (lixiv. tart.) whoſe taſte cannot be perceived, when diluted with lb. ſs. of diſtilled water, will render it ſufficiently alk. to produce this effect. As to what the Doctor alledges of the green colour produced by the union of acids with iron, none but the vitriolic have this effect, the nitrous and vegetable giving a ſolution of a dark red, and the muriatic of a yellow, gold colour. As to the *mucilagium ferri*, we really do not comprehend it, and the iron earth contained in ſyrup of violets, though not the Doctor's invention, we ſcarce expected to have been called forth to produce this effect.

bably,

bably, conſidered as ſuch, can have very little power in influencing its effects as a Mineral Water; as it is likely that a quantity of it, not exceeding a drop of the concentrated vitriolic acid, is preſent in many pounds of the water. This is rendered farther probable by the Experiment before cited of it, when combined with iron. This proportion being ſo ſmall, ſeems to be the reaſon why it exhibits none, or ſcarce any perceptible effervescence with alkaline bodies.

Alkalies.

Alkalies. Foſſil Alkali.

Were our opinion, with reſpect to the laſt mentioned ſubſtance, aſcertained, we might be well aſſured, that this had no ſhare in the impregnation of the waters, in its ſeparate ſtate; but as we offer that only as matter of probable conjecture, we ſhall examine the reaſons which might ſupport or contradict the opinion of the preſence of this ſubſtance in theſe Waters.

The only circumſtance that gives us any reaſon to think that the foſſil alkali enters

enters into their compoſition, is, that the vegetable blues and purples ſeem to acquire a greeniſh caſt on being added to the water which has ſtood ſome time. This, however, though a quality of alkalies, is by no means a certain teſt of that ſubſtance. Waters impregnated with calcareous earths, in form of quicklime, will produce this effect as well as alkalies, though not, indeed, ſo powerfully. No marks of this ſalt appeared in the reſiduum left by evaporation, or in the ſalts formed by addition of the weaker acids; and the precipitation of ſilver, lead, and mercury from their ſolutions, was probably owing to another cauſe, which we ſhall mention hereafter. The iron contained in the water, in a ſtate of ſolution by an acid, the curdling of ſoap, and the coagulation of milk, likewiſe afford ſufficient proof that this ſubſtance, in its native form, uncombined with any other body, has no ſhare in the compoſition of theſe celebrated waters.

Compound Salts.

Glaub. Salt.

It does not appear, by any Experiments, that there is any reaſon to think that this ſalt is contained in the Bath Waters. Some of the cryſtals left on evaporation, were, indeed, of an hexagonal priſmatic form, but were likewiſe of a ſlightly auſtere, and aſtringent taſte, and of very difficult ſolution in water, qualities that ill agree with Glauber's ſalt. Theſe circumſtances afford ſufficient evidence of what we have before laid down, as, if this ſalt had exiſted in the ſmalleſt quantity in the waters in a ſtate of ſolution, it muſt have been thus diſcovered, as this ſalt is not ſo ſubject to decompoſition, by long boiling, as many others are.

Common Salt.

The exiſtence of this ſubſtance in the Bath Waters has been pretty generally acknowledged, though its proportion there ſeems too ſmall to have any ſhare in their medicinal effects. Moſt Writers ſeem to have thought the cubical figure, and peculiar taſte of the cryſtals, a ſufficient evidence of this. Some Authors,

thors, perhaps, may not be ſo ready to allow, for granted, our deciſions on the contents of waters deduced from the figure of the cryſtals of the ſalts they yield; we ſhall, therefore, beg the reader's patience, while we ſay a few words in defence of this way of reaſoning. Dr. Sutherland has affirmed, "that no two ſalts, of the ſame denomination, anſwer the ſame proofs in every reſpect." If by this the Doctor means, that no two portions of the ſame ſalt will, on being diſſolved in water, cryſtallize again in the ſame form, we can venture to aſſure him that they will, and appeal to experiment for the truth of it. By haſty evaporation, and too ſudden application of cold, the cryſtals of many ſalts are often left imperfect; but what remains of them is always ſufficient to indicate the form which they tended to aſſume.

The cryſtals of nitre and common ſalt, for inſtance, are often left imperfect, but no art can make the former cryſtallize into cubes, and the latter in hexagonal priſms. Dr. Hill has, indeed, ſaid, that

common

common ſalt, by a certain method of cryſtallization, ſhoots into oblong parallelopipedons*. This, however, is now found to be a miſtake, as they are only a number of cubes adhering together by their flat ſides, which are ſometimes produced when the cryſtallization is made to begin at the bottom of the veſſel, by excluſion of the air, and introduction of any foreign body, for the cryſtals to form upon. Mr. Rouelle, of the French Academy, who has juſtly merited the applauſe of the learned world, for his ingenious Treatiſe on this ſubject, has made a diviſion of thoſe ſalts that cryſtallize at the bottom and top of their containing menſtruum. This,

* Common ſalt often forms hollow pyramids, but this cannot confute the opinion of cubes being the proper form of its cryſtals. For the manner in which theſe are produced is this: A cube is formed on the ſurface of the liquor, which ſinks a certain ſpace, but has not gravity enough to carry it to the bottom. On each ſide of it a new cube is formed, which carries it ſtill farther down, and then other cubes are formed on the external edges of the laſt, as we ſee them, which at length carry it down to the bottom.

however,

however, is only true of ſuch as are equally ſoluble in the cold, as well as heat.

All ſalts that diſſolve in larger proportion in hot, than cold liquors, cryſtallize firſt where the cold is firſt applied. Thus, if a ſuperſaturated ſolution of nitre be removed from the fire, and the ſurface covered, to prevent the acceſs of cold to the top, while the bottom is placed on a cold ſubſtance, all the cryſtals will be formed there. It was formerly thought, likewiſe, that the cryſtals of different ſalts had different directions in their formation. Thus nitre was ſaid to cryſtallize pointing upwards, Glauber's ſalt horizontally.

It is now, however, found, that the cryſtals of all theſe ſalts are directed from that part, where the cold is ſufficient to cauſe them to cryſtallize. Thus, if on a vial, filled with a ſuperſaturated ſolution of nitre, in hot water, we place a wet cloth, ſo cold as to cauſe a cryſtallization, all the cryſtals will be directed from thence, whether it be the top, bottom, or ſide of the veſſel.

Dr.

Dr. Sutherland's arguments on this head have been before anſwered by Dr. Lucas. Nevertheleſs, Dr. Linden, in his ſeaſonable and modeſt reply to Dr. Lucas's curſory remarks, has aſſerted boldly, "That no perſon in his ſenſes now continues to believe any ſpecific difference in the cryſtals of ſalts;" and, in ſupport of this opinion, he urges the authority of Dr. Neuman. If by this he means Caſpar Neuman, whoſe works Dr. Lewis has abridged, we acknowledge we have read no more of them than what that learned Gentleman has communicated, as they are moſtly written in the German language. But in that part we cannot diſcover any reaſon to believe that he was of that opinion.

On the contrary, in his account of the mineral ſalts, he has diſtinguiſhed them frequently by theſe marks *. Dr. Linden farther alledges, "That the *nitrum cubi-*

Vide p. 187. Of alumn. P. 198. On the diſtinction of Glaub. ſalt from nitre. P. 200. On the diſtinction of common ſalt from nitre.

cum

cum contradicts all that can be ſaid on this ſubject, as it has all and every quality of the *nitrum priſmadale*, or common nitre." We really do not ſee the efficacy of this reaſoning, except it could be proved, that the *nitrum cubicum* ſometimes cryſtallized like common nitre, which it never does, nor does the Doctor pretend to alledge it.

The ſenſible qualities of theſe are nearly alike, and very few chemical experiments have been made to prove any difference between the cubic and common nitre. Their cryſtals are, however, invariably different; thoſe of common nitre being always, when carefully cryſtallized, hexagonal priſms, terminating, at one end, at leaſt in a ſix-ſided pyramid; whereas thoſe of cubic nitre, are, indeed, ſix-ſided, but theſe ſides are of a rhomboidal figure. He next ſays, "That the refiners are informed, by experimental facts, that large or ſmall cryſtals proceed from ſlow, or quick boiling, during the evaporation." This circumſtance is nothing at all to the purpoſe.

purpoſe. No one, who has formed a ſyſtem of this kind, has drawn his arguments from the ſize, but figure of the cryſtals.

Some ſalts, we own, are diſpoſed in equal circumſtances to ſhoot into larger cryſtals than others, as in the caſe of Glauber's ſalt and common ſalt, but this is no ſpecific diſtinction, as being neither conſtant nor aſcertained in degree. The great Linnæus, in Botany and Natural Hiſtory, has not drawn his diſtinction from the ſize of plants, and animals, but from ſome marks which are invariable, whatever be the bulk of the object: much leſs ought this to be here brought as a ſpecific diſtinction, as in this caſe the ſlighteſt variation in the heat will cauſe a difference. In ſome ſalts, however, which are diſſolved together in the ſame menſtruum, and, of conſequence, in the ſame circumſtances with reſpect to heat and cold, it may, when they cryſtallize in nearly ſimilar forms, ſometimes afford a preſumptive diſtinction; as in natural hiſtory the ſize of ſome plants and animals,

mals, though no eſſential difference, is allowed to do. Dr. Sutherland has, indeed, drawn one inference from the cryſtallization of ſalts relative to borax, extraordinary, indeed, in its kind. This has, however, been ſufficiently anſwered, (though rather too ludicrouſly for the ſubject) by Dr. Lucas. We will venture, however, to repeat here a circumſtance relative to the cryſtallization of ſalts, which Dr. Sutherland ſeemed unacquainted with, that all ſalts, which are equally ſoluble in hot as cold liquors, will cryſtallize on the naked fire, as well as in *Balneo Arenæ*.

The cryſtallization of common ſalt, by evaporation of the menſtruum only, without the liquors cooling, mentioned by Dr. Lucas, is a ſufficient evidence of this.

We ſhould be glad to know what Dr. Sutherland means by ſimple ſalts, as we know of none but acid and alkaline ſalts; of the former of which, none of the foſſile ones can be procured in a cryſtallized form, and only ſome of the vegetable kind,

kind, as the eſſential ſalts of plants, with the ſalt of amber, and the acid baſis of borax, called ſedative ſalt, can be got in a cryſtallized ſtate. The foſſil alkali may be got in this form; but, in general, alkalies are ſo averſe to cryſtallization, that an over proportion of them, joined to an acid, will often hinder the chryſtallization of the neutral ſalt.

Dr. Linden farther alledges, that no common ſalt is contained in the Bath Waters. This, however, is no more than his *ipſe dixit*, and, in anſwer to him, we may alledge all the experiments that have been made on theſe Waters, and, among the reſt, thoſe of his friend Dr. Sutherland. The teſt he requires, of extracting ℥vj. of ſalt, at leaſt, to make experiments on, cannot, indeed, eaſily be complied with, ſince it requires a larger apparatus for evaporation than moſt people are maſters of, as the water contains it in ſo ſmall proportion. But, in our opinion, a much leſs quantity may ſerve to prove this point, as the

the figure and taſte of its cryſtals are the moſt indubitable teſts of it we are acquainted with.

Theſe, joined to our Experiments I. and II. * render the preſence of this ſubſtance very certain, though it is but in a very ſmall proportion, and, probably, of little conſequence in producing any effects uſually attributed to the Bath Waters. The proportion could not eaſily be determined; it ſeemed, however, not to exceed five or ſix grains in a gallon of the water.

Inflammable Bodies.

Oils, per ſe. The next claſs of bodies that offers itſelf to our conſideration, is that of Inflammables, among which the foſſile oil, in its ſeparate ſtate, bears the firſt place. Of this, however, we have little more to ſay, than that the

* N. B. The vitriolic acid, and the ſalts containing it, precipitate the ſolution of ſilver. With the firſt, however, the precipitation is not near ſo plentiful as with common ſalt, and always aſſumes more or leſs of a yellow colour; whereas this was of a milky whiteneſs.

Bath

Bath Waters do not give the leaſt ſuſpicion of any impregnation of this kind, either by their ſenſible qualities, or chemical analyſis. The taſte and ſmell of this ſubſtance are, indeed, in general, ſo potent, and ſo diſtinguiſhable, as to leave no room for a miſtake of this for any other impregnation. The immiſcibility of this oil with water, likewiſe, affords an eaſy and obvious method of detecting it, even though its quantity ſhould be too ſmall, and its nature too pure, to admit of a diſcovery from its other ſenſible qualities *.

As this oil, however, is not, in the leaſt degree, ſoluble, and only diffuſible in water, however minute this may be, it muſt ſeparate on ſtanding. No ſuch circumſtance, however, has ever been obſerved

* The foſſil oils, when pure, in form of naptha, are thin, nearly colourleſs, and tranſparent, and have none of that ſtrong ſmell and flavour they ſo eminently poſſeſs in the form we get them. The two laſt qualities are, probably, owing to the admixture of ſome foreign body, which Dr. Cullen thinks to be the vitriolic acid.

in the Bath Waters, nor do their ſmell, taſte, *&c.* favour any opinion of this kind. We may, therefore, ſafely conclude, that the Bath Waters do not contain this ſubſtance in the ſmalleſt degree.

Oils in form of ſoap. There does not ſeem to be any more reaſon for believing that this ſubſtance is contained in the water in its compound, than in its ſimple ſtate. The taſte and ſmell of it would be equally diſtinguiſhable in this, as in the laſt mentioned form; and if even (for the reaſons above mentioned) theſe might not be ſo obſervable, yet an addition of any acid ſubſtance would preſently make the diſcovery, by the ſeparation of the oil from the water it was united with. If our opinion, that the Bath Waters contained vitriolic acid in ſubſtance, was confirmed, it would put an end to all doubts of this kind at once; but as we offer that, not as an abſolute certainty, but only as matter of great probability, we ſhall not lay any ſtreſs on it in point of argument. The pre-

preſence, however, of this acid, united with iron in the waters, which is fully proved, affords ſufficient evidence, that they contain no impregnation of this kind; as the acid, by its ſuperior attraction of the alkali, which held the oil ſuſpended, would cauſe it to ſeparate from the water.

Moreover, if the oil were thus combined with the water in form of ſoap, it muſt diminiſh its tranſparency, (ſince the oil is then only in a ſtate of minute diffuſion, through the water.) As none, however, of theſe circumſtances occur, we may rationally believe, that there are no more grounds for believing that oily ſubſtances are contained in the waters in this, than the laſt mentioned form.

Sulphur, per ſe.

We now come to the laſt impregnation of this kind, viz. ſulphur. This queſtion has been much agitated by many able Writers, ſome of whom have maintained, and others denied its exiſtence there, with as much vehemence as they would have done, had every thing valuable belonging to them depended on this ſimple

queſtion. Many have maintained the opinion of ſulphur's being the principal ingredient in theſe waters, from a lucrative view, as imagining, ſhould this point be once diſproved, it would diminiſh the credit of the waters, as their ſalutary effects were, by the generality of people, attributed to their impregnation with this ſubſtance.

Though we cannot greatly commend this motive, yet we cannot help thinking, with Dr. Lucas, that theſe fears have not the leaſt foundation, ſince the undoubted teſtimonies of their good effects, which could not be influenced by this queſtion, would much outweigh any theoretical reaſoning that could be drawn from the efficacy or inefficacy of any of the ingredients in their compoſition.

We ſhall now briefly examine the arguments that may be brought in favour of, or againſt the opinion, of the exiſtence of this ſubſtance in the Bath Waters.

In confirmation of its exiſtence, it has been ſaid, that the ſand and mud taken up from

from the bottoms of the baths, are evidently ſulphureous from their ſmell *; that the former, laid on a red hot iron, emits a blue flame, and a ſuffocating vapour; that a ſolution of mercury is precipitated in yellow clouds by it, which is the colour it aſſumes when precipitated by ſulphureous bodies; that corroſive ſublimate is decompoſed in the ſame manner; that a ſolution of ſilver in the nitrous acid is precipitated by them; that the mud of the waters, ſublimed with arſenic in a retort, produced a true orpiment †; and that the reſiduum left by the waters had the ſame effect.

On the other hand, it has been alledged, that, granting the ſand and mud taken from the bottom of the baths, contained ſulphur in any proportion, yet that would not prove its exiſtence in the waters, ſince we know ſulphur to be inſoluble in a watery menſtruum; and that if it were united with the water, by means of a ſubtile diffuſion, that this would be ſoon diſcovered by

* Sutherland's Treatiſe, p. 31, 32.
† Ibid. p. 35. Exp. I. and III.

the precipitations happening on the water's ſtanding; by the incruſtations of the ciſterns into which it firſt ſprings, and of the pipes through which it flows, as at Aix la Chapelle; none of which circumſtances are ever obſerved here. That the ſolutions of mercury, and corroſive ſublimate, were changed to a yellow colour by the vitriolic acid, and that the blueiſh white clouds ſuddenly precipitating in grumes, on addition of the ſolution of ſilver, are owing to the common ſalt contained in the water. That the reſiduum, on evaporation, appears to be moſtly a calcareous earth, and the remainder a ſaline ſubſtance, and that it gives no appearance of ſulphur when laid on a red hot iron, only fuming and crackling ſlightly, without any ſulphureous ſmell*, blue flame, ſparkles, or detonation. That its effervescence with acids proved it not to be ſulphureous, as that ſubſtance is not affected by them. That the taſte of it ſhewed no ſigns of any contents of this nature, be-

* Lucas, Vol. III. p. 312.

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ing only ſimply ſaline, and that but in a moderate degree; that the colour of bright, poliſhed ſilver, was not tarniſhed or impaired by lying in the waters a conſiderable length of time *.

On a review of theſe arguments, we are inclined to think that the latter, on the whole, are tolerably concluſive, as to this point, though they are far from being all of equal weight, or fairly ſtated. That which has been moſt relied on, viz. of the reſiduum left by the waters on evaporation yielding no ſulphur, is the leaſt determinate of any; as the ſulphur, if but in ſmall proportion, would undoubtedly be diſſipated in the evaporation, as ſulphur is decompoſed by long boiling, and plentiful dilution with water. Nevertheleſs, as they have no taſte of this kind, nor depoſit any ſubſtance on ſtanding, that bears the leaſt reſemblance to it, and do not tarniſh ſilver, or turn black with ſolution of ſacch. ſaturni, we may ſafely conclude, that, in this

* Lucas, Vol. III. p. 281.

form, it makes no part of the compoſition of the water *.

Hep. Sulph. with an alk. Sulphur, (as was before obſerved,) though not ſoluble in water, *per ſe*, becomes ſo, in a conſiderable degree, when combined with a cauſtic alkali, and even, in ſome degree, with a mild one.

As this combination is by no means infrequent in the bowels of the earth, and is,

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* By Dr. Sutherland's experiment, of the arſenic ſubliming yellow, when mixed with the reſiduum of the waters, we ſhould be led to imagine, that they contained ſulphur. — We do not deny the fact he relates, but obſerve only, that even the Doctor himſelf ſeems rather diffident, as he ſays only "inclining to yellow;" whereas when the ſame experiment was tried with Bath ſand, he ſays, "the ſublimate was of "a deep, orange colour." If, however, we allow Dr. Sutherland's poſition, that ſalts and ſulphur are inſeparable, and that the former cannot be generated without the latter, no further enquiry is neceſſary; as all waters, from thoſe of the atmoſphere to the deepeſt well, muſt be ſulphureous, ſince none have been yet diſcovered without ſome admixture of a ſaline ſubſtance. What plentiful magazines of ſulphur, then, muſt ſome of our ſalt ſprings in England be, which are nearly ſaturated!—This ſubject would afford much more opportunity for criticiſm, but has been already ſufficiently handled by an abler pen.

indeed,

indeed, no uncommon impregnation of Mineral Waters, and as thoſe of Bath undoubtedly meet with many ſubſtances in their paſſage that yield ſulphur plentifully, (as was taken notice of before) many have imagined it was united to them by ſome means of this kind. There ſeems, however, to be little foundation for ſuch a ſuppoſition, as the taſte and ſmell of this compound are ſo diſtinguiſhable, even in ſmall quantities, as to leave little doubts concerning its nature when preſent. No ſuch qualities, however, have been ever obſerved in the Bath Waters. They are nearly inodorous, and their taſte, though peculiar, by no means reſembles thoſe of that kind. Should it be urged, in anſwer, that the quantity contained in the Waters is too ſmall to affect their ſenſible qualities, (in which caſe it could be but of little effect,) we may reply, that, even granting it were ſo, chemical experiments by no means favour an opinion of this kind. It appears by theſe, that ſilver is not tarniſhed, in the ſmalleſt degree, by lying in them, and the ſolution of ſacch.

ſaturni precipitated, not in a dark coloured, but a yellow cloud. Acids, likewiſe, make no precipitation in them, which would undoubtedly be the caſe, did the ſprings contain ſulphur in this form; as we find by experiment of the Harrowgate, and other Waters, that contain an hepar ſulph. of this ſort. We may, therefore, fairly conclude, that the Bath Waters do not contain ſulphur in this form.

Hep. Sulph. c. calce vivâ. Calcareous earths, in their cauſtic ſtate, on being mixed with ſulphur, render it, in ſome degree, ſoluble in a watery menſtruum, as well as alkaline ſalts, though not in ſo large a proportion. From the frequency of both theſe ſubſtances in the earth, we ſhould expect this to be a common impregnation; and, indeed, we believe it to be much oftener preſent than it is ſuſpected to be.

An eminent Writer on the Bath Waters, has taken much pains to prove, that ſulphur makes no part of their compoſition. His reaſonings on this head ſeem well adapted to the ſubject, and prove very fully,

fully, that ſulphur, in the two forms above mentioned, has no ſhare in it. That ingenious Gentleman ſeems to have failed only in making his poſition too general, to which he ſeems to have been induced, by too great attachment to theoretical reaſoning, as it does not appear he made any direct experiments to prove this point. It is likely he concluded, and not without great appearance of probability, that a water thus impregnated, would exhibit the ſame appearances with other ſubſtances, on experiment, (though, perhaps, in a leſs degree) as one that had the true hepar ſulph. in its compoſition.

We are not aſhamed to own, that when we firſt began to reaſon on the ſubject, we were miſled in the ſame manner. Experiments, however, made with the ſand which the water brings up with it, proving, very clearly, that in this were contained ſulphur, and a calcareous earth, which, as was before obſerved, formed a compound ſoluble in water, inclined us to believe, that this muſt make a part in the

compoſition of thoſe of Bath. Nevertheleſs, the accounts given of this ſubſtance, and its effects, by ſo eminent a perſon, and ſo competent a judge as Dr. Lucas *, by no means correſponding with our Experiments on the Bath Waters, ſtaggered our opinions much on this ſubject. However, as the Doctor had related no experiments made with ſulphur in this form, it occurred to us, that he might have overlooked it, for the reaſons above mentioned. This inclined us to make the following Experiments with an artificial preparation of this kind, when, to our great ſurprize, they turned out totally different from what the Doctor had aſſerted, and our own theory had led us to ſuggeſt.

EXPERIMENT I.

Two drachms of flowers of ſulphur waſhed, and a like quantity of freſh quick lime, were rubbed together in a glaſs mortar. To this compound was added, by

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* Lucas on Mineral Waters, Vol. III. p. 278, ſection 134.

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degrees, during the trituration, ℥xvi. of diſtilled water. This was afterwards filtred, and appeared a tranſparent fluid. * Its taſte was pretty ſtrong and peculiar, but no ways reſembling any of the ſulphureous preparations, or the Harrowgate waters.

On ſtanding expoſed to the air, it abated of its pellucidity, and depoſited a whitiſh ſediment; and this happened, in ſome degree, even when the air was excluded. The quantity taken up by the water ſeemed to diminiſh very little the bulk of the original compound.

EXP. 2. *Alkalies cauſtic.*

To ℥i. of the laſt mentioned preparation, joined to ℥i. of diſtilled water, was added gutt. x. of lixiv. ſaponar. This, on ſtanding, produced a ſlight milky co-

* A tea ſpoonful of the above mixture, diluted with two ounces of diſtilled Water, with the addition of a few grains of common ſalt, formed a compound reſembling the taſte of the Bath Water when grown cold.

lour,

lour, with ſome ſmall precipitation, as in EXP. VI. with the * Bath waters.

EXP. 3. *Alkal. mild.*

To ℥i. of the aforeſaid mixture, diluted as in the laſt Experiment, was added gutt. x. of lixiv. tart. a ſudden flaky and copious precipitation took place, preciſely of the ſame colour as in EXP. VIII. and which, on ſtanding, fell to the bottom, and left the fluid about clear.

EXP. 4. *Alk. volat. cauſtic.*

To ℥ij. of the above mixture, diluted as before, was added gutt. xl. of ſp. ſal. ammon. c. calce vivâ, which produced the ſmalleſt degree of a milky caſt, and gave no precipitation on ſtanding.

EXP. 5. *Alk. volat. mild.*

To ℥ij. of the above mixture, was added gutt. xl. of ſpir. ſal. ammon. com-

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* On this addition, the diluted mixture became nearly of the taſte of the Harrowgate Spa. N. B. The mixture had the ſame effect on ſoap, and its ſolution, in rectified ſpirits, as the Bath Water.

mun.

mun. This cauſed a milky appearance, with a flaky precipitation, but not ſo conſiderable as in the Experiment with lixiv. tartari.

EXP. 6. *Calc. Earths deprived of their fixed Air.—Lime Water.*

To ℥ij. of the mixture, diluted as aforeſaid, was added ℥ſs. of lime water, which produced not the leaſt ſenſible alteration in the body of the fluid.

EXP. 7. *Solution* of Metals.—Of Silver in the Nitrous Acid.*

To ℥ij. of the mixture, diluted as above, was added gutt. vi. of ſol. of ſilver. This cauſed only a very ſlight milkineſs on ſtanding, ſcarce perceptible.

EXP. 8. *Of Lead in the ſame.*

To ℥ij. of the mixture was added gutt. vi. of ſol. of lead. This cauſed ſcarce any

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* To one ounce of the diſtilled water uſed here, was added gutt. vi. of ſol. of ſilver. This induced a ſlight milkineſs, as in Experiment 7. with the hep. ſulph. c. calce vivâ.

change,

change, except a very ſlight milkineſs, even leſs than in the former Experiment.

EXP. 9. *Sol. of Sacch. Sat. in Water.*

To ℥ij. of the mixture as before was added gutt. x. of the ſol. of ſacch. ſaturni. This cauſed a whitiſh cloudy precipitation, of a reddiſh tinge, as in EXP. XXI. with the Bath waters.

EXP. 10. *Acids. Sp. Vitr. Nitri & Salis.*

To ℥ij. of the mixture as above, was added gutt. v. of the vitriolic, nitrous, and muriatic acids, without cauſing the leaſt efferveſcence, precipitation, or change of colour.

EXP. 11. *Solut. of Corr. Subl. in Water.*

Ten drops of a ſaturated ſolution of corroſive ſublimate were added to ℥ij. of the mixture as before. A blueiſh white cloud was immediately precipitated, and a thin film floated on the top, as in EXP. XXIV. with the Bath waters.

EXP. 12. *Of white Vitr. in the ſame.*

To ℥ij. of the ſol. of hep. ſulph. c. calce vivâ, diluted as above, was added gutt.

gutt. x. of a ſaturated ſolution of white vitriol. This cauſed ſcarce any change, except a ſmall blueiſh tinge towards the bottom of the veſſel. When the ſolution of hepar ſulph. was uſed in leſs proportion, as xxx. gutts. to ℥i. of diſtilled water, (which gave nearly the ſame taſte as the Bath water when cold,) no change was obſerved.

EXP. 13. *Sol. of Merc. in Sp. of Nitre.*

To ʒi. of the original preparation, diluted with ℥i. of diſtilled water, was added gutt. xv. of ſol. of merc. in the nitr. acid. This cauſed a ſlight reddiſh white precipitation, which remained in the middle of the liquor, but did not ſubſide.

EXP. 14. *With the Reſiduum depoſited on ſtanding by the Sol. of Hep. ſ. c. c. viv.*

Six grains of a whitiſh equable reſiduum depoſited by the ſol. of hep. ſ. c. calce vivâ, on ſtanding, were collected. Two grains of this were laid on a red hot iron; it fumed ſlightly, but gave no blue flame, ſparkles, or detonation, nor emitted the leaſt

leaſt ſulphureous ſmell, though carefully obſerved. The reſiduum, on burning, changed from a white, to a light aſh colour.

N. B. This Experiment was ſeveral times repeated.

EXP. 15. *With the ſame Acids.*

Ten grains of the above reſiduum were collected, and carefully dried with a very gentle heat. To this were added gutt. v. of the vitriolic, nitrous, and muriatic acids. It efferveſced ſtrongly with each of theſe, and with the vitriolic, formed a ſaline ſubſtance, which appeared from its taſte, &c. to be ſelenites.

EXP. 16. *Vegetable Blues, with the Mixture.*

A piece of writing paper, ſtained with the blue leaves of violets, and another with the purple of polyanthus flowers, was immerſed in a quantity of the mixture, diluted as above, and freſh made. No change of colour happened. The ſame Experiment was tried with it, after having ſtood expoſed to the air ſome time, when

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it immediately changed them to a green colour.

EXPERIMENT 17.

Two ounces of the mixture were added to an equal quantity of the Bath water, without any obſervable change.

From a review of the above Experiments, it appears, that moſt of them correſpond in effect with thoſe made with the Bath Water; and in thoſe where the appearances differ, we think the variation is owing to ſome other ſubſtances, which are known to form the impregnation of the Bath Waters beſides the foregoing. In order to evince this more clearly, we propoſe to give a ſhort comparative view of the effects produced by the ſame Experiments on the Bath Water, and our artificial preparation, and then ſee if theſe different appearances may not be explained on the foregoing principles.

EXP. VI. 2. *Alk. Cauſt.*

The effect of this ſeems nearly the ſame in both. The cauſtic alk. ſeems to act in each,

each, by decompoſing the hep. ſulph. c. calce vivâ, diſengaging the lime from the ſulph. and taking its place; which, however, as the cauſtic alk. ſupplies no fixed air *, ſtill remains diſſolved in the water.

EXP. VIII. 3. *Alk. mild.*

The hepar ſulph. is here decompoſed †, as in the foregoing Experiment, though the mild alk. is but very ſparingly miſcible with ſulphur. A double decompoſition, however, here takes place, which ſeems to effect their union. The quick lime at-

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* Some ſmall precipitation happened in the artificial precipitation, as well as in the Bath Water, probably owing to the alk. not being perfectly cauſtic, which is difficult to procure. The Bath Water exhibited a much larger precipitation when freſh, than after having ſtood ſome time, which proceeded, probably, from the quick lime, diſengaged by the alk. from the ſulphur, attracting the fixed air ſuddenly, which we have before ſeen to be ſo plentifully contained in the water, when freſh drawn, and being thus precipitated. This accounts for this circumſtance not being ſo obſervable in the water that had ſtood ſome time.

† Experiments VI. 2. VIII. 3. In both theſe Experiments a true hep. ſulph. is formed.

tracts

tracts the fixed air from the mild alk. which is thus rendered cauſtic, and enabled to unite with the ſulphur, while the lime, thus rendered mild, and, of courſe, inſoluble in water, falls down in form of a mild calcareous earth, and forms the copious, white precipitation, obſerved in the Experiment. This, however, will be better underſtood by the annexed ſcheme.

EXP. IX. 4. *Vol. Alk. cauſt.*

The appearances ſhewn on addition of this ſubſtance, ſeem to be the ſame in both *.

* It is doubtful here, if the hep. ſ. c. c. v. would be decompoſed, as the quick lime ſeems to have a ſtronger attraction to ſulphur than the vol. alk. Probably the ſlight precipitation (obſerved on ſtanding) in both, was owing to the alk. not being perfectly cauſtic, which is very difficult, and, indeed, nearly impoſſible to procure, as it attracts fixed air from even a ſilver veſſel, in which the evaporation is performed, when wanted in a dry form.

EXPE-

EXP. X. 5. *Vol. Alk. mild.*

* The earth is here precipitated in both, for the reaſons given above, when we ſpoke of the fixed alkali, but not in ſo large proportion, as the vol. alk. is ſcarce ever got ſo mild as the fixed, and, beſides, does not contain fixed air in ſo large proportion.

EXP. X. 6. *Calc. earths deprived of their air.—Lime water.*

The effects of this on the mixt and on the Bath Water when freſh, are totally different. With the former no perceivable effect was produced, whereas with the latter it occaſioned a copious precipitation. This difference, however, may be eaſily explained. The Bath Waters, when freſh, are known to contain fixed air in a large quantity, which the quick lime in the water greedily attracts, and is thus rendered inſoluble, and, of courſe, precipitated.

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* The hep. ſ. c. c. v. ſeems to be here decompoſed by a double elective attraction, which may be underſtood by the ſcheme laid down in the foregoing page, only ſubſtituting the volatile, in place of the fixed alkali.

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EXP. 13. *Sol. of Merc. Nitr. Acid.*

The difference of the effects produced on addition of this ſubſtance to the mixt, and to the Bath Water, is very obſervable. With the former it exhibited a ſlight, reddiſh cloud; with the latter, a copious, white precipitation. This, however, ſeems owing to the ſame cauſe as the foregoing. In the former, the ſolution of mercury ſeems precipitated by the vitriolic acid, which is ſeparated from the ſulphur by the attraction of the mercury, or by the decompoſition of the hepar ſulph. c. c. vivâ, in ſome degree, by its ſolution in water; which cauſes the precipitate to be of that reddiſh, yellow colour, which is the ſame that mercury, precipitated by the vitriolic acid, always aſſumes. In the latter caſe, the precipitation is certainly occaſioned by the common ſalt, the muriatic acid in it having a ſtronger affinity with mercury than the vitriolic acid has, which cauſes the difference of colour in the precipitations. What confirms this is, that if a few grains of common ſalt be previouſly added to the

mixt, the mercury is precipitated from the ſolution, of a white colour.

EXP. XXVI. 11. *Sol. of Corr. Sub. in Water.*

The appearances in both caſes, on addition of this ſubſtance, ſeem nearly the ſame, and, probably, would have been exactly ſo, could we have brought the mixt to the exact ſtandard of proportion of impregnation with the Bath Waters.

EXP. XXV. 12. *Sol. of White Vitriol.*

No perceptible difference was obſerved between the mixt and the Bath Waters, on addition of this ſolution.

EXP. XIV, XV. 10. *Acids.—Vitriolic, nitrous, muriatic.*

The acids ſeem to have had no viſible effect on either the mixt, or the Bath Waters.

EXP. XXVI. 16. *Vegetable Blues.*

The mixt, when freſh, ſeems to agree with the Bath Water, in its ſhewing little change at firſt in the colour of vegetable blues; though when kept ſome time it exhibited the ſame effect. The Bath Water, indeed,

indeed, when freſh drawn, ſeemed to change the vegetable blues to a little of a reddiſh caſt, but this was probably owing to a ſuperfluous quantity of the volatile vitriolic acid, which, as we before obſerved, there is great reaſon to ſuſpect the preſence of in theſe Waters.

From what has been before urged, and from the above compariſon of the Experiments, we think there is the greateſt reaſon to believe, that ſulphur, in this form, makes a part in the impregnation of the Bath Waters. We own, that all the comparative Experiments do not coincide; but thoſe which differ, we hope have been ſatisfactorily explained to proceed from the effect of ſome other ſubſtance, whoſe preſence there we are aſſured of. The compoſition of the ſubſtance thrown up by the waters, called Bath ſand, being demonſtrated to be ſulphur, joined to a calcareous earth, proves the poſſibility, if not (as forming a compound ſoluble in water) the neceſſity of ſuch an impregnation; and the agreement of the comparative Experiments

made with an artificial compoſition of this kind, with thoſe made on the Bath Waters, in all the material circumſtances, give, in our opinion, a rational proof of the exiſtence of this impregnation.

Metallic Subſtances.

The next claſs of bodies that comes under our conſideration, is that of Metallic Subſtances; the firſt of which, in the order they are placed in our table, is — Copper.

Copper.

There does not ſeem to be the leaſt reaſon to ſuſpect the preſence of copper in the Bath Waters. Iron immerſed in them is, indeed, ſoon corroded; but no precipitation reſembling copper is ever depoſited on its ſurface, as is the caſe with all waters that contain that metal in a ſtate of ſolution. The Bath Waters ſeem, indeed, to have very little effect on copper, as we ſee by the rings in the King's Bath for the bathers to hold by, which are moſtly made of copper, and many of them, as appears by their dates, have continued near a century, and ſome of them more, and ſtill remain

main little diminiſhed; whilſt thoſe of iron are entirely conſumed in a twentieth part of the time. The cauſtic volatile alkali likewiſe ſhews no ſigns of a cupreous impregnation, but mixes with the water without any change of colour. No ſigns of this metal, in any form, appeared in the reſiduum left on evaporating the waters. The cryſtals there were all colourleſs, and in taſte and effects by no means reſembled the blue vitriol. On the whole, we may rationally conclude, that this metal is not contained, in any form, in the Bath Waters.

Iron.

The preſence of this metal, in theſe waters, has been acknowledged by all the Writers on this ſubject. The purple tinge it ſtrikes with ſolution of galls, when freſh, the ochrous incruſtations of the baths, which we ſhewed by Experiment XXXVIII. were capable of being revived into a metallic form; the Experiments made with the reſiduum of the waters on evaporation, and with the Bath ſand, put this circumſtance beyond a doubt. As to the form in which it is con-

tained in them, it is here, in our opinion, ſuſpended, by means of the volatile vitriolic acid *. This is indicated by the purple tinge it ſtrikes with ſolution of galls, and the reddiſh one it gives to the vegetable blues when freſh, and by the ceaſing of both theſe effects on the water's ſtanding, and by the ſpontaneous precipitation, on its expoſure to the air, of the ochrous ſub-

* It has been ſuggeſted to us, by a very ingenious and learned Phyſician, Dr. Haygarth, of Cheſter, that the chalybeate impregnation was owing to the fixed air contained in the waters, and not to the volatile vitriolic acid, according to a theory founded on experiments mentioned in the *Philoſophical Tranſactions*. That this would account for the ſlightneſs of the impregnation, as the water would contain but a certain portion of the mephitic air, which was capable of diſſolving a very ſmall proportion of iron only. That this, likewiſe, would equally account for the precipitation of the iron, on the water's being expoſed to the air. Theſe reaſons are ingenious, and worthy of our conſideration; and yet we are not inclined to think them ſatisfactory in this caſe, for the following reaſons.

1ſt. Becauſe the ſand depoſited at the bottom of the baths, contains iron united with the vitriolic acid, in a form ſoluble in water, as is proved by pouring common or diſtilled water on it, which, in a few minutes, extracts a ſtrong chalybeate tincture from it.

2dly, Be-

ſtance before mentioned. As to the proportion of this metal contained in the Bath Waters, it is, undoubtedly, very ſmall. Dr. Lucas has computed it at one thirty-ſeventh and a half of a grain of iron in a pint of the water, and this computation ſeems tolerably juſt. This circumſtance, however, as he very properly obſerves, is very difficult to be aſcertained with any great degree of exactneſs. As to the notion of a volatile vitriol, that has already been ſufficiently refuted in another part of our Work; and thoſe who deſire to ſee more on this ſubject, we would refer to Dr. Lucas, who has, with great learning and judgment, expoſed this opinion, and proved, that what gave occaſion to this notion, was no other than the flying off of the volatile vitriolic acid, which held the iron diſſolved, on which the water ceaſed to ex-

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2dly, Becauſe the Bath Waters themſelves, even when cold, are capable of acting on iron filings.

3dly, Becauſe a ſolution of galls precipitates the iron from the Bath Water of the ſame colour as it does from a ſolution of green vitriol.

hibit the appearances which are commonly accounted proofs of a chalybeate impregnation. The iron, however, in this caſe, was ſo far from being volatilized, that it was precipitated.

A curious queſtion ariſes on the ſubject of this impregnation, which we have not ſeen taken notice of by any other Writers, and which, we own, we are not able to reſolve ſatisfactorily, viz. why theſe waters do not give ſtronger proofs of a chalybeate impregnation than they do? It does not appear, on their analyſis, that they contain any ſubſtance that would precipitate the iron, were it contained in them in much larger quantities than it really is. Dr. Lucas ſays, in confirmation of the above opinion, that Bath water, poured on filings of iron, diſſolved them plentifully; and it appears by our own Experiments, that even cold water extracted, in a few minutes, ſo ſtrong a chalybeate impregnation from the Bath ſand, as to ſtrike a deep black with ſolution of galls. Nevertheleſs, the Bath waters, which, undoubtedly, paſs through many beds of minerals containing this metal in large

* large quantity, and that, too, in a form capable of ſolution in water, exhibit but a very faint impregnation of this kind. This circumſtance ſeems difficult to account for. Perhaps it may be owing to the large proportion to, and ſwift paſſage of, the water over the pyrites, containing this metal. This, however, is not fully ſatisfactory, as it would hold equally ſtrong againſt all the other impregnations, ſome of which are contained in the waters in much greater proportion than the chalybeate one. We will venture, however, to ſuggeſt a circumſtance, which, though not of itſelf quite ſatisfactory, may yet throw ſome light on this ſubject. The learned Dr. Lewis gives an account of an Experiment, that has been related in the former part of our Work, in which he found, that, on addition of a fixed alkaline ſalt, to a ſolution of green vitriol, no decompoſition enſued while the air was excluded; but that, on its admiſſion, the acid

* Both theſe circumſtances may be reaſonably preſumed, from the Experiments related with the Bath ſand.

and alkali preſently united. May not the volatile vitriolic acid, in like manner, exert but little effect on the ferruginous particles, until the communication with the air is obtained, and then its ſwift paſſage may not afford opportunity for a more plentiful impregnation *.

If this theory ſhould be blamed, as too vague, or uncertain, we beg leave to repeat the excuſe we have formerly made, which is, that we offer theſe things only as matters of conjecture; and this, we hope, will plead in behalf of our mentioning them.

On the whole, then, the preſence of this metal in the waters is beyond a doubt, though its proportion there ſeems to be ſmaller than in any chalybeate we have examined.

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* It may be alledged, that this argument might be urged, with equal force, againſt all chalybeates whatever. Theſe, however, may ſome of them have acceſs to the air, by ſome ſubterraneous paſſages, or caverns, ſimilar to thoſe mentioned in our account of the vitriolic acid *per ſe*, and its ſeparation, by decompoſition, from the pyrites, which may not be the caſe with the Bath Waters.

The

Zinck.

The preſence of this Mineral has never been ſuſpected here. Indeed (as has been before obſerved) it is a doubt if ever it forms a native impregnation of ſprings. However this may be, there does not ſeem to be the leaſt reaſon for thinking it makes any part of the compoſition of the Bath Waters. Its ſenſible qualities, and the effects it produces even in very minute quantities, when diſſolved by the vitriolic acid, which is the form it muſt exiſt in, if at all, by no means coincide with thoſe uſually produced by theſe celebrated Waters. Zinck thus diſſolved, is poſſeſſed of emetic, and, at the ſame time, narcotic qualities; and theſe effects are produced by a very ſmall proportion of it. Theſe qualities, however, ill agree with thoſe of the Bath Waters, and the cure of thoſe diſorders for which they are ſo much famed. The cryſtals, likewiſe, procured on evaporation of the Bath water, have nothing of the ſweetiſh taſte ſo remarkable in the white vitriol, and are likewiſe of more difficult ſolution in water. In a word, we have not

the leaſt reaſon, either from the ſenſible qualities, or chemical analyſis of them, to ſuſpect that zinck enters into their compoſition.

In the former part of our Work, we mentioned the three impregnations above ſpoken of, as being all of the metallic kind, that were to be found native in Mineral Waters. Notwithſtanding, however, this aſſertion, which we believe to be juſt as to native impregnations, an accidental combination with another metallic ſubſtance, and that, too, not the moſt innocent with reſpect to the human body, may ſometimes take place in them, eſpecially in thoſe of the thermal kind.

Lead. The effects of lead on the human body are well known: "Obſtinate conſtipations, violent colics, "pains and contractions of the limbs, tre- "mors and reſolutions of the nerves, and "ſlow waſting fevers, are the conſequences "of this metal taken internally, and of the "fumes to which the workmen are ex-

"poſed

" poſed * in the fuſion of this metal, in the " way of buſineſs;" and even the external application of ceruſſe has been known to produce this effect. This metal, however, is generally thought not to be ſoluble in the vitriolic acid, unleſs in a boiling heat; and this ſeems true with regard to the fixed; but as to the volatile, it is by no means to be depended on, as that will act on lead in an inferior degree of heat; and though its attraction to metals does not ſeem to be ſo ſtrong, yet it diſſolves them in much larger proportion than the other.

After having given the above account of the effects of this pernicious metal, we ſhould be ſorry to inſinuate any ſuſpicion of its preſence in theſe ſalutary ſprings. Nevertheleſs, the ciſtern, which ſerves as a reſervoir for the ſpring at its firſt riſe, appears plentifully corroded on its inſide, by the long furrows which are viſible in every part of it. This proves the poſſibility of

* Lewis Mat. Med. Art. Plumbum.

ſuch

ſuch an impregnation, though, probably, its proportion there is too ſmall, or perhaps counteracted by ſome other qualities of the waters, to work any obvious effects on the human body. This, however, is, by no means, a juſtification of the uſe of any thing liable to give an impregnation of this ſort in the ſlighteſt degree. A portion of ſeveral metallic ſubſtances, almoſt too minute to be diſcerned, is capable of working great changes in the human frame; and among theſe *Lead* claims the chief place, and is perhaps the moſt dangerous, as it frequently works by ſlow, and almoſt imperceptible degrees, and has often compleated the miſchief before the perſon was ſenſible of his danger, or to what cauſe to attribute his malady *. The noted Colic

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* Nec minus infelices qui aquam plumbo divitem bibunt, plumbeis ædes tectæ laminis, ubi pluvialis ſola bibitur, in ciſternis collecta, vel in plumbeis ſervata vaſis, quod peſſimum, frequentiorem multo faciunt morbum: et hæc eſt ratio quare inſolitus olim colicus dolor, graſſetur nunc Amſtelodami. Tegulis antea tectæ, hodie plumbo teguntur ædes, ſuperne olim declives, nunc planæ. Volitantia ſub finem autumni folia decidua, viridarium enim credereris urbem,

at Amſterdam was of this kind, which for a long time eluded the ſearch of the learned with reſpect to its cauſe; and it ſeems probable, from ſome ingenious Experiments, by Dr. Baker and others, that the Devonſhire Colic proceeds from the ſame origin.

If to this it ſhould be objected, that we have no accounts of any ſuch effects produced by the Bath Waters, and that, on the contrary, they have been proved to be very efficacious in the cure of theſe very diſeaſes, we may reply, that the action of the water on this metal has been ſufficiently proved, and that it is poſſible, that the unfavourable ſymptoms ſometimes produ-

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urbem, ventis in tecta feruntur, macerata ibi aquâ ſtagnante, hanc inficiunt acore, quo ſolutum plumbum in ceruſſam abit, ad ciſternam dein rapitur imbre, ſic ſenſim inficitur aqua. Nec mirum ſi in aliis locis ubi deficit plumbum, arboreſque deſunt, minus frequentes ſint colici dolores. Hinc intelligitur quare, ſi, cadentibus foliis, tenues nullæve ſint auræ, ſi caute ligno tegatur plumbum, ſalubrior aqua fit. Fidem obſervata merentur, vidi malum in integras ſæviiſſe familias, undecim in unâ domo, uno tempore decumbentes, horrendis cruciatibus convulſi, membris ſoluti, mutato tecto, renovatâ aquâ, convaluere.—*Tronchin de Colicâ Pictonum*, Art. X. p. 66, 7.

ced

ced on drinking them, which we know not how to account for otherwiſe, may be produced by ſome ſuch impregnation; as this metal, though its effects are ſometimes latent, is ſeldom inactive. It may be, perhaps, owing to this cauſe, that ſome diſorders of the ſpaſmodic kind, as the opiſthotonus, ſeem ſometimes rather enhanced by drinking the waters, when bathing alone is of great ſervice. This may likewiſe occaſion the retardation, and ſometimes the failure of cure, of many bowel diſorders; and the obſtinate coſtiveneſs*, ſo much complained of on drinking the Bath Waters, which is a conſtant effect of that mineral, makes this conjecture not improbable. Effects, when ſlowly produced, and the reaſons not ſelf-evident, are often neglected, or attributed to unavoidable cauſes, or circumſtances to which they do not belong. The noted Colic at Amſterdam had many cauſes aſſigned for it, before the true one was diſcovered; and it is poſſible, that this quality in the Bath Waters may not be

* The waters of the hot Bath are obſerved rather to open than bind the body. The reſervoir there is made of ſtone.

origi-

originally inherent in them, but perhaps owing to ſome accidental circumſtance of this nature.

From an examination of their contents, we can diſcover nothing to which this effect can rationally be aſcribed; and, if we reaſon from analogy, all the ſulphureous preparations tend rather to looſen than bind the body. An eminent and ingenious writer has cautioned againſt the uſe of lead in our common pumps, as he ſays, that although lead may not be obviouſly ſoluble in common water, that a portion of it may be abraded, and ſo minutely comminuted by the working of the pump, as to be ſuſpended in water, and thus capable of being received into the human body. If this caution was well founded, as to laying aſide the uſe of lead in common pumps, how much ſtronger will it be applicable in this inſtance, where the pump is worked daily many hours together, and the abraſion conſequent on it proportionably greater, and the very water drawn by it capable of holding it in a ſtate of ſolution? If it be

farther

farther alledged, that no lead appears to be found in the waters, even * by our own experiments, we may anſwer, that this metal is ſufficiently proved to be acted on by the effect beforementioned to be produced on the reſervoir; and though the proportion contained in any quantity of water capable of coming under our examination, might elude a diſcovery by a chemical analyſis, yet its effects on the human body might be ſtill poſſibly exerted. This was the caſe at Amſterdam before quoted, where, though the diſorder was undoubtedly owing to this cauſe, and its proportion vaſtly larger than it could be in this inſtance, it was ſtill ſo minute, as to be ſcarce diſcoverable by a chemical examination.

On the whole, when we conſider the nature of thoſe diſeaſes which are generally recommended to theſe waters for relief,

* It is not improbable, that the decompoſition of the tinctura ſulph. volat. mentioned by Dr. Lucas, which we find, on repetition of the ſame experiment, to be true, may be owing to ſome degree of an impregnation of this kind.

which

which are * many of them of the ſame kind with thoſe occaſioned by this pernicious mineral, and ſome actually produced by it, we ſhall then ſee the peculiar propriety of avoiding any poſſibility of an impregnation of this nature. We would, therefore, humbly, though earneſtly, recommend to thoſe, who are the guardians of theſe antient and juſtly celebrated fountains, to ſubſtitute a reſervoir of marble, or what, perhaps, may be full as proper, of grit ſtone, in place of the leaden one now uſed; and wooden, or, what may ſerve the purpoſe ſtill better, caſt iron pipes, for the ſupply of the pump.

Earthy Subſtances, ſimple.

We mentioned, in the former part of our Work, that there was but one kind of earth that was ever found, in its ſimple ſtate, native in ſprings, in ſufficient quantity to bring them

* Many minute circumſtances, which perhaps might have ſcarce any perceptible effect on a perſon in health, might be of the worſt conſequence to thoſe who are already prediſpoſed to diſorders of this kind.

under

under our definition of Mineral Waters; and this is the calcareous. Whether this enters into the compoſition of the Bath Waters, uncombined with any other ſubſtance, is a curious queſtion. The copious precipitation of a calcareous earth, conſequent on the addition of a mild alkaline ſalt, would lead us to imagine this to be caſe; as this always happens on their being added to lime water.

Calcareous Earth.

Though we do not deny that a ſmall proportion of calcareous earth, in form of lime, may be found in the Bath Water that has ſtood ſome time, which is rendered ſtill more likely, by the greeniſh tinge the water gives to the vegetable blues in theſe circumſtances; yet we have no reaſon to think any ſuch ſubſtance is united with them when freſh, as they then ſeem to give proofs rather of an acid impregnation*. The ſigns they ſeem to give of an impregnation of an alk.

* Vide Experiment XXVI. where it is ſaid to change the vegetable blues to a reddiſh tinge.

nature,

nature, may be owing to the decompoſition of the hep. ſulph. c. calce vivâ contained in the water, cauſed by the flying off of part of the acid, and leaving a ſuperfluous quantity of the calcareous earth in form of quick lime united with the water. By our Experiments it appears, that the hep. ſulph. c. calce vivâ anſwered all the teſts above mentioned, which are commonly accounted proofs of the preſence of a calcareous earth. The manner that this comes to paſs has been above explained, when we treated of that ſubſtance. What proves, however, that calcareous earths are not found native in theſe waters, is, that no precipitation happens on addition of a few drops of the vitriolic acid, which would undoubtedly be the caſe, did the water contain the earth in this form, as they both would then be precipitated together in form of ſelenites. The plentiful impregnation of theſe waters with fixed air, likewiſe ſeems to confirm this opinion, as this would undoubtedly unite with the calcareous earth, and, by reſtoring it to a

mild

mild ſtate, deſtroy its ſolubility in water *.

We may, therefore, ſafely conclude, that calcareous earth is not found native and uncombined with any other ſubſtance in the Bath Water.

Though we cannot allow that calcareous earths *per ſe* have any ſhare in the compoſition of theſe waters, we are ready to own that, in their compound ſtate, they form one of its principal impregnations. Combined with acid, in form of ſelenites, they are undoubtedly contained in the wa-

Earthy ſubſtances. Compound.

Selenites.

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* The calcareous earth, left on evaporation of the Bath Waters, might countenance the opinion of its preſence there in a ſeparate ſtate. This, however, may happen, and is probably occaſioned by the decompoſition of the hep. ſulph. c. calce vivâ, which, on ſtanding expoſed to the air, and more eſpecially by ſtrong boiling, ſuffers a decompoſition, and of conſequence, ſeparation of its parts: The vol. vitr. acid and phlogiſton being diſſipated, and the calcareous earth precipitated in a mild ſtate. Selenites, too, which is largely contained in theſe waters, undergoes in the ſame circumſtances a ſimilar decompoſition, and may in part occaſion this appearance.

ters,

ters, as appears plainly from the cryſtals left on evaporation, which were of * an hexagonal priſmatic form, of ſmall ſize, nearly inſipid, and ſcarce perceptibly ſoluble in water. To this impregnation the curdling of ſoap may poſſibly be owing, though that may be produced by the hepar. ſulph. cum calce vivâ †. On the whole, the foregoing Experiments ſufficiently prove the preſence of this ſubſtance, though it

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* Selenites is deſcribed by many authors(*), who have wrote on the cryſtals of ſalts, as cryſtallizing on the ſurface of its menſtruum in theſe laminæ(*). This, however, is only a miſtake, ſince it only happens when the evaporation is carried ſo far as to form a pellicle on the ſurface. In that caſe it cryſtallizes in a ſeemingly laminated form; but on microſcopical examination even theſe appear to be compoſed of hexagonal priſmatic cryſtals, though ſmall and irregularly formed, occaſioned by their running into cluſters by too haſty a cryſtallization. By a judicious management of the heat, and ſometimes by addition of a ſmall quantity of rectified ſpirit towards the end of the evaporation, ſelenites may be brought to form in fair and well ſhaped cryſtals at the bottom of the veſſel.

† Vide Note on Experiment II.

(*) Lewis's New Diſpenſatory, p. 461, edit. 2.

does

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ſlight in compariſon with the other. They are likewiſe of ſmall ſize, and not ſoluble, unleſs in a very large proportion of water, which ſufficiently diſtinguiſhes them from thoſe of the ſal. cath. amar. which is ſoluble in as ſmall proportion of water as any ſaline ſubſtance we are acquainted with.

Alumn.

The next ſubſtance that preſents itſelf to our enquiries is Alumn. The Bath Water, when nearly evaporated, has ſome degree of an auſtere, bitter taſte, but does not poſſeſs that nauſeous, ſweetiſh one, which is always inherent in alumn. A ſolution of a fixed alkaline ſalt, cauſes, indeed, a white precipitation, but by no means in the flocculous form in which the earth of alumn is always precipitated, nor is any part of the precipitate re-diſſolved, which is always the caſe, when the fixed alkali is not added in ſufficient proportion to ſaturate the ſuperabundant acid contained in the alumn. Add to this, that the earth of alumn is equally precipitated by cauſtic, as mild al-

kalies, which is not the caſe with the Bath Waters.

On examination, likewiſe, of the reſiduum of the Bath Waters, no marks of alumn are to be found; the ſaline particles are all hexagonal or cubical, and of ſmall ſize; whereas alumn, as was before obſerved, ſhoots into large, angular maſſes, conſiſting of eleven planes, five of which are hexagonal, and ſix quadrangular. Alumn, likewiſe, is much more ſoluble in water than the ſalt thus obtained; the former requiring only about ten times its weight of water to diſſolve in, but the latter infinitely more. On the whole, we have no reaſon to think alumn to be an ingredient in their compoſition.

Aërial bodies. We now come to the laſt head of Impregnations, viz. *Aërial Bodies*; of theſe, the firſt mentioned in our catalogue is *Common Air*.

Common air. This ſeems to be very ſparingly contained in the Bath Water, when freſh, as fewer bubbles are obſerved in it, when placed under the exhauſted

exhauſted receiver *, than in water that has ſtood ſome time expoſed to the atmoſphere. This obſervation may, indeed, be applied to many ſprings, as they are all found to contain it in leſs quantity when freſh, than after remaining ſome time in an open veſſel. Probably to this, among other cauſes, it is owing, that ſome waters become fit for ſeveral purpoſes, on ſtanding ſome time expoſed to the air, ſuch as the ſolution of ſeveral bodies, *&c.* which they were not when freſh drawn. Thus if a ſaturated ſolution of any ſaline ſubſtance be placed under a receiver, and the air exhauſted, the ſalt is largely precipitated, as the air ſeparates from the water, and, on its re-admiſſion, is ſlowly re-diſſolved, as the water again acquires its proportion of air. The air, likewiſe, contained in theſe waters, muſt be highly rarefied by their heat, inſo-

* Though the Bath Waters, freſh from the ſpring, ſhew but little marks of their containing air, by the Experiment mentioned above, yet, when grown cold, and having been expoſed ſome time to the air, it exhibits the ſame appearances with common water.

much as to be diſſipated nearly on their firſt communication with the atmoſphere, before it could be poſſible to make them the ſubjects of our experiment. Thus we ſee common water, that has been boiled, or ſtrongly heated in an open veſſel, gives, for ſome time after, very little marks of containing air, exhibiting few or no air bubbles under the exhauſted receiver, and freezing without any increaſe of bulk. If what has been ſuggeſted by an ingenious * Writer be true, that ſeveral diſorders, as glandular obſtructions, *&c.* are owing to drinking water deprived of its air, this would be a good reaſon againſt the uſe of boiled water for common drink, which many prefer, and is recommended by ſeveral Phyſicians, and has, indeed, ſome advantages; or, at leaſt, not to uſe it until it had remained a ſufficient time expoſed to the atmoſphere, to recover its proportion of common air. It ſeems probable, that, in the Bath Waters, the fixed air, which we ſhall next treat of, ſupplies that deficiency.

* Dr. Percival, of Mancheſter, on the pump-water of that place.

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Fixed air.

Although common air ſeems to be contained in the Bath Waters but in ſmall proportion, this is by no means the caſe with the fixed or mephitic air, whoſe preſence here is very evident, and is probably one of the greateſt ſources of their admired qualities. The ſparkling appearance, pungent taſte, and, on many, if taken in large quantity, inebriating effects, are ſufficient evidences of this. Perhaps, likewiſe, the odour mentioned by Dr. Lucas, as prejudicial to weak lungs, and of an acid pungency, might be more owing to this, than to the volatile vitriolic acid to which it is uſually attributed. Theſe, indeed, may be very eaſily miſtaken for one another, as it is not improbable that an acid is always either united with, or makes part of the compoſition of fixed air, ſince even that, when accumulated in large quantity, as on the ſurface of fermenting liquors, is found to change the colour of vegetable blues to red. Chemical experiments, likewiſe, confirm our opinion of this impregnation, which their ſenſible qualities had indicated. The pre-

cipitation of the lime from lime water, on admixture of the Bath water, when freſh, and the ceaſing of this effect on its ſtanding expoſed to the air, the film produced on the ſame by the ſteam of freſh drawn Bath water, conveyed by a bended tube on its ſurface, prove this very clearly. To this, likewiſe, is owing the burſting of the bottles, if corked up as ſoon as filled from the ſpring, and the ſenſible diminution of the bulk of the water, on ſtanding a few minutes expoſed to the air. To this, however, it may poſſibly be objected, that, if the Bath water contained fixed air in large quantity, its effects on the human body, ſo far from being ſalutary, muſt be highly prejudicial, ſince that ſubſtance is known to cauſe deleterious, and even fatal effects, witneſs the many accidents that have happened from too near an approach to a veſſel of fermenting liquor, whoſe effluvia, which we know to be compoſed principally, if not altogether, of fixed air, produce the moſt ſudden and fatal conſequences to animal life, that we are acquainted with.

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the vital organs, ſhould, when taken into the ſtomach, prove a powerful and invigorating ſtimulant.

The celebrated effects of theſe Waters, in reſtoring weak ſtomachs, and enabling them to retain food, are, in all probability, owing to this part of their impregnation. To the diſſipation likewiſe of this volatile ſubſtance, may be aſcribed the ſmall effects which theſe waters produce when drank cold, or at a diſtance from the ſpring, compared with thoſe produced by them when freſh.

The common ſaline mixture, called, from its effects, *antiemetic*, affords a ſtriking analogy to the effects of Bath water, in this reſpect, as this was found to exert none of its antiemetic qualities, unleſs taken during the effervescence; and by the account given of it by Sir John Pringle, its * antiſeptic effects were much more obſervable when taken in this manner, than after that had ceaſed. For this reaſon that learned and judicious practitioner has

* This is likewiſe confirmed by Mr. Macbride's experiments.

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delivered an elegant formula, for the exhibition of this preparation in the act of effervescence, whereby its effects of this kind may be best preserved. The nature of this substance seems to have been little understood by most of the authors who have written on this subject; some supposing it to consist of "iron * minutely subtilized," whereas it is often found in large quantity in those waters that give not the least sign of their containing iron; witness those of Buxton, in Derbyshire; others calling it an ætherial spirit, with many vague and indeterminate appellations besides, to which no proper idea can be affixed. To give a farther account of this substance would exceed the limits of our work, and there is less necessity for an attempt of this kind, which must be infinitely inferior to one which the world is in daily expectation of, from the celebrated Dr. Black, Professor of Chemistry at Edinburgh. We may be assured, that the Bath water contains mephitic air in large proportion.

* Sutherland on Bath waters. P. 8. Ed. 2.

Review of the Experiments, and Deduction from them, concerning the Contents of the Bath Waters.

From a review of the above reaſoning and experiments, we find, that out of the ſubſtances which we mentioned as poſſible native impregnations of Mineral Waters, thoſe of Bath contain the following:

Table of the Contents of the Bath Waters.

I. Saline bodies.	Simple.—1. Vitr. acid per ſe. *Qu.?*
	Compound.—2. Common ſalt in ſmall quantity.
II. Inflammable bodies.	3. Hepar ſulph. cum calce vivâ, in large quantity.
III. Metallic bodies.	4. Iron, one-thirty-ſeventh and a half of a grain in a pint of the water.—Lucas.
	5. Lead. *Qu.?* if this is not an accidental impregnation.
V. Earthy bodies.	6. Selenites, in large quantity.
V. Aërial bodies.	7. Common air. *Qu.?*
	8. Mephitic air, in large quantity.

PART

PART IV.

Application of the Whole to the Purpoſes of Medicine.

WE now come to the laſt, and moſt important part of our Work, viz. the application of the foregoing to the purpoſes of Medicine.

And here we would not have it underſtood, that we mean to give a general account of the effects of the Waters on the human body, and of the ſeveral diſorders in which their uſe may be advantageous or prejudicial, with the ſeveral periods of each, at which they are to be recommended or forbidden, *&c.*

Such a work, which might not improperly be termed the more ſtrictly medical part of an eſſay of this kind, though

highly uſeful, can only be the reſult of long obſervation, and extenſive practice, and would, moreover, if properly performed, be much too voluminous to come within the limits of a book of this ſize. We, however, preſume to flatter ourſelves, that the method we have choſen, will not be deemed entirely uſeleſs to the publick, though formed in a much more contracted deſign than the former. We propoſe, then, the Experiments, before related, as the foundation of our plan, and hope to render them, and the deductions to be drawn from thence, of ſome ſervice to the practice of phyſic relative to the Waters. This ſeems to have been, and, indeed, we muſt own, not much to the honour of the Profeſſion, hitherto purely empirical, and a courſe of food and medicines has been preſcribed, with little alteration, for a long ſeries of years, to be taken with the Bath water, without any view to the chemical effect produced by their admixture, or what might be the conſequences of ſuch a combination. It will here, probably, be alledged, that experience is the beſt guide

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in ſuch caſes, and that the food and medicines, the propriety of whoſe uſe, in ſuch circumſtances, had ſtood the teſt of time, could never be properly diſproved by any theoretical reaſoning to the contrary. Had we our choice of one of theſe only for our guide in ſuch caſes, this would undoubtedly be true, as one good practical obſervation is of more advantage to ſcience than all the unſupported theory that the world ever produced. But is not Reaſon an excellent companion to Experience? Is not the latter of ſmall value, when deſtitute of the former to direct its applications? Is it not a duty which a Phyſician owes to the public, to ſearch diligently for amendments in his practice, and not reſt indolently ſatisfied with any peculiar method, ſo long as there is, as there always will be, a rational proſpect of improvement; and, when he is ſatisfied of this, it is his duty to embrace it, without any regard to the quarter from whence it may be derived. This, we hope, will plead in excuſe of this part of our Work, and of the directions here laid down, which we only

only mean to offer to the conſideration of, not impoſe them on the public, as certain rules to be indiſcriminately followed, as we own we have great doubts concerning ſeveral of the circumſtances mentioned. We hope, however, we have inſerted nothing wherein we have not, at leaſt, ſome degree of probability on our ſide. A work of this kind is certainly capable of great improvement; and the Author of the following ſheets is fully conſcious that he has proceeded but a very few ſteps, and that there is ſtill a large field for any ſucceeding writer to exerciſe his genius in. He hopes, however, it will plead in his favour, that no book he has yet ſeen, has been wrote profeſſedly with this view, and will think himſelf happy, if, by his means, any future Author may be induced to throw ſome farther light on this ſubject, hitherto ſo little conſidered.

We beg the Reader's pardon for this digreſſion, and ſhall now proceed to give the plan of the remaining part of our Work, which, as it is moſtly deduced from

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our Experiments, and chiefly regards the compoſition of the waters, and the changes produced on them in various circumſtances, may be ſaid, in oppoſition to that before-mentioned, to be wrote on a pharmaceutical plan.

We propoſe, then, to conſider as follows:

I. In what ſtate the Water poſſeſſes its medicinal qualities in the higheſt degree.

In what ſtate Bath Waters are in greateſt perfection.

When we conſider the nature of the ſubſtances with which the Bath water is impregnated, we ſhall have little doubt with regard to our determination of this queſtion. Out of the ſix ſubſtances that enter into its compoſition, one, and that perhaps the moſt important, viz. the mephitic air, is of ſo fugitive a nature, as to be in a great meaſure diſſipated, ſoon after its expoſure to the atmoſphere. The chalybeate one, likewiſe, whether from its peculiar nature or qualities belonging to it, or from its ſlightneſs, ſeems remarkably ſoon deſtroyed; the water ſcarce giving any ſigns of it, except

cept examined ſoon after its riſe. In all caſes, therefore, where the patient is able to bear them, and the effects of the water are wanted in their full extent, theſe are undoubtedly in greateſt perfection, when drank at the fountain head. Many caſes, however, may be ſuppoſed, in which, although the uſe of the waters, in ſome reſpects, may be adviſeable, yet the effects of the mephitic air may prove too violent a ſhock for a tender frame, eſpecially many female ones, to endure. In ſuch caſes, by ſuffering it to ſtand a few minutes after it has been drawn, this ſubſtance will be, in a great meaſure, diſſipated, and its ſtimulating qualities nearly deſtroyed, or, at leaſt, much abated. It is probable that the good effects produced by drinking theſe waters, in many ſcrophulous, leprous, and other cutaneous diſorders, do not depend ſo much on the volatile part of the impregnation, as that which is more fixed, viz. the combination of ſulphur with an earthy ſubſtance. As in caſes of this nature a conſiderable portion of the good effects of the waters depends on their being taken in

large

large quantity, often to the amount of ſeveral quarts in a day, ſhould theſe waters be drank freſh, in ſo large proportion, it might be productive of ſome troubleſome conſequences, by over-heating the body, *&c.* In ſuch caſes, therefore, it might be adviſeable not to drink the waters at the pump, but more at leiſure in private, and that not until their heat, on which their ſtimulus in ſome meaſure depends, was abated. Care, however, ſhould be taken, that it be not ſuffered to ſtand ſo long as to cauſe any precipitation, as this might be productive of the loſs of many of its valuable qualities *.

In all caſes, however, where the Bath waters are meant to act as reſtoratives†,

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* As the chalybeate impregnation in the Bath waters, would, by this management, be loſt; if it ſhould be thought proper to reſtore it, as it is ſometimes imagined to be of ſervice in diſorders of this kind, that may eaſily be performed by the addition of a few drops, two or three, for inſtance, of a ſaturated ſolution of green vitriol in water, to a pint of the Bath water.

† To thoſe to whom the Bath waters are preſcribed with this intent, and whoſe ſituations are ſuch as do

not

and, of conſequence, their ſtimulus, in ſome degree at leaſt, muſt be of ſervice, we would always adviſe them to be drank freſh at the ſpring, and to moderate their effects, if too powerful, rather by leſſening the quantity, than uſing them when deprived of ſome of their ſerviceable qualities. It is obſervable likewiſe of theſe waters, and, indeed, of all others that poſſeſs this impregnation, that their heating qualities are much leſs perceived, when the quantity to be taken is divided into a number of ſmall doſes, than when ſeveral of theſe are accumulated into one, even though the quantity taken in the former caſe ſhould, on the whole, exceed the latter. Thus one pint of the water drank at once, is found to have greater effects in raiſing the pulſe,

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not admit them to venture out, we would recommend a bottle with a ground glaſs ſtopple, (ſuch as we commonly ſee in Apothecaries ſhops,) for the conveyance of the water from the ſpring to their houſes, in place of thoſe now uſed, which are cloſed with a cork. Such a one might be eaſily fitted to one of the tin machines for carrying the water, and retaining its heat, commonly uſed.

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and heating the body, than three half pints drank at an hour's diſtance between each. In caſes therefore of the laſt mentioned kind, it ſhould ſeem adviſeable, to divide the quantity to be taken in a day into a number of ſmall doſes, to be taken at moderate intervals, by which means its ſtimulus would be leſs ſenſible, and, probably, more permanent.

What alterations are produced on the qualities of the waters by ſtanding.

The ſubject now before us naturally leads to another queſtion, viz. How theſe waters bear tranſportation? or, in other words, what alteration of their qualities is produced by ſtanding? In order to explain this more effectually, it will be neceſſary to make a ſhort recapitulation of the phœnomena that appear in theſe circumſtances.

It appears, by our experiments, that the Bath water, newly pumped, emits a large quantity of air bubbles, which are plentifully evolved from every part of it, and that this impregnation is ſo volatile, that it can ſcarcely be carried any diſtance, without

out loſing, in a great degree, that ſparkling appearance, and pungent taſte, ſo remarkable in it when freſh. Its chalybeate taſte and qualities are then much diminiſhed, and on remaining a little time expoſed to the air entirely ceaſe.

On cooling, the ſaline taſte, and that of the hep. ſulph. cum calce vivâ become much more remarkable, and, indeed, ſome alteration ſeems to take place in the laſt mentioned impregnation, as the water then gives a green tinge to the vegetable blues. If expoſed to the air it ſoon aſſumes a wheyiſh turbid appearance, and lets fall a light aſh-coloured precipitate, and the latter happens in ſome degree even in cloſe veſſels, though the change of colour is not ſo remarkable. From theſe appearances we are induced to believe, that the common opinion, that the Bath water loſes moſt of its valuable qualities on ſtanding, is not ill founded.

The fixed air and chalybeate impregnations are, undoubtedly, deſtroyed, and the hep. ſ. c. calce vivâ ſeems to undergo a de-

decompoſition of its parts. A circumſtance happens here that is far from being common in waters of this kind. Moſt of thoſe that contained fixed air along with a chalybeate impregnation, bear tranſportation very well, and when carefully cloſed up at the ſpring, may be carried to any diſtance, with ſcarce any diminution of their valuable qualities. The Bath waters, however, which contain both theſe impregnations, and the former of them in very large proportion, and although the bottles containing it be cloſed up with the greateſt accuracy, as ſoon as filled from the ſpring, on their being again opened, give very little marks of the chalybeate impregnation, and ſcarce any of the aërial one. This alteration ſeems remarkable, as we cannot ſuppoſe it poſſible for the fixed air to have eſcaped, eſpecially as we ſee it retained, in like circumſtances, in many other waters. The cauſe of this, however, ſeems as if it might be explained as follows.

All the preparations, by which ſulphur is rendered miſcible with water, both by means

means of an alcali and quick lime, are in ſome degree decompoſed on ſuch admixture, and the latter more eaſily than the former. As we have the utmoſt reaſon to believe, that the laſt mentioned combination makes a part of the impregnation of the Bath waters, it is probable that ſuch a decompoſition takes place here, the quick lime and the ſulphur ſeparating from one another. In that caſe the quick lime, whoſe ſtrong affinity with fixed air has been before taken notice of, being now at liberty, attracts that contained in the water, and is thus rendered inſoluble, and makes part of the precipitation obſerved to be formed in the Bath water on ſtanding.

This accounts for the ſparkling appearance, and pungent taſte not being obſerved on the bottles, containing the water, being again opened, as the mephitic air is then in a fixed ſtate, and ſtrongly united with the lime. By this it ſhould ſeem, that the Bath waters can ſerve very few uſeful purpoſes in medicine, when uſed at a diſtance from the ſpring, their impregnation

with

with fixed air being thus deſtroyed, and the chalybeate and ſulphureous ones nearly ſo. Some ſmall impregnation of the laſt mentioned kind may, indeed, remain, as even mild calcareous earths render ſulphur, in ſome degree, miſcible with water; but then this proportion of it is extremely ſmall.

We can therefore ſay very little in recommendation of their uſe at a diſtance from the ſpring, as they ſeem to be then little more than ſimple water impregnated with a large portion of ſelenites, and a ſmall one of common ſalt, which certainly are not impregnations likely to ſerve many uſeful purpoſes in medicine. Much has been ſaid, formerly, of the ſeaſons of the year at which they are in the higheſt perfection; but, by what we are able to judge, the virtues of the waters * remain the ſame

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* We deſire to have it here underſtood, that we do not mean to inſinuate, that every time of the year is equally proper for the drinking the waters. Experience ſhews the contrary. We only mean, that the qualities of the waters are not altered by theſe. How one

at all of theſe, as the origin of the ſprings probably lies too deep to be affected by rains, froſt, heat, or other changes of the atmoſphere.

How the Bath Water is altered in its qualities by admixture of other ſubſtances?

II. The next queſtion that occurs to our conſideration is, how the Bath Water is altered in its qualities, by admixture of other ſubſtances, which we may ſuppoſe to be taken along with it, in the way of medicine? And here we beg leave to repeat what we before ſaid, viz. that we do not intend to argue on the propriety or impropriety of preſcribing the following ſubſtances to be taken with the waters any otherwiſe, than as regards their pharmaceutical intention, as to the compound they may form with, and aſſiſt or defeat the effects of them.

Alkaline ſalts. Mild.

It appears by our Experiments, that fixed mild alkaline ſalts added to the Bath water, cauſed a

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one time of the year may ſuit the diſorders recommended to theſe waters, better than another, is a medical queſtion which we do not profeſs to enter upon.

total decompoſition of its parts, the calcareous earth ſeparating from the ſulphur, and the alkali uniting with it in its place; while the fixed air is abſorbed from the alkali by the cauſtic calcareous earth, which thus becomes mild and inſoluble in water, which is the cauſe of the white precipitation ſo obſervable on ſuch addition.

Cauſtic.

The like decompoſition happens with the cauſtic alkali, ſave that, this ſupplying no fixed air, the lime ſtill remains diſſolved in the water, and no precipitation is obſerved*. The ſame happens on addition of the vol. alkalies, though in a leſs degree.

Vol. alk. mild and cauſtic.

From their obſervation of this decompoſition, many writers have concluded,

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* It was before remarked, that if this Experiment be tried with the Bath water freſh at the ſpring head, ſome precipitation happens, which is probably occaſioned by the abſorption of the fixed air, (which is ſo largely contained in the Bath water freſh drawn) by the quick lime, ſet looſe from the ſulphur by the alkali.

that all ſubſtances of this kind were very improper additions to the Bath waters; and this remark is, undoubtedly, in general very juſt, as we can never expect the original effects of the waters, after the addition of a ſubſtance, which ſo highly alters the nature of their compoſition. By our Experiments it appears, that the aërial part of their impregnation is in a great meaſure deſtroyed by ſuch addition, being abſorbed by the earth.

In all caſes, therefore, where the reſtorative qualities of the waters are moſt deſired, in which this ſubſtance bears a principal part, this addition is by no means adviſeable. Perhaps the propriety of its uſe in other caſes, where this part of the impregnation ſeems not the moſt efficacious, may likewiſe be doubted, as the ſulphureous impregnation is altered by ſuch addition in its nature from an hepar ſulph. with quick lime, to a true hepar ſulphuris.

Notwithſtanding, however, theſe objections, the force of which we acknowledge, it is not yet improbable, that alkaline ſalts may,

may, in ſome caſes, prove an uſeful addition to the Bath waters.

Obſtinate coſtiveneſs is an effect of theirs much complained of, which frequently retards their good effects, and ſometimes diſappoints our hopes from them, by preventing their uſe. In conſequence of this, medicines of the purgative kind are frequently neceſſary. Theſe, however, agree often very indifferently with many weak ſtomachs and bowels, ſuch as make many of the caſes that ſeek relief from theſe waters. Could a medicine be found out, that would obviate this inconvenience of them, it would probably be of great ſervice in extending their uſe. It does not ſeem improbable, that fixed alkaline ſalts, added to the Bath waters, might ſupply our wants of this kind. The qualities of the true hepar ſulph. in keeping the body mildly open, without irritating the bowels, are well known, and their application ſeems well adapted to the removal of this troubleſome conſequence, ſo frequently attending the drinking of the waters.

If uſed occaſionally in ſmall quantities with them, it would probably act as a mild eccoprotic, without any neceſſity of confinement, or reſtraint of moderate exerciſe, both of which are ſo prejudicial to the generality of thoſe caſes, recommended to theſe waters for their cure. An addition of this kind likewiſe promiſes to be of ſervice on another account.

Among the many complaints that find benefit from theſe waters, thoſe of the bilious kind have not the leaſt ſhare.

It is obſerved of theſe diſorders, that when the ſecretion by the kidneys is encreaſed on drinking the waters, it is a favourable ſymptom, and in general prognoſticates, that the patient will receive benefit by them *. It frequently, however, happens, that they do not take this direction, and in ſuch caſes, unleſs they run off

* The ſame may be ſaid of leprous, and other cutaneous diſorders, in which the uſe of theſe waters is adviſed, as diuretic medicines are found in all of them of the greateſt ſervice.

by

by ſtool, or a plentiful diaphoreſis, they remain a long time as a dead weight on the ſtomach, impair and pall the appetite, and ſometimes aggravate the very diſorders they were intended to relieve. A ſubſtance, therefore, which would encourage the determination of the waters to paſs off by the urinary ſecretions, and at the ſame time keep the body mildly open, muſt needs be a valuable acquiſition. We are inclined to think the fixed alkali might be of ſervice in both theſe intentions, and humbly recommend the trial of it to the Faculty, as conducive to ſuch a purpoſe. Perhaps it might be moſt proper to make uſe of it with this intention in its cauſtic ſtate; but this will be beſt determined by experience.

Acids.

We mentioned in our Experiments, that the acids ſeemed to have no perceptible effect in altering the qualities of the Bath waters. In all caſes, therefore, where acids are proper, we do not find any thing in the compoſition of the waters that forbids their uſe. When

mixed with them, in form of an elixir, or dulcified ſpirit, a very grateful compound is produced, and this circumſtance may be of ſervice in reconciling the waters to the taſte of many, to whom, in their native form, they were very diſguſtful. On trial, the dulcified ſpirit of nitre ſeemed to form the moſt agreeable compound of any of the acid preparations with the waters. Poſſibly, likewiſe, theſe may be of uſe in encouraging the determination of the waters to paſs off by the kidneys.

As theſe organs, however, are differently affected in different people, by ſeveral ſubſtances, where this ſecretion is neceſſary to be encouraged, it may be of ſervice to make trial of acids and alkalies both in their turns, and, perhaps, even neutral ſalts, and to fix on ſuch as we find moſt efficacious to fulfil ſuch intention. It is probable, likewiſe, that in many caſes where the waters are found too heating, an addition of this kind would moderate this effect of them, and enable the patient to take them in larger quantity, without ex-

poſing

poſing himſelf to any inconvenience from that circumſtance.

Neutral ſalts.

Should the neutral ſalts be judged proper, they may any of them be taken with, or in the waters, without injuring their qualities in the leaſt, the volatile vitriolic acid being weaker in its attraction to alkalies than any of the other acids, therefore no decompoſition of the ſalt could happen. In ſome caſes, where any inconvenience happens from the heating qualities of the waters, an addition of ſome of the more cooling ones of this kind, ſuch as nitre, and regenerated tartar, might be of ſervice in obviating theſe effects of them. The coſtiveneſs, likewiſe, before mentioned to be a common conſequence of theſe waters, might be thus relieved, and their diuretic effects encouraged by theſe means. A judicious Phyſician will ſoon diſcern whether theſe, or the ſimple ſalts, as acids and alkalines, are moſt effectual in the ſeveral circumſtances.

Abſorbent earths.

Earths of this kind, in their mild ſtate, ſeem to produce little change on the qualities of the Bath waters, on being mixed with them. They may, indeed, perhaps, detain the volatile vitriolic acid, and haſten the precipitation of the ferrugineous particles, on which laſt account theſe ſubſtances muſt be always improper, where any dependence is laid on that part of the impregnation. If any addition of that kind ſhould, however, be thought neceſſary, we would adviſe the uſe of magneſia rather than any abſorbents of the calcareous kind, on account of its laxative qualities; whereas the calcareous ones rather tend to promote a coſtive habit, which is already but too frequent an attendant on thoſe who uſe the Bath waters. It is poſſible that the opening effects of magneſia might be increaſed, on its being mixed with the Bath water, as it might, in part, by its attraction of the volatile vitriolic acid contained in the water, be converted into a purgative earthy ſalt. We can ſcarce, however, think, that the quantity formed

formed in this manner could produce any great effect. As magneſia, however, by itſelf, poſſeſſes, in many habits, the quality of keeping the body mildly open, an addition of this kind might be often of ſervice to be uſed with this intention, which it might, in many habits, anſwer as well, or better than alkalines or neutral ſalts, eſpecially in thoſe where acids abound in the firſt paſſages. It ſeems not improbable, that, when we deſire to encreaſe the tendency of the waters to go off by the urinary ſecretions, that alkalines, or neutral ſalts, would be preferable to magneſia; but where keeping the body mildly open, and obviating acidities were the points aimed at, magneſia might be more efficacious.

Calcareous earths, in their cauſtic ſtate, ſeem very improper additions, on many accounts, to the Bath waters.

Lime water.

It appears by our Experiments, that a copious precipitation was generated in them when freſh, on addition of lime water, which was undoubtedly cauſed by the lime in the lime

water attracting the mephitic air from the Bath water, and thus becoming mild, and of courſe precipitated. From this we may judge, that in all caſes, where the mephitic air may be of ſervice, that lime water muſt be a very improper ſubſtance to be joined to it, as it abſorbs it inſtantly, and unites with it very ſtrongly. Lime water added to the Bath water freſh, ſeems to impart no additional qualities to it, except a diſagreeable empyreumatic taſte; the calcareous earth being ſeparated in an inſoluble form, and nothing remaining of it except the ungrateful flavour before-mentioned. In all caſes, therefore, where lime water may be preſcribed to be taken with a courſe of the Bath waters, we would recommend them to be taken with the greateſt poſſible interval between each.

Veg. aſtringents and bitters.

Vegetable aſtringents and bitter ſubſtances, are often preſcribed to be taken with, and frequently in the waters, as coinciding with their intention, and enabling the ſtomach the better to retain them. What are the effects of

of theſe ſubſtances in general, united with the Bath waters, conſidered as a compound, we muſt own to be rather ambiguous. The vegetable aſtringents, we know, precipitate all the ſolutions of iron from their acid menſtrua, which is the cauſe of that blackiſh or purple colour, produced on ſuch addition. This would ſeem to forbid their uſe with any water, where the chalybeate impregnation was depended on for any good effect.

This argument, nevertheleſs, however ſpecious, does not ſeem to be well founded, as the iron, although ſeparated from its menſtruum, is not precipitated to the bottom, but remains diffuſed through the body of the ſurrounding fluid, (as we ſee in ink) and might thus be received into the body along with the water. It is obſervable, that iron thus precipitated is very eaſily rediſſolved by all the acids *, even the vegetable, as we ſee by the eaſe with which ſpots of ink are

* Calces of iron, that precipitate ſpontaneouſly from chalybeate waters, are not ſo eaſily rediſſolved, as thoſe formed in this manner.

taken out of linen, &c. by juice of lemons, or vinegar. It is probable, therefore, that the acid of the ſtomach would ſoon reconvert the iron into a ſaline ſtate, and put it into a capacity of exerting its effects.

Some objections, however, remain againſt the uſe of theſe ſubſtances with the ſtronger chalybeates. The black colour, which they ſtrike, is by no means to be choſen for a medicine, where it can be avoided, as it renders it very unſightly, and diſguſtful to weak ſtomachs; and, what is ſtill more to be regarded, the taſte of the chalybeate is by no means improved by ſuch addition, becoming more nauſeouſly ſtyptic, as we may ſee by the difference of the taſte of ink, from a ſimple ſolution of green vitriol in water. This objection, however, does not hold againſt their uſe (if deemed proper) with waters ſo ſlightly chalybeate as thoſe of Bath. The taſte of theſe is not very obviouſly injured by a ſmall addition of this kind, and the colour being only changed to a light purple is not diſagreeable. This objection, however, although

though true in its full extent, affects only the ſimple aſtringents, or ſuch bitters as are combined with them.

Moſt of the woods, barks, fibrous roots, ſtalks, and rinds of fruits, ſome leaves, and the cortical part of ſeeds, poſſeſs ſome degree of aſtringency; whilſt, on the other hand, the pulps of ripe fruits, ſimple gums, eſſential and expreſſed oils, balſams, gum-reſins, and bulbous roots, are nearly diveſted of it. It is probable, therefore, that all the ſubſtances of the latter kind might be taken without the leaſt alteration of the qualities of the Bath water; and if the Phyſician ſhould deem any of the former to be proper, a few drops of the elixir of vitriol, no incongrous addition, would reſtore the tranſparency, and improve the taſte of the waters.

Metallic preparations.

Few of theſe, we believe, are often preſcribed to be taken at the ſame time with a courſe of the Bath waters. Nevertheleſs, as we have before mentioned ſome of the chalybeate kind as likely, in ſome circumſtances, to

prove

prove uſeful additions to them, and as caſes may occur, eſpecially in diſorders of the cutaneous kind, wherein the uſe of ſome of the antimonial, or mercurial preparations, may be adviſeable, it may not be entirely uſeleſs to conſider, what would probably be the conſequence of their admixture with the Bath waters.

Iron. In treating of this metal in a former part of our Work, it was remarked, that the Bath waters, poured on filings of iron, *diſſolved them plentifully. It ſhould ſeem, then, no improper method of adminiſtring this ſubſtance, to uſe it in this form, when we deſire to add ſtrength to the chalybeate impregnation. Were it thus taken immediately before drinking them, the ſolution of the metal might be performed in the ſtomach, and we might then rely, with more certainty, on the effects of the chalybeate. By this means, likewiſe, we might depend on the nature of the additional chalybeate impregnation being the ſame

* See Lucas on the Bath waters.

with

with that originally contained in the waters, which we could not do if the ſolutions of iron, in other menſtrua, were uſed for that purpoſe.

Perhaps it might here be objected, that, according to the principles we had before laid down, concerning the neceſſity of an intercourſe with the air, in order to the ſolution of this metal, no effects could be expected from it in this mode of exhibition; ſince this metal, as well as many other ſubſtances, is only active in a ſtate of ſolution, which could not be expected in theſe circumſtances, where all commerce with the air muſt neceſſarily be excluded. To this, however, it may be replied, that iron is very manifeſtly proved to be diſſolved in the ſtomach, by the effects conſequent on taking it in this form, which are produced by its being there reduced to a ſaline ſtate. Now the volatile vitriolic acid, eſpecially when dilute, is a more powerful ſolvent of iron than the acid of the ſtomach, which in ſtrength and qualities approaches nearly to the vegetable.

Another

Another reaſon, however, may, with more plauſibility be urged againſt this form of a chalybeate medicine. It is ſaid of iron, given in ſubſtance, that its effects are very uncertain, owing to its ſolution depending on the quantity of acid preſent in the ſtomach, which, as that is more or leſs, occaſions a larger or ſmaller proportion of the iron to be diſſolved, and renders the dependence we ſhould have on it, as a medicine, precarious, ſince its activity muſt be owing to a circumſtance, concerning which we are not able to judge with ſufficient certainty. Although this reaſon carries ſome weight with it, we cannot admit it to conclude ſatisfactorily againſt this form of adminiſtring this ſubſtance, either conſidered as a medicine by itſelf, or as added to increaſe the chalybeate qualities of the Bath waters. Of theſe we lately obſerved their power of diſſolving it, and we may, moreover, add, that thoſe to whom chalybeate medicines are, in general, of moſt ſervice, are ſuch as have a ſuperabundant acid predominant in their ſtomachs, and in theſe the chalybeate ſeldom fails of its

its effect, when given in its metallic ſtate. By this means, likewiſe, its effects might be proportioned by nature, in ſome meaſure, according to the exigency of the caſe; as thoſe ſtomachs which were moſt diſpoſed to generate acid, which are generally the moſt languid, and in greateſt need of a ſtimulus, would diſſolve it moſt plentifully, and, of conſequence, be moſt ſtrongly acted on. Conſidered ſimply as a medicine by itſelf, we are induced to think this form preferable to many of the compound preparations, at leaſt in ſome caſes, ſince the metal thus acts as an abſorbent of the acidity, which would not have been the caſe, had it been given previouſly united with an acid, as its effects would then have been ſimply aſtringent and ſtimulant. We mentioned before, that the mephitic air was probably a ſource of ſome of the good qualities of the Bath Waters. It is poſſible, then, that ſome advantage may occur in this mode of exhibition, from the generation of that ſubſtance in the ſtomach during the diſſolution of the iron, when it is always copiouſly produced. It may not, there-

therefore, be, on the whole, unreaſonable to ſuppoſe, that in thoſe caſes where chalybeates are proper, in which we are tolerably certain of the preſence of an acid in the ſtomach, that this form may be preferable; but where that is doubtful, as in many ſcorbutic and cutaneous complaints, that it would be more eligible to uſe it previouſly combined with an acid, as in ſome of the compound preparations.

As to the compound preparations of this metal, that moſt commonly uſed, viz. the ſal martis, might probably be employed with advantage for that purpoſe, as being ſufficiently concentrated, tolerably certain in its effects, capable of being reduced to a ſtandard, and not liable to be decompoſed by any ſubſtance contained in the Bath waters. The ſame may be ſaid of the ſolution of iron in the muriatic and vegetable acids as in the caſe of the tinct. mart. cum ſp. ſalis, and the mars ſolubilis ſeu chalybs tartarizatus. Perhaps, however, the ſal martis may be thought preferable to any of theſe, as being leſs liable

to

to uncertainty in point of ſaturation, ſince we have it in a cryſtallized form. One inconvenience, however, it is liable to, which is, that when uſed in a liquid form, as diſſolved in water, the iron is apt to ſeparate on ſtanding, which renders the doſe uncertain. The tinct. mart. cum ſp. ſalis is not liable to this inconvenience, and on that account would be more eligible. As to the preparations of iron with an alkali, and with a neutral ſalt, as in the mars ſolub. alcalizatus, and the flores martiales, their uſe would be leſs adviſable, as being more liable to decompoſition.

We find, by our Experiments, that on addition of an alkaline ſalt to the waters, a conſiderable change was induced on their qualities. This would probably happen were the mars ſolub. alcaliz. uſed, the iron would be precipitated, and that too, probably, in a form not eaſy to be rediſſolved. With regard to the flores martiales, in which the iron is united with ſal ammoniac, we are inclined to think that their effect would not be ſo certain, as the neutral ſalts

are

are at beſt but incompleat ſolvents of iron, and would in that caſe only ſerve to increaſe the bulk, without imparting any valuable qualities to the medicine. On the whole, the pure filings per ſe, a ſol. of ſal. mart. in water, or the tinct. mart. in ſp. ſalis, ſeem preferable to any of the other preparations to be uſed, in order to increaſe the chalybeate qualities of the Bath waters.

Antimony. How the effects of this metal on the human body would be altered by an admixture with the Bath waters, is a queſtion not eaſy to determine, and can only be known by a long attention to the conſequences produced by it in theſe circumſtances, under all its ſeveral forms. We will venture, however, to make a few obſervations on this ſubject, (which we offer only as hints) deduced from chemiſtry, and we own are not ſo perfect as we could wiſh, as the chemical hiſtory of antimony is very incomplete.

This ſubſtance, in its crude ſtate, would probably not be affected by admixture with the Bath waters. Alkaline ſalts, indeed, and

even

even calcareous earths, in their cauſtic ſtate, as lime water, act upon it by forming a hepar ſulph. with the ſulphur contained in it, by which its activity is increaſed. Whether this is done by the alk. or lime, forming with the ſulphur a compound capable of diſſolving the antimony, or by abſtracting part of the ſulphur, which rendered it inert, is a curious queſtion. Did theſe waters contain an alkaline ſalt uncombined with any other ſubſtance, or a calcareous earth ſeparate in its cauſtic ſtate, they might then affect the qualities of the crude antimony; but as here the calcareous earth is already ſaturated with ſulphur, no ſuch change of them would probably occur. The vitriolic acid likewiſe, which we mentioned before, as contained in the waters, does not affect antimony combined with ſulphur.

As to antimony, in form of regulus or glaſs, theſe are very ſeldom uſed *per ſe* in a ſolid form, except in the caſe of the vitrum antimonii ceratum, which would be probably not acted on by the Bath waters, as the antimony would be protected by its union with the wax.

As

As to the compound preparations of this metal, the ſaline combinations of it with the *vitriolic and †nitrous acids are nearly inert, and that with the muriatic too ſtimulant for internal uſe. The ſolutions of it, therefore, in the vegetable acid, are moſt commonly uſed, as the tartarum emeticum, and vinum antimoniale. How theſe would be affected by the Bath water would be a curious medical, as well as chemical queſtion. The hep. ſulph. cum calce vivâ, as we before obſerved, is not decompoſed by any of the acids ſingly, but when theſe are combined with a metal, as in this caſe a double elective attraction ‡ might take place, as in the following ſcheme:

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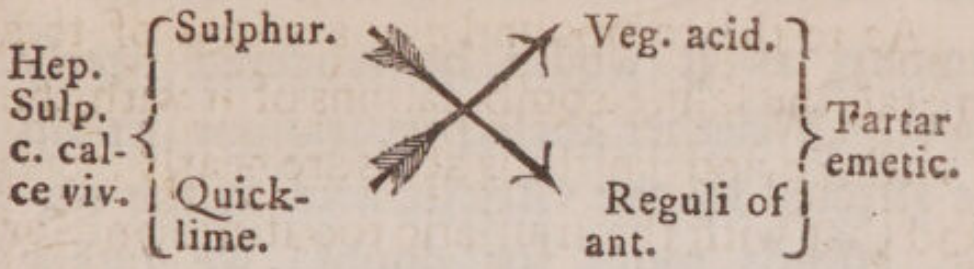
* Antimonium vitriolatum. WERLHOFF.

† Bezoardium minerale. Bez. Joviale.

From this character of the combination of antimony with the vitriolic acid, we may conclude, that if any portion of the reguline, or other preparations of antimony be diſſolved, or corroded by the vitriolic acid in the waters, its activity would, by that means, be rather diminiſhed than increaſed.

‡ Dr. Lucas does not ſeem to have thoroughly underſtood the nature of double elective attractions, when, from a notion of the ſtrong attraction ſubſiſting between the fixed alkali and the vitriolic acid, he



If this ſhould happen, we might be diſappointed in our expectations from the an-

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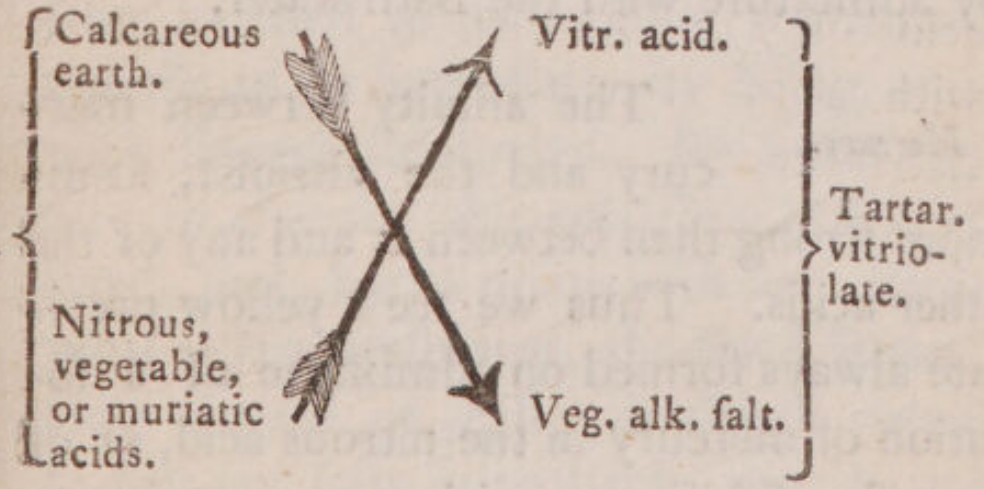
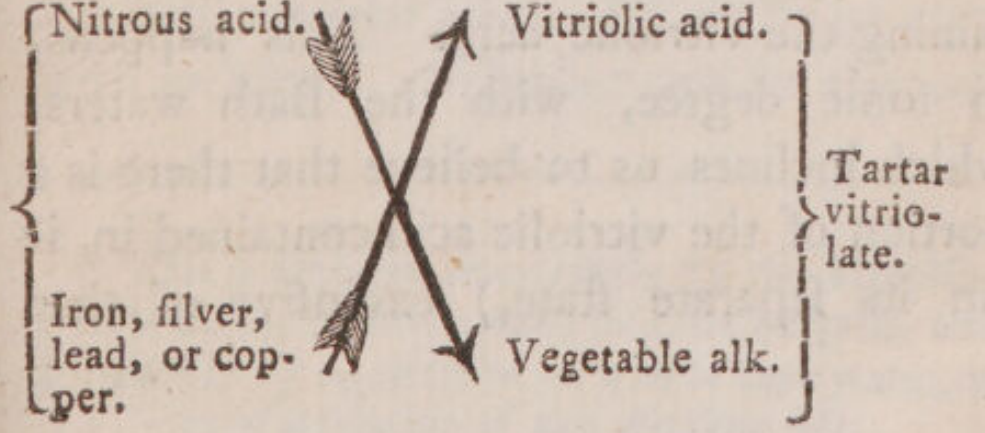
he aſſerted this ſalt could not be decompoſed by any other means than by adding the phlogiſton. Vitriolate tart. may be decompoſed by a ſolution of calcareous earths, or metals, in any of the other acids, as in the following ſchemes.





timony,

timony, as it would be rendered nearly inert. Whether theſe preparations would be affected by the vitriolic acid in the water, affords room for doubt; we rather think not, as the vitriolic acid is in its volatile ſtate, in which, its attraction to antimony ſeems inferior to the vegetable acid. As to the combinations of antimony with hep. ſulph. as in the ſulph. auratum antimonii precipitat. it does not ſeem probable that their qualities would be altered by admixture with the Bath water.

Mercury. The affinity between mercury and the vitriolic, ſeems more ſtrong than between it and any of the other acids. Thus we ſee a yellow precitate always formed on admixture of a ſolution of mercury in the nitrous acid, or of corroſive ſublimate, with any water containing the vitriolic acid. This happens, in ſome degree, with the Bath waters, which inclines us to believe that there is a portion of the vitriolic acid contained in it (in its ſeparate ſtate,) excluſive of that which

which holds the iron diſſolved *. It might be here objected, that we have before repreſented the volatile vitriolic acid as leſs ſtrong in its attraction to other ſubſtances, than any of the other acids, and, conſequently, could not decompoſe any ſubſtance, of whoſe compoſition they made a part; and this ſeems true with reſpect to alkaline ſalts, and, perhaps, ſome other ſubſtances, but does not hold univerſally. The vitriolic acid is found to be changed from its fixed to its volatile, and from its volatile to its fixed ſtate, by being united with ſeveral ſubſtances. By mere expoſure to the air, the volatile acid becomes fixed, and, by its union with iron, and ſeveral other ſubſtances, the fixed ſeems, in ſome degree at leaſt, rendered volatile. It does not ſeem improbable, that the volatile acid may be rendered fixed by its union with mercury. Whether this be the caſe,

* This is rendered more likely by the blackiſh or purple colour it ſtrikes with ſolution of galls, being heightened by an addition of a little lime water, or a few drops of a ſolution of any alkaline ſalt.

or that its attraction to that ſubſtance be nearly as ſtrong in its volatile, as its fixed form, we cannot determine with certainty. If this be true, many of the mercurial preparations, eſpecially the more active ones, muſt be altered in their nature, on admixture with the Bath water, and changed into a merc. emetic flavus, or turpethum minerale. We are not able to diſcover if any decompoſition of the ſulphureous impregnation of the water happens, which we might ſuppoſe poſſible, in the ſame manner as we before mentioned of antimony in like circumſtances *. We are, however, inclined to believe this not to be the caſe, as the precipitation would then probably have been of a darker colour. Theſe facts would lead us to think, that we could not depend, with any degree of certainty, on the effects of any preparation of mercury,

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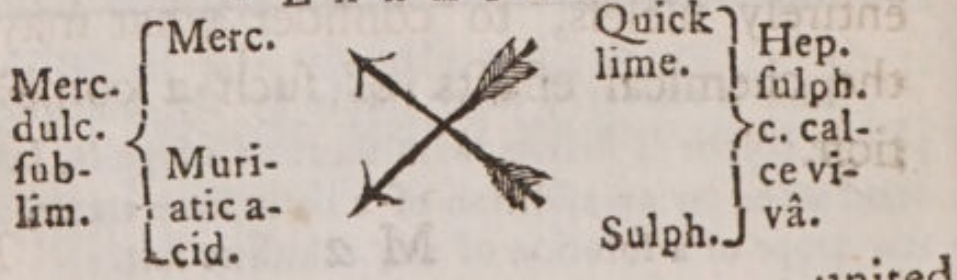
* EXAMPLE.



united

united with an acid, except its combination with the vitriolic, if taken in or at the ſame time with the Bath waters. It would therefore ſeem adviſeable to omit the uſe of the Bath waters, during the time of taking the mercurial preparations commonly exhibited. Perhaps, however, if they were united with ſome of the gum-reſinous ſubſtances, as is ſometimes practiſed, they might be defended from the action of any of the ſubſtances contained in the Bath water, and their effects thus ſecured.

We beg leave, however, here to repeat again, what we formerly ſaid, that we offer theſe things only as conjectures, that, we think, bear ſome appearance of probability.

Milk.

As the compound formed by admixture of milk with the Bath waters, is frequently preſcribed to be taken in the way of medicine, it will not be entirely uſeleſs, to conſider what may be the chemical effects of ſuch a combination.

The Bath water, in the proportion of equal quantities, produces with milk heated to the boiling point, a ſeparation of its parts, the cheeſy part dividing from the ſerous, in form of a looſely cohering curd. In theſe proportions, however, the ſeparation is by no means perfect; but when made with two parts of Bath water to one of milk, the curd is then ſeparated nearly completely. The whey, thus made, has little peculiarity of taſte, and, indeed, in moſt of its qualities, by what we can learn, differs little from common whey, made with an acid ſubſtance, and diluted with water. By the time and apparatus neceſſary for the making it, the aërial impregnation is entirely diſſipated, and it is not improbable that the ſulphureous one may be decompoſed by ſuch addition, as the whey, thus made, poſſeſſes very little, if any, of the peculiar taſte which the Bath water acquires on ſtanding. On the whole, this compoſition, however ſpecious, appears to us to be a very incongruous one, for the reaſons above mentioned; and the common pretence alledged in defence of it,

that

that of reconciling the ſtomachs and palates of many to the Bath Water, who would not, elſe, be able to bear it, ſeems by no means ſufficient to juſtify its uſe. Moſt of thoſe who come to Bath for ſtomach complaints, receive the greateſt benefit from that part of the impregnation, which, by this means, is entirely diſſipated, not to mention that the bulk of the doſe is thus increaſed one third part, which is a matter of great conſequence in ſuch caſes. In theſe circumſtances, therefore, if the Bath waters give diſguſt, or are with difficulty retained on the ſtomach, it would be more adviſeable to reconcile their uſe by ſome grateful aromatic addition, and by leſſening the doſes of it, than by uſing it when its qualities are impaired, and its bulk conſiderably augmented. If whey, however, be deemed a neceſſary addition, we would adviſe a proportionable quantity of freſh whey already made, to be added to the water freſh drawn, and to be immediately drank, by which means the qualities of the waters will be little injured. We are, indeed, of opinion ourſelves, that whey drank at the

ſame time with a courſe of the waters, eſpecially in the ſpring ſeaſon, might often, in many complaints, eſpecially thoſe uſually called ſcorbutic, be a very proper preſcript, as contributing to obviate the coſtive habit, and heating effects, which theſe waters ſo frequently occaſion. We cannot, however, ſee any neceſſity for mixing it with the waters, as its good effects would be equally powerful if taken at ſome interval. On the whole, we are inclined to believe, that this remarkable effect of the water on milk, has contributed much to recommend the product of ſuch a combination as a medicine, as impoſing, by a kind of juggler's contrivance, on the underſtandings of many, and perſuading them to believe, that ſo remarkable a production muſt have ſome very uncommon virtues. To ſum up all; this preparation ſeems incongruous to the general intentions wherewith the Bath water is preſcribed, and not qualified to anſwer any purpoſe which might not as effectually be done by other means.

We

Whether an artificial Bath water be practicable, &c.

We now come to the third and laſt queſtion which we propoſe to conſider, which is, Whether an artificial Bath water be practicable to be made? what preparation approaches neareſt to it? and to what purpoſes it may be applicable in medicine? In order to determine this queſtion properly, it will be neceſſary to conſider it ſeparately under its ſeveral heads, as here divided.

As to the firſt of theſe, viz. Whether an artificial Bath water be practicable? from a review of its contents, we might be, at firſt ſight, tempted to pronounce this to be far from a difficult operation. As to thoſe parts of its impregnation which ſeem moſt efficacious, viz. the ſulphureous, the chalybeate, and the aërial one, the firſt of theſe has been proved, by our Experiments, to be very eaſily performed; and the two latter, according to the experiment before cited from Dr. Lewis, mentioned in Neuman's Chemiſtry*, appear to be equally ſo.

* Page 176.

By forming, therefore, a combination of ſulphur with water, by means of quick lime, and adding this compound (previouſly filtred) to a portion of green vitriol and quick lime, (which laſt equally decompoſes the vitriol, as well as the alkaline he recommends,) in the manner he mentions, we might expect to ſee formed a water poſſeſſed of ſulphureous, chalybeate, and aërial impregnations, in the ſame manner with the Bath waters; capable of being made to any degree of ſtrength, and wanting nothing material except the heat, which might eaſily, by immerſing bottles of it in boiling water, be imparted to it.

Notwithſtanding, however, the ſpeciouſneſs of this reaſoning, we are inclined to believe, that a compound thus formed, though it might be applicable to ſome uſeful purpoſes, and in many caſes, perhaps, worth the trial, when the freſh Bath water cannot be procured, would prove much inferior, on many accounts, to the Bath waters themſelves. Artificial preparations of this kind muſt labour under ſeveral diſadvantages. Firſt, The proportions

tions of the ſeveral ingredients of which the Bath water is compoſed, ſeem very happily adjuſted to form a compound almoſt univerſally agreeable to the ſtomachs and palates of mankind, and, probably, on this, no ſmall ſhare of their medicinal efficacy depends.

Theſe proportions are unknown to us, and, indeed, almoſt impoſſible to be either aſcertained in the original, or exactly adjuſted in any artificial imitation of them. According, however, to the method by which we might expect to imitate them, the chalybeate impregnation muſt be vaſtly ſtronger in proportion to the other parts of its compoſition, than in the Bath waters themſelves, in order to produce an equal quantity of mephitic air. This would render the taſte diſagreeably aſtringent, and in all probability diſguſtful to weak ſtomachs, which can ill bear a ſtrong chalybeate.

On ſuppoſition, however, that the aërial impregnation might be mechanically performed, which, it is ſaid, may now be

done, and that then we might add the chalybeate impregnation in what proportion we thought proper, another difficulty, however, ſtill remains. Calcareous earths poſſeſs the quality of rendering ſulphur miſcible with water, only in their cauſtic ſtate, or when deprived of their fixed air. The only method we have of performing this applicable to practice, is by calcination. This, however, whether from any remains of ſome inflammable * ſubſtance united with the earth, or from ſome other cauſe, is not yet determined, never fails of imparting a ſtrong empyreumatic taſte to the water with which it is mixed.

A great chemiſt, however, is of opinion, that this is not the only method by which calcareous earths may be deprived of their air, and rendered miſcible with water; ſince we find it in large quantities

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* This ſeems not unlikely, as the lime made from ſhells, which we might ſuppoſe to have ſome animal inflammable ſubſtances adhering to them, is found to impart a ſtronger empyreumatic taſte to water, than the lime made from ſtones.

diſſolved

diſſolved in many ſprings, which poſſeſs none of the empyreumatic taſte, ſo diſtinguiſhable in lime water. How this may be performed has hitherto eluded our ſearch, and may, poſſibly, continue to be reckoned among thoſe wonderful phœnomena of Nature, for which we are not able to account by any viſible means. The chemiſts, however, are of opinion, that this may be performed by ſeveral methods; and to the difference of manner in which the earth is deprived of its air, they attribute the different taſtes which theſe waters are obſerved to poſſeſs.

That there is a juſt foundation for theſe ſuppoſitions, appears from the Bath waters, which, although they contain manifeſtly a calcareous earth in a cauſtic ſtate, united with the ſulphur, have nothing of the empyreumatic taſte of the compound, which, in other reſpects, reſembles it. Many of the petrifying waters, likewiſe, which contain calcareous earth in large quantity, which they ſoon depoſit when expoſed to the air, in the ſame manner

with lime water, are wholly diveſted of the empyreumatic flavour belonging to that ſubſtance.

Theſe reaſons, in our opinion, weigh very ſtrongly againſt the probability of entire ſucceſs from an attempt of this kind. Nevertheleſs ſuch trials may not be without their uſe.

The Bath waters, as was before obſerved, loſe many of their valuable properties on ſtanding; could any preparation, therefore, be invented, which might in any ways reſemble them in their effects, ſome deficiency, in point of agreeableneſs, might be complied with. It is not impoſſible, that, by repeated trials, the proportion of the ingredients might be ſo adjuſted, as to form a compound not very diſagreeable to the taſte. If this could be effectually performed, it might be of great ſervice to many, whoſe ſtate of health, or circumſtances in life, do not allow them to take ſo long a journey, as this place muſt neceſſarily be from many parts of the kingdom. How it may be beſt done we ſhall next conſider.

We

We now come to the ſecond diviſion of our queſtion, which is, What preparation approaches neareſt to the Bath water in taſte and qualities? For the reaſons above given, we muſt not expect any very exact imitation of them, eſpecially in the firſt of theſe articles, but the preparation, which ſeemed on the whole moſt to reſemble them, was as follows:

What preparation approaches neareſt to Bath water, &c.

Let ʒij. of waſhed flowers of ſulphur be ground with ℥ſs. of quick lime; during the trituration, add gradually ℔ij. of pure rain, or diſtilled water; ſtrain it off. Take then a ſtrong glaſs, or ſtone bottle, of a quart contents, put into it ʒſs. of green vitriol, and ʒij. of quick lime*, (freſh burnt;) pour on it the forementioned liquor, and cork it cloſe up immediately. This preparation will keep, cloſe corked, three

* Lime made from lime ſtone is preferable to that made from ſhells, as the latter is obſerved to give more of an empyreumatic taſte. As, however, they both poſſeſs it in ſome degree, it ſeems to give ſome foundation for the ſuppoſition, that all lime ſtone were originally formed from the exuviæ of animals.

or

or four days, without any remarkable ſeparation of its parts.

When wanted for uſe, ℥ij. of it may be added to ℥vj. of common rain, or diſtilled water previouſly heated rather above the degree of the Bath water, and drank immediately.

This compoſition, thus diluted and heated, reſembles, in ſome meaſure, the Bath water, though we own it to be very deficient in point of agreeableneſs of taſte. The proportion of the ingredients that form this compoſition to one another, and to the fluid with which they are united, is not eaſy to be aſcertained, as we know not in what quantity the hep. ſulph. c. calce vivâ is miſcible with water, and as to the fixed air, that is ſtill leſs determinate. The proportion of the iron, however, in ℥viij. of the preparation, is ſomething leſs than two grains of the green vitriol, to ℥viij. of the fluid, and as each grain of this is ſuppoſed to contain one-third of a grain only of iron, ℥viij. of this mixture contains two-thirds of a grain of iron, which, though

though no great quantity, is yet vaſtly ſtronger than the Bath waters, which, although their taſte is evidently chalybeate, do not contain above one thirty-ſeventh of a grain in ℥xvj. of the water. The proportion, therefore, between the artificial preparation, and the native Bath waters, as to ſtrength of chalybeate, is nearly as forty-nine and a half, to one, omitting fractions, which is a very great diſproportion.

To what purpoſe the artificial Bath water may be applicable in medicine.

We now come to the laſt and moſt important diviſion of the queſtion, viz. To what purpoſe the artificial compoſition we lately mentioned may be applicable in medicine? It would much exceed the limits of a work of this kind, and, moreover, require a great degree of practical experience in the effects produced by it, which we do not pretend do, in order to determine this queſtion fully. For theſe reaſons, we ſhall not enter into particular circumſtances, but only give a few general hints, drawn from analogy, chiefly relative

relative to thoſe kinds of diſorders in which it is likely to be of ſervice, or not, in ſupplying the place of the Bath waters.

As no fair trial has been yet made of it in practice, our reaſoning on its effects can be only theoretical: As we have, however, great reaſon to believe, that it reſembles the Bath water in moſt of the material articles in its compoſition, it will ſcarce be thought unreaſonable, if we attribute ſome degree, at leaſt, of the ſame effects to it. As we do not, however, pretend to alledge that it poſſeſſes the qualities of the Bath water entire, it will properly come under our conſideration, to enquire how far this variation may influence its effects.

The principal differences between the artificial preparation, and the native Bath water, ſeem to be, that in the firſt, the taſte (for the reaſons before mentioned) is leſs agreeable, and the chalybeate impregnation ſtronger. As to the proportion of fixt air, which they reſpectively contain, it is not eaſy to determine; there is, however, ſufficient proof, that it enters

into

into the compoſition of each in large quantity: The Bath water, indeed, contains beſides a portion of ſelenites, and a ſmall quantity of common ſalt, neither of which form any part of the compoſition of our imitation of it. If it ſhould be thought proper to make the reſemblance more exact, a few grains of each of the laſt-mentioned ſubſtances may eaſily be added. From the inactivity of the former, and ſmall proportion of * both theſe ingredients, we cannot, however, think ſuch a nicety at all requiſite, or that the Bath waters themſelves would be in the leaſt injured in their medical virtues, ſhould they be deprived of theſe parts of their impregnation. Although we cannot think this difference of any great conſequence,

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* In the table of contents of the Bath waters, it was there ſaid, that it contained ſelenites in large quantity. This, however, is only to be underſtood of its proportion of ſaturation, in compariſon with other ſaline bodies, it being ſcarcely perceptibly ſoluble. The real quantity contained in them is extremely ſmall, in proportion to their reſpective bulks.

yet

yet the firſt we mentioned, viz. that of taſte, is a very material one, and which muſt greatly enhance the value of the Bath waters, above every imitation of them that is deficient in this article.

This circumſtance would prevent its coming into uſe among a conſiderable part of the caſes recommended to theſe waters for relief. Great numbers of theſe conſiſt of ſuch as have injured their health by too free a courſe of life: Of theſe, the ſtomachs in general are very delicate and tender, and ſuch as, being accuſtomed to great indulgence, we can ſcarce expect can be brought to ſubmit to make a proper trial of a remedy, whoſe good effects muſt of neceſſity be ſlow, and often not ſufficiently evident to compenſate for the diſagreeable circumſtance of taking a medicine of an ungrateful flavour, whoſe doſe muſt be large, frequently repeated, and continued for a length of time, before any conſiderable benefit can be expected from it. Of theſe we could have little ſecurity in their perſiſting in the uſe of it

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a ſufficient time to make a proper trial of its effects; and even if any ſhould have ſufficient reſolution to attempt it, it is probable that the diſguſt it might occaſion, would either prevent its being retained on the ſtomach, or ſo influence its effects, as to diſappoint our hopes. It is a common obſervation of medicines that are given with the intent of ſtrengthening the ſtomach, and powers of digeſtion, that, unleſs they can be made tolerable to the taſte, little good is to be expected from them.

The chalybeate impregnation likewiſe, though in general well adapted to the cure of theſe complaints, would here, probably, on ſeveral accounts, be too ſtrong to be ventured on, at firſt eſpecially, as being then ſo apt to give diſguſt to weak ſtomachs, and as the irritation occaſioned by it might prove too violent a ſhock in many of the caſes recommended to theſe waters, which are often themſelves, when freſh drawn, too heating, and would, probably, be much more ſo did they contain ſo large a proportion of the chaly-

beate

beate as is neceſſary to form the artificial one. Some degree of ſtimulus is generally of great ſervice, but an exceſs in this point, eſpecially in many female complaints, may be of dangerous conſequence. The firſt of theſe reaſons would ſeem likely to diſappoint our hopes, in all caſes where the ſtomach was, in any conſiderable degree, primarily or ſecondarily the ſeat of the complaint, as in many bilious and gouty caſes the nephritic colic, indigeſtions, retchings to vomit, *&c.* ſuch as females are peculiarly liable to, and other weakneſſes of the alimentary canal, in all which the native Bath water is of great ſervice. The large proportion of chalybeate, likewiſe, in the artificial Bath water, would render a trial of it improper in all caſes where there was any degree of a feveriſh tendency, although on other accounts it might be likely to be of ſervice, as it would moſt probably aggravate theſe complaints. This would forbid its uſe in many rheumatic caſes of the acute kind, which often find great benefit from the Bath waters.

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Notwithſtanding, however, theſe diſadvantages, we are ſtill inclined to believe, that there may ſome caſes occur wherein the aforementioned preparation may form an uſeful ſubſtitute to them. Many complaints in which the ſtomach is little (at leaſt obviouſly affected, ſuch as leproſies, ſcrophulous diſorders, ſcorbutic eruptions, and, in general, cutaneous diſorders unattended with fever, ſeem particularly adapted to a trial of this kind. The ſulphureous and chalybeate impregnations ſeem here to be of great ſervice, as is proved by analogy of the good effects of theſe ſubſtances when given in the way of medicine in theſe diſorders; and it is not improbable to ſuppoſe, that, from theſe parts of their compoſition, the Bath waters have gained a great part of the reputation they ſo juſtly merit in the cure of theſe complaints.

As, however, both the chalybeate and ſulphureous impregnations may be taken in ſubſtance in much larger proportion than can be contained in any quantity of the Bath waters that we can ſuppoſe to be taken

taken in a moderate ſpace of time, it would, probably, be of great ſervice could a method be invented of adapting the ſtrength of the medicine to the circumſtances of the patient, without increaſing the bulk of the doſe.

The artificial preparation above mentioned, ſeems likely to fulfil this intention, as it may be diluted to any degree, in the manner above-mentioned, without the leaſt injury to its qualities. Although we excepted bilious caſes out of the number of thoſe in which our artificial preparation was likely to be of ſervice, we deſire to be underſtood to mean thoſe only in which the ſtomach is ſo affected in conſequence, as to make it doubtful if it would be retained. On the contrary, it ſeems likely to ſuit many complaints of the liver kind, eſpecially obſtructions of that viſcus, (always excepting thoſe attended with any degree of fever, in all which its uſe would be highly improper,) eſpecially as it is poſſeſſed of a quality, the want of which ſometimes prevents the uſe of the Bath waters, that

that of keeping the body mildly open, a circumſtance of the utmoſt conſequence in theſe complaints. From obſervation of this quality, we ſhould imagine it likely to be of ſervice in many colicky diſorders, particularly the *Colica Pictonum*, for the cure of which the Bath waters are ſo remarkable. If it ſhould be found efficacious here, it would be a diſcovery of great importance, as this diſeaſe is chiefly confined to the lower rank of people, artificers eſpecially, whoſe circumſtances and employment would not permit them to make uſe of the waters themſelves. Whether or no it would anſwer, we do not pretend to determine. Where, however, an opportunity of uſing the Bath waters cannot be had, we ſhould, from analogy of its contents, and eſpecially from the laſt-mentioned effect of it, recommend a trial to be made.

In caſes, likewiſe, where the aſtringent and corroborant effects of the Bath water are required, as in many female weakneſſes, barrenneſs ariſing from this cauſe, and other

other complaints of this kind, we ſhould think this preparation likely to be of ſervice, as the chalybeate impregnation, which is in theſe caſes of great efficacy, is much ſtronger than in the Bath waters themſelves, and may be increaſed at pleaſure. The eccoprotic effects of the ſulphureous impregnation likewiſe, ſeem exceedingly well adapted to obviate the heating effects of the chalybeate, and allow its uſe in larger quantity than otherwiſe it would be prudent to venture on. In chronic rheumatiſms, likewiſe, where there is none, or but ſmall degree of feveriſh diatheſis, this medicine ſeems likely to ſupply the place of the Bath waters with good ſucceſs, as chalybeate waters are found, in many ſtages of it, of remarkable efficacy; and the quality of this, lately mentioned, which is contrary to the generality of the native waters of this kind, would much encourage our expectations from it. The Bath waters have ſometimes been found of great uſe in calculous, nephritic complaints. From analogy of its contents, and more eſpecially from its poſſeſſing the laſt mentioned quality,

lity, we ſhould be inclined to think our imitation not unlikely, in ſome meaſure, to ſupply the want of it in theſe caſes. Aſtringents have, of late years, been found particularly ſerviceable in this diſorder, and this quality our artificial compoſition poſſeſſes in a high degree, which may be ſtill farther increaſed, at the ſame time that its heating effects are not ſo remarkable, on account of its laxative qualities. By this, however, we only mean, ſuch caſes as have no marks of a conſiderable calculus being already formed, and are not attended with any ſigns of fever, or inflammation of the part, as in both, or either of theſe caſes, the native Bath water, and our imitation of it, would be equally improper. In all caſes, likewiſe, where the ſtomach is drawn into conſent during the nephritic proxyſm, and retchings to vomit, nauſea, &c. are the conſequent ſymptoms attending it, the uſe of our preparation would be by no means likely to ſucceed, as it is at beſt but diſagreeable in taſte, and, at ſuch a ſeaſon, would probably ſerve only to aggravate the

ſymptoms before mentioned, which we ought, by all means, to attempt to alleviate. Moreover, as theſe circumſtances are generally attended with ſome degree of fever, the ſtimulus of the ſtrong chalybeate would then be highly improper.

The caſes that ſeem beſt ſuited to a trial of this kind, and indeed to the Bath waters themſelves, ſeem to be of thoſe who are ſubject at times to ſlight gravelly complaints, yet without any reaſon to think a calculus is really formed. If uſed in the intervals of theſe paroxyſms, it may be of ſervice, acting as a gentle ſtimulus to the organs of ſecretion, and promoting the urinary as well as abdominal diſcharges. By theſe means the gravelly concretions might be either prevented, (as they ſeem ſometimes owing to too long a ſtay of the urine in the body, as we ſee thoſe moſt liable to it, who, from neceſſity or any other cauſe, have been accuſtomed to retain

their

their water a long time,) or at leaſt diſcharged as ſoon as formed. In diſorders wherein the ſtimulating qualities of the Bath waters ſeem to be moſt efficacious, as in paralytic complaints, it is not eaſy to determine how far our artificial preparation would be qualified to ſupply their place. The fixed air in theſe caſes ſeems to be the moſt efficacious part of their compoſition, and it is not certainly known what proportion of this ingredient the native Bath water and our preparation bear to one another. It has even of late been made a doubt, if the fixed air itſelf be not diverſified in its qualities, according to the ſubſtances from which it is procured. If this be true, we can have no ſecurity of any artificial compoſition whatever reſembling the Bath water in this reſpect, as we know not by what means the latter becomes thus impregnated. There does not, however, ſeem to be any good grounds for ſuch an opinion. As, however, the chalybeate impreg-

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which the Bath waters are ſo much famed, is ſtill more difficult to conjecture. The intentions of cure vary ſo much in the ſeveral ſtages of this diſorder, that ſcarce any medicine whatever can be ſaid to be univerſally of ſervice.

In what manner the native Bath waters act in this diſorder, is very difficult to determine, as their good effects ſeem generally to be produced without any apparent operation on the body. Their *modus operandi* here is very difficult to explain, nor can that ever be ſatisfactorily done, until the cauſe of the gout itſelf be diſcovered.

Unfortunately, however, for medicine, very little progreſs has been made in this inveſtigation of the nature of this diſorder, nor (which is of more conſequence) has any method of practice been eſtabliſhed in it, of which the faculty of phyſic have any great reaſon to boaſt, notwithſtanding it has been treated on a footing

footing of this kind, at leaſt as much as any one incident to the human ſpecies. The efficacy, however, of theſe celebrated waters, has never been doubted, though the practice relative to them, in this complaint, has been hitherto, in a great meaſure, empirical.

How the artificial compoſition may reſemble them in their good effects, is not poſſible for us to determine, as experience is the only guide we can rely on in this caſe.

If, however, we may be allowed to conjecture, as it ſeems to reſemble the Bath water in many of its qualities, it is not improbable it might be of ſervice here. If the action of the Bath waters be in reſtoring the tone of the ſtomach and inteſtines, which are generally particularly affected in this diſorder, we ſhould not think this medicine ill qualified to anſwer ſuch an intention, as it contains the fixed air and chalybeate impregnation in large proportion, both

which

which are very efficacious in this reſpect.

One great inconvenience, however, the artificial preparation would be liable to: In gouty complaints, the native Bath waters are obſerved to be remarkably efficacious in removing the ſeat of the diſorder from the head and ſtomach to the extremities. When this is the caſe, nauſea and vomitings are generally concomitant ſymptoms, and theſe the Bath water ſeems peculiarly to relieve, and is frequently the only ſubſtance which the ſtomach can be induced to retain. In all probability, their being of a taſte almoſt univerſally acceptable, is a great ſource of this quality.

In this circumſtance, indeed, our imitation falls far ſhort of the original, and until this deficiency can be ſupplied, which, at preſent, does not ſeem likely, we can have little hopes of its proving of equal efficacy in the cure of this diſorder.

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Moreover, as the gout attacks thoſe generally, who have been accuſtomed to great indulgence of their palate, we are apt to think, that few of thoſe who owe their diſorder to this cauſe, would be inclined to make a ſufficient trial of a medicine that had ſo little to recommend it in that reſpect.

Fortunately, however, this diſorder falls chiefly on thoſe who have it in their power to make a trial of the Bath waters themſelves, and to theſe we would always recommend them, in preference to any imitation. As, however, the gout ſometimes attacks the lower ranks of life, and many ſuch as we cannot ſuppoſe have it in their power to make the experiment, to theſe a trial of our imitation of them might not be improperly recommended. If drank diluted, in the manner before mentioned, during the intervals of the fit, it might poſſibly be of ſervice in ſhortening their duration, and rendering them more tolerable.

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One circumſtance ſeems to recommend its uſe in this, and ſeveral other complaints, which is, that, if drank with the general cautions above mentioned, no harm is likely to accrue from it.

We have thus gone over, in a curſory manner, the general diſorders in which the Bath waters are found of uſe, and thoſe rather more particularly, in which the laſt mentioned preparation was likely to be of ſervice. Perhaps it may be thought that we have delivered our thoughts on this ſubject too freely, as we acknowledged that our opinions were unſupported by experience.

But we hope the candid Reader will recollect, what we ſaid in a former part of this Work, that we ſuggeſt what has been here ſaid, concerning the medicinal effects of our imitation of the Bath waters, only as hints that we think bear ſome appearance of probability; and do not expect, or wiſh, to ſee them made a foundation for general practice, until they

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are eſtabliſhed on the firmer baſis of experience.

We ſhould now proceed to conſider the hot and croſs Bath waters, and the effects of all with reſpect to their external uſe, with a compariſon of their qualities with one another. This, however, we propoſe as the ſubject of another Work.

FINIS.

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