

Heat & Cold.

Sal Armoniac dissolved in dew water, also
 so very much of y^e colour of y^e water, which
 change has been observed in y^e glass
 Glass water dissolved in water makes a water } 14
 perfectly white then it was, though in apt to take
 flame
 Spirit of wine taken inwardly heats applied } 23 24
 outwardly cools. Camphire does as both
 Nitre by sal armoniac though cold a part of
 though nitre by its self may be melted in a Con
 with y^e salt and sal armoniac being there into acid } 24 25
 in powder it will take fire as with flash very much
 Sal Armoniac: water by out of y^e trial much } 27 28
 greater can be in y^e trial. though any 2 of }
 thus together as y^e trial of cold

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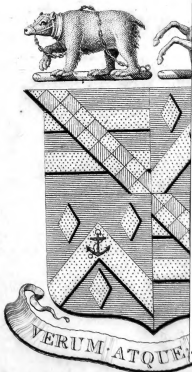
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F. 123

*The Reverend
Sir George Sec. Barons,
Hartwell.*

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GIFT OF
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Of Tests.

Zinc many ways dissolvable as well by Alkalis } 20
 spirit of wine or vinegar for this give drink fast } 21
 drink things minerals & others in dissolved by the }
 spirit of wine or vinegar can be made with spirit } 23-24
 of wine & distilled with one big hat a good long time }
 to make excellent Raspberry wine } 29.

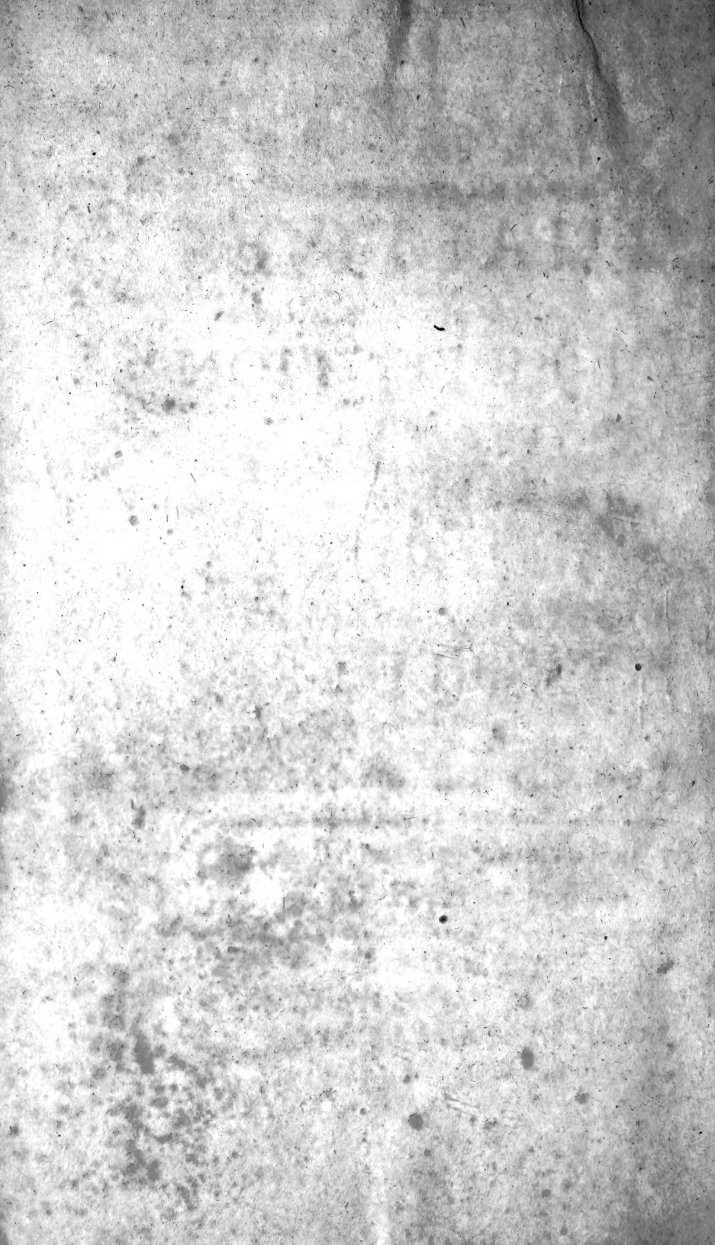
Of Uses

Camphir dissolved in oil of vitriol loses its smell, } 5
 but if poured altogether with fair water returns }
 it again }
 Beech-wood in increasing yeasts a small bit of rosin } 9
 Salt of tartar having spirit of wine drop upon it }
 may be made shal into crystals with out salt } 9.10
 Oyle of blue vitriol distilled with spirit of wine yeasts } 13.
 an excellent smelk oil. }
 To improve good smelk by a due operation, as to smelk } 28 29 }
 wine. } 30 31

Alkali or Acid

Spirit of vinegar in an Alkali will dissolve filings } 6
 of copper as well as better in an acid. }
 Oile of Sulphur put into a great earthen }
 pipper with water: dissolved in spirit of wine } 6
 better as well as oyle of tartar when an } 7.8.9
 alkali will be your good oil.

One Acid takes sometimes by weight 1/2 lb
30th by 2 other acid 1/2
Spirit of Nitre dissolved Camphire into oyle 1/2
congruently other oyle into a bottle sufficient 1/2
Some take spirit of wine to be an Alcholy 1/2
in water



Experiments, Notes, &c. (A)

ABOUT THE

Mechanical Origine or Production

Of divers particular

QUALITIES:

Among which is inserted a Discourse of the

IMPERFECTION

OF THE

CHYMIST'S Doctrine

OF

QUALITIES;

Together with some Reflections upon the

HYPOTHESIS

OF

ALCALI and ACIDUM.

By the Honourable *Robert Boyle, Esq;*
Fellow of the *R. Society.*

L O N D O N,

Printed by *E. Flesher*, for *R. Davie*
Bookseller in *Oxford.* 1675.

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LONDON

Printed by E. Blount for A. Loe

Bookeller in St. Dunstons Church

Q
155
B79
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MHT

*Directions for the Book-binder ;
to be put immediately after the
general Title Page.*

THE several Tracts of this Book
are to be bound in the order
following, *viz.*

After the Preface of the *Publisher
to the Reader*, and the *Advertisements
relating to the whole Treatise*, is to fol-
low,

1. The Tract of *Heat and Cold.*
2. Of *Tasts.*
3. Of *Odours.*
4. Of the imperfection of the *Chy-
mists Doctrine of Qualities.*
5. Reflexions upon the Hypothesis
of *Alcali and Acidum.*
6. Advertisments relating to *Chy-
mical Qualities* to be bound next af-
ter the Title Page to *Volatility.*
7. Of *Volatility.*
8. Of *Fixtnefs.*
9. Of *Corroftiveness & Corroftibility.*
10. Of *Chymical Precipitation.*
11. Of *Magnetifm.*
12. Of *Electricity.*

(*)

ERRA

ERRATA.

In the Tract of *Heat and Cold*, p. 28. at the end of the page dele *Finis*, and go on to *Exp. IX.* p. 40. l. 21. r. *degree of rapidness.* p. 102. l. 15. put a *comma* after the word *before*.

In the Tract of *Corrosiveness and Corrosibility* read in the current Title on the top of p. 2. and 3. & *seqq.* *Corrosiveness and Corrosibility*, not *or*.

THE
PUBLISHER
TO THE
Reader.

TO keep the Reader from being at all surpriz'd at the Date of the Title-Page, I must inform him, that a good part of the ensuing Tracts were Printed off, and in my custody, the last year; and the rest had come out with them divers moneths ago, if the Noble Author had not been hinder'd from committing them to the Press by the desire and hope of being able in a short time to send them abroad more numerous, and by his being hinder'd to do so partly by Remove, partly by the want of some Papers that were odly lost or spoil'd, and partly by the sickness of himself, and divers of his near

To the Reader.

Relations. And some of these Impediments do yet suppress what the Author intended should have made a part of the Book, which now he suffers to be publish'd without them, though divers of his Papers about some other particular Qualities have been written so long ago, as to have lain for many years neglected among other of his old Writings: Which that he may have both leisure and health to review, and fit for publication, is the ardent wish of the sincere Lovers of Real Knowledge, who have reason to look on it as no mean proof of his constant kindness to Experimental Philosophy, that in these Tracts he perseveres in his course of freely and candidly communicating his Experiments and Observations to the publick, notwithstanding the liberty that hath been too boldly taken to mention them as their own by some later Writers; as particularly by the Compiler of the Treatise, entitul'd Polygraphice, who in two Chapters hath allow'd himself to present his Reader with above Fifty Experiments, taken out of

To the Reader.

our Authors Book of Colours, without owning any one of them to Him, or so much as naming him or his Book in either of those Chapters, nor, that I remember, in any of the others. Nor did I think this practice justified by the confession made in the Preface, importing, that the Compiler had taken the particulars he deliver'd from the Writings of others. For, this general and perfunctory acknowledgment neither doth right to particular Authors, nor, by naming them, enables the Reader to know, whether the things deliver'd come from persons fit to be credited or not : And therefore, since 'tis but too likely, that such Concealment of the Names, if not Usurpation of the Labours of the Benefactors to Philosophy, will prove much more forbidding to many others to impart their Experiments, than as yet they have to our generous Author ; it seems to be the Interest of the Commonwealth of Learning openly to discountenance so discouraging a practice, and to shew, that they do not think it fit that Possessors of useful pieces of

To the Reader.

knowledge should be strongly tempted to envy them to the Publick, to the end onely that a few Compilers should not be put upon so reasonable and easie a work, as by a few words or names to shew themselves just, if not grateful.

But not to keep the Reader any longer from the perusal of these Tracts themselves, I shall conclude with intimating onely, that what our Author saith in one of them concerning the Insufficiency of the Chymical Hypothesis for explaining the Effects of Nature, is not at all intended by him to derogate from the sober Professors of Chymistry, or to discourage them from useful Chymical Operations; forasmuch as I had the satisfaction, some years since, to see in the Authors hands a Discourse of his about the Usefulness of Chymistry for the Advancement of Natural Philosophy; with which also 'tis hoped he will e're long gratifie the Publick.

ADVERTISEMENT

Relating to the following

TREATISE.

TO obviate some misapprehensions that may arise concerning the ensuing Notes about Particular Qualities, it may not be improper to adde something in this place to what has been said in another † Paper in reference to those Notes, and consequently to premise to the particular Experiments some few general Advertisements about them.

† See Tracts about Cosmical Qualities, &c. to which is prefixt an *Introduction to the History of Particular Qualities*; Printed at Oxford 1671.

And I. we may consider, that there may be three differing ways of treating Historically of Particular Qualities. For *either* one may in a full and methodical History prosecute the Phænomena; *or* one may make a Collection of various Experiments and Observations whence may be gathered divers Phænomena to illustrate *several*, but not all of the Heads or Parts of such an ample or methodical History; *or* (in the third place) one may in a more

confin'd way content ones self to deliver
 such Experiments and Observations of
 the Production, or the Destruction or
 Change of this or that Quality, as, being
 duly reason'd on, may suffice to shew
 wherein the nature of that Quality doth
 consist, especially in opposition to those
 erroneous conceits that have been enter-
 tained about it. Of the *First* of these
 three ways of treating of a Quality I
 pretend not to have given any *complete*
 example; but you will find, that I have
 begun such Histories in my *Specimens* a-
 bout *Fluidity* and *Firmness*, and in the
 Experiments, Observations, &c. that I
 have put together about *Cold*. The *Second*
 sort of Historical Writings I have given an
 Instance of in my Experiments about *Co-
 lours*; but in these ensuing Notes, the
 occasion I had to make them having ob-
 liged me chiefly to have an eye to the dis-
 proval of the errors of the Peripateticks
 and the Chymists about them, I hope I
 shall not be thought to have fallen very
 short in my Attempt, if I have (here
 and there) perform'd what may be re-
 quired in the *Third* way of writing Histo-
 rically of a Quality; my present Design
 being chiefly to give an Intelligent and
 Historical Account of the Possible *Me-
 chanical Origination*, not of the *various*
Pha-

Phænomena of the particular Qualities succinctly mentioned in these Notes; though, my *secondary* end being to become a Benefactor to the History of Qualities by providing Materials for my self or better Architects, I have not scrupled to adde to those, that tend more directly to discover the *Nature* or Essence of the Quality treated of, and to derive it from *Mechanical* Principles, some others (which happen'd to come in my way) that acquaint us but with some of the less luciferous Phænomena.

II. That you may not mistake what is driven at in many of the Experiments and Reasonings deliver'd or propos'd in the ensuing Notes about *Particular Qualities*, I must desire you to take notice with me, what it is that I pretend to offer you some proofs of. For, if I took upon me to demonstrate, that the Qualities of bodies cannot proceed from (what the Schools call) *Substantial Forms*, or from any other Causes but Mechanical, it might be reasonably enough expected, that my Argument should directly exclude them all. But since, in my Explications of Qualities, I pretend only, that they *may* be explicated by *Mechanical Principles*, without enquiring, whether they are explicable by any other; that which I need to prove, is,
not

not that Mechanical Principles are the *necessary* and *only* things whereby Qualities may be explain'd, but that probably they will be found *sufficient* for their explanation. And since *these* are confessedly more manifest and more intelligible than *Substantial Forms* and other Scholastic Entities (if I may so call them) 'tis obvious, what the consequence will be of our not being oblig'd to have recourse to things, whose existence is very disputable, and their nature very obscure.

There are several ways that may be employed, some on one occasion, and some on another, either more directly to reduce *Qualities* (as well as divers other things in nature) to Mechanical Principles; or, by shewing the insufficiency of the Peripatetic and Chymical Theories of Qualities, to recommend the Corpuscularian Doctrine of them.

For further Illustration of this Point, I shall adde on this occasion, that there are three distinct sorts of Experiments (besides other proofs) that may be reasonably employ'd, (though they be not equally efficacious) when we treat of the *Origine* of Qualities. For some Instances may be brought to shew, that the propos'd Quality may be Mechanically *introduc'd* into a portion of matter, where it

was

was not before. Other Instances there may be to shew, that by the same means the Quality may be notably *varied* as to degrees, or other not essential Attributes. And by some Instances also it may appear, that the Quality is Mechanically *expell'd* from, or *abolish'd* in, a portion of matter that was endow'd with it before. Sometimes also by the same Operation the former quality is destroyed, and a new one is produc'd. And each of these kinds of Instances may be usefully employ'd in our Notes about Particular Qualities. For, as to the *first* of them, there will be scarce any difficulty. And as to the *second*, since the permanent Degrees as well as other Attributes of Qualities are said to flow from (and do indeed depend upon) the same Principles that the Quality it self does; if, especially in bodies inanimate, a change barely Mechanical does notably and permanently alter the *degree* or other considerable attribute; it will afford, though not a clear proof, yet a probable presumption, that the Principles whereon the Quality it self depends are Mechanical. And *lastly*, if, by a bare Mechanical change of the internal Disposition and structure of a body, a permanent Quality, confess'd to flow from its substantial Form or inward Principle, be abolish'd,

olish'd, and perhaps also immediately succeeded by a new Quality Mechanically producible; if, I say, this come to pass in a body Inanimate, especially if it be also, as to sense similar, such a *Phenomenon* will not a little favour that *Hypothesis* which teaches, that these Qualities depend upon certain contextures and other Mechanical Affections of the small parts of the bodies, that are indowed with them, and consequently may be abolish'd when that necessary Modification is destroyed. This is thus briefly premis'd to shew the pertinency of alledging differing kinds of Experiments and *Phenomena* in favour of the *Corpuscular Hypothesis* about Qualities.

What has been thus laid down, may, I hope, facilitate and shorten most of the remaining work of this Preamble, which is to shew, though but very briefly, that there may be several ways, not impertinently employable to recommend the *Corpuscularian Doctrine* of Qualities.

For *first*, it may sometimes be shewn, that a *Substantial Form* cannot be pretended to be the necessary Principle of this or that Quality; as will (for instance) hereafter be made manifest in the *Asperity* and *Smoothness* of bodies, and in the *Magnetical Vertue* residing in a piece of Iron that has been impregnated by a Loadstone.

stone. 'Tis true, that the force of such Instances is indirect, and that they do not expressly prove the *Hypothesis* in whose favour they are alledged; but yet they may do it good service by disproving the Grounds and Conclusions of the Adversaries, and so (by removing Prejudices) making way for the better entertainment of the truth.

Secondly, we may sometimes obtain the same or the like Quality by Artificial and sometimes even temporary Compositions, which, being but factitious bodies, are by Learned Adversaries confess'd not to have *Substantial Forms*, and can indeed reasonably be presum'd to have but resulting Temperaments: As will be hereafter exemplifi'd in the production of *Green* by compounding Blew and Yellow, and in the *Electrical* Faculty of Glass; and in the temporary whiteness produc'd by beating clear Oyl and fair Water into an Ointment, and by beating water into a froth, and, more permanently, in making Coral white by flaving it with heat; and in divers other Particulars, that will more properly be elsewhere mention'd.

Thirdly then, in some cases the Quality propos'd may be either *introduced*, or *vary'd*, or *destroy'd* in an inanimate body, when no change appears to be made in the body,

dy, except what is Mechanical, and what might be produc'd in it, supposing such a parcel of matter were *artificially* fram'd and constituted as the body is, though without any *Substantial Form*, or other such like internal Principle. So when a piece of Glass, or of clarify'd Rosin, is, by being beaten to powder, deprived of its Transparency, and made white, there appears no change to be made in the pulveriz'd body, but a comminution of it into a multitude of Corpuscles, that by their number and the various scituations of their surfaces are fitted copiously to reflect the sincere Light several ways, or give some peculiar Modification to its Rays; and hinder that free passage of the beams of Light, that is requisite to Transparency.

Fourthly, as in the cases belonging to the foregoing number there appears not to intervene in the Patient or Subject of the change, any thing but a *Mechanical* alteration of the Mechanical Structure or Constitution; so in some other cases it appears not, that the Agent, whether natural or factitious, operates on the Patient otherwise than Mechanically, employing onely such a way of acting as may proceed from the Mechanisme of the matter, which it self consists of, and that of the
body

body it acts upon. As when Goldsmiths burnish a Plate or Vessel of Silver, that having been lately boil'd lookt white before, though they deprive it of the greatest part of its colour, and give it a new power of reflecting the beams of Light and visible Objects, in the manner proper to specular bodies; yet all this is done by the intervention of a burnishing Tool, which often is but a piece of Steel or Iron conveniently shap'd; and all that this Burnisher does, is but to depress the little prominencies of the Silver, and reduce them, and the little cavities of it, to one physically level or plain Superficies. And so when a Hammer striking often on a Nail, makes the head of it grow hot, the Hammer is but a purely Mechanical Agent, and works by local motion. And when by striking a lump of Glass, it breaks it into a multitude of small parts that compose a white powder, it acts as Mechanically in the production of that Whiteness as it does in driving in a Nail to the head. And so likewise, when the powder'd Glass or Colophony lately mention'd is, by the fire, from a white and opacous body, reduc'd into a colourless (or a reddish) and transparent one, it appears not, that the fire, though a natural Agent, need work otherwise than

Mecha-

Mechanically, by colliquating the incoherent grains of powder into one mass; wherein, the ranks of pores not being broken and interrupted as before, the incident beams of Light are allow'd every way a free passage through them.

Fifibly, the like Phænomena to those of a Quality to be explicated, or at least as difficult in the same kind, may be produc'd in bodies and cases, wherein 'tis plain we need not recurre to *Substantial Forms*. Thus a varying Colour, like that which is admired in a Pigeons Neck, may be produc'd in changeable Taffety, by a particular way of ranging and connecting Silk of several Colours into one piece of Stuff. Thus we have known *Opals* casually imitated and almost excell'd by Glass, which luckily degenerated in the Furnace. And somewhat the like changeable and very delightful Colour I remember to have introduced into common Glass with Silver or with Gold and Mercury. So likewise meerly by blowing fine Crystal-Glass at the flame of a Lamp to a very extraordinary thinness, we have made it to exhibit, and that vividly, all the Colours (as they speak) of the Rainbow; and this power of pleasing by diversifying the Light, the Glass, if well preserved, may keep for a long time. Thus
also

also by barely beating Gold into such thin leaves as Artificers and Apothecaries are wont to employ, it will be brought to exhibit a green Colour, when you hold it against the Light, whether of the day, or of a good Candle; and this kind of Greenness as 'tis permanent in the foliated Gold, so I have found by trial, that if the Sun-beams, somewhat united by a Burning-glass, be trajected through the expanded Leaf, and cast upon a piece of white paper, they will appear there as if they had been tinged in their passage. Nay, and sometimes a slight and almost momentary Mechanical change will seem to over rule Nature, and introduce into a body the quite opposite Quality to that she had given it: As when a piece of black Horn is, onely by being thinly scraped with the edge of a knife or a piece of glass, reduced to permanently white Shavings. And to these Instances of Colours, some Emphatical and some Permanent, might be added divers belonging to other Qualities, but that I ought not to anticipate what you will elsewhere meet with.

There is yet another way of arguing in favour of the *Corpuscularian* Doctrine of Qualities, which, though it do not afford direct proofs of its being the best

B

Hypo-

Hypothesis, yet it may much strengthen the Arguments drawn from other Topics, and thereby serve to recommend the Doctrine it self. For, the use of an *Hypothesis* being to render an intelligible account of the Causes of the Effects of Phænomena propos'd, without crossing the Laws of Nature or other Phænomena, the more numerous and the more various the Particulars are, whereof some are *explicable* by the assign'd Hypothesis, and some are *agreeable* to it, or at least are not dissonant from it, the more valuable is the Hypothesis, and the more likely to be true. For 'tis much more difficult, to finde an *Hypothesis* that is not true which will suit with *many* Phænomena, especially if they be of various kinds, than but with *few*. And for this Reason I have set down among the Instances belonging to particular Qualities some such Experiments and Observations, as we are now speaking of; since, although they be not direct proofs of the preferableness of our Doctrine, yet they may serve for Confirmation of it; though this be not the only or perhaps the chief Reason of their being mention'd. For whatever they may be as Arguments, since they are matters of fact, I thought it not amiss to take this occasion of preserving them from being lost;

lost; since, whether or no they contribute *much* to the establishment of the Mechanical Doctrine about Qualities, they will at least contribute to the Natural History of them.

III. I shall not trouble the Reader with a Recital of those unlucky Accidents, that have hinder'd the Subjects of the following Book from being more numerous, and I hope he will the more easily excuse their paucity, if he be advertised, that *although* the particular Qualities, about which some Experiments and Notes, by way of *Specimens*, are here presented, be not near half so many as were intended to be treated of; yet I was careful to chuse them such as might comprehend in a small number a great variety; there being scarce one sort of Qualities, of which there is not an Instance given in this small Book, since therein Experiments and thoughts are deliver'd *about* Heat and Cold, which are the chief of the four *FIRST QUALITIES*; *about* Tasts and Odours, which are of those, that, being the immediate objects of Sense, are wont to be call'd *SENSIBLE QUALITIES*; *about* Volatility and Fixity, Corrosiveness and Corrosibility, which, as they are found in bodies purely natural, are referable to those Qualities, that many

Physical Writers call *SECOND QUALITIES*, and which yet, as they may be produced and destroyed by the Chymists Art, may be stiled *Chymical Qualities*, and the Spagyrical ways of introducing or expelling them may be referr'd to *Chymical Operations*, of which there is given a more ample *Specimen* in the Mechanical account of *Chymical Precipitations*. And lastly, some Notes are added *about Magnetism and Electricity*, which are known to belong to the Tribe of *Occult Qualities*.

IV. If a want of apt Coherence and exact Method be discover'd in the following Essays, 'tis hop'd, that defect will be easily excus'd by those that remember and consider, that these Papers were originally little better than a kind of Rapfody of Experiments, Thoughts, and Observations, occasionally thrown together by way of Annotations upon some Passages of a Discourse, (about the differing Parts and Redintegration of Nitre) wherein some things were *pointed at* relating to the particular Qualities that are here more largely *treated of*. And though the Particulars that concern some of these Qualities, were afterwards (to supply the place of those borrow'd by other Papers whilst these lay by me) increas'd in number; yet it was not to be expected, that their

their Accession should as well correct the Form as augment the Matter of our Annotations. And as for the two Tracts, that are inserted among these Essays about Qualities ; I mean *the Discourse of the Imperfection of the Chymical Doctrine of them,* and the Reflections on the *Hypothesis of Acidum and Alkali*, the occasion of their being made parts of this Book is so far express'd in the Tracts themselves, that I need not here trouble the Reader with a particular Account of it.

V. I do not undertake, that all the following Accounts of Particular Qualities would prove to be the very true ones, nor every Explication the best that can be devis'd. For besides that the difficulty of the Subject, and Incompleatness of the History we yet have of Qualities, may well deterre a man, less diffident of his own abilities than I justly am, from assuming so much to himself, it is not absolutely necessary to my present Design. For, Mechanical Explications of natural Phænomena do give so much more satisfaction to ingenious minds, than those that must employ *Substantial Forms, Sympathy, Antipathy, &c.* that the more judicious of the vulgar Philosophers themselves prefer them before all others, when they can be had ; (as is elsewhere shewn

at large,) but then they look upon them either as confined to Mechanical Engines, or at least but as reaching to very few of Nature's *Phænomena*, and, for that reason, unfit to be received as Physical Principles. To remove therefore this grand Prejudice and Objection, which seems to be the chief thing that has kept off Rational Inquirers from closing with the Mechanical Philosophy, it may be very conducive, if not sufficient, to propose such Mechanical accounts of Particular Qualities themselves, as are intelligible and possible, and are agreeable to the *Phænomena* whereto they are applied. And to this it is no more necessary that the account propos'd should be the truest and best that can possibly be given, than it is to the proving that a Clock is not act'd by a vital Principle, (as those *Chineses* thought, who took the first, that was brought them out of *Europe*, for an *Animal*,) but acts as an Engine, to do more than assign a Mechanical Structure made up of Wheels, a Spring, a Hammer, and other Mechanical pieces, that will regularly shew and strike the hour, whether this Contrivance be or be not the very same with that of the Particular Clock propos'd; which may indeed be made to move either with Springs or Weights, and may consist of a greater or lesser number of
Wheels,

Wheels, and those differinglſc situated and connected; but for all this variety 'twill ſtill be but an Engine. I intend not therefore by propoſing the Theories and Conjectures ventur'd at in the following Papers, to debar my ſelf of the Liberty either of altering them, or of ſubſtituting others in their places, in caſe a further progreſs in the Hiſtory of Qualities ſhall ſuggeſt better *Hypotheſes* or *Explications*. And 'twas but agreeable to this Intention of mine, that I ſhould, as I have done, on divers occaſions in the following Notes, imploy the word *Or*, and expreſs my ſelf ſomewhat doubtingly, mentioning more than one *Cauſe* of a *Phænomenon*, or *Reason* of an opinion, without dogmatically declaring for either; ſince my purpoſe in theſe Notes was rather to ſhew, it was not neceſſary to betake our ſelves to the Scholaſtick or Chymical Doctrines about Qualities, than to act the *Umpire* between the differing *Hypotheſes* of the *Corpuſcularians*; and, provided I kept my ſelf within the bounds of Mechanical Philoſophy, my deſign allowed me a great latitude in making *explications* of the *Phænomena*, I had occaſion to take notice of.

FINIS.

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 and second of the three
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OF THE
MECHANICAL
ORIGINE
OF
HEAT and *COLD*.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society*.

L O N D O N,

Printed by *E. Flesher*, for *R. Davis*
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Experiments and Notes
ABOUT THE
MECHANICAL ORIGINE
OR
PRODUCTION
OF
HEAT and *COLD*.

SECT. I.

*About the Mechanical Production of
Cold.*

H *EAT* & *COLD* being generally
lookt upon as the most active
among Qualities, from which
many other Qualities are deducible,
and by which many of Nature's
Phænomena, especially among the

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Peri-

2 Of the Mechanical Origine

Peripateticks, are attempted to be explicated; I suppose it will be very proper to begin with Instances of them to shew, that Qualities may be Mechanically produced or destroyed. A not useless Paraphrase of which expression may be this, That a portion of matter may come to be endowed with a Quality, which it *had not* before, or to be deprived of one that it had, *or* (sometimes) to acquire or lose a degree of that Quality; *though* on the part of the Matter (or, as some would speak, of the Patient) there do not appear to intervene any more than a change of Texture, or some other Mechanical Alteration; and *though* the Agents (on their part) do not appear to act upon it otherwise, than after a Mechanical manner, that is, by their bigness, shape, motion, and those other Attributes by vertue whereof Mechanical Powers and Engines perform their operations; and this without having recourse to the Peripatetic Substantial Forms and Elements,

ments, or to the Hypostatical Principles of the Chymists.

And having here (as in a proper place) to avoid ambiguity, premised once for all, this

*Summary Declaration of the sense, agree-

* See more of this in the Preamble.

ably whereunto I would have these Terms understood in the following Notes about the Origine of Particular Qualities; I proceed now to set down some few examples of the Mechanical Production of *Cold & Heat*, beginning with those that relate to the former, because by reason of their Paucity they will be quickly dispatcht. And I hope I shall not need to make an Apology for mentioning no greater number; since I scarce remember to have met with any Instances of this kind in any of the Classick Writers of Natural Philosophy.

EXPER. I.

MY first Experiment is afforded me by the Dissolution of Sal Armoniac, which I have somewhat wonder'd, that Chymists having often occasion to purifie that Salt by the help of Water, should not have, long since, and publickly, taken notice of. For if you put into three or four times its weight of Water a pound or but half a pound (or even less) of powder'd Sal Armoniack, and stir it about to hasten the dissolution, there will be produc'd in the mixture a very intense degree of Coldness, such as will not be onely very sensible to his hand that holds the Glass whilst the Dissolution is making, but will very manifestly discover it self by its Operation upon a Thermoscope. Nay, I have more than once by wetting the outside of the Glass, where the dissolution was making, and nimbly stirring

ring the Mixture, turn'd that externally adhering water into real Ice, (that was scrap'd off with a knife) in less than a minute of an hour. And this thus generated Cold continued considerably intense, whilst the action of dissolution lasted; but afterwards by degrees abated, and within a very few hours ceas'd. The particular Phænomena I have noted in the Experiment, and the practical uses that may be made of it I reserve for another place*, the knowledge of them being not necessary in this, where what I have already related, may suffice for my present Argument.

* Divers of the Phænomena, &c. of this Experiment were afterwards printed Numb. 15. of the *Ph. Transact.*

And to shew, that not onely a far more intense degree of Cold may emerge in this Mixture, than was to be found in either of the Ingredients before they were mingled, but a considerable Coldness may be *begun* to be produc'd between Bodies that were neither of them actually Cold

6 Of the Mechanical Origine

before they were put together, I will subjoin a Transcript of what I find to this purpose among my *Adversaria*.

EXPER. II.

[I Remember that once I had a mind to try, Whether the Coldness produced upon the Solution of beaten Sal Armoniac in water, might not be more probably referr'd to some change of Texture or Motion resulting from the action of the Liquor upon the Salt, than to any Infrigidation of the water made by the suddain dispersion of so many Saline grains of powder, which by reason of their Solidity may be suspected to be actually more cold than the Water they are put into; I therefore provided a Glass full of that Liquor, and having brought it to such a Temper, that its warmth made the Spirit of Wine in the seal'd Weather-glass
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manifestly, though not nimbly, ascend; I took out the Thermoscope, and laid it in powder'd Sal Armoniac, warm'd beforehand; so that the tincted Liquor was made to ascend much nimblier by the Salt than just before by the Water; and having presently remov'd the Instrument into that Liquor again, and poured the somewhat warm Sal Armoniac into the same, I found, as I imagin'd, that within a space of time which I guess'd to be about half a minute or less, the Spirit of Wine began hastily to subside, and within a few minutes fell above a whole division and a quarter below the mark at which it stood in the water, before that Liquor or the Salt were warm'd. Nor did the Spirit in a great while reascend to the height which it had when the water was cold.

The same Experiment, being at another time reiterated, was tried with the like success; which second may therefore serve for a Confirmation of the first.]

EXPER.

EXPER. III.

HAVING a mind likewise to shew some Ingenious men, how much the production of Heat and Cold depends upon Texture and other Mechanical Affections, I thought fit to make again a Sal Armoniac by a way I formerly publish'd, that I might be sure to know what Ingredients I employ'd, and shew their effects as well before conjunction as after it. I took then Spirit of Salt, and Spirit of fermented or rather putrified Urine; and having put a seal'd Weather-glass into an open Vessel, where one of them was pour'd in, I put the other by degrees to it, and observ'd, that, as upon their mingling they made a great noise with many bubbles, so in this conflict they lost their former coldness, and impell'd up the Spirit of Wine in the seal'd Thermoscope: Then slowly evaporating the superfluous moisture, I obtained

tained a fine sort of Sal Armoniac for the most part figur'd not unlike the other, when being dissolv'd and filtrated, it is warily coagulated. This new Salt being gently dry'd I put into a wide Glass of water, wherein I had before plac'd a seal'd Weather-glass, that the included Spirit might acquire the temper of the ambient Liquor, and having stirr'd this Salt in the water, though I took it then off the mantle-tree of a Chimney that had had fire in it divers hours before, it did, as I expected, make the tincted Spirit hastily subside and fall considerably low.

EXPER. IV.

Since if two bodies upon their mixture acquire a greater degree of Cold than either of them had before there is a production of this additional degree of that Quality, it will

10 Of the Mechanical Origine

will be proper to add on this occasion the ensuing Experiment.

We took a competent quantity of acid spirit distill'd from Roch-allom, (that, though rectifi'd, was but weak,) which, in the spirit of that salt, is not strange. Of this we put into a wide mouth'd Glass (that was not great) more than was sufficient to cover the globulous part of a good seal'd Thermoscope, and then suffering the instrument to stay a pretty while in the liquor, that the Spirit of wine might be cool'd as much as the ambient was, we put in little by little some volatile salt sublimed from Sal Armoniac and a fixt *Alkali*, and notwithstanding the very numerous (but not great) bubbles, and the noise and froath that were produced, as is usual upon the reaction of Acids and Alcalys, the tincted spirit in the Weather-glass, after having continued a good while at a stand, began a little to descend, and continued (though but very slowly) to do so, till the spirit of Allom was glutted with
with

with the volatile salt; and this descent of the tinted liquor in the Instrument being measur'd, appear'd to be about an inch (for it manifestly exceeded seven eighths.) By comparing this Experiment with the first part of the foregoing, we may gather, that when Volatile and Urinous Salts or Spirits (for the saline particles appear sometimes in a dry and sometimes in a liquid form) tumultuate upon their being mixt with Acids; neither the Heat nor the Cold that ensues is produc'd by a Conflict with the Acids precisely as it is Acid, since we have seen that an urinous spirit produc'd an actual Heat with spirit of Salt, and the distill'd Salt of Sal Armoniac, which is also Urinous, with the acid spirit of Roch-Allom produces not a true effervescence, but a manifest Coldness: As the same Salt also did in a Trial of another sort, which was this.

E X.

EXPER. V.

WE took one part of Oyl of Vitriol, and shaking it into twelve parts of water we made a mixture, that at first was sensibly warm; then suffering this to cool, we put a sufficient quantity of it into a wide mouth'd glass, and then we put a good Thermoscope Hermetically seal'd, above whose Ball the compounded liquor reached a pretty way. After some time had been allowed that the liquor in the Thermometer might acquire the temper of the ambient; we put in by degrees as much volatile Salt of Sal Armoniac as would serve to satiate the acid spirits of the mixture: for, though these two made a notable conflict with tumult, noise, and froth, yet 'twas but a cold ebullition (if I may so stile it,) for the spirit in the Thermoscope descended about an inch beneath the mark it rested at, when the seeming effervescence began. EX-

EXPER. VI.

TIs known that Salt-peter being put into common water produces a sensible Coldness in it, as it also does in many other Liquors: But that the same Salt put into a Liquor of another Constitution may have a quite differing effect, I have convinc'd some inquisitive persons by mingling eight ounces of fine Salt-peter powder'd with six ounces of Oyl of Vitriol: For by that commixture with a Salt that was not only actually, but, as to many other bodies, potentially cold, the Oyl of Vitriol, that was sensibly cold before, quickly conceived a considerable degree of Heat, whose Effects also became visible in the copious Fumes that were emitted by the incalcescent Mixture.

EX-

EXPER. VII.

THis brings into my mind, that *though* Gunpowder seems to be of so igneous a nature, that, when 'tis put upon a Coal, it is turn'd presently into flame capable of promoting the deflagration of the Charcoal, and kindling divers bodies it meets with in its way; *yet* if some ounces of Gunpowder reduced to powder be thrown into four or five times as much water, it will very manifestly impart a Coldness to it, as experience made *with*, as well as *without*, a seal'd Thermoscope has assured me.

This and the foregoing Experiment do readily suggest an Inquiry into the nature of the Coldness, which Philosophers are wont to oppose to that which immediately and upon the first contact affect the organs of sense, and which therefore they call Actual or Formal.

The

The success of this Experiment upon a second trial serv'd to confirm it, which is the more strange, because I have found, that a small quantity of Oyl of Vitriol, not beforehand mingled with water, would produce a notable heat in its conflict with a small portion of just such Salt as I employed before (both the parcels having been, if I well remember, taken out of the same Glass.) And this heat did upon trial, made with the former Thermoscope, make the tinged Spirit ascend much further than the lately recited Experiment made it subside.

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DIGRESSION

ABOUT

POTENTIAL COLDNESS.

Potential Coldness has been generally lookt upon, and that partly perhaps upon the score of its very name, as so abstruse a Quality, that 'tis not onely rational but necessary to derive it from the *substantial Forms* of bodies. But I confess I see no necessity of believing it not to be referrable to Mechanical Principles. For as to the chief Instances of Potential Coldness, which are taken from the effects of some Medicines and aliments in the bodies of men, it may be said without improbability, that the produced Refrigeration proceeds chiefly from this, that the potentially cold

cold body is made up of Corpuscles of such size, shape, &c. that being resolved and disjoined by the Menstruum of the stomach, or the fluids it may elsewhere meet with, they do so associate themselves with the small parts of the blood and other liquors, as, by clogging them or otherwise, to lessen their wonted agitation, and perhaps make them act in a peculiar way as well as less briskly on the nervous and fibrous parts; and the perception of this Imminution (and perhaps change) of motion in the organs of feeling is that, which, being referr'd to the body that produces it, we call its *Potential* Coldness. Which Quality appears by this account to be, as I was saying before, but a Relative thing, and is wont to require the diffusion or dispersion of the small parts of the Corpuscles of the Agent, and their mingling themselves with the liquors or the small parts of the body they are to refrigerate. And therefore, if it be granted, that

in Agues there is some morbidick matter of a viscos or not easily dissippable texture, that is harbor'd in some part of the body, and requires such a time to be made fluid and resolvable; the Cold Fits of Agues need not be so much admired as they usually are; since, though just before the Fit the same parcel of matter that is to produce it were actually in the body, yet it was not by reason of its clamminess actually resolved into small parts, and mingled with those of the bloud, and consequently could not make such a change in the motion of that liquor as is felt in the *Cold Fit* of an Ague; (for, of the further Change that occasions the *Hot Fit*, I am not here to speak) And in some other Diseases a small quantity of matter, being resolved into minute parts, may be able to produce a great sense of Coldness in some part of a body, which by reason of the structure of that part may be peculiarly disposed to be affected thereby; as

I have known Hypochondriack and Hysterical women complain of great Degrees of Coldness, that would suddenly invade some particular part, chiefly of the Head or Back, and be for a good while troublesome there. And that, if a frigid vapour or matter be exceeding subtile, an inconsiderable Quantity of it being dispersed through the blood may suffice to produce a notable Refrigeration, I have learnt by Inquiry into the Effects of some Poysons; and 'tis not very material, whether the Poyson, generally speaking, be cold or hot, if it meet with a body dispos'd to have those affections that pass for cold ones produced in it. For I have made a Chymical Liquor, that was penetrant and fiery enough to the Taste, and had acquired a Subtlety and briskness from Distillation, with which I could almost in a trice, giving it but in the quantity of about a drop, cast an *Animal* into that which appear'd a sleep, and the like

20 Of the Mechanical Origine

Liquor, in a not much greater quantity, being, by I know not whose mistake, apply'd to the aking Tooth of a very Ingenious Person, did presently, as he soon after told me, give him an universal Refrigeration, and trembling, worse than the cold Paroxisme of a Quartane. And though Scorpions do sometimes cause, by their sting, violent Heats in the parts they hurt, yet sometimes also the quite contrary happens, and their Poyson proves, in a high degree, potentially cold; as may be learnt from the two following Observations recorded by

* Feniven. cap. eminent Physicians.**Fa-*
 56. *Abditoram mulum habui,* (saith *Be-*
 apud Schenk. *nivenius*) *qui à Scorpì-*
 Lib. 7. de ve- *one ictus, tam subito ac*
 nen. Obseru. 24. *tam frigido sudore toto corpore perfusus*
est, ut argentiissimâ nive atque glacie se-
se opprimi quereretur. Verum cum
argenti illi solam Theriacam ex vino
potentiore exhibuissẽ, illicò curatus
est: Thus far he: To whose Narrat-
ive I adde this of Amatus Lusitanus.

Vir

Vir qui à Scorpione in manus digito punctus fuit, multum dolebat, & refrigeratus totus contremebat, & per corpus dolores, cute totâ quasi acu punctâ, formicantes patiebatur, &c. Cent. 6. Observ.

I cannot now stay to enquire, Whether there may not be in these great Refrigerations, made by so small a quantity of Poyson, some small Concretions or Coagulations made of the minute particles of the bloud into little clots, less agile and more unwieldy than they were when they moved separately: which may be illustrated by the little Curdlings that may be made of the parts of Milk by a very small proportion of Runnet or some acid liquor, and the little coagulations made of the Spirit of Wine by that of Urine: Nor will I now enquire, whether, besides the retardment of the motion of the bloud, some poysons and other analogous Agents may not give the motion of it a new modification, (as if some Corpuscles that usually are

22 Of the Mechanical Origine

more whirl'd or brandish'd be put into a more direct Motion) that may give it a peculiar kind of grating or other action upon the nervous and fibrous parts of the body. These, I say, and other suspicions that have sometimes come into my thoughts, I must not stay to examine; but shall now rather offer to Consideration, Whether, since some parts of the humane body are very differing from others in their structure and internal Constitution; and since also some Agents may abound in Corpuscles of differing shapes, bulks, and motions, the same Medicine may not in reference to the same humane body be potentially cold or potentially hot, according as 'tis applied; or perhaps may, upon one or both of the accounts newly mentioned, be cold in reference to one part of the body, and hot in reference to the other. And these effects need not be always ascrib'd to the meer and immediate action of the Corpuscles of the Medicine, but some.

sometimes to the new Quality they acquire in their Passage by associating themselves with the bloud or other fluids of the body, or to the expulsion of some calorific or frigorific Corpuscles, or to the Disposition they give the part on which they operate, to be more or less permeated and agitated than before by some subtile æthereal matter, or other Efficients of Heat or Cold. Some of these Conjectures about the Relative Nature of Potentially cold bodies, may be either confirmed or illustrated by such Instances as these; that Spirit of Wine being inwardly taken is potentially very hot, and yet being outwardly applied to some Burns and some hot Tumours does notably abate the Heat of the inflamed parts, though the same Spirit applied even outwardly to a tender eye will cause a great and dolorous agitation in it. And Camphire, which in the Dose of less than a half or perhaps a quarter of a Scruple, has been observed to diffuse

24 **Of the Mechanical Origine**
fuse a Heat through the body, is
with success externally applied by
Physicians and Chirurgeons in refri-
gerating Medicines.

But I leave the further Inquiry in-
to the Operations of Medicines to
Physicians, who may possibly, by
what has been said, be assisted to
compose the differences between
some famous Writers about the tem-
perament of some Medicines, as Mer-
cury, Camphire, &c. which some
will have to be cold, and others
maintain to be hot; and shall onely
offer by way of confirming, in gene-
ral, that Potential Coldness is onely
a Relative Quality, a few Particu-
lars; the first whereof is afforded
by comparing together the VI. and
the VII. Experiment before-going,
(which have occasion'd this Digres-
sion about Potential Coldness;) since
by them it seems probable, that the
same thing may have it in reference
to one body, and not to another,
according to the disposition of the
body it operates upon, or that ope-
rates

rates upon it. And the Fumes of Lead have been observed sometimes (for I have not found the Effect to succeed always) to arrest the fluidity of Mercury, which change is supposed to be the effect of a Potential Coldness belonging to the Chymists Saturn in reference to fluid Mercury, though it have not that operation on any other liquor that we know of.

And lastly, (for I would not be too prolix) though Nitre and Sal Armoniac be both apart and joyntly Cold in reference to Water, and though, however Nitre be thoroughly melted in a Crucible, it will not take fire of it self, yet if, whilst it is in Fusion, you shall by degrees cast on it some powder'd Sal Armoniac, it will take fire and flash vehemently, almost as if Sulphur had been injected.

But

26 Of the Mechanical Origine

But our Excursion has, I fear, lasted too long, and therefore I shall presently re-enter into the way, and proceed to set down some Trials about Cold.

EX.

EXPER. VIII.

IN the *first* Experiment we observed, that upon the pouring of water upon Sal Armoniac there ensued an intense degree of Cold, and we have elsewhere recited, that the like effect was produc'd by putting, instead of common water, Oyl of Vitriol to Sal Armoniac; but now, to shew further, what influence Motion and Texture may have upon such Trials, it may not be amiss to adde the following Experiment: To twelve ounces of Sal Armoniac we put by degrees an equal weight of water, and whilst the Liquor was dissolving the Salt, and by that action producing a great Coldness, we warily pour'd in twelve ounces also of good Oyl of Vitriol; of which new mixture the event was, that a notable degree of Heat was quickly produced in the Glass wherein the Ingredients were confounded, as unlikely as it seem'd, that, whereas
each

each of the two Liquors is wont with Sal. Armoniac to produce an intense Cold, both of them acting on it together should produce the contrary Quality. But the reason I had to expect the success, I met with, was this, that 'twas probable the Heat arising from the mixture of the two Liquors would overpower the Coldness produceable by the operation of either, or both, of them upon the Salt.

FINIS.





EXPER. IX.

IN most of the Experiments that we have hitherto proposed, *Cold* is wont to be *regularly* produc'd in a Mechanical way; but I shall now adde, that in some sort of Trials I found that the Event was *varied* by unobserv'd Circumstances; so that sometimes manifest Coldness would be produced by mixing two Bodies together, which at another time would upon their Congress disclose a manifest Heat, and sometimes again, though more rarely, would have but a very faint and remis degree of either.

Of this sort of Experiments, whose Events I could not confidently undertake for, I found to be, the dissolution of Salt of Tartar in Spirit of Vinegar, and of some other Salts, that were not acid, in the same Menstruum, and even Spirit of Verdigrease (made *per se*) though a more
C potent

potent Menstruum than common Spirit of Vinegar, would not *constantly* produce near such a heat at the beginning of its operation, as the greatness of the seeming Effervescence, then excited, would make one expect, as may appear by the following Observation transcrib'd *verbatim* out of one of my *Adversaria*.

[Into eight ounces of Spirit of Verdigrease (into which we had put a while before a standard-Thermoscope to acquire the like temper with the Liquor) we put in a wide-mouthed Glass two ounces of Salt of Tartar, as fast as we durst for fear of making the matter boil over; and though there were a great commotion excited by the action and reaction of the Ingredients, which was attended with a copious froth and a hissing noise; yet 'twas a pretty while e're the Glass was sensibly warm on the outside; but by that time the salt was all dissolv'd, the Liquor in the Thermoscope appear'd to be impell'd

pell'd up about three inches and an half.]

And yet, if my memory do not much deceive me, I have found, that by mixing Salt of Tartar with another Salt, the Texture of the fixt *Alkali* was so alter'd, that upon the affusion of spirit of Verdigrease, (made without spirit of Vinegar and spirit of Wine,) though there ensued a great conflict with noise and bubbles, yet, instead of an Incalcescence, a considerable degree of Coldness was produced.

EXPER. X.

TIs very probable that further Trials will furnish us with more Instances to shew how the Production of Cold may in some cases be effected, varied, or hinder'd by Mechanical Circumstances that are easily and usually overlook'd. I remember, on this occasion, that though

28 Of the Mechanical Origine

in the Experiment above recited we observ'd, that Oyl of Vitriol and water being first shaken together, the volatil salt of Sal Armoniac being afterwards put to them, produced a sensible Coldness; yet I found, that if a little Oyl of Vitriol and of the volatile Salt were first put together, though soon after a considerable proportion of water were added, there would be produc'd not a Coldness, but a manifest degree of Heat, which would impell up the liquor in the Thermoscope to the height of some inches. And I remember too, that though Salt of Tartar will, as we shall see e're long, grow hot in the water, yet having distill'd some Salt of Tartar and Cinaber in a strong fire, and put the whole *Caput mortuum* into distill'd or Rain-water, it made indeed a hissing there as if it had been Quick-lime, but produced no Heat, that I could by feeling perceive. I shall adde, that not onely, as we have seen already, some unheeded Circumstances may promote

or

or hinder the artificial Production of Cold by particular Agents, but, which will seem more strange, some unobserv'd, and perhaps hardly observable, Indisposition in the Patient may promote or hinder the effects of the grand and Catholick Efficients of Cold, whatever those be. This suspicion I represent as a thing that further experience may possibly countenance, because I have sometimes found, that the degree of the Operation of Cold has been much varied by latent Circumstances, some bodies being more wrought upon, and others less, than was upon very probable grounds expected. And particularly I remember, that though Oyl of Vitriol be one of the fieriest liquors that is yet known, and does perform some of the Operations of fire it self, (as we shall elsewhere have occasion to shew) and will thaw Ice sooner than Spirit of Wine or any other liquor, as I have tried; yet having put about a pound or more, by our estimate, of choice rectified

C 3

Oyl

34 Of the Mechanical Origine

Oyl of Vitriol into a strong Glass-Vial proportionable to it, we found, that, except a little that was fluid at the top, it was all congeal'd or coagulated into a mass like Ice, though the Glass stood in a Laboratory where a fire was constantly kept not far from it, and where Oyl of Vitriol very seldom or never has before or since been observ'd to congeal or coagulate so much as in part. And the edness of our *Phænomenon* was increas'd by this Circumstance, that the Mass continued solid a good while after the weather was grown too mild to have such Operations upon Liquors far less indispos'd to lose their fluidity by Cold, than even common Oyl of Vitriol is. On the other side I remember, that about two years ago, I expos'd some Oyl of sweet Almonds hermetically seal'd up in a Glass-bubble, to observe what Condensation an intense cold could make of it, (for though Cold expands water, it condenses common oyl;) but the next day I
found

found to my wonder, that not onely the oyl remain'd unfrozen by the sharp frost it had been expos'd to, but that it had not its transparency troubled, though 'tis known, that oyl will be brought to concrete and turn opacous by a far less degree of Cold than is requisite to freeze water; notwithstanding which this liquor, which was lodged in a glass so thin, that 'twas blown at the flame of a Lamp, continued fluid and diaphanous in very frosty weather, so long till I lost the expectation of seeing it congeal'd or concreted. And this brings into my mind, that though Camphire be, as I formerly noted, reckon'd by many potentially cold, yet we kept some oyl of it, of our making, wherein the whole body of the Camphire remain'd, being onely by some Nitrous Spirits reduc'd to the form of an Oyl; we kept it, I say, in such intense degrees of Cold, that would have easily frozen water, without finding it to lose its Trans-

parency or its Fluidity.

And here I shall put an end to the first Section, (containing our Notes about *Cold*) the design of which may be not a little promoted by comparing with them the beginning of the ensuing Section. For if it be true, that (as we there shew) the nature of *Heat* consists either one-ly or chiefly in the local motion of the small parts of a body Mechanically modified by certain conditions, of which the principal is the vehemency of the various agitations of those insensible parts; and if it be also true, as Experience witnesses it to be, that, when the minute parts of a body are in or arrive at such a state, that they are more slowly or faintly agitated than those of our fingers or other organs of feeling, we judge them cold: These two things laid together seem plainly enough to argue, that a Privation or Negation of that Local Motion that is requisite to constitute Heat, may suffice for the denominating a body Cold, as Cold-
ness

ness is a quality of the Object, (which as 'tis perceiv'd by the mind, is also an affection of the Sentient :) And therefore an Imminution of such a degree of former motion as is necessary to make a body Hot as to sense, and which is sufficient to the Production of sensible Coldness, may be Mechanically made, since Slowness as well as Swiftmess being a Mode of Local motion is a Mechanical thing: And though its effect, which is Coldness, seem a Privation or Negation; yet the Cause of it may be a positive Agent acting Mechanically, by clogging the Agile Calorific Particles, or deadning their motion, or perverting their determination, or by some other intelligible way bringing them to a state of Coldness as to sense: I say Coldness as to sense; because as 'tis a Tactile Quality, in the popular acception of it, 'tis relative to our Organs of Feeling; as we see that the same luke-warm water will appear hot and cold to the same mans hands, if,

when

38 Of the Mechanical Origine

when both are plung'd into it, one of them shall have been newly held to the fire, and the other be benumbed with frost. And indeed the custom of speaking has introduced an ambiguity into the word *Cold*, which often occasions mistakes, not easily without much attention and sometimes circumlocution also to be avoided; since usually by *Cold* is meant that which immediately affects the sensory of him that pronounces a body *Cold*, whereas sometimes 'tis taken in a more general notion for such a Negation or Immixtion of motion, as though it operates not perceivably on our senses, does yet upon other bodies; and sometimes also it is taken (which is perhaps the more Philosophical sense) for a perception, made in and by the mind, of the alteration produced in the Corporeal Organs by the operation of that, whatever it be, on whose account a body is found to be cold.

But

But the Discussion of these Points is here purposely omitted, as for other Reasons, so principally because they may be found expressly handled in a fitter place.

SECT.

SECT. II.

Of the Mechanicall Origine or Production of HEAT.

After having dispatched the Instances I had to offer of the Production of Cold, it remains that I also propose some Experiments of *Heat*, which Quality will appear the ~~more likely to be Mechanically producible~~, if we consider the nature of it, which seems to consist mainly, if not onely, in that Mechanical affection of matter we call Local motion mechanically modified, which modification, as far as I have observed, is made up of three Conditions.

The first of these is, that the agitation of the parts be *vehement*, by which degree or rapidness, the motion proper to bodies that are hot
 distin-

distinguishes them from bodies that are barely *fluid*. For these, as such, require not near so brisk an agitation, as is wont to be necessary to make bodies deserve the name of *hot*. Thus we see that the particles of water in its natural (or usual) state, move so calmly, that we do not feel it at all warm, though it could not be a liquor unless they were in a restless motion; but when water comes to be actually hot, the motion does manifestly and proportionably appear more vehement, since it does not onely briskly strike our organs of feeling, but ordinarily produces store of very small bubbles, and will melt butter or coagulated oyl, cast upon it, and will afford vapours, that, by the agitation they suffer, will be made to ascend into the air. And if the degree of Heat be such as to make the water boil, then the agitation becomes much more manifest by the confus'd motions, and waves, and noise, and bubbles, that are excited, and by other
obvious

obvious effects and Phænomena of the vehement and tumultuous motion, which is able to throw up visibly into the air great store of Corpuscles, in the form of vapours or smoak. Thus in a heated Iron the vehement agitation of the parts may be easily inferr'd from the motion and hissing noise it imparts to drops of water or spittle that fall upon it. For it makes them hiss and boil, and quickly forces their particles to quit the form of a liquor, and flye into the air in the form of steams. And lastly, Fire, which is the hottest body we know, consists of parts so vehemently agitated, that they perpetually and swiftly flye abroad in swarms, and dissipate or shatter all the combustible bodies they meet with in their way; fire making so fierce a dissolution, and great a dispersion of its own fuel, that we may see whole piles of solid wood (weighing perhaps many hundred pounds) so dissipated in very few hours into flame and smoak, that oftentimes

tentimes there will not be one pound of Ashes remaining. And this is the first Condition required to Heat.

The second is this, that the *determinations be very various*, some particles moving towards the right, some to the left, hand, some directly upwards, some downwards, and some obliquely, &c. This variety of determinations appears to be in hot bodies both by some of the Instances newly mention'd, and especially that of flame, which is a body; and by the diffusion that metals acquire, when they are melted, and by the operations of Heat that are exercis'd by hot bodies upon others, in what posture or scituation soever the body to be heated be applied to them. As a thoroughly ignited Coal will appear every way red, and will melt wax, and kindle brimstone, whether the body be apply'd to the upper or to the lower, or to any other part of the burning Coal. And congruously to this Notion, though
air

44 Of the Mechanical Origine

air and water be mov'd never so vehemently, as in high Winds and Cataracts, yet we are not to expect that they should be manifestly hot, because the vehemency belongs to the progressive motion of the whole body; notwithstanding which, the parts it consists of may not be near so much quickned in their motions made according to other determinations, as to become sensibly hot. And this Consideration may keep it from seeming strange, that in some cases, where the whole body, though rapidly moved, tends but one way, 'tis not by that swift motion perceived to be made Hot.

Nay, though the agitation be very *various* as well as *vehement*, there is yet a third Condition required to make it Calorific, namely, that the agitated particles, or at least the greatest number of them, be so minute as to be singly *insensible*. For though a heap of sand or dust it self were vehemently and confusedly agitated by a whirlwind, the bulk of
the

the grains or Corpuscles, would keep their agitation from being properly Heat, though by their numerous strokes upon a man's face, and the brisk commotion of the spirits and other small particles that may thence ensue, they may perchance occasion the production of that Quality.

If some attention be employ'd in considering the formerly propos'd Notion of the nature of Heat, it may not be difficult to discern, that the Mechanical production of it may be divers ways effected. For, excepting in some few Anomalous cases, (wherein the regular course of things happens to be over-rul'd,) by whatever ways the *Insensible parts* of a body are put into a very *confus'd* and *vehement agitation*, by the same ways Heat may be introduc'd into that body: agreeably to which Doctrine, as there are several Agents and Operations by which this Calorific Motion (if I may so call it) may be excited, so there may be several ways of Mechanically producing

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Heat,

44 Of the Mechanical Origine

Heat, and many Experiments may be reduc'd to almost each of them, chance it self having in the Laboratories of Chymists afforded divers *Phenomena* referrable to one or other of those Heads. Many of the more familiar Instances, applicable to our present purpose, have been long since collected by our justly famous *Vernham* in his short, but excellent, Paper *de forma calidi*, wherein (though I do not acquiesce in every thing I meet with there) he seems to have been, at least among the Moderns, the Person that has first handled the Doctrine of *Heat* like an Experimentall Philosopher. I shall therefore decline accumulating a multitude of Instances of the Production of Heat, and I shall also forbear to insist on such known things, as the Incalescence observable upon the pouring either of Oyl of Vitriol upon Salt of Tartar, (in the making of *Tartarum Vitriolatum*) or of *Aqua fortis* upon Silver or Quicksilver, (in the dissolution of these Metals) but shall

shall rather chuse to mention some few Instances not so notorious as the former, but not unfit by their variety to exemplifie several of the differing ways of exciting Heat.

And yet I shall not decline the mention of the most obvious and familiar Instance of all, namely the Heat observed in Quick-lime upon the affusion of cold water, because among learned men, and especially Peripateticks, I find causes to be assign'd that are either justly questionable or manifestly erroneous. For as to what is inculcated by the Schools about the Incalescence of a mixture of Quick-lime and water by vertue of a supposed *antiperistasis* or Invigoration of the internal Heat of the Lime by its being invironed by cold water, I have elsewhere shewn, that this is but an Imaginary Cause, by delivering upon Experiment (which any man may easily make) that, if instead of cold water the liquor be poured on very hot, the ebullition of the Lime will not be the

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less,

46 Of the Metaphysical Origine

less, but rather the greater: And Oyl of Turpentine, which is a lighter, and is lookt upon as a subtler liquor than water, though it be poured quite cold on Quick-lime, will not, that I have observed, grow so much as sensibly hot with it.

And now I have mentioned the Incalcescence of Lime, which, though an abvious *Phænomenon*, has exercised the wits of divers Philosophers and Chymists, I will adde two or three Observations in order to an Inquiry that may be some other time made into the genuine Causes of it; which are not so easie to be found as many learned men may at first sight imagine. The acute *Helmont* indeed and his followers have ingeniously enough attempted to derive the Heat under consideration from the conflict of some Alcalizate and Acid salts, that are to be found in Quick-lime, and are dissolved, and so set at liberty to fight with one another by the water that slakes the Lime. But though we have some manifest marks
of

of an Alcalizate Salt in Lime, yet that it contains also an Acid Salt, has not, that I remember, been proved; and if the emerging of Heat be a sufficient reason to prove a latent acid Salt in Lime, I know not, why I may not infer, that the like Salt lies conceal'd in other bodies, which the Chymists take to be of the purest or meereft sort of *Alcalys*.

For I have purposely *EXPER. I.* tried, that by putting a pretty quantity of dry Salt of Tartar in the palm of my hand, and wetting it well in cold water, there has been a very sensible Heat produced in the mixture; and when I have made the trial with a more considerable quantity of salt and water in a Viol, the heat proved troublesomely intense, and continued to be at least sensible a good while after.

This Experiment seems to favour the opinion, that the Heat produced in Lime whilst 'tis quenching, proceeds from the *Empyreuma*, as the Chymists call it, or impression left

48 Of the Mechanical Origine

by the violent fire, that was employ'd to reduce the stone to Lime. But if by *Empyreuma* be meant a bare impression made by the fire, 'twill be more requisite than easie, to declare intelligibly, in what that impression consists, and how it operates to produce such considerable effects. And if the effect be ascribed to swarms of Atomes of fire, that remain adherent to the substance of the Lime, and are set at liberty to flye away by the liquor, which seems to be argued by the slaking of Lime without water, if it be for some time left in the air, whereby the Atomes of fire get opportunity to flye away by little and little: If this, I say, be alledged, I will not deny but there may be a sense, (which I cannot explicate in few words) wherein the Cooperation of a substantial *Effluviu*m, for so I call it, of the fire, may be admitted in giving an account of our *Phenomenon*. But the Cause formerly assigned, as 'tis crudely proposed, leaves in my mind

some

some Scruples. For 'tis not so easie to apprehend, that such light and minute bodies as those of fire are supposed, should be so long detained as by this Hypothesis they must be allowed to be, in Quick-lime, kept in well-stopt vessels, from getting out of so laxe and porous a body as Lime, especially since we see not a great Incalescence or Ebullition ensue upon the pouring of water upon *Minium*, or *Crocus Martis per se*, though they have been calcined by violent and lasting fires, whose Effluviiums or Emanations appear to adhere to them by the increase of weight, that Lead, if not also *Mars*, does manifestly receive from the Operation of the Fire. To which I shall adde, that, whereas one would think that the igneous Atoms should either flye away, or be extinguished by the supervening of water, I know, and elsewhere give account, of an *EXPER. II.* Experiment, in which two Liquors, whereof one was furnished

50 Of the Mechanical Drigine
nished me by Nature, did by being
several times separated and recon-
joyned without additament, at each
congress produce a sensible Heat.

And an Instance of
EXPER. III. this kind, though
not so odd, I pur-
posely sought and found in Salt of
Tartar, from which, after it had
been once heated by the affusion of
water, we abstracted or evaporated
the Liquor without violence of fire,
till the Salt was again dry; and then
putting on water a second time, the
same Salt grew hot again in the Vial,
and, if I misremember not, it pro-
duced this Incalescence the third
time, if not the fourth; and might
probably have done it oftner, if I
had had occasion to prosecute the
Experiment. Which seems at least
to argue, that the great violence of
fire is not necessary to impress what
passes for an *Empyreum* upon all
calcined bodies that will heat with
water.

And

And on this occasion I shall venture to adde , that I have sometimes doubted, whether the Incalescence may not much depend upon the particular Disposition of the calcined body , which being deprived of its former moisture , and made more porous by the fire, doth by the help of those igneous Effluviūms, for the most part of a saline nature , that are dispersed through it, and adhere to it, acquire such a Texture , that the water impell'd by its own weight, and the pressure of the Atmosphere, is able to get into a multitude of its pores at once, and suddenly dissolve the Igneous and Alcalizate Salt it every where meets with there , and briskly disjoyn the earthy and solid particles , that were blended with them; which being exceeding numerous , though each of them perhaps be very minute, and moves but a very little way , yet their multitude makes the confused agitation of the whole aggregate of them, and of the particles of the water and salt vehement

ment enough to produce a sensible Heat ; especially if we admit, that there is such a change made in the Pores, as occasions a great increase of this agitation, by the ingress and action of some subtile ethereal matter, from which alone *Monfieur des Cartes* ingeniously attempts to derive the Incalcescence of Lime and water, as well as that of metals dissolved in corrosive Liquors; though as to the *Phanomena* we have been considering, there seems at least to concur a peculiar disposition of body, wherein Heat is to be produced to do one or both of these two things, namely, to retain good store of the igneous *Effluvia*, and to be, by their adhesion or some other operation of the fire, reduced to such a Texture of its component Particles, as to be fit to have them easily penetrated, and briskly as well as copiously dissipated, by invading water. And this Conjecture (for I propose it as no other) seems favour'd by divers *Phanomena*, some whereof I shall
now

now annex. For here it may be observed, that both the dissolved Salt of Tartar lately mentioned, and the artificial Liquor that grows hot with the natural, reacquires that Disposition to Incalescence upon a bare Constipation or closer Texture of the parts from the superfluous moisture they were drowned in before: The Heat that brought them to this Texture having been so gentle, that 'tis no way likely that the igneous Exhalations could themselves produce such a Heat, or at least that they should adhere in such numbers as must be requisite to such an effect, unless the Texture of the Salt of Tartar (or other body) did peculiarly dispose it to detain them; since I have found by Trial, that Sal Armoniac dissolved in water, though boiled up with a brisker fire to a dry salt, would, upon its being again dissolved in water, not produce any Heat, but a very considerable degree of Cold. I shall adde, that though

EXPER. IV.

though one would expect a great Cognation between the particles of Fire adhering to Quick-Lime, and those of high rectified Spirit of Wine, which is of so igneous a nature, as to be totally inflammable; yet I have not found, that the affusion of Alkaol of Wine upon Quick-Lime, would produce any sensible Incalescence, or any visible dissolution or dissipation of the Lime, as common water would have done, though it seemed to be greedily enough soaked in by the lumps of Lime. And I further tried, that, if on this Lime so drenched I poured cold water, there ensued no manifest Heat, nor did I so much as find the lump swelled, and thereby broken, till some hours after; which seems to argue, that the Texture of the Lime was such, as to admit the particles of the Spirit of Wine into some of its pores, which were either larger or more congruous, without admitting it into the most numerous ones, whereinto the Liquor
must

must be received, to be able suddenly to dissipate the Corpuscles of Lime into their minuter particles, into which (Corpuscles) it seems that the change that the aqueous particles received by associating with the spirituous ones, made them far less fit to penetrate and move briskly there, than if they had enter'd alone.

I made also an Experiment that seems to favour our Conjecture, by shewing how much the Disposition of Lime to Incalescence may depend upon an idoneous Texture, and the Experiment, as I find it registred in one of my Memorials, is this.

EXPER. V.

[U]pon Quick-lime we put in a Retort as much moderately strong Spirit of Wine as would drench it, and swim a pretty way above it; and then distilling with a gentle

56 Of the Mechanical Origine

gentle fire, we drew off some Spirit of Wine much stronger than that which had been put on, and then the Phlegm following it, the fire was increas'd, which brought over a good deal of phlegmatic strengthless Liquor; by which one would have thought that the Quick-lime had been slaked; but when the remaining matter had been taken out of the Retort, and suffer'd to cool, it appear'd to have a fiery disposition that it had not before. For if any lump of it as big as a Nutmeg or an Almond was cast into the water, it would hiss as if a coal of fire had been plung'd into the Liquor, which was soon thereby sensibly heated. Nay, having kept divers lumps of this prepared *Calx* well cover'd from the air for divers weeks, to try whether it would retain this property, I found, as I expected, that the *Calx* operated after the same manner, if not more powerfully. For sometimes, especially when 'twas reduced to small pieces, it would upon
its

its coming into the water make such a brisk noise, as might almost pass for a kind of Explosion.]

These *Phænomena* seem to argue, that the Disposition that Lime has to grow hot with water, depends much on some peculiar Texture, since the aqueous parts, that one would think capable of quenching all or most of the Atomes of Fire that are supposed to adhere to Quick-lime, did not near so much weaken the disposition of it to Incalescence, as the accessi-
on of the spirituous Corpuscles and their Contexture, with those of the Lime, increased that igneous Disposition. And that there might intervene such an association, seems to me the more probable, not onely because much of the distill'd Liquor was as phlegmatick, as if it had been robb'd of its more active parts, but because I have sometimes had Spirit of Wine come over with Quick-lime not in unobserved steams, but white fumes. To which I shall adde, that, besides that the Taste, and perhaps
Odour

Odour of the Spirit of Wine, is often manifestly changed by a well-made Distillation from Quick-lime; I have sometimes found that Liquor to give the Lime a kind of Alcalizat penetrancy, not to say fieriness of Taste, that was very brisk and remarkable. But I will not undertake, that every Experimenter, nor I myself, shall always make trials of this kind with the same success that I had in those above recited, in regard that I have found Quick-limes to differ much, not onely according to the degree of their Calcination, and to their Recentness, but also, and that especially, according to the differing natures of the stones and other bodies calcined. Which Observation engages me the more to propose what hath been hitberto deliver'd about Quick-lime, as onely Narratives and a Conjecture; which I now perceive has detain'd us so long, that I am oblig'd to hasten to the remaining Experiments, and to be the more succinct in delivering them.

EXPER. VI.

And it will be convenient to begin with an instance or two of the Production of Heat, wherein there appears not to intervene any thing in the part of the Agent or Patient but Local Motion, and the natural Effects of it. And as to this sort of Experiments, a little attention and reflection may make some familiar *Phænomenon* apposite to our present purpose. When, for example, a Smith does hastily hammer a Nail or such like piece of iron, the hammer'd metal will grow exceeding hot, and yet there appears not any thing to make it so, save the forcible motion of the hammer which impresses a vehement and variously determin'd agitation of the small parts of the Iron; which being a cold body before, by that superinduc'd commotion of its small parts, becomes in divers senses hot; first in a

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60 Of the Mechanical Origin

more *lax* acceptation of the word in reference to some other bodies, in respect of whom 'twas cold before, and then *sensibly hot*; because this newly gain'd agitation surpasses that of the parts of our fingers. And in this Instance 'tis not to be overlookt, that oftentimes neither the hammer, *by* which, nor the anvil, *on* which a *cold piece of Iron* is forged, (for all iron does not require precedent ignition to make it obey the hammer) continue cold, after the operation is ended; which shews, that the Heat acquir'd by the forged piece of iron was not communicated by the Hammer or Anvil as Heat, but produc'd in it by motion, which was great enough to put so small a body as the piece of iron into a strong and confus'd motion of its parts without being able to have the like operation upon so much greater masses of metal, as the Hammer and the Anvil; though if the percussions were often and nimbly renew'd, and the Hammer were but small,
this

this also might be heated, (though not so soon nor so much as the iron;) by which one may also take notice, that 'tis not necessary, a body should be it self hot, to be calorific. And now I speak of striking an iron with a Hammer, I am put in mind of an Observation that *seems* to contradict, but does *indeed* confirm, our Theory: Namely, that, if a somewhat large nail be driven by a hammer into a plank or piece of wood, it will receive divers strokes on the head before it grow hot; but when 'tis driven to the head, so that it can go no further, a few strokes will suffice to give it a considerable Heat; for whilst, at every blow of the hammer, the nail enters further and further into the wood, the motion that is produc'd is chiefly progressive, and is of the whole nail tending one way; whereas, when that motion is stopt, then the impulse given by the stroke being unable either to drive the nail further on, or destroy its intireness, must be spent in making a

various vehement and intestine commotion of the parts among themselves, and in such an one we formerly observ'd the nature of Heat to consist.

EXPER. VII.

IN the foregoing Experiment the brisk agitation of the parts of a heated iron was made sensible to the *touch*; I shall now adde one of the attempts, that I remember I made to render it discoverable to the *eye* it self. In order to this, and that I might also shew, that not onely a sensible but an intense degree of heat may be produc'd in a piece of cold iron by Local Motion, I caus'd a bar of that metal to be nimbly hammer'd by two or three lusty men accustomed to manage that Instrument; and these striking with as much force, and as little intermission as they could upon the iron, soon brought it to that degree of Heat, that

that not onely 'twas a great deal too hot to be safely touched, but probably would, according to my design, have kindled Gunpowder, if that which I was fain to make use of had been of the best sort: For, to the wonder of the by-standers, the iron kindled the Sulphur of many of the grains of the corns of powder, and made them turn blue, though I do not well remember, that it made any of them go off.

EXPER. VIII.

BESIDES the effects of manifest and violent Percussions, such as those we have been taking notice of to be made with a hammer, there are among *Phænomena* obvious enough, some that shew the Producibleness of Heat even in cold iron, by causing an intestine commotion of its parts: For we find, that, if a piece of iron of a convenient shape and bulk be nimbly filed with a large rough File,

64 Of the Mechanical Organe

a considerable degree of Heat will be quickly excited in those parts of the iron where the File passes to and fro, the many prominent parts of the Instrument giving a multitude of strokes or pushes to the parts of the iron that happen to stand in their way, and thereby making them put the neighbouring parts into a brisk and confus'd motion, and so into a state of Heat. Nor can it be well objected, that upon this account the File it self ought to grow as hot as the iron, which yet it will not do; since, to omit other answers, the whole body of the File being moved to and fro, the same parts, that touch the iron this moment, pass off the next; and besides have leasure to cool themselves by communicating their newly received Agitation to the air before they are brought to grate again upon the iron, which, being supposed to be held immoveable, receives almost perpetual shakes in the same place.

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We find also, that Attrition, if it be any thing vehement, is wont to produce Heat in the solideſt bodies; as when the blade of a Knife being nimbly whetted grows preſently hot. And if having taken a braſs Nail, and driven it as far as you can to the end of the ſtick, to keep it faſt and gain a handle, you then ſtrongly rub the head to and fro againſt the floor or a plank of wood, you may quickly find it to have acquired a Heat intense enough to offend, if not burn ones fingers. And I remember, that going once in exceeding hot weather in a Coach, which for certain reaſons we cauſ'd to be driven very faſt, the attrition of the Nave of the Wheel againſt the Axle-tree was ſo vehement as oblig'd us to light out of the Coach to ſeek for water, to cool the over-chafed parts, and ſtop the growing miſchief the exceſſive Heat had begun to do.

The vulgar Experiment of ſtriking fire with a Flint and Steel ſufficiently declares, what a heat in a trice

66. Of the Mechanical Origine
may be produc'd in cold bodies by
Percussion, or Collision; the later of
which seems but mutual Percussion.

But Instances of the same sort
with the rest mention'd in this VI.
Experiment being obvious enough,
I shall forbear to multiply and insist
on them.

EXPER. IX.

FOR the sake of those that think
the Attrition of contiguous
air is necessary to the Producti-
on of manifest Heat, I thought a-
mong other things of the follow-
ing Experiment, and made Trial of
it.

We took some hard black Pitch,
and having in a Bason, Poringer, or
some such Vessel, placed it a conve-
nient distance under water, we cast
on it with a good Burning-glass the
Sun-beams in such a manner, that
notwithstanding the Refraction that
they suffer'd in the passage through
the

the interposed water, the *Focus* fell upon the Pitch, wherein it would produce sometimes bubbles, sometimes smoak, and quickly communicated a degree of Heat capable to make Pitch melt, if not also to boil.

E X P E R. X.

THough the first and second Experiments of Section I. shew, that a considerable degree of Cold is produc'd by the dissolution of Sal Armoniac in common water; yet by an additament, though but single, the Texture of it may be so alter'd, that, instead of Cold, a notable degree of Heat will be produced, if it be dissolved in that Liquor. For the manifestation of which we devis'd the following Experiment.

We took Quick-lime, and slaked it in common cold water, that all the igneous or other particles, to which its power of heating that Liquor

68 Of the Mechanical Dyzine
quor is ascrib'd , might be extracted
and imbib'd , and so the *Calx* freed
from them ; then on the remaining
powder fresh water was often pour-
ed, that all adhering reliques of Salt
might be wash'd off. After this, the
thus dulcified *Calx*, being again well
dried , was mingled with an equal
weight of powder'd Sal Armoniac,
and having with a strong fire melted
the mass , the mixture was poured
out ; and being afterwards beaten
to powder, having given it a com-
petent time to grow cold , we put
two or three ounces of it into a wide-
mouthed Glass , and pouring water
upon it, within about a minute of an
hour the mixture grew warm , and
quickly attain'd so intense a Heat,
that I could not hold the Glass in my
hand. And though this Heat did
not long last at the same height , it
continued to be very sensible for a
considerable time after.

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EXPER. XI.

TO confirm this Experiment by a notable variation; we took finely powder'd Sal Armoniac, and filings or scales of Steel, and when they were very diligently mixt (for that Circumstance ought to be observ'd) we caus'd them to be gradually sublim'd in a glass vessel, giving a smart fire towards the latter end. By this Operation so little of the mixture ascended, that, as we desired, far the greatest part of the Sal Armoniac staid at the bottom with the metal; then taking out the *Caput mortuum*, I gave it time thoroughly to cool, but in a Glass well stoppt, that it might not imbibe the moisture of the Air, (as it is very apt to do.) And lastly, though the Filings of Steel, as well as the Sal Armoniac, were bodies actually cold, and so might be thought likely to increase, not check,

check, the coldness wont to be produced in water by that Salt; yet putting the mixture into common water, there ensued, as we expected, an intense degree of Heat. And I remember, that having sublim'd the forementioned Salt in distinct Vessels, with the Filings of Steel, and with Filings of Copper, and for curiosities sake kept one of the *Caput mortuum*s (for I cannot certainly call to mind which of the two it was,) divers moneths, (if I mistake not, eight or nine,) we at length took it out of the Vessel, wherein it had been kept carefully stopt, and, upon trial, were not deceiv'd in having expected, that all that while the disposition to give cold water a notable degree of Heat was preserved in it.

EXPER. XII.

IF Experiments were made after the above recited manner with Sal Armoniac and other mineral bodies than Iron and Copper, 'tis not improbable, that some of the emerging *Phænomena* would be found to confirm what has been said of the Interest of Texture, (and some few other Mechanical Affections) in the Production of *Heat and Cold*. Which Conjecture is somewhat favoured by the following Trial. Three ounces of Antimony, and an equal weight of Sal Armoniac being diligently powder'd and mixt, were by degrees of fire sublimed in a Glass-vessel, by which Operation we obtain'd three differing Substances, which we caused to be separately powder'd, when they were taken out of the Subliming Glass, lest the air or time should make any change in them; and having before put the ball of a
good

72 Of the Mechanical Origine
good seal'd Weather-glass for a
while into water, that the Spirit of
Wine might be brought to the tem-
per of the external Liquor, we put
on a convenient quantity of the
powder'd *Caput mortuum*, which a-
mounted to two ounces, and seem'd
to be little other than Antimony,
which accordingly did scarce sensi-
bly raise the Spirit of Wine in the
Thermoscope, though that were a
tender one. Then laying aside that
water, and putting the Instrument
into fresh, of the same temper, we
put to it a very yellow Sublimate,
that ascended higher than the other
parts, and seem'd to consist of the
more sulphureous flowers of the An-
timony, with a mixture of the more
volatile parts of the Sal Armoniac.
And this Substance made the tinct-
ed Spirit in the Thermoscope de-
scend very slowly about a quarter of
an inch; but when the Instrument
was put into fresh water of the same
temper, and we had put in some of
the powder of the lower sort of Sub-
limate,

limate, which was dark coloured, though both the Antimony and Sal Armoniac, it consisted of, had been long exposed to the action of a Subliming Heat; yet the water was thereby speedily and notably cooled, insomuch, that the Spirit of Wine in the Weather-glass hastily descended, and continued to sink, till by our guess it had fallen not much short of three inches. Of these *Phænomena* the Etiology, as some Moderns call the Theory, which proposes the Causes of things, is more easie to be found by a little consideration, than to be made out in few words.

We made also an Experiment like that above recited, by subliming three ounces a piece of Minium and Sal Armoniac; in which Trial we found, that though in the *Caput mortuum*, the Salt had notably wrought upon the *Calx* of Lead, and was in part associated with it, as appear'd by the whiteness of the said *Caput mortuum*, by its sweetish Taste, and by

74 Of the Mechanical Dzigine

by the weight (which exceeded four drams that of all the *Minium*;) yet a convenient quantity of this powder'd mixture being put into water, wherein the former Weather-glass had been kept a while, the tinted Spirit of Wine was not manifestly either raised or deprest. And when in another Glass we prosecuted the Trial with the Sal Armoniac that had been sublimed from the *Minium*, it did indeed make the Spirit of Wine descend, but scarce a quarter so much as it had been made to fall by the lately mention'd Sublimate of Sal Armoniac and Antimony.

EXPER. XIII.

TIs known that many learned men, besides several Chymical Writers, ascribe the Incalescences, that are met with in the dissolution of Metals, to a conflict arising from a certain Antipathy or Hostility, which they suppose between the conflicting bodies, and particularly between the Acid Salt of the one, and the Alcalizate Salt, whether fixt or volatile, of the other. But since this Doctrine supposes a hatred between Inanimate bodies, in which 'tis hard to conceive, how there can be any true passions, and does not intelligibly declare, by what means their suppos'd Hostility produces Heat; 'tis not likely, that, for these and some other Reasons, Inquisitive Naturalists will easily acquiesce in it. And on the other side it may be consider'd, whether it be not more probable, that Heats, suddenly produ-

F

ced,

76 Of the Mechanical Origine

ced in mixtures, proceed *either* from a very quick and copious diffusion of the parts of one body through those of another, whereby both are confusedly tumbled and put into a caloric motion; *or* from this, that the parts of the dissolved body come to be every way in great numbers violently scatter'd; *or* from the fierce and confused shocks or justlings of the Corpuscles of the conflicting bodies, or masses which may be suppos'd to have the motions of their parts differingly modified according to their respective Natures: *Or* from this, that by the plentiful ingress of the Corpuscles of the one into the almost commensurate parts of the other, the motion of some ethereal matter that was wont before swiftly to permeate the distinct bodies, comes to be check'd and disturbed, and forced to either brandish or whirl about the parts in a confus'd manner, till it have settled it self a free passage through the new mixture, almost as the Light does thorow di-

vers

vers troubled liquors and vitrified bodies, which at length it makes transparent. But without *here* engaging in a solemn examination of the *Hypothesis* of *Alcali* and *Acidum*, and without determining whether any one, or more of the newly mention'd Mechanical Causes, or whether some other, that I have not yet named, is to be entitled to the effect; it will not be impertinent to propose divers Instances of the Production of Heat by the Operation of one Agent, *Oyl of Vitriol*, that it may be consider'd whether it be likely, that this single Agent should upon the score of Antipathy, or that of its being an Acid Menstruum, be able to produce an intense Heat in many bodies of so differing natures as are some of those that we shall have occasion to name. And now I proceed to the Experiments themselves.

F 2 Take

78 Of the Mechanical Origine

Take some ounces of strong Oyl of Vitriol, and shaking it with three or four times its weight of common water, though both the liquors were cold when they were put together, yet their mixture will in a trice grow intensely hot, and continue considerably so for a good while. In this case it cannot probably be pretended by the Chymists, that the Heat arises from the conflict of the Acid and Alcalizate Salts abounding in the two liquors, since the common water is suppos'd an elementary body devoid of all salts; and at least, being an insipid liquor, 'twill scarce be thought to have *Alcali* enough to produce by its Reaction so intense a Heat. That the Heat emergent upon such a mixture may be very great, when the Quantities of the mingled liquors are considerably so, may be easily concluded from one of my Memorials, wherein I find that no more than two ounces of Oyl of Vitriol being poured (but not all at once) into four ounces onely of distilled

stilled Rain-water, made and kept it manifestly warm for a pretty deal above an hour, and during no small part of that time, kept it so hot, that 'twas troublesome to be handled.

EXPER. XIV.

THe former Experiment brings into my mind one that I mention without teaching it in the History of Cold, and it appear'd very surprizing to those that knew not the ground of it. For having sometimes merrily propos'd to heat cold liquors with Ice, the undertaking seem'd extravagant if not impossible, but was easily perform'd by taking out of a bason of cold water, wherein divers fragments of Ice were swimming, one or two pieces that I perceived were well drenched with the liquor, and immersing them suddenly into a wide-mouth'd Glass wherein strong Oyl of Vitriol had

80 Of the Mechanical Engine

been put ; for this Menstruum , presently mingling with the water that adher'd to the ice, produc'd in it a brisk heat , and that sometimes with a manifest smoke , which nimbly dissolv'd the contiguous parts of Ice , and those the next , and so the whole Ice being speedily reduced to water , and the corrosive Menstruum being by two or three shakes well dispersed through it, and mingled with it, the whole mixture would grow in a trice so hot, that sometimes the Vial that contain'd it, was not to be endured in ones hand.

EX-

EXPER. XV.

NOtwithstanding the vast difference betwixt common water and high rectified Spirit of Wine, whereof men generally take the former for the most contrary body to fire, and whereof the Chymists take the later to be but a kind of liquid Sulphur, since it may presently be all reduc'd into flame; yet, as I expected, I found upon trial, that Oyl of Vitriol being mingled with pure Spirit of Wine, would as well grow hot, as with common water. Nor does this Experiment always require great quantities of the liquors. For when I took but one ounce of strong Oyl of Vitriol, though I put to it less than half an ounce of choice Spirit of Wine, yet those two being lightly shaken together, did in a trice conceive so brisk a Heat, that they almost fill'd the vial with fumes, and made it so hot, that I had una-

wares like to have burnt my hand with it before I could lay it aside.

I made the like Trial with the same Corrosive Menstruum, and common *Aqua vite* bought at a Strong-water-shop, by the mixture of which Liquors, Heat was produc'd in the Vial that I could not well endure.

The like success I had in an Experiment wherein Oyl of Vitriol was mixt with common Brandy; save that in this the Heat produced seem'd not so intense as in the former Trial, which it self afforded not so fierce a Heat as that which was made with rectified Spirit of Wine.

EXPER. XVI.

THose Chymists, who conceive that all the Incalescencies of bodies upon their being mixt, proceed from their antipathy or hostility, will not perhaps expect, that the parts of the same body, (either numerically, or in *specie*, as the Schools phrase it,) should, and that without manifest conflict, grow very hot together. And yet having for trials sake put two ounces of *Colcothar* so strongly calcin'd, that it was burnt almost to blackness, into a Retort, we poured upon it two ounces of strong Oyl of English Vitriol, and found, that after about a minute of an hour they began to grow so hot, that I could not endure to hold my hand to the bottom of the Vessel, to which the mixture gave a heat, that continued sensible on the outside for between twenty and thirty minutes.

EX-

EXPER. XVII.

THough I have not observ'd any Liquor to equal Oyl of Vitriol in the number of Liquors with which it will grow hot ; yet I have not met with any Liquor wherewith it came to a greater Incallescence than it frequently enough did with common *Oyl of Turpentine*. For when we caused divers ounces of each to be well shaken together in a strong vessel, fasten'd, to prevent mischief, to the end of a pole or staff; the Ebullition was great and fierce enough to be not undeservedly admired by the Spectators. And this brings into my mind a pleasant adventure afforded by these Liquors, of each of which, having for the Production of Heat and other purposes, caus'd a good bottle full to be put up with other things into a box, and sent down into the Countrey with a great charge,
that

that care should be had of the Glasses; the Wagon, in which the box was carried, happen'd by a great jolt, that had almost overturn'd it, to be so rudely shaken, that these Glasses were both broken, and the Liquors, mingling in the box, made such a noise and stink, and sent forth such quantities of smoke by the vents, which the fumes had open'd to themselves, that the Passengers with great outcries and much haste threw themselves out of the Wagon, for fear of being burnt in it.

The Trials we made with Oyl of Turpentine, when strong Spirit of Nitre was substituted in the stead of Oyl of Vitriol, belong not to this place.

EX-

EXPER. XVIII.

BUt though *Petroleum*, especially when rectified, be, as I have elsewhere noted, a most subtile Liquor, and the lightest I have yet had occasion to try; yet to shew you how much the Incalescence of Liquors may depend upon their Texture, I shall adde, that having mixt by degrees one ounce of rectified *Petroleum*, with an equal weight of strong Oyl of Vitriol, the former Liquor seemed to work upon the Surface of this last named, almost like a *Menstruum*, upon a metal, innumeros and small bubbles continually ascending for a while into the *Oleum Petreæ*, which had its colour manifestly alter'd and deepen'd by the operation of the spirituous parts. But by all the action and re-action of these Liquors, there was produced no such smoaking and boiling, or intense heat, as if Oyl of Turpen-
tine

tine had been employed instead of Oyl of Vitriol; the change which was produc'd as to *Qualities* being but a kind of Tepidness discoverable by the Touch.

Almost the like success we had in the Conjunction of *Petroleum*, and Spirit of Nitre, a more full account whereof may be elsewhere met with.

In this and the late Trials I did not care to make use of Spirit of Salt, because, at least, if it be but ordinarily strong, I found its operation on the Liquors above mention'd inconsiderable, (and sometimes perhaps scarce sensible) in comparison of those of Oyl of Vitriol, and in some cases of dephlegm'd Spirit of Nitre.

EXPER. XIX.

EXperienced Chymists will easily believe, that 'twere not difficult to multiply Instances of Heat producible by Oyl of Vitriol upon solid bodies, especially Mineral ones. For 'tis known, that in the usual preparation of *Vitriolum Martis*, there is a great effervescence excited upon the affusion of the Oyl of Vitriol upon Filings of Steel, especially if they be well drench'd in common water. And it will scarce be doubted, but that, as Oyl of Vitriol will (at least partly) dissolve a great many both calcin'd and testaceous bodies, as I have try'd with Lime, Oyster-shells, &c. so it will, during the dissolution, grow sensibly, if not intensely hot with them, as I found it to do both with those newly named, and others, as Chalk, *Lapis Calaminaris*, &c. with the last of which, if the Liquor be strong, it will heat exceedingly.

EX-

EXPER. XX.

Wherefore I will rather take notice of its Operation upon Vegetables, as bodies which corrosive Menstruums have scarce been thought fit to dissolve and grow hot with. To omit then Cherries, and divers Fruits abounding in watery juices, with which, perhaps on that very account, Oyl of Vitriol will grow hot; I shall here take notice, that for trial sake, having mixt a convenient quantity of that Liquor with Raisins of the Sun beaten in a Mortar, the Raisins grew so hot, that, if I misremember not, the Glass that contain'd it had almost burnt my hand.

These kind of Heats may be also produc'd by the mixture of Oyl of Vitriol with divers other Vegetable Substances; but, as far as I have observed, scarce so eminently with any dry body, as with the crumbs of
white

90 Of the Mechanical Engine
white bread, (or even of brown)
with a little of which we have some-
times produced a surprising degree
of Heat with strong or well-de-
phlegm'd Oyl of Vitriol, which is
to be suppos'd to have been em-
ployed in the foregoing Experi-
ments, and all others mention'd to
be made by the help of that Men-
struum in our Papers about Quali-
ties, unless it be in any particular case
otherwise declared.

EXPER. XXI.

TIs as little observed that Cor-
rosive Menstruums are able
to work, as such, on the soft parts of
dead Animals, as on those of Vege-
tables, and yet I have more than
once produced a notable Heat by
mixing Oyl of Vitriol with minced
flesh whether roasted or raw.

EXPER. XXII.

THough common Sea-salt does usually impart some degree, though not an intense one, of Coldness unto common water, during the act of Dissolution; yet some Trials have informed me, that if it were cast into a competent quantity of Oyl of Vitriol, there would for the most part insue an Incalescence, which yet did not appear to succeed so regularly, as in most of the foregoing Experiments. But that Heat should be produc'd usually, though not perhaps constantly, by the above-named Menstruum and Salt, seems therefore worthy of our notice, because 'tis known to Chymists, that common Salt is one main Ingredient of the few that make up common factitious Sal Armoniac, that is wont to be sold in the Shops. And I have been inform'd, that the excellent Academians of *Florence* have

observed, that Oyl of Vitriol would not grow hot but cold by being put upon Sal Armoniac: Something like which I took notice of in rectified Spirit of Sulphur made *per Campanam*, but found the effect much more considerable, when, according to the Ingenious *Florentine* Experiment, I made the Trial with Oyl of Vitriol; which Liquor having already furnished us with as many *Phenomena* for our present purpose as could be well expected from one Agent, I shall scarce in this Paper about Heat make any farther use of it, but proceed to some other Experiments, wherein it does not intervene.

EXPER. XXIII.

WE took a good lump of common Sulphur of a convenient shape, and having rub'd or chaf'd it well, we found, as we expected, that by this attrition it grew sensibly warm; and, That there was an intestine agitation, which you know is Local Motion, made by this attrition, did appear not onely by the newly mention'd Heat, whose nature consists in motion, and by the antecedent pressure, which was fit to put the parts into a disorderly vibration, but also by the sulphureous steams, which 'twas easie to smell by holding the Sulphur to ones nose, as soon as it had been rub'd. Which Experiment, though it may seem trivial in it self, may be worth the consideration of those Chymists, who would derive all the Fire and Heat we meet with in sublunary bodies from Sulphur. For in our case

a mass of Sulphur, before its parts were put into a new and brisk motion, was sensibly cold, and as soon as its parts were put into a greater agitation than those of a mans fingers, it grew sensibly hot; which argues, that 'twas not by its bare presence, or any emanative action, (as the Schools speak) that the Sulphur communicated any Heat to my hand; and also that, when 'twas briskly moved, it did impress that Quality, was no more than another solid body, though incombustible as common Glass, would have done, if its parts had been likewise put into an agitation surpassing that of my organs of feeling; so that in our Experiment, Sulphur it self was beholden, for its actual Heat, to Local Motion, produced by external agents in its parts.

EXPER. XXIV.

WE thought it not amiss to try, whether when Sal Armoniac, that much in frigidates water, and Quick-lime, which is known to heat it, were by the fire exquisitely mingled, the mixture would impart to the Liquor a moderate or an intense degree of either of those Qualities. In prosecution of which Inquiry we took equal parts of Sal Armoniac and Quick-lime, which we fluxed together, and putting an ounce, by ghefs, of the powder'd mixture into a Vial with a convenient quantity of cold water, we found, that the colliquated mass did, in about a minute, strike so great a heat through the Glass upon my hand, that I was glad to remove it hastily for fear of being scorched.

EXPER. XXV.

WE have given several, and might have given many more, Instances of the Incalescence of Mixtures, wherein both the Ingredients were Liquors, or at least one of them was a fluid body. But sometimes Heat may also be produc'd by the mixture of two powders; since it has been observed in the preparation of the Butter or Oyl of Antimony, that, if a sufficient quantity of beaten Sublimate be very well mingled with powder'd Antimony, the mixture, after it has for a competent time (which varies much according to circumstances, as the weather, vessel, place, &c. wherein the Experiment is made) stood in the air, would sometimes grow manifestly hot, and now and then so intently so, as to send forth copious and fetid fumes almost as if it would take fire. There is another Experiment

riment made by the help of Antimony, and a pulveriz'd body, wherein the mixture, after it had been for divers hours expos'd to the air, visibly afforded us mineral Fumes. And to these I could adde more considerable, and perhaps scarce credible, Instances of bodies growing hot without Liquors, if Philanthropy did not forbid me. But to return to our Butter of Antimony, it seems not unfit to be enquired, whether there do not unobservedly intervene an aqueous moisture, which (capable of relaxing the salts, and setting them a work) I therefore suspected might be attracted (as men commonly speak) from the air, since the mixture of the Antimony and the Sublimate is prescribed to be placed in Cellars; and in such we find, that Sublimate, or at least the saline part of it, is resolved *per deliquium*, (as they call it) which is nothing but a solution made by the watery steams wandering in the Air.

EXPER. XXVI.

I Have formerly deliver'd some Instances of the Incalescence produc'd by water in bodies that are readily dissolv'd in it, as Salt of Tartar and Quick-lime. But one would not lightly expect, that meer water should produce an Incalescence in solid bodies that are generally granted to be insoluble in it; and are not wont to be, at least without length of time, visibly wrought on by it; and yet trial has assured me, that a notable Incalescence may be produc'd by common water in flower or fine powder of Sulphur, and Filings of Steel or Iron. For when, in Summer time, I caus'd to be mingled a good quantity, (as half a pound or rather a pound of each of the Ingredients) and caus'd them to be thoroughly drenched with common water, in a convenient quantity whereof they were very well stirred

red up and down, and carefully mingled, the mixture would in a short time, perhaps less than an hour, grow so hot, that the Vessel that contain'd it could not be suffer'd in ones hand; and the Heat was manifested to other Senses than the Touch, by the strong sulphureous stink that invaded the nose, and the thick smoak that ascended out of the mixture, especially when it was stirr'd with a stick or spattle. Whether the success will be the same at all times of the year, I do not know, and somewhat doubt, since I remember not, that I had occasion to try it in other Seasons than in Summer, or in Autumn.

EX.

EXPER. XXVII.

IN the Instances that Chymistry is wont to afford us of the Heat produc'd by the action of Menstruums upon other bodies, there intervenes some liquor, properly so call'd, that wets the hands of those that touch it; and there are divers of the more judicious Chymists, that joyn with the generality of the Naturalists in denying, that Quicksilver, which is indeed a fluid body, but not a moist and wetting one in reference to us, will produce Heat by its immediate action on any other body, and particularly on Gold. But though I was long inclinable to their opinion, yet I cannot now be of it, several Trials having assur'd me, that a Mercury, whether afforded by Metals and Minerals, or impregnated by them, may by its preparation be enabled to insinuate it self nimbly into the
body

body of Gold, whether calcin'd or crude, and become manifestly incalescent with it in less than two or three minutes of an hour.

EXPER. XXVIII.

Since we know that some natural Salts, and especially Salt-peter, can produce a Coldness in the water they are dissolved in, I thought it might not be impertinent to our enquiry into Heat and Cold, and might perhaps also contribute somewhat to the discovery of the Structure of Metals, and the salts that corrode them, if Solutions were made of some Saliform'd bodies, as Chymists call them, that are made up of metalline and saline parts, and do so abound with the latter, that the whole Concretions are on their account dissoluble in common water.

Other

Other Experiments of this sort belonging less to this place than to another, I shall here onely for example sake take notice of one that we made upon Quicksilver, which is esteem'd the coldest of Metals. For having by distilling from it four times its weight of Oyl of Vitriol, reduc'd it to a powder, which on the account of the adhering Salts of the Menstruum that it detain'd, was white and glistering, we put this powder into a wide-mouth'd Glass of water, wherein a seal'd Weather-glass had been left before it began manifestly to heat the water, as appear'd by the quick and considerable ascent of the tincted Spirit of Wine, that continued to rise upon putting in more of the Magistery; which warm event is the more remarkable, because of the observation of *Helmont*, that the Salt adhering to the Mercury, corroded in good quantity by Oyl of Vitriol,

if

if it be washed off and coagulated, becomes a kind of Alom.

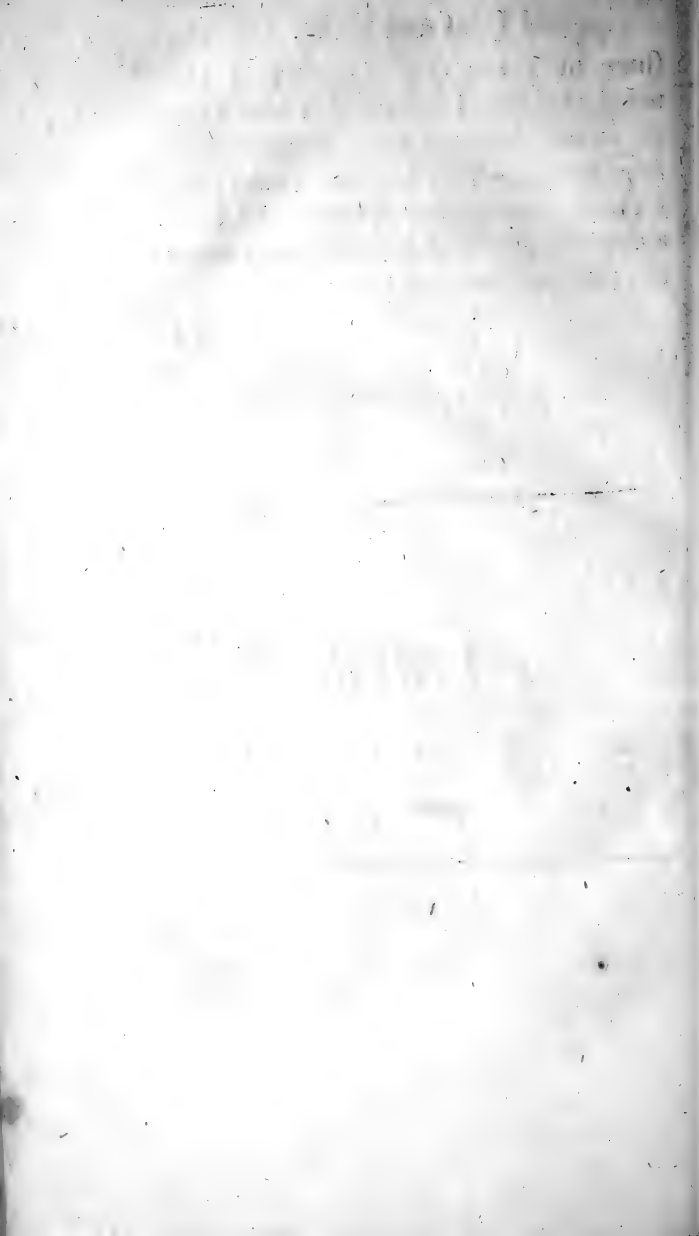
The event of the former Trial deserves the more notice, because having after the same manner and with the same Weather-glass made an Experiment with common water, and the powder of *Vitriolum Martis*, made with Oyl of Vitriol and the Filings of Steel, the tincted Spirit of Wine was not at all impell'd up as before, but rather, after a while, began to subside, and fell, though very slowly, about a quarter of an inch. The like Experiment being tried with powder'd Sublimate in common water, the liquor in the Thermoscope was scarce at all sensibly either rais'd or depress'd, which argued the alteration as to Heat or Cold, to have been either none or very inconsiderable.

Having

Having given warning at the beginning of this Section, that in it I aimed rather at offering various than numerous Experiments about the Production of Heat, I think what has been already deliver'd may allow me to take leave of this Subject without mentioning divers Instances that I could easily adde, but think it fitter at present to omit. For those afforded me by Trials about *Antiperistasis* belong to a Paper on that Subject. Those that might be offer'd about Potential Heat in humane bodies, would perchance be thought but unnecessary after what has been said of Potential Coldness; from which an attentive Considerer may easily gather, what according to our Doctrine is to be said of the contrary Quality. And divers *Phenomena*, which would have been of the most considerable I could have mentioned of the Production of Heat,
since

since in them that Quality is the most exalted, I reserve for the Title of *Combustibleness* and *Incombustibility*, having already suffer'd this Collection (or rather Chaos) of Particulars *about the Production of Heat* to swell to too great a bulk.

FINIS.



EXPERIMENTS,
AND
OBSERVATIONS,
About the
Mechanical Production
OF
TASTS.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Flesher*, for *R. Davis*
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EXHIBIT

OBITUARY

NOTICE

OF THE DEATH OF

ESTABLISHED

BY THE BOARD OF

HEALTH AND VITAL STATISTICS

OF THE CITY OF

NEW YORK

1900

(3)

EXPERIMENTS,

AND

OBSERVATIONS,

About the

Mechanical Production

OF

TASTS.

TO make out the Mechanical Origine or Production of *Sapors*, as far as is necessary for my present purpose, 'twill be expedient to premise in general, that, according to our notion of Tasts, they may depend upon the bigness, figure and motion of the saporifick corpuscles, considered separately, and as the affections of single and very minute particles of matter; or else in a state of conjunction, as two or more

A 2

of

of these affections, and the particles they belong to, may be combined or associated, either among themselves, or with other particles, that were not saporous before. And as these Coalitions and other Associations come to be diversified; so the Tasts, resulting from them, will be altered or destroyed.

But, to handle these distinctly and fully, were a task not onely too difficult and long, but improper in this place, where I pretend to deliver not Speculations, but matters of Fact: in setting down whereof nevertheless, to avoid too much confusion, I am content, where I can doe it readily and conveniently, in some of my Trials, to couch such references as may best point at those Heads, whence the Mechanical explications may be derived, and consequently our Doctrine confirmed.

By Tast considered as belonging to the Object, (under which Notion I here treat of it,) I mean that quality, or whatever else it be, which enables

bles a body by its operation, to produce in us that sensation, which we feel or perceive when we say we *tast*.

That this something, whether you will call it a quality, or whatever else it be that makes or denominates an object *saporous*, or rather (if I may be allowed a barbarous term) *saporifick*, may so depend upon the shape, size, motion, and other Mechanical affections of the small parts of the tasted body, and result from the association of two or more of them, not excluding their congruity or incongruity to the organs of Tasting, may be made probable by the following Instances.

Of the Mechanical

EXPER. I.

To divide a Body, almost insipid, into two Bodies of very strong and very differing Tasts.

THIS observed, that Salt-peter refined, and by that purification freed from the Sea-salt that is wont to be mingled with it, does rather cool the tongue, than make any great saporifick impressions on it. And though I will not say, that it is, as some have thought, an insipid body; yet the bitterishness, which seems to be its proper tast, is but very faint and languid. And yet this almost insipid body, being distilled by the way of Inflammation, (which I elsewhere teach,) or even by the help of an additament of such clay as is it self a tasteless body, will afford a Nitrous spirit, that is extreamly sharp or corrosive upon the tongue, and will dissolve several Metals themselves, and a fixt salt, that is likewise

Production of Tasts. 7

wise very strongly tasted, but of a taste altogether different from that of the Spirit, that is extremely sharp or corrosive upon the tongue; and accordingly, this salt will dissolve divers compact bodies that the other will not work on, and will precipitate divers metals and other concretes out of those solutions, that have been made of them by the Spirit.

EXPER. II.

Of two Bodies, the one highly Acid and corrosive, and the other Alkalizat and fiery, to produce a Body almost insipid.

THIS may be performed by the way I have elsewhere mentioned of composing Salt-peter. For if upon a liquour of fixt Nitre, made *per Deliquium*, you warily drop good Spirit of Nitre, till it be just enough to satiate the Alkaly, (for if there

be too much or too little, the Experiment may miscarry,) we may by a gentle evaporation, and sometimes without it, and that in a few minutes, obtain Crystals, which, being dried after they have been, if it be needfull, freed from any adhering particles, (not of their own nature,) will have upon the tongue neither a sharp nor an alkalizate tast, but that faint and scarce sensible bitterness that belongs to Salt-peter, if it be pure Salt-peter; for the impure may perhaps strongly relish of the common Salt that is usually contained in it.

The like production of Salt-peter we have sometimes made in far less time, and sometimes indeed in a trice, by substituting, in stead of the fixed Salt of Nitre, the saline parts of good Pot-ashes, carefully freed by solution and filtration from the earthy and feculent ones.

I have sometimes considered, whether the *Phænomena* of these two Experiments may not be explicated by supposing them to arise from the new
mag-

Production of Taste. 9

magnitudes and figures of the particles, which the fire, by breaking them, or forcibly rubbing them one against the other, or also against the Corpuscles of the additament, may be presumed to give them; as if, for example, since we find the larger and best formed Crystals of Nitre to be of a prismatical shape with six sides, we should suppose the corpuscles of Nitre to be little prisms, whose angles and ends are too obtuse or blunt to make vigorous and deep impressions on the tongue; and yet, if these little prisms be by a violent heat split, or otherwise broken, or forcibly made as it were to grind one another, they may come to have parts so much smaller than before, and endowed with such sharp sides and angles, that, being dissolved and agitated by the spittle that usually moistens the tongue, their smalness may give them great access to the pores of that organ, and the sharpness of their sides and points may fit them to stab and cut, and perhaps sear the nervous
and

and membranous parts of the organ of Taste, and that variously, according to the grand diversities, as to shape and bulk, of the saporifick particles themselves. And this being granted, it seemed further conceivable, that when the Alkalizate and Acid particles come to be put together in the fluid mixture, wherein they swam, many of them might, after a multitude of various justlings and occurrences, meet with one another so luckily and opportunely, as to recompose little prisms, or convene into other bodies, almost like those that made up the Crystals of Nitre, before 'twas exposed to the fire. To illustrate which, we may conceive, that, though a prism of iron may be so shaped, that it will be wholly unfit to pierce the skin; yet it may be so cut by transverse planes reaching to the opposite *bases* or ends, as to afford wedges, which, by the sharpness of their edges, may be fit both to cleave wood, and cut the skin; and these wedges, being again put together after a requisite

quisite manner, may recompose a prism, whose extreams shall be too blunt to be fit for the former use. This may be also illustrated by the breaking of a dry stick circularly cut off at the ends, which though it is unapt, whilst intire and of that bulk, to prick the hand; yet if it be violently broken, the ragged ends of it and the splinters may prove stiff, slender, and sharp enough to pierce and run into the hand: To which divers other such Mechanical Illustrations might be added. But, since I fear you think, as well as I, the main conjecture may not be worthy any farther prosecution, I shall not insist any longer on it. And because the historical part of these Experiments was for the main delivered by me already in the Essay about the *Analysis* and Redintegration of Nitre, I shall now proceed to other Trials.

EXPER.

EXPER. III.

*Of two Bodies, the one extremely bitter,
and the other exceeding salt, to make
an insipid mixture.*

TO make this Experiment, we must very warily pour upon Crystals made of Silver, dissolved in good Aqua fortis or Spirit of Nitre, strong brine made of common salt and water. For the mixture of these two being dried, and afterwards brought to fusion in a Crucible, and kept a competent while in that state, will afford a tough mass, the Chymists call *Luna Cornea*, which you may lick divers times, and scarce judge it other than insipid; nor will it easily be brought to dissolve in much more piercing Menstruums than our spittle, as I have elsewhere shewn.

EXPER.

EXPER. IV.

*Of two Bodies, the one extreamly sweet,
and the other salter than the strongest
Brine, to make an insipid mixture.*

THE doing of this requires some skill and much wariness in the Experimenter, who, to perform it well, must take a strong solution of *Minium*, made with an appropriated Menstruum, as good Spirit of Vinegar, or else *Saccharum Saturni* it self, dissolved in a convenient Vehicle; and then must have great care and caution to put to it, by degrees, a just proportion of strong Spirit of Sal Armoniac, or the like Urinous Spirit, till the whole be precipitated; and if the two former tasts are not sufficiently destroyed in the mixture, it may be dried and fluxed, as was above directed about *Luna Cornea*.

EXPER.

EXPER. V.

Of an insipid Body and a sour one, to make a Substance more bitter than Gall or Aloes.

THis is easily performed by dissolving in strong Spirit of Nitre or good Aqua fortis as much pure Silver as the Menstruum will take up; for, this solution being filtrated, has been often esteemed more bitter than so much Gall or Wormwood, or any other of those simples that have been famous for that quality: And if the superfluous moisture be abstracted, you may by coagulation obtain Crystals of Luna, that have been judged more strongly bitter than the solution it self. And that the corpuscles of these Crystals should leave a far more lasting tast of themselves, than the above-mentioned bitter bodies are wont to doe, will not seem so marvellous, as I remember some that tried have complained; if we
take

take notice, how deep the particles of these Crystals may pierce into the spongy organs of Taste, since, if one does but touch the pulp or nail of ones finger, (first a little wetted with spittle or otherwise,) with the powder of these Crystals, they will so penetrate the skin or nail, and stick so fast there, that you cannot in a reasonable time wash the stain off of the skin, and much less off of the nail, but it will continue to appear many hours on the former, and many days on the other.

EXPER. VI.

Of an insipid Body and a highly corrosive one, to make a Substance as sweet as Sugar.

THis is easily done, by putting upon good Minium purified Aqua fortis or Spirit of Nitre, and letting them work upon one another in a gentle heat, till the liquour have dissol-

dissolved its full proportion of the metal. For then, if the ingredients were good, and the operation rightly performed, the Menstruum would have a sweetness like that of ordinary *Saccharum saturni*. But 'twas not for nothing that I intimated, the ingredients should be also pure and good in their kind; for, if the *Minium* be adulterated, as often it is, or the Spirit of Nitre or Aqua fortis be mingled, as it is usual before it be purged with Spirit of common Salt or other unfit ingredients, the operation may be successless, as I have more than once observed.

EXPER. VII.

Of obtaining without addition from the sweetest Bodies, Liquours corrosive enough to dissolve Metals.

IF Sugar be put into a sufficiently capacious Retort, and warily distilled, (for otherwise it will be apt
to

to break the Vessel) it will afford, among other things, a copious red Spirit, which, being slowly rectified, will lose its colour, and come over clear. The *Caput Mortuum* of the Sugar, which I have more than once had of an odd Contexture, may be found either almost or altogether insipid. And though the Spirit will be of a very penetrant taste, yet it will be very far from any kind of sweetness; and though that liquor be thought to be homogeneous, and to be one of the Principles of the analyzed Sugar, yet (as I have elsewhere shewn) I found it to be a mixture of two Spirits; with the one of which, besides bodies of a less close Texture, I dissolved (even in the cold) crude Copper, as was easie to be seen by the deep and lovely colour of the solution. And to these four Spirits, afforded by Sugar it self, we have restored a kind of Saccharine sweetness, by compounding them with the particles of so insipid a body as Minium; part of which

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they

they will in digestion dissolve. A like Spirit to that distilled from Sugar may be obtained from *Honey*; but in regard of its aptness to swell exceedingly, Chymists are not wont to distill it without Sand, Brick, or some other additament.

EXPER. VIII.

To divide a Body, bitter in the highest degree, into two Substances, the one extremely sour, and the other perfectly insipid.

THIS is easily done by putting some fine Crystals of *Luna* into a good Retort, and then distilling them in a Sand-furnace, capable of giving them so strong a fire, as to drive away all the spirits from the Silver. For, this remaining behind, according to its metalline nature, will be insipid, and the spirits, that are driven away from it, will unite in the Receiver into an acid and corrosive Menstruum. EX-

EXPER. IX.

To produce variety of Tasts in one insipid Body, by associating it with divers Menstruums.

AS this operation may, upon the account I elsewhere mention, be serviceable to investigate the figures of the particles of dissolved metals and other bodies; so 'tis very fit to manifest, what we would here have it shew, how much Tast may be diversified by, and consequently depend upon, Texture; since a body that has no tast, may, in conjunction with sapid bodies, give them strong tasts all differing from one another, and each of them from that which the saporous bodies had before. I could propose divers ways of bringing this to trial, there being several insipid bodies, which I have found this way diversifiable. But because I remember not, that I have met with any mineral, that is

dissoluble by near so many saline Menstruums, as Zinke, I look on that as the most fertile Subject to afford Instances to our present purpose. For I have found, that it will be dissolved not onely by Aqua fortis, Aqua Regis, Oil of Vitriol, Spirit of Nitre, Spirit of Salt, and other mineral Menstruums, but also by Vegetable Spirits, as distilled Vinegar, and by Animal ones too, as Spirit of Sal Armoniac; though the one be Acid, and the other Urinous. And if the several Solutions, which may be made of this mineral, by so many differing liquours, be compared, the number of their differing tastes will suffice to make good the Title of the Experiment.

EXPER. X.

To produce variety of Tasts with one Menstruum, by associating it with insipid Bodies.

THis Proposition a Mathematician would go near to call the Converse of the foregoing; and as it may serve as well as that to discover the structure of the minute parts of divers metalline and mineral bodies; so it may not onely as well, but better than that, serve us to illustrate the Corpuscularian Doctrine of Tasts, by shewing us, that a single, and, as far as Chymistry teaches us, a simple body, endowed with a peculiar tast, may, by being compounded with others, each of them insipid of it self, produce a considerable number of differing tasts. There may be more Instruments than one made use of in this Trial; but of those that are known, and we may easily obtain, the most proper are Spirit of Nitre,

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and

and good Aqua fortis : For that, with refined *Silver*, will make a Solution bitter as Gall; with *Lead*, 'twill be of a Saccharine sweetness; with that part of *Tin*, which it will keep dissolved, (for the greatest 'tis wont but to corrode and præcipitate) it produces a tast very distant from both the former, but not odious; with *Copper*, it affords an abominable tast; with *Mercury* and *Iron*, it affords other kinds of bad Tasts. Nor are Metals the onely mineral bodies it will work upon : For, 'twill dissolve Tin-glass, Antimony, Brass; to which I could add Emery, Zinke, and other bodies whereon I have tried it. All which together will make up no despicable number of differing Tasts.

EXPER. XI.

Of two Liquours, the one highly corrosive, and the other very pungent and not pleasant, to compose a Body of a pleasant and Aromatick Taste.

THis Experiment, which I elsewhere mention to other purposes, does in some regards better suit our present design, than most of the foregoing; since here the Corrosive Menstruum is neither mortified by fixt nor urinous Salts, supposed to be of a contrary nature to it; nor yet, as 'twere, tired out nor disarm'd by corroding of metals or other solid bodies. The Experiment being somewhat dangerous to make at first in great, it may suffice for our present turn, to make it in the less quantity, as follows.

Take one ounce of strong Spirit of Nitre, or of very good Aqua fortis it self, and put to it by little and little, (which caution if you neglect, you

may soon repent it,) and another ounce of such rectified Spirit of Wine, as, being kindled in a Spoon, will flame all away : When these two liquours are well mixt, and grown cold again, you may, after some digestion, or, if hast require, without it, distill them totally over together, to unite them exquisitly into one liquor, in which, if the operation have been well performed, the corrosive particles of the Salts will not onely loose all their cutting acidity, wherewith they wounded the palat s but by their new composition with the Vinous Spirits, the liquor acquires a Vinous tast, that is not onely not acid or offensive, but very pleasing, as if it belonged to some new or unknown Spice.

EXPER. XII.

To imitate by Art, and sometimes even in Minerals, the peculiar Tasts of natural Bodies, and even Vegetables.

THis is not a fit place to declare, in what sense I do or do not admit of Souls in Vegetables, nor what I allow or deny to the Seminal or Plastick principle ascribed to Plants: But perhaps it will not be erroneous to conceive, that, whatever be the Agent in reference to those Tasts, that are said to be specifick to this or that Plant, that, on whose immediate account it is or becomes of this or that nature, is a complication of Mechanical Affections, as shape, size, &c. in the particles of that matter which is said to be endowed with such a specifick tast.

To illustrate this, I thought it expedient, to endeavour to imitate the tast of some Natural bodies by Artificial

cial Compositions or Preparations, but found it not easie, beforehand to be assured of the success of such Trials : And therefore I shall content my self here to mention three or four Instances, that, except the first, are rather Observations than such Experiments as we are speaking of.

I remember then, that, making some Trials to alter the sensible Qualities of Smell, Taste, &c. of Oil of Vitriol, and Spirit of Wine, I obtained from them, among other things that suited with my design, a certain Liqueur, which, though at first pleasant, would, at a certain nick of time, make one that had it in his mouth think it had been imbued with Garlick.

And this brings into my mind, that a skilful person, famous for making good Sider, coming one day to advise with me, what he should doe to heighten the tast of it, and make it keep the longer, complained to me, that having, among other trials, put into a good Vessel full of juice of Apples

Apples a certain proportion of Mustard-seed, with hopes it would make the Sider more spirituous and pickant, he found, to his wonder and loss, that, when he came to draw it, it stank of Garlick so rank, that every body rejected it.

I remember also, that, by fermenting a certain proportion (for that we found requisite) of *semen Dauci* with Beer or Ale, the Liquour had a very pleasant Relish of Limon-pills.

But that seems much more considerable, which I shall now add; That, with an insipid Metal and a very corrosive Menstruum, one may compound a tast, that I have several times observed to be so like a Vegetable, that I presume it may deceive many. This may be done by dissolving Gold, without any gross Salt, in the mixture of Aqua fortis and the Spirit of Salt, or even in common Aqua Regis, made by dissolving Sal Armoniac in Aqua fortis. For if the Experiment be happily made, one may obtain either a Solution or a Salt,

Salt, whose austere tast will very much resemble that of Sloes, or of unripe Bullace. And this tast, with some little variety, I found in Gold dissolved without any distilled Liquour at all; and also, if I much forget not, in Gold that by a peculiar Menstruum I had volatilized.

The last Instance I shall give of the imitation of Tasts, I found to have been, for the main, known to some ingenious Ladies. But to make the Experiment succeed very well, a due proportion is the principal Circumstance, which is wont to be neglected. I cannot readily call to mind that which I found to succeed best; but the Trial may be indifferently well made after such a manner as this:

Take a pint or a pound of *Malaga* or *Canary* Sack, (for though *French* and the like Wines may serve the turn, yet they are not so proper;) and put into it a drachm or two of good odoriferous Orrice Roots, cut into thin slices, and let them infuse
in

in the Liqueur a convenient time, 'till you perceive that they have given it a desired tast and smell; then keep the thus perfumed Wine exactly stopped in a cool place: According to which way, I remember, that (when I hit on the right proportion of Ingredients, and kept them a due time in infusion) I had many years ago a Wine, which, being coloured with *Cocheneele*, or some such tingeing ingredient, was taken for good Raspberry-Wine, not onely by ordinary persons, but, among others, by a couple of eminent Physicians, one of whom pretended to an extraordinary criticalness of palate on such occasions; both of them wondering, how at such an unlikely time of the year, as I chose to present them that Liqueur among others, I could have such excellent Raspberry-Wine: Some of which (to add that by the by) I found to preserve the specifick tast two or three years after it was made.

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EXCURSION

About some Changes made

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B Y

MATURATION.

IT will not perhaps be thought impertinent, but rather necessary, to add a word or two on this occasion for their sakes, that think the Maturation of Fruits, and the changes of Tasts, by which 'tis usually known, must needs be the effect of the Vegetable Soul of the Plant. For, after the Fruit is gathered, and so, by being no longer a part of the Tree, does,

does, according to the most common opinion, cease to be a part of the living Plant, as a Hand or a Foot cut off is no more reckoned among the Lims of the man it belonged to; yet 'tis very possible that some Fruits may receive maturation, after they have been severed from the Plants that bore them. For, not to mention, that Apples, gathered somewhat before the time, by lying in heaps, do usually obtain a mellowness, which seems to be a kind or degree of Maturation; or that Medlars, gathered whilst they are hard and harsh, do become afterwards in process of time soft and better tasted; in which state though some say they are rotten, yet others think that supposed rottenness is the proper Maturity of that kind of Fruit: Not to mention these, I say, or the like Instances, 'tis a famous Assertion of several Writers of the Indian affairs, that the Fruit they call *Bananas* is usually gathered green, and hung up in bunches or clusters in the house, where they ripen by degrees,

grees, and have an advantageous change made both of their colour and of their tast. And this an ancient acquaintance of mine, a literate and observing person, of whom I inquired about it, assured me, he had himself lately tried and found to be true in *America*. And indeed I see not, why a convenient degree of warmth, whether external from the Sun and Fire, or internal from some degree of fermentation or analogous intestine Commotion, may not (whether the Fruit be united to the Plant or no) put the saporifick Corpuscles into motion, and make them, by various and insensible transcurfions, rub against each other, and thereby make the little bodies more slender or thin, and less rigid, or cutting and harsh, than they were before, and by various motions bring the Fruit they compose to a state wherein it is more soft in point of consistence, and abound in Corpuscles less harsh and more pliable, than they were before, and more congruous
to

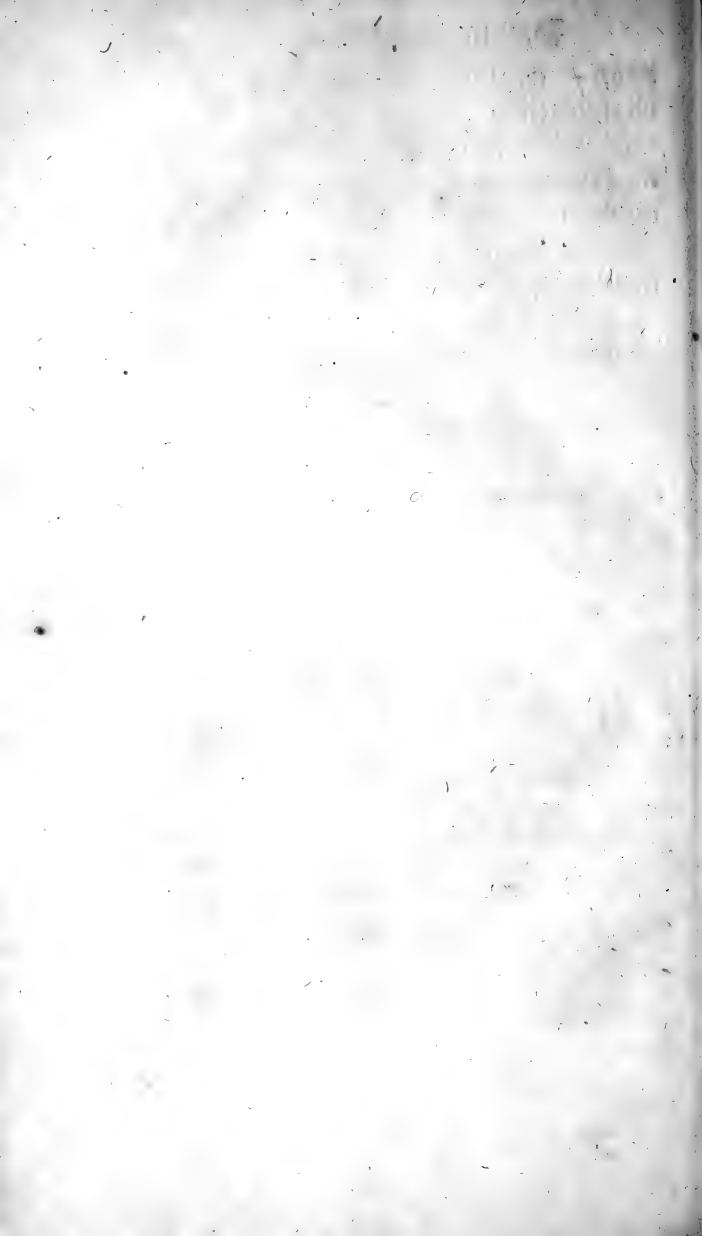
to the pores of the organ of Taste: And, in a word, make such a change in the constitution of the Fruit, as men are wont to express by the name of *Maturity*. And that such Mechanical changes of Texture may much alter the Qualities, and among them the Taste of a Fruit, is obvious in bruised Cherries and Apples, which in the bruised parts soon come to look and taste otherwise than they did before. The possibility of this is also obvious by *Wardens*, when slowly roasted in embers with so gentle a fire, as not to burn off the paper they are wont to be wrapt in, to be kept clean from the ashes. And I have seen, in the bordering Country betwixt *France* and *Savoy*, a sort of Pears, (whose name I now remember not,) which being kept for some hours in a moderate heat, in a Vessel exactly closed, with embers and ashes above and beneath them, will be reduced to a juicy substance of a lively red colour, and very sweet and luscious to the taste. Many other sorts

of Fruit in other Countries, if they were handled after the same way, or otherwise skilfully wrought on by a moderate heat, would admit as great alterations in point of tast. Neither is that sort of Pear to be here omitted, which by meer Compression, duly ordered, without external heat, will in a few minutes be brought to exchange its former hardness and harshness for so yielding a Texture and pleasant a tast, as I could not but think very remarkable. And that even more solid and stubborn Salts than those of Vegetables, may have the sharpness and piercingness of their tastes very much taken off by the bare internal action of one part upon the other, without the addition of any sweetning body, I have been induced to think by having found, upon trial, that, by the help of insipid Water, we may, without any violence of Fire, reduce Sea-salt into a Brine of so mild and peculiar (I had almost said) pleasant a tast, that one would scarce suspect what it had been,

been, or believe that so great a change of a Mineral body could be effected by so slight an intestine Commotion as indeed produced it; especially, since the alteration of tasts was not the most considerable that was produced by this Operation.

As to Liquours that come from Vegetables, the emerging of new *Sapors* upon the intestine Commotion of the saporifick parts, as Consequences of such Commotions, is more obvious than is commonly considered in the juice of Grapes, which, from a sweet and spiritless Liquour, do by that internal motion we call Fermentation, acquire that pleasing pungency and briskness of tast that belongs to Wine, and afterwards degenerates into that acid and cutting tast that is proper to Vinegar; and all this, by a change of Constitution made by the action of the parts themselves on one another, without the help of any external additament.

FINIS.



EXPERIMENTS,
AND
OBSERVATIONS,
About the
Mechanical Production
OF
ODOURS.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

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EXPERIMENTS,

AND

OBSERVATIONS,

About the

Mechanical Production

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ODOURS.

Since *Tasts* and *Odours* (perhaps by reason of the nearness of the Organs they affect) are wont, by Physical Writers, to be treated of next to one another, I also shall imitate them in handling those two Qualities, not onely for the intimated Reason, but because, what I have premised in general, and some other things that I have said already under the Title of *Tasts*, being applicable

4 Of the Mechanical
to Odours also, 'will not be necessary, and therefore 'would be tedious, to repeat them here.

EXPER. I.

With two Bodies, neither of them odorous, to produce immediately a strong Urinous smell.

TAke good Quick-lime and Sal Armoniac, and rub or grind them well together, and holding your Nose to the mixture, you will be saluted with an Urinous smell produced by the particles of the volatil Salt, untied by this operation, which will also invade your Eyes, and make them to water.

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EXPER. II.

By the bare addition of common Water, to produce immediately a very strong smell in a Body that had no such smell before.

THis is one of the Phænomena of an Experiment made with Camphire and Oil of Vitriol, which I have elsewhere mentioned to another purpose. For, if in that corrosive *Menstruum* you dissolve a good proportion, but not too much, of the strongly sented Gum, the odour of the Camphire will be quite concealed in the mixture; but if you pour this mixture into a good quantity of fair Water, the dissolved Gum will immediately recover out of the *Menstruum*, and smell as strong as before, if not (by reason of the warmth produced in the Operation) more strongly.

EXPER. III.

Of producing some Odours, each of them quite differing from that of any of the Ingredients.

HAVING taken two ounces (or parts) of clear Oil of Turpentine, and mixt it with one ounce (or part) of Oil of Vitriol, (which must be done by degrees, for otherwise the Vessel will be endangered,) the clear Liqueur that came over, upon the distillation of the mixture in a Sand-furnace, in stead of the odour of Turpentine, (for the Oil of Vitriol alone is wont to be inodorous,) smelt very strong of Sulphur; inlomuch that once, when I shewed this Experiment, approaching my Nose very boldly and hastily to the Receiver newly severed from the Retort, the sulphureous stink proved so strong, that it had almost (to speak with the vulgar) taken away my breath. And to illustrate yet farther the possible
emer-

emergency of such odours upon the mixture of Ingredients, as neither of them was apart endowed with, we caused the substance that remained behind in the Retort (in the form of a thin extract) after one of the newly mentioned Distillations to be farther pressed by a stronger fire, which forced most of it over, partly in the form of a thick Oil, and partly in that of Butter; both which we keep together in the same Vial, because their odour is neither that of Oil of Turpentine, nor that of Brimstone, but they smell exceedingly like the distilled Oil of Bees-wax.

EXPER. IV.

About the production of some Odours by Local motion.

I Shall not now examine, whether the Local motion of an external Agent may not, without materially concurring to the operation, produce,

duce, by agitating and shuffling the parts, odorous corpuscles: But that the celerity and other modifications of the Local motion of the *effluvia* of Bodies may not onely serve to diversifie their odours, but so far produce them, as to make them perceptible by the sense, which otherwise would not be so, may be gathered from some observations, which, being obvious, are not so proper for this place. Wherefore I shall rather take notice, that I know several Bodies that are not onely inodorous when cold, but when considerably hot, and are fixt in the fire, and yet, by having their parts put into a peculiar kind of agitation, will presently grow plainly odorous. On this occasion I shall add, that, as there are some very hard Woods, that acquire a strong smell by the motion they may be exposed to in a Turner's Lath, (as I have observed by trialls particularly made with the hard and ponderous *Lignum Vite*,) so some afford, whilst the operation lasts, an unexpected odour.

And

And having inquired about this matter of two eminent Artists, (whom I often employ,) concerning the odour of Beech-wood whilst it is turning, they both agreed, that it would emit well-sented *effluvioms*. And one of them affirmed to me farther, that, having bought a great block of that Wood, to make divers pieces of workmanship with it, when he came to turn it, there would issue out not onely a copious odour, but of such a peculiar fragrancy, that one that knew not whence it proceeded would have concluded he was smelling Roses.

EXPER. V.

By mixing a good proportion of a very strongly sented Body with an almost inodorous one, to deprive it speedily of all its smell.

TAke Salt of Tartar, and drop upon it either Spirit of Nitre or Aqua fortis not too much dephlegmed,

phlegmed, till all the effervescence cease, and the Liqueur will no longer work upon the Alkali. These, by a slow Evaporation of the superfluous moisture, may be made to shoot into Crystals like those of Nitre, which, after you have (if need be) by rubbing them with a dried cloath, freed them from loose adhering Corpuscles, will emulate Salt-peter, as in other Qualities, so in its not being odorous; though, if you distill them, or burn them on kindled coals, their fumes will quickly make you sensible, that they abounded with the stinking Spirits, that make *Aqua fortis* so offensive to the smell.

EXPER. VI.

By putting a very strongly stinking Body to another of a not sweet smell, to produce a mixture of a pleasant and strongly Aromatick odour.

WHat is here proposed is performed at the same time that the Eleventh of the foregoing Experiments of Tasts is made. For the Liquour thereby produced, if it be well prepared, has not onely a spicy *tast*, but also a kind of Aromatick and pleasant *smell*; and I have some now by me, that, though kept not over-carefully, does, after some years, retain much of its former odour, though not so much as of its *tast*.

EXPER. VII.

By digesting two Bodies, neither of them well sented, to produce Bodies of a very subtile and strongly fragrant odour.

WE took a pound (for instance) of Spanish Wine, and put to it some ounces of Oil of Vitriol; then, keeping them for a reasonable time in digestion, we obtained, as we expected, a mixture odoriferous enough. But this Triall you will find improved by that which insues.

EXPER. VIII.

By the bare addition of a Body almost inodorous, and not well sented, to give a pleasant and Aromatick Smell to Spirit of Wine.

THis we have several times done, by the ways elsewhere related for another scope, the summ of which, as far as it needs be mentioned in this place, is this.

We took good Oil of blew Vitriol (that was brought from *Dantzick*,) though the very common will serve well, and having put to it, by degrees, an equal weight of Spirit of Wine totally inflammable, we digested them together, for two, three, or four weeks, (sometimes much longer, and then with better success;) from which, when we came to distill the mixture, we had a very fragrant Spirit, which was sometimes so subtile, that, though distilled in a tall Glass with a gentle Heat, it would
(in

(in spite of our care to secure the closeness of the Vessels at the junctures) pierce through, and fill the Laboratory with a perfume, which, though men could not guess what body afforded it, yet they could not but wonder at it. Whence we may learn, both *how much* those spirituous and inflammable particles, the Chymists call the vegetable Sulphur of Wine, may work on and ennoble a mineral Sulphur; (for, that such an one there is in Oil of Vitriol, I have elsewhere proved by experience;) and *how much* the new Commissions and Contextures made by digestion may alter the odours of Bodies, whether Vegetable or Mineral. That also another Constitution of the same matter, without any manifest addition or recess of particles, may proceed to exhibit a very differing smell, will appear by the following Triall.

EXPER. IX.

To make the forementioned fragrant Body, without addition or fire, degenerate into the rank smell of Garlick.

TO make out this, I need onely relate, that I have more than once put the above mentioned fragrant Liqueur in stopt Glasses, whereof the one, and not the other, stood in a warm place, till in process of time I found that odoriferous Liqueur so to degenerate in point of sent, that one would have thought it to have been strongly infected with Garlick. And the like unpleasant Smell I observed in a certain Oil made of Vegetable and Mineral Substances distilled together.

And on this occasion I will add, (though not as an Argument,) this Observation, which though I shall not undertake it will always succeed, I think may not impertinently be set
down

down in this place, partly because of the likeness of the odour produced, to that which was the effect of the last named Triall; and partly (or rather chiefly) because it may shew us, that a Body, which it self is not onely inodorous, but very fixt, may yet, in some cases, have a great stroke in the *Phænomena* of Odours; whether by being wrought on by, and sometimes mingled with, the parts of the odorous body, and thereby giving it a new modification, I shall not now stay to enquire.

We took then good Salt of Tartar, and put to it several times its weight of the expressed juice of Onions; we kept them in a light digestion for a day or two, and then unstopping the Vial, we found the former smell of the Onions quite degenerated into a rank smell of Garlick, as was judged; even when fresh juice of Garlick was procured to compare them. To vary this Experiment, we made with fixt Salts, and some other strongly sented Juices, Trialls, whose events
 'twould

'twould perhaps be tedious here to relate.

EXPER. X.

With an inodorous Body, and another not well-sented, to produce a muskie smell.

THis we have sometimes done by casting into Spirit (not Oil) of Vitriol a large proportion of small Pearls unbroken. For the action of the acid Menstruum upon these being moderated, partly by the weakness of the Menstruum, and partly by the intireness of the Pearls, the dissolution would sometimes last many hours. Holding from time to time my nose to the open orifice of the Glass, 'twas easie to perceive a pleasant muskie smell, which also others, to whom I mentioned it, took notice of as well as I. And, if I misremember not, I took notice of the like smell, upon Pearls not onely
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dissol-

dissolved in Spirit of Vinegar, but in another Liqueur that had but a bad sent of its own. The foregoing Experiment calls to my mind that which follows.

EXPER. XI.

With fixt Metals, and Bodies either inodorous or stinking, to produce strong and pleasant smells, like those of some Vegetables and Minerals.

THat Gold is too fixt a body to emit any odour, and that Aqua Regis has an odour that is very strong and offensive, I think will be easily granted. But yet *Aurum fulminans* being made (as 'tis known) by precipitating with the inodorous Oil of Tartar the Solution made of the former in the latter, and this Precipitate being to be farther proceeded with in order to another Experiment; we fulminated it *per se* in a Silver Vessel like that, but better

ter contrived, that is (if I misremember not) somewhere described by *Glauberus*. And among other *Phænomena* of this operation, that belong not to this place, we observed with pleasure, that, when the fulmination was recently made, the steams, which were afforded by the metal that had been fired, were endowed with a delightful smell, not unlike that of musk. From which Experiment and the foregoing we may learn, that Art, by lucky Contextures, may imitate the odours that are presumed to be natural and specifick; and that Mineral and Vegetable Substances may compound a smell that is thought to be peculiar to Animals.

And as Art sometimes imitates Nature in the production of Odours, as may be confirmed by what is above related concerning counterfeit Raspberry-Wine, wherein those that drank it believed they did not onely taste, but smell the Raspberry; so sometimes Nature seems

*See in the
Paper of Tasts,
Exper. XII.*

to imitate her self, in giving like odours to bodies extreamly differing. For, not yet to dismiss the smell of Musk, there is a certain Seed, which, for the affinity of its odour to that perfume, they call the *Musk-seed*; and indeed, having some of it presented me by a Gentleman, that had newly brought it from the *West-Indies*, I found it, whilst 'twas fresh, to have a fragrancy suitable to the name that was given it. There is also a sort of Rats in *Muscovy*, whose skins, whereof I have seen several, have a smell that has procured them the name of *Musk-Rats*. To which I know not, whether we may not add the mention of a certain sort of Ducks, which some call *Musk-Ducks*, because at a certain season of the year, if they be chaf'd by violent motion, they will under the wing emit a musky instead of a sweaty sent; which upon trial I perceived to be true. On the other side, I have known a certain Wood growing in the *Indies*, which, especially when the sent is excited by
rub-

rubbing, stinks so rankly and so like *Paracelsus's Zibetum Occidentale*, (*stercus Humanum*,) that one would swear it were held under his Nose. And since I have been speaking of good scents produced by unlikely means, I shall not pretermitt this Observation, that, though generally the fire impresses a strong offensive smell, which Chymists therefore call *Empyreumatical*, upon the odorous bodies that it works strongly on; yet the constitution of a body may be such, that the new Contexture that is made of its parts, even by the violence of the fire, shall be fit to afford Effluvia rather agreeable to the organs of smelling, than any way offensive. For I remember, that, having for a certain purpose distilled *Saccharum Saturni* in a Retort with a strong fire, I *then* obtained, (for I dare not undertake for the like success to every Experimenter,) besides a piercing and Empyreumatical Liqueur that was driven over into the Receiver, a good Lump of a *Caput*

Mortuum of a grayish colour, which, notwithstanding the strong impression it had received from the fire, was so far from having any Empyreumatical sent, that it had a pleasing one, and when 'twas broken, smelt almost like a fine Cake new baked, and broken whilst yet warm. And as the fire, notwithstanding the *Empyreuma* it is wont to give to almost all the bodies it burns, may yet be reduced to confer a good smell on some of them, if they be fitted upon such a contexture of their parts to emit steams of such a nature, (whatever were the efficient cause of such a contexture;) so we observe in the *Musk animal*, that Nature in that Cat, or rather Deer, (though it properly belong to neither kind,) produces Musk by such a change, as is wont in other Animals to produce a putrefactive stink. So that, provided a due constitution of parts be introduced into a portion of matter, it may on that account be endowed with noble and desirable Sents, or other Qualities, though

though that Constitution were introduced by such unlikely means, as Combustion and Putrefaction themselves. In Confirmation of which, I shall subjoyn in the ensuing account a notable, though casual, Phænomenon, that occur'd to a couple of *Virtuosi* of my Acquaintance.

An eminent Professor of Mathematicks affirmed to me, that, chancing one day in the heat of Summer with another Mathematician (who I remember was present when this was told) to pass by a large Dunghil that was then in *Lincolns-Inn-fields*, when they came to a certain distance from it, they were both of them surprized to meet with a very strong smell of Musk, (occasioned, probably, by a certain degree or a peculiar kind of Putrefaction,) which each was for a while shy of taking notice of, for fear his Companion should have laughed at him for it; but, when they came much nearer the Dunghill, that pleasing smell was succeeded by a stink proper to such a heap of Ex-
B 4
crements,

crements. This puts me in mind of adding, that, though the excrements of Animals, and particularly their sweat, are usually foetid; yet, that 'tis not the nature of an excrement, but the constitutions, that usually belong to them, make them so, hath seemed probable to me upon some Observations. For, not to mention, what is related of *Alexander the Great*, I knew a Gentleman of a very happy Temperature of body, whose sweat, upon a critical examination, wherein I made use also of a surprize, I found to be fragrant; which was confirmed also by some Learned men of my acquaintance, and particularly a Physician that lay with him.

Though *Civet* usually passes for a Perfume, and as such is wont to be bought at a great rate; yet it seems to be but a clammy excrement of the Animal that affords it, which is secreted into Bags provided by Nature to receive it. And I the rather mention *Civet*, because it usually affords
a Phæ-

a Phenomenon that agrees very well with the Mechanical Doctrine concerning *Odours*, though it do not demonstrate it. For, when I have had the curiosity to visit divers of those Civet-Cats, (as they call them) though they have heads liker Foxes than Cats; I observed, that a certain degree of Laxity (if I may so style it) of the odorous Atmosphere was requisite to make the smell fragrant. For, when I was near the Cages, where many of them were kept together, or any great Vessel full of Civet, the smell (probably by the plenty, and perhaps the over-brisk motion of the *effluvia*,) was rather rank and offensive than agreeable; whereas, when I removed into the next room, or to some other convenient distance, the steams (being less crowded, and farther from their fountain,) presented themselves to my Nostrills under the notion of a Perfume.

And, not to dismiss this our Eleventh Experiment without touching once more

more upon Musk, I shall add, that an Ingenious Lady, to whom I am nearly related, shewed me an odd *Monkey*, that had been presented her as a rarity by the then Admiral of *England*, and told me, among other things, that she had observed in it, that, being sick, he would seek for Spiders as his proper remedies, for some of which he then seemed to be looking, and thereby gave her occasion to tell me this; which when he had eaten, the alteration it made in him would sometimes fill the room with a musky sent: But he had not the good luck to light on any whilst my visit lasted.

EXPER. XII.

To heighten good smells by Composition.

TIS well known to Perfumers, and is easie to be observed, that Amber-greece alone, though esteemed the best and richest perfume that

that is yet known in the world, has but a very faint and scarce a pleasant sent. And I remember, that I have seen some hundreds of ounces together newly brought from the *East-Indies*; but if I had not been before acquainted with the smell of Amber-greece alone, and had had onely the vulgar conceit of it, that 'tis the best and strongest of perfumes, my Nostrills would scarce have made me suspect those lumps to have been any thing a-kin to Amber-greece. But if a due proportion of Musk, or even Civet, be dexterously mixt with Amber, the latent fragrancý, though it be thereby somewhat compounded, will quickly be called forth, and exceedingly heightned. And indeed 'tis not, as 'tis commonly presumed, the plenty of the richest Ingredients, as Amber-greece and Musk, but the just proportion and skilful mixture of them, that makes the noblest and most lasting perfume, of which I have had sufficient experience; so that with a far less quantity of Musk
and

and Amber, than not onely ordinary persons, but Perfumers themselves are wont to imploy, we have had several Perfumes, that for fragrancy were much preferred to those where Musk and Amber-greece are so plentifully imployed. The proportions and ways of mixture we best approved of, would be too long, and are not necessary, to be here set down; but you will not much erre in making use of such a proportion as this, *viz.* eight parts of Amber-greece, two of Musk, and one of Civet: which quantities of Ingredients if they be skilfully and exactly mingled, you will not miss of a good Composition, with which you may innoble other materials, as *Benzoin, Storax, Sweet Flowers, &c.* fit to make Pastills, Ointments for Leather, Pomander, &c. And we may here add, that, upon the score of the new Texture acquired by Composition, some things, that are not fragrant themselves, may yet much heighten the fragrancy of Odoriferous bodies.

And

And of liquid perfumes I remember, 'twas the secret of some Court-Ladies, noted for Curiosity about perfumes, to mingle always a due proportion of Wine-vinegar with the odoriferous Ingredients. And on this occasion, to shew the power of mixtures in improving *Odours*, I shall add something about a Liqueur of mine, that has had the good fortune to be very favourably spoken of by persons of Quality accustomed to choice Perfumes. This Liqueur; though thought an elaborate preparation, as well for another reason, as to recommend it to some, whose Critical palates can tast the very titles of things, I called it *Essence of Musk*, is indeed a very plain simple preparation, which I thus make.

I take an arbitrary Quantity of choice Musk without finely powdering it, and pour upon it about a finger's breadth of pure Spirit of Wine; these in a Glass closely stopt I set in a quiet place to digest, without the help of any Furnace, and
after

after some days, or a few weeks, (according as Circumstances determined,) the Spirit, which is somewhat odd, will in the cold have made a solution of the finest parts of the Musk, and will be thereby much tinged, but not of a red colour. This Liqueur being decanted, I keep by it self as the richest of all; and pour a like quantity of Spirit on the remaining Musk, which usually will in the cold, though more slowly, draw a tincture, but fainter than the former, which being poured off, the remaining Musk may be employed for inferiour uses. Now that which made me mention this Preparation as pertinent to our present Subject, is this Phænomenon of it, that the first essence, or rather tincture, being smelt to by it self, has but a faint, and not very pleasing, odour of Musk, so that every body would not discover that there was Musk in it; but if a single drop, or two drops at most, were mixt with a pint, or perhaps a quart, of good Sack, the

the whole body of the Wine would presently acquire a considerably musky sent, and be so richly perfumed both as to tast and smell, as seemed strange enough to those that knew the vast disproportion of the Ingredients.

F I N I S.

38 SOLUTION OF DUBIUMS
the whole body of the Wine would
precisely acquire a consistency in-
ly less and be so richly perfumed
both as to taste and smell, as would
be enough to make the Wine
the most agreeable of the kind
dient.

F. T. L.

OF THE
IMPERFECTION
OF THE
Chymist's
DOCTRINE
OF
QUALITIES.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Flesher*, for *R. Davis*
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(3)

OF THE
I M P E R F C T I O N
OF
The Chymist's Doctrine
OF
Q U A L I T I E S.

CHAP. I.

Since a great part of those Learned Men, especially Physicians, who have discerned the defects of the vulgar Philosophy, but are not yet come to understand and relish the *Corpuscularian*, have slid into the Doctrine of the Chymists; and since the Spagyrist is wont to pretend to make out all the Qualities of bodies from the Predominancy of some one of their three *Hypostatical*

A 2

Prin-

4 Imperfection of the Chymist's Principles, I suppose it may both keep my opinion from appearing too presumptuous, and (which is far more considerable) may make way for the fairer Reception of the *Mechanical* Hypothesis about Qualities, if I here intimate (though but briefly and in general) some of those defects, that I have observed in Chymists Explications of Qualities.

And I might begin with taking notice of the *Obscurity* of those Principles, which is no small defect in Notions whose proper office it should be to conduce to the illustration of others. For, how can that facilitate the understanding of an obscure Quality or Phenomenon which is itself scarcely intelligible, or at least needs almost as much explanation as the thing 'tis designed & pretended to explicate? Now a man need not be very conversant in the writings of Chymists to observe, in how Laxe, Indefinite, and almost Arbitrary Senses they employ the Terms of *Salt*, *Sulphur* and *Mercury*; of which I could

could never find that they were agreed upon any certain Definitions or settled Notions; not onely differing Authors, but not unfrequently one and the same, and perhaps in the same Brook, employing them in very differing senses. But I will not give the Chymists any rise to pretend, that the chief fault that I find with their Hypothesis is but verbal; though that it self may not a little blemish any Hypothesis, one of the first of whose Requisites ought to be *Clearness*; and therefore I shall now advance and take notice of defects that are manifestly of another kind.

And first the Doctrine that all their Theory is grounded on, seems to me *Inevident* and undemonstrated, not to say precarious. It is somewhat strange to me, that neither the Spagyrist themselves, nor yet their Adversaries, should have taken notice, that Chymists have rather supposed than evinced, that the Analysis of bodies by fire, or even that at least some *Analysis* is the onely instrument of in-

6 **Imperfection of the Chymist's**
vestigating what Ingredients mixt bodies are made up of, since in divers cases That may be discovered by Composition as well as by Resolution; as it may appear, that Vitriol consists of metalline parts (whether Martial, or Venereal, or both) associated by Coagulation with acid ones, one may, I say, discover this as well by making true Vitriol with Spirit (improperly called Oil) of Sulphur, or that of Salt, as by distilling or Resolving Vitriol by the fire.

But I will not here enlarge on this subject, nor yet will I trouble you with what I have largely discoursed in the *Sceptical Chymist*, to call in question the grounds on which Chymists assert, that all mixt bodies are compounded of *Salt, Sulphur, and Mercury*. For it may suffice me now to tell you, that, whatsoever they may be able to obtain from other bodies, it does not appear by Experience, which is the grand, if not the onely, Argument they rely on, that all mixt bodies that have Qualities, consist of
their

their *tria prima*, since they have not been able, that we know, truly, and without new Compositions, to resolve into those three, either *Gold*, or *Silver*, or *Crystal*, or *Venetian Talck*, or some other bodies, that I elsewhere name; & yet these bodies are endowed with divers *Qualities*, as the two former with Fusibleness and Malleability, and all of them with Weight and Fixity; so that in these and the like bodies, whence Chymists have not made it yet appear, that their Salt, Sulphur and Mercury, can be truly and adequately separated, 'twill scarce be other than precarious, to derive the malleableness, colour, and other *Qualities* of such bodies from those Principles.

Under this Head I consider also, that a great part of the Chymical Doctrine of *Qualities* is bottom'd on, or supposes, besides their newly questioned Analysis by fire, some other things, which, as far as I know, have not yet been well proved, and I question whether they ever will be.

8 Imperfection of the Chymists's

One of their main Suppositions is, that this or that Quality must have its *πρῶτον δεκτικόν*, as *Sennertus*, the Learnedst Champion of this opinion, calls it, or some particular material Principle, to the participation of which, as of the primary native and genuine subject, all other bodies must owe it: But upon this point having purposely discoursed elsewhere, I shall now onely observe, that, not to mention Local motion and Figure, I think 'twill be hard to shew, what is the *πρῶτον δεκτικόν* of Gravity, Volatility, Heat, Sonorousness, Transparency and Opacity, which are Qualities to be indifferently met with in bodies whether simple or mixt.

And whereas the Spagyrist's are wont to argue, that, because this or that Quality is not to be derived truly from this or that particular Principle, as *Salt*, for instance, and *Mercury*; therefore it must needs be derivable from the third, as *Sulphur*. This way of arguing involves a farther Supposition than that newly examined.

For

For it implies, that every Quality in a compounded body must arise from some one of the *tria prima*, whereas experience assures us, that bodies may, by Composition, obtain Qualities, that were not to be found in any of the separate Ingredients. As we see in painting, that though blew and yellow be neither of them green, yet their mixture will be so. And though no single Sound will make an octave or *diapason*; yet two sounds, whose proportion is double, will have an eighth. And Tinn and Copper melted and mingled together in a due proportion, will make a bell-metal far more sonorous than either of them was before. 'Tis obvious enough for Chymists themselves to observe, that, though Lead be an insipid body, and Spirit of Vinegar a very sharp one, yet *Saccharum Saturni*, that is compounded out of these two, has a sweetness that makes it not ill deserve its name.

But this ill-grounded Supposition of the Chymists, is extended farther
in

10 Imperfection of the Chymist's
in an usual Topic of theirs, according
to which they conclude, That I know
not how many Qualities, as well ma-
nifest as occult, must be explicated
by their *tria prima*, because they are
not explicable by the four elements
of the *Peripateticks*. To make which
argumentation valid, it must be pro-
ved, (which I fear it will never be)
that there are no other ways, by
which those Qualities may be expli-
cated, but by a determinate number
of Material Principles, whether four
or three: Besides that, till they have
shewn that such Qualities may be in-
telligibly explicated by *their* Prin-
ciples, the objection will lye as strong
for the *Aristotelians* against them, as
for them against the *Aristotelians*.

CHAP. II.

NExt I consider, that there are
divers Qualities even in mixt
bodies, wherein it does not appear,
that the use of the Chymical Doctrine
is

is Necessary. As, for instance, when pure Gold is by Heat onely brought to fusion, and consequently to the state of fluidity, and upon the remission of that heat, grows a solid and consistent body again, what addition or expulsion or change of any of the *tria prima* does appear to be the cause of this change of consistence? Which is easie to be accounted for according to the *Mechanical* way, by the vehement agitation that the fire makes of the minute parts of the Gold to bring it to fusion; and the cohesion of those parts, by vertue of their gravity and fitness to adhere to one another, when that agitation ceases. When *Venice Glass* is meerly by being beaten to powder deprived of its Transparency and turned into a body opacous and white, what need or use of the *tria prima* have we in the explication of this Phænomenon? Or of that other which occurs, when by barely melting down this white and opacous body it is deprived of its opacity and colour, and becomes diapha-

12 Imperfection of the Chymist's diaphanous? And of this sort of Instances you will meet with divers in the following Notes about particular Qualities; for which reason I shall forbear the mention of them here.

CHAP. III.

I Observe too, that the Spagyricall Doctrine of Qualities is *Insufficient* and too narrow to reach to all the Phænomena or even to all the notable ones, that ought to be explicable by them. And this Insufficiency I find to be two-fold; for, *first*, there are divers Qualities, of which Chymists will not so much as attempt to give us explications, and of other particular Qualities the explications, such as they are, that they give us, are often very deficient and unsatisfactory; and do not sometimes so much as take notice of divers considerable Phænomena that belong to the Qualities whereof they pretend to give an account; of which you will

will meet with divers Instances in the ensuing Notes. And therefore I shall onely, (to declare my meaning the better,) invite you to observe with me, that though *Gold* be the body they affect to be most conversant with; yet it will be very hard to shew, how the specific weight of Gold can be deduced from any or all of the three Principles, since *Mercury* it self, that is of bodies, known to us, the heaviest next to Gold, is so much lighter than Gold, that, whereas I have usually found Mercury to be to an equal weight of water, somewhat, though little, less than fourteen to one, I find *pure* Gold to be about nineteen times as heavy as so much water. Which will make it very difficult, not to say impossible for them to explain, how Gold should barely by participating of Mercury, which is a body much lighter than it self, obtain that great specific gravity we find it to have; for the two other Hypostatical Principles, we know, are far lighter than Mercury. And I think

14 Imperfection of the Chymist's
think it would much puzzle the Chymists, to give us any examples of a compounded body, that is specifically heavier than the heaviest of the Ingredients that it is made up of. And this is the *first* kind of Insufficiency I was taking notice of in the Chymical Doctrine of Qualities.

The *other* is, That there are several bodies which the most Learned among themselves confess not to consist of their *tria prima*, and yet are indowed with Qualities, which consequently are not in those subjects to be explicated by the *tria prima* which are granted not to be found in them. Thus *elementary Water*, though never so pure, (as distilled Rain-water,) has fluidity and coldness and humidity and transparency and volatility, without having any of the *tria prima*. And the purest *Earth*, as Ashes carefully freed from the fixt salt, has gravity and consistence and dryness and colour and fixity, without owing them either to Salt, Sulphur, or Mercury; not to mention, that there are Cele-

Celestial bodies which do not appear, nor are wont to be pretended, to consist of the *tria prima*, that yet are indowed with Qualities. As the *Sun* has Light, and as many Philosophers think, Heat, and Colour; and the *Moon* has a determinate consistence and figuration, (as appears by her mountains) and Astronomers observe, that the higher Planets and even the Fixt stars appear to be differently coloured. But I shall not multiply Instances of this kind, because what I have said, may not onely serve for my present purpose, but bring a great Confirmation to what I lately said, when I noted, that the Chymical Principles were in many cases *not necessary* to explicate Qualities: For since in Earth, Water, &c. such diffused Qualities, as gravity, fixtness, colour, transparency and fluidity, must be acknowledged not to be derived from the *tria prima*; 'tis plain, that portions of matter may be endowed with such Qualities by other causes and agents than Salt,
Sulphur

16 Imperfection of the Chymist's Sulphur and Mercury. And then why should we deny, that also in compounded bodies those Qualities may be (sometimes at least) produced by the same or the like Causes? As we see, that the reduction of a diaphanous Solid to powder, produces whiteness, whether the comminution happens to Rock-crystal or to Venice-glass, or to Ice: The first of which is acknowledged to be a natural and perfectly mixt body; the second a factitious and not onely mixt but decomposed body; and the last, for ought appears, an elementary body, or at most very slightly and imperfectly mixt. And so by mingling Air in small portions with a diaphanous Liquor, as we do when we beat such a Liquor into foam, a whiteness is produced, as well in pure Water, which is acknowledged to be a simple body, as in white Wine, which is reckoned among perfectly mixt bodies.

CHAP.

C H A P. I V.

I Further observe, that the Chymists Explications do not reach deep and far enough. For *first*, most of them are not sufficiently distinct and full, so as to come home to the particular *Phenomena*, nor often times so much as to all the grand ones, that belong to the History of the Qualities they pretend to explicate. You will readily believe, that a Chymist will not easily make out by his Salt, Sulphur, and Mercury, why a Loadstone capp'd with steel may be made to take up a great deal more Iron, sometimes more than eight or ten times as much, than if it be immediately applied to the iron; or why, if one end of the Magnetic Needle is dispos'd to be attracted by the North-pole, for instance, of the Loadstone, the other Pole of the Loadstone will not attract it but drive it away: or, why a bar or rod of iron, being heated red-hot and cooled perpendi-

B cularly,

18 Imperfection of the Chymist's
cularly, will with its lower end drive
away the flower de Luce, or the
North-end of a Marriners Needle,
which the upper end of the same barr
or rod will not repell but draw to it.
In short, of above threescore Pro-
perties or notable Phænomena of
Magnetic Bodies, that some Writers
have reckon'd up, I do not remember
that any three have been by Chymists
so much as attempted to be solved by
their three Principles. And even in
those Qualities, in whose explicati-
ons these Principles may more pro-
bably than elsewhere pretend to have
a place, the Spagyrist's accounts are
wont to fall so short of being distinct
and particular enough, that they use
to leave divers considerable *Phæno-
mena* untouch'd, and do but very
lamey or slightly explicate the more
obvious or familiar. And I have so
good an opinion of divers of the em-
bracers of the Spagyrical Theory of
Qualities (among whom I have met
with very Learned and worthy men)
that I think, that if a Quality being
pro-

pos'd to them, they were at the same time presented with a good Catalogue of the Phænomena, that they may take, in the History of it, as it were with one view, they would plainly perceive that there are more particulars to be accounted for, than at first they were aware of; and divers of them such, as may quite discourage considering men from taking upon them to explain them all by the *Tria prima*, and oblige them to have recourse to more Catholic and comprehensive Principles. I know not, whether I may not add on this occasion, that, methinks, a Chymist, who by the help of his *Tria Prima*, takes upon him to interpret that Book of Nature of which the Qualities of bodies make a great part, acts at but a little better rate than he, that seeing a great book written in a Cypher, whereof he were acquainted but with three Letters, should undertake to decypher the whole piece. For though 'tis like, he would in many words find one of the Letters of his

20 Imperfection of the Chymist's
short key, and in divers words two
of them, and perhaps in some all
three; yet, besides that in most of
the words wherein the known Letter
or Letters may be met with, they
may be so blended with other un-
known Letters as to keep him from
decyphering a good part of those ve-
ry words, 'tis more than probable,
that a great part of the book would
consist of words wherein none of his
three Letters were to be found.

CHAP. V.

AND this is the *first* account, on
which I observe that the Chy-
mical Theory of Qualities does not
reach far enough: But there is *ano-
ther* branch of its deficiency. For
even, when the explications seem to
come home to the Phænomena, they
are not primary, and, if I may so
speak, *Fontal* enough. To make this
ap-

appear, I shall at present imploy but these two Considerations. The *first* is, that those substances themselves, that Chymists call their Principles, are each of them indowed with several Qualities. Thus *salt* is a consistent, not a fluid, body; it has its weight, 'tis dissoluble in water, is either diaphanous or opacous, fixt or volatile, sapid or insipid; (I speak thus disjunctively, because Chymists are not all agreed about these things; and it concerns not my Argument, which of the disputable Qualities be resolved upon.) And *sulphur*, according to *them*, is a body fusible, inflammable, &c. and, according to Experience, is consistent, heavy, &c. So that 'tis by the help of more primary and general Principles, that we must explicate some of those Qualities, which being found in bodies, supposed to be perfectly similar or homogeneous, cannot be pretended to be derived in one of them from the other. And to say, that 'tis the nature of a Principle to have this or that

22 Imperfection of the Chymist's
Quality, as, for instance, of Sulphur
to be fusible, and therefore we are
not to exact a Reason why it is so;
though I could say much by way of
answer, I shall now only observe, that
this Argument is grounded but upon
a supposition, and will be of no force,
if from the primary affections of bod-
ies one may deduce any good Me-
chanical Explication of Fusibility in
the general, without necessarily sup-
posing such a Primigeneal Sulphur,
as the Chymists fancy, or deriving
it from thence in other bodies. And
indeed, since not only Salt-peter, Sea
salt, Vitriol and Allum, but Salt of
Tartar, and the Volatile Salt of Urine
are all of them fusible; I do not well
see, how Chymists can derive the fu-
sibleness even of Salts obtained by
their own *analysis* (such as Salt of
Tartar and of Urine) from the par-
ticipation of the Sulphureous Ingredi-
ent; especially since, if such an at-
tempt should be made, it would over-
throw the *Hypothesis* of three Simple
bodies, whereof they will have all
mixt

mixt ones to be compounded; and still 'twould remain to be explicated, upon what account the Principle, that is said to endow the other with such a Quality, comes to be endowed therewith it self. For 'tis plain, that a mass of Sulphur is not an Atomical or Adamantine body; but consists of a multitude of Corpuscles of determinate Figures, and connected after a determinate manner: so that it may be reasonably demanded, why such a Convention of particles, rather than many another that does not, constitutes a fusible body.

CHAP. VI.

AND this leads me to a further Consideration, which makes me look upon the Chymists explications as not deep and radical enough; and it is this, that, when they tell us, for instance, that the fusibleness of bodies proceeds from Sulphur, in case they say true, they do but tell us *what* material Ingredient 'tis that being mingled with and dispers'd through the other parts of a body, makes it apt to melt: But this does not intelligibly declare, *what it is* that makes a portion of matter fusible, and *how* the sulphureous Ingredient introduces that disposition into the rest of the mass, wherewith 'tis commixt or united. And yet 'tis such explications as these, that an inquisitive Naturalist chiefly looks after, and which I therefore call *Philosophical*. And to shew, that there may be more *Fontal* explications, I shall only ob-

observe, that, not to wander from our present instance, Sulphur it self is fusible. And therefore, as I lately intimated, Fusibility, which is not the Quality of one Atome, or Particle, but of an Aggregate of Particles, ought it self to be accounted for in that Principle, before the Fusibleness of all other bodies be derived from it. And 'twill in the following notes appear, that in *Sulphur* it self that Quality may be probably deduced from the convention of Corpuscles of determinate shapes and sizes, contexed or connected after a convenient manner. And if either nature, or art, or chance, should bring together particles endowed with the like Mechanical Affections, and associate them after the like manner, the resulting body would be fusible, though the component particles had never been parts of the Chymists primordial sulphur: And such particles so convening might perhaps have made Sulphur it self, though before there had been no such body in the world.

26 Imperfection of the Chymist's world. And what I say to those Chymists, that make the sulphureous Ingredient the cause of fusibility, may easily, *mutatis mutandis*, be applied to their Hypothesis, that rather ascribe that quality to the Mercurial or the Saline Principle, and consequently cannot give a rational account of the fusibility of Sulphur. And therefore though I readily allow (as I shall have afterwards occasion to declare) that Sulphur, or an other of the *tria prima*, may be met with, and even abound in several bodies endowed with the quality that is attributed to their participation of that Principle; yet that this may be no certain sign that the propos'd Quality must flow from that Ingredient, you may perhaps be assisted to discern by this illustration, That if Tin be duly mixt with Copper or Gold, or, as I have tried, with Silver or Iron, it will make them very brittle; and it is also an Ingredient of divers other bodies that are likewise brittle, as blew, green, white, and otherwise colour'd, Amels, which

which are usually made of calcin'd Tin (which the Tradesmen call *Puttee*,) colligated with the Ingredients of Crystal-glass and some small portion of Mineral pigment. But though in all the above-named brittle bodies, Tin be a considerable Ingredient; yet 'twere very unadvised to affirm, that Brittleness in general proceeds from Tin. For provided the solid parts of consistent bodies touch one another but according to small portions of their surfaces, and be not implicated by their contexture, the Metalline or other Composition may be brittle, though there be no Tin at all in it. And in effect, the materials of glass being brought to fusion will compose a brittle body, as well when there is no *Puttee* colligated with them, as when there is. Calcin'd Lead by the action of the fire may be melted into a brittle mass, and even into transparent Glass, without the help of Tin or any other additament. And I need not add, that there are a multitude of other bodies, that cannot be pretend-

ed

28 Imperfection of the Chymist's
ed to owe their brittleness to any participation of Tin, of which they have no need, if the matter they consist of wants not the requisite Mechanical Dispositions.

And here I shall venture to add, that the way employed by the Chymists, as well as the Peripateticks, of accounting for things by the Ingredients, whether Elements, Principles, or other bodies, that they suppose them to consist of, will often frustrate the Naturalists expectation of events, which may frequently prove differing from what he promis'd himself, upon the Consideration of the Qualities of each Ingredient. For the ensuing Notes contain divers Instances, wherein there emerges a new Quality differing from, or even contrary to, any that is conspicuous in the Ingredients; as two transparent bodies may make an opacous mixture, a yellow body and a blew, one that is green, two malleable bodies, a brittle one, two actually cold bodies, a hot one,

one, two fluid bodies, a consistent one, &c. And as this way of judging by material Principles hinders the foreknowledg of Events from being certain; so it much more hinders the assignation of Causes from being satisfactory; so that perhaps some would not think it very rash to say, that those who judg of all mixt bodies as Apothecaries do of Medicines, barely by the Qualities and Proportions of the Ingredients (such as among the *Aristotelians* are the four Elements, and among the Chymists the *tria prima*,) do, as if one should pretend to give an account of the Phænomena and operations of Clocks and Watches, and their Diversities by this, That some are made of brass wheels, some of iron, some have plain ungilt wheels, others of wheels overlaid with Gold, some furnished with gutstrings, others with little chains, &c. and that therefore the Qualities and Predominancies of these metalls that make parts of the Watch, ought to have ascribed to them, what indeed
flows

30 Imperfection of the Chymist's
flows from their Coordination and
Contrivance.

CHAP. VII.

THE *last* defect I observe in the Chymical Doctrine of Qualities, is, that in many cases it agrees not well with the Phænomena of Nature, and that by one or both of these ways. *First*, there are divers changes of Qualities, wherein one may well expect, that a Chymical Principle should have a great stroak, and yet it does not at all appear to have so. He that considers, what great operations divers of the Hermeticks ascribe to this or that Hypostatical Principle, and how many Qualities according to them must from it be derived, can scarce do other than expect, that a great change as to those Qualities happening in a mixt body, should at least be accompany'd with some notable action *of*, or alteration *in* the Prin-

Principle. And yet I have met with many instances, wherein Qualities are produced, or abolished, or very much altered, without any manifest introduction, expulsion, or considerable change of the Principle, whereon *that* Quality is said to depend, or perhaps of either of the two *others*: As when a piece of fine silver, that having been neald in the fire, and suffer'd to cool leisurely, is very flexible, is made stiff and hard to bend, barely by a few stroaks of a hammer. And a string of a Lute acquires or loses a sympathy, as they call it, with another string of the same or another Instrument, barely by being either stretch'd so as to make an Unison with it, or screw'd up or let down beyond or beneath that degree of Tension.

To multiply instances of this kind would be to anticipate those, you will hereafter meet with in their due places. And therefore I shall pass on from the first sort of *Phænomena*, that favour not the Chymical Hypothesis
about

32 Imperfection of the Chymist's
about Qualities, to the other which
consists of those, wherein either that
does not happen which according to
their Hypothesis ought to happen, or
the contrary happens to what accord-
ing to their Hypothesis may justly be
expected. Of this you will meet with
instances hereafter ; I shall now trou-
ble you but with one, the better to
declare my meaning. 'Tis not un-
known to those Chymists, that work
much in Silver and in Copper, that
the former will endure Ignition and
become red-hot in the fire, before it
will be brought to fusion ; and the
latter is yet far more difficult to be
melted down than the other ; yet if
you separately dissolve those two
metalls in *Aqua fortis*, and by evapo-
ration reduce them to Crystals ;
these will be brought to fusion in a
very little time, and with a very mo-
derate Heat, without breaking the
glasses that contain them. If you
ask a vulgar Chymist the cause of
this facility of fusion, he will proba-
bly tell you without scruple, that 'tis
from

from the saline parts of the *Aqua fortis*, which, being imbodyed in the metals and of a very fusible nature, impart that easiness of fusion to the metals they are mixt with. According to which plausible explication one might well expect, that, if the saline Corpuscles were exquisitly mingled with Tin, they would make it far more fusible than of it self it is. And yet, as I have elsewhere noted, when I put Tin into a convenient quantity of *Aqua fortis*, the metal being corroded, subsided, as is usual, in the form of whites of eggs, which being well dried, the Tinn was so far from being grown more fusible by the addition of the saline particles of the *Menstruum*, that, whereas 'tis known that simple Tin will melt long before it come to be red-hot, this prepar'd Tin would endure for a good while not only a thorow ignition, but the blast of a pair of double bellows, (which we usually imploy'd to melt Silver and Copper it self,) without being at all brought to fusion. And

34 Imperfection of the Chymist's
as for those Spagyrist's that admit, as
most of them are granted to do, that
all kinds of metals may be turned into
Gold by a very small proportion of
what they call the Philosophers
Elixir, one may I think shew them
from their own concessions, that di-
vers Qualities may be changed even
in such constant bodies as Metals,
without the addition of any consider-
able proportion of the simple Ingre-
dients, to which they are wont to as-
cribe those Qualities; provided the
Agent, (as an efficient rather than as a
material Cause,) be able to make a
great change in the Mechanical af-
fections of the parts whereof the
metal it acts on is made up. Thus if
we suppose a pound of Silver, a pound
of Lead, and a pound of Iron to be
transmuted into Gold, each by a grain
of the powder of projection, this
tinging powder, as a material Cause
is inconsiderable, by reason of the
smallness of its bulk, and as an effi-
cient cause it works differing and even
contrary effects, according to the dis-
position,

position, wherein it finds the metal to be transmuted, and the changes it produces in the constituent Texture of it. Thus it brings Quick-silver to be fixt, which it was not before, and deprives it of the Fluidity which it had before; it brings Silver to be indissolvable in *Aqua fortis*, which readily dissolved it before, and dissoluble in *Aqua Regis*, which before would not touch it; and which is very considerable to our present purpose, whereas it makes Iron much more fusible than *Mars*, it makes Lead much less fusible than whilst it retained its pristine form, since *Saturn* melts ere it come to ignition, which Gold requires to bring it to fusion. But this is proposed only as an Argument *ad hominem*, till the Truth of the transmutation of metals into Gold, by way of projection, be sufficiently proved, and the circumstances and phænomena of it particularly declared.

I must not forget to take notice, that some learned modern Chymists would be thought to explicate divers

36 Imperfection of the Chymist's
of the Changes that happen to Bodies
in point of Odours, Colours, &c. by
saying that in such alterations the Sul-
phur or other Hypostatical Principle
is *intraverted* or *extraverted*, or, as o-
thers speak, *inverted*. But I confess,
to me these seem to be rather new
terms than real explications. For, to
omit divers of the Arguments men-
tioned in this present Treatise, that
may be applied to this way of solving
the Phænomena of Qualities, one may
justly object, that the supposed Ex-
traversion or Intraversion of Sulphur
can by no means reach to give an ac-
count of so great a variety of Odours,
Colours, and other Qualities as may
be found in the changed portions of
matter we are speaking of. And
which is more, what they call by these
and the like names, cannot be done
without Local motion transposing the
particles of the matter, and conse-
quently producing in it a change of
Texture, which is the very thing we
would infer, and which being suppo-
sed, we may grant Sulphur to be often-
times

times actually present in the altered Bodies, without allowing it to be always necessary to produce the alterations in them, since Corpuscles so condition'd and contex'd would perform such Effects, whether Sulphur, as such, did, or did not, make up the subject-matter of the Change.

And now I shall conclude, and partly recapitulate what has been delivered in this and the two foregoing Chapters, with this summary consideration, That the Chymist's Salt, Sulphur and Mercury themselves are not the first and most simple Principles of Bodies, but rather primary Concretions of Corpuscles or Particles more simple than they, as being endowed only with the first, or most radical (if I may so speak) and most Catholick Affections of simple Bodies, namely Bulk, Shape, and Motion, or Rest; by the different Conventions or Coalitions of which minutest portions of matter are made those differing Concretions that Chymists name Salt, Sulphur and

38 Imperfection of the Chymist's Mercury. And to this Doctrine it will be consonant, that several Effects of this or that Spagyricall Principle need not be derived from Salt, for instance, or Sulphur as such, but may be explained by the help of some of those Corpuscles that I have lately call'd more Simple and Radical; and such Explications being more simple and Mechanical, may be thought upon that score more fundamental and satisfactory.

CHAP. VIII.

I Know it may be objected in favour of the Chymists, that as their Hypostatical Principles, Salt, Sulphur and Mercury, are but three, so the Corpuscularian Principles are but very few; and the chief of them *Bulk*, *Size*, and *Motion*, are but three neither; so that it appears not why the Chymical Principles should be more

more barren than the Mechanical. To which allegation I answer, that, besides that these last nam'd Principles are more numerous, as taking in the Posture, Order, and Scituation, the Rest, and, above all, the almost infinitely diversifiable Contextures of the small parts, and the thence resulting structures of particular bodies, and fabrick of the world: Besides this, I say, each of the three Mechanical Principles, specified in the objection, though but one in name, is equivalent to many in effect; as *Figure*, for instance, comprehends not only Triangles, Squares, Rhombusses, Rhomboids, Trapezions, and a multitude of Polygons, whether ordinate or irregular; but, besides Cubes, Prismes, Cones, Spheres, Cylinders, Pyramids, and other Solids of known Denominations, a scarce numerable multitude of hooked, branched, Eel-like, screw-like, and other irregular bodies; whereof though these, and some others, have distinct appellations, yet the greatest

40 Imperfection of the Chymist's
part are nameless; so that it need be
no wonder, that I should make the
Mechanical Principles so much
more fertile, that is, applicable to
the production and explication of a
far greater number of *Phenomena*, than
the *Chymical*; which, whilst they
are considered but as similar bodies,
that are Ingredients of mixt and com-
pounded ones, are chiefly variable
but by the greater or lesser quanti-
ty that is employed by Nature or Art
to make up the mixt body. And
Painters observe, that Black and
White, though mixt in differing Pro-
portions, will still make but lighter
and darker grays. And if it be said,
that these Ingredients, by the Tex-
ture resulting from their mixtures,
may acquire Qualities that neither of
them had before; I shall answer, that,
to alledge this, is in effect to confess,
that they must take in the *Mechanical*
Principles, (for to them belongs the
Texture or Structure of bodies) to as-
sist the *Chymical* ones. And on this
occasion, to borrow an illustration
from

from our unpublished *Dialogue of the Requisites of a good Hypothesis*, I shall add, that a Chymist that should pretend, that because his three Principles are as many as those of the Corpuscularians, they are as sufficient as these to give an account of the Book of Nature, methinks, I say, he would do like a man that should pretend, that with four and twenty words he would make up a language as well as others can with the four and twenty Letters of the Alphabet, because he had as many words already formed, as they had of bare Letters; not considering that instead of the small number of variations that can be made of his words by Prepositions and Terminations, the Letters of the Alphabet being variously combined, placed and reiterated, can be easily made to compose not only his four and twenty words, with their variations, but as many others as a whole language contains.

CHAP. IX.

Notwithstanding all that I have been obliged to say to the Disadvantage of the Chymical Principles, in reference to the Explication of Qualities, I would not be thought to grant, that the *Peripateticks* have reason to triumph, as if their four Elements afforded a better Theory of Qualities. For, if I had, together with leisure enough to perform such a Task, any obligation to undertake it, I presume, it would not be difficult to shew, that the *Aristotelian* Doctrine about particular Qualities is liable to some of the same Objections with the Chymical, and to some others no less considerable; and that, to derive all the *Phænomena* their Doctrine ought to solve from *Substantial Forms* and *real Qualities Elementary*, is to impose on us a Theory more barren and precarious than that of the Spagyrist.

That

That to derive the particular Qualities of bodies from those Substantial Forms, whence the Schools would have them to flow, is but an insufficient and unfit way of accounting for them, may appear by this, that *substantial Forms* themselves are things, whose existence many Learned Philosophers deny, whose Theory many of them think Incomprehensible, and the most Candid and Judicious of the *Peripateticks* themselves confess it to be very abstruse; so that from such doubtful and obscure Principles we can hardly expect clear Explications of the nature and *Phenomena* of Qualities; not to urge, that the *Aristotelian* Definitions, both of Qualities in general, and of divers of the more familiar Qualities in particular, as Heat, Cold, Moisture, Diaphaneity, &c. are far enough from being clear and well framed, as we elsewhere have occasion to shew.

Another thing, which makes the Scholastic Doctrine of Qualities unsatisfactory, is, that it seldom so much

44 Imperfection of the Chymist's
as attempts to teach the Manner how
the Qualities themselves and their
Effects or Operations are produced.
Of this you may elsewhere find an
Instance given in the Quality that is
wont to be first in the list, viz that of
Heat, which though it may intelligi-
bly and probably be explicated by the
Corpuscular Hypothesis, yet in the
Peripatetic account that is given of it,
is both too questionable and too su-
perficial to give much Content to a
Rational Inquirer. And indeed to say,
that a *Substantial Form* (as that of the
Fire) acts by a Quality (call'd *Heat*)
whose Nature 'tis to produce such an
effect (as to soften Wax or harden
Clay) seems to be no other in sub-
stance, than to say, that it produces
such an effect by some power it has
to produce it. But what that power
is, and how it operates, is that, which,
though we most desire to know, we
are left to seek. But to prosecute the
Imperfections of the *Peripatetick Hy-*
pothesis, were to intrench upon ano-
ther discourse, where they are more
fully

fully laid open. And therefore I shall now but lightly glance upon a couple of imperfections, that more particularly relate to the Doctrine of Qualities.

And first I do not think it a Convincing Argument that is wont to be employed by the *Aristotelians* for their *Elements*, as well as by the *Chymists* for their *Principles*, that, because this or that Quality, which they ascribe to an Element or a Principle, is found in this or that body, which they call mixt, therefore it must owe that Quality to the participation of that Principle or Element. For, the same Texture of parts or other modification of matter may produce the like Quality in the more simple and the more compounded body, and they may both separately derive it from the same Cause, and not one from the Participation of the other. So Water and Earth and Metals and Stones, &c. are heavy upon the account of the common Cause of Gravity, and not because the rest partake
of

46 Imperfection of the Chymist's
of the Earth; as may appear in Ele-
mentary water, which is as simple a
body as it, and yet is heavy: So wa-
ter and oil, and exactly deflegm'd Spi-
rit of Wine, and Mercury, and also
Metals and Glass of Antimony, and
Minium or calcin'd Lead, whilst these
three are in fusion are fluid, being
made so by the variously determined
motions of their minute parts and o-
ther Causes of Fluidity, and not by
the participation of water, since the
arid *Calces* of Lead and Antimony
are not like to have retained in the
fire so volatile a liquor as water, and
since Fluidity is a Quality that Mer-
cury enjoys in a more durable man-
ner than Water it self: For that me-
talline liquor, as also Spirit of Wine
well Rectified, will not be brought to
freeze with the highest degree of
Cold of our sharpest winters, though
a far less degree of Cold would make
water cease to be fluid and turn it into
Ice.

To this I shall only add (in the se-
cond place,) that 'tis not unpleasant

to see, how arbitrarily the *Peripateticks* derive the Qualities of bodies from their four Elements, as if, to give an instance in the lately named Quality, *Liquidity*, you shew them exactly deflegmed Spirit of Wine, and ask them, whence it has its great Fluidness, they will tell you from water, which yet is far less fluid than it, and this spirit of wine it self is much less so than the flame into which the spirit of wine is easily resolvable. But if you ask, whence it becomes totally inflammable, they must tell you, from the fire; and yet the whole body, at least as far as sense can discover, is fluid, and the whole body becomes flame, (and then is most fluid of all;) so that fire and water as contrary as they make them, must both be by vast odds predominant in the same body. This spirit of wine also, being a liquor whose least parts that are sensible are actually heavy, and compose a Liquor which is seven or eight hundred times as heavy as Air of the same bulk, which yet experience shews

48 Imperfection of the Chymist's
shews not to be devoid of weighty
must be supposed to abound with
Earthy particles, and yet this spiri-
tuous liquor may in a trice become
Flame, which they would have to be
the lightest body in the world.

But, to enlarge on this subject,
would be to forget, that the design
of this Tract engages me to deal not
with the *Peripatetic* School, but the
Spagyric. To which I shall there-
fore return, and give you this ad-
vertisement about it, that what I
have hitherto objected is meant a-
gainst the more common and receiv-
ed Doctrine about the Material Prin-
ciples of bodies reputed mixt, as 'tis
wont by vulgar Chymists to be ap-
plied to the rendring an account of
the Qualities of substances Corpo-
real; and therefore I pretend not,
that the past objections should con-
clude against other Chymical Theo-
ries than that which I was concern-
ed to question. And if *a*dept Philo-
sophers, (supposing there be such) or
any

By other more than ordinarily Intelligent Spagyrist, shall propose any particular Hypotheses, differing from those that I have questioned, as their Doctrine and Reasons are not yet known to me; so I pretend not that the past Arguments should conclude against them, and am willing to think, that Persons advantaged with such peculiar opportunities to dive into the Mysteries of Nature, will be able to give us, if they shall please, a far better account of the Qualities of bodies than what is wont to be proposed by the generality of Chymists.

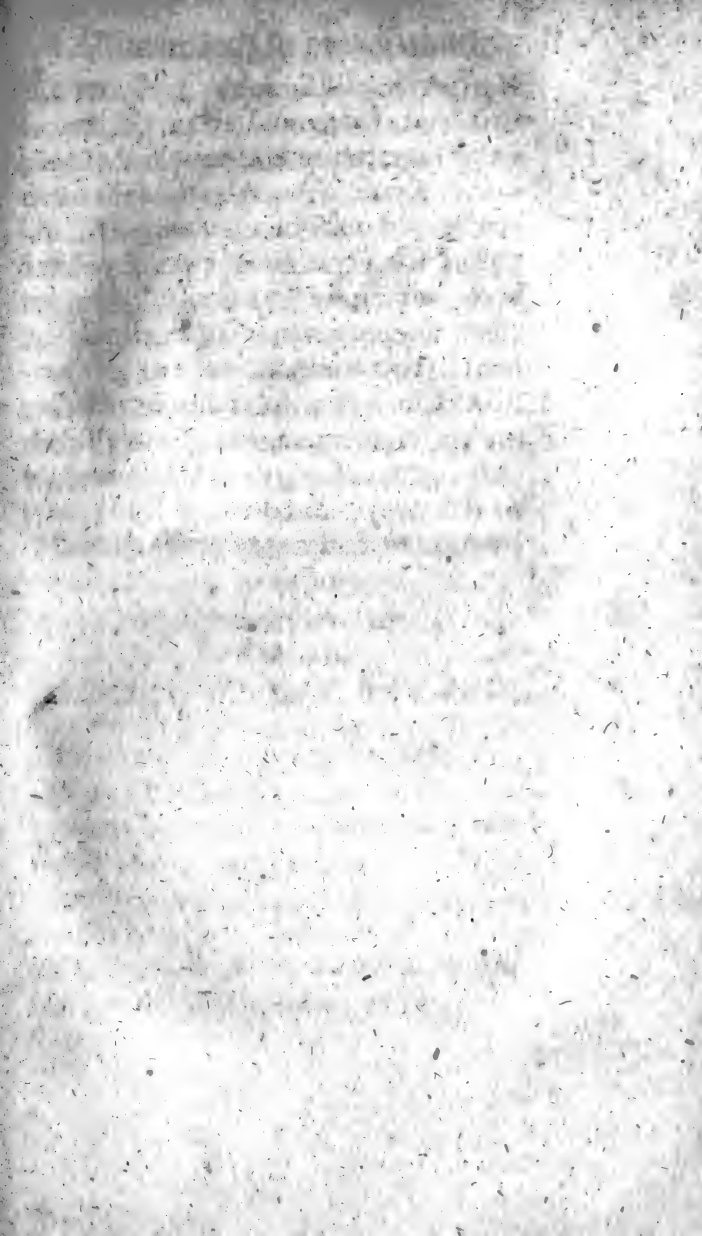
Thus, dear *Pyrophilus*, I have laid before you some of the chief Imperfections I have observed in the vulgar Chymists Doctrine of Qualities, and consequently I have given you some of the chief Reasons that hinder me from acquiescing in it. And as my objections are not taken from the Scholastical subtleties nor the doubtful speculations of the Peripateticks or other Adversaries of the

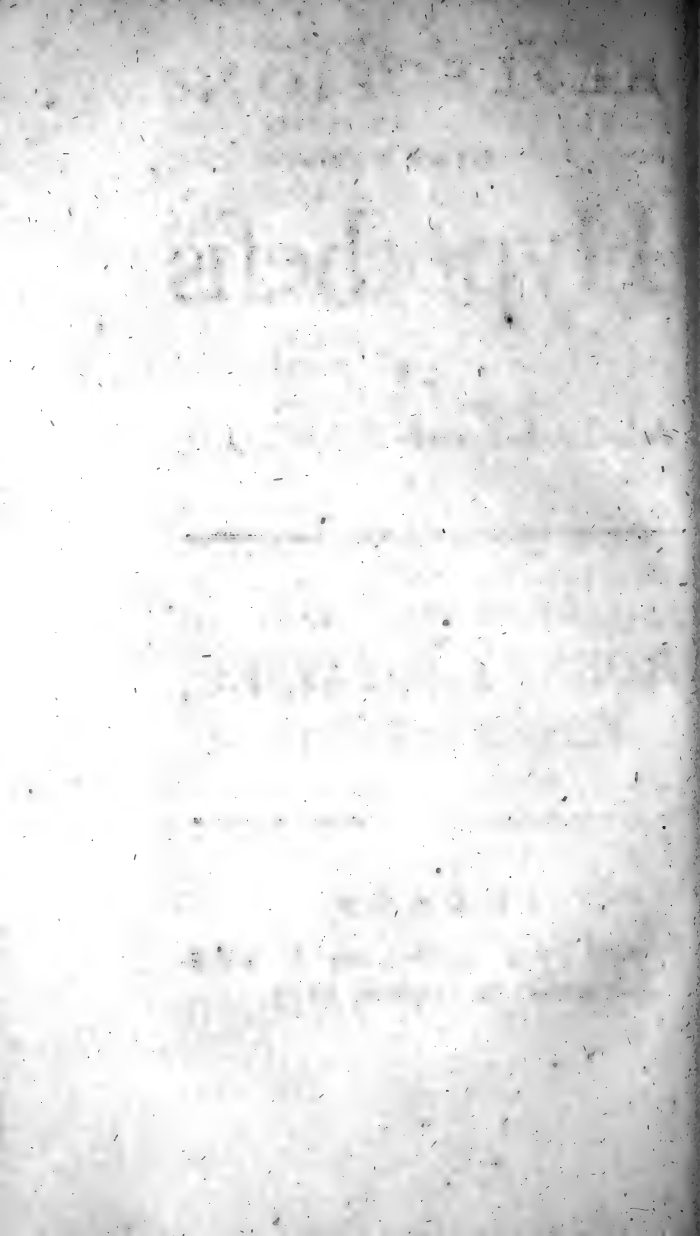
D

Her-

50 Imperfection of the Chymists, &c
Hermetick Philosophy, but from the
nature of things and from Chymical
experiments themselves; so I hope,
if any of your Spagyricall friends have
a minde to convince me, he will at-
tempt to doe it by the most proper
way, which is, by actually giving us
clear and particular explications, at
least of the grand *Phænomena* of Qua-
lities; which, if he shall do, he will find
me very ready to acquiesce in a Truth
that comes usher'd in, and endear'd by
so acceptable and useful a thing, as a
Philosophical Theory of Qualities.

F I N I S.





REFLECTIONS

UPON THE

Hypothesis

OF

ALCALI and ACIDUM.

By the Honourable

ROBERT BOYLE Esq;

Fellow of the *R. Society.*

L O N D O N,

Printed by *E. Flesher*, for *R. Davis*
Bookseller in *Oxford.* 1675.

REFLECTIONS
ON
Hypothesis

THough the following Discourse was at first written by way of *Appendix* to the Treatise of the Imperfection of the Chymical Doctrine of Qualities; yet the bulk of it, swelling beyond what was foreseen, made it seem expedient to publish it as a Tract by it self.

Printed by E. Smith at the Sign of the Anchor in St. Dunstons Church Lane London 1713.

(3)

REFLECTIONS

UPON THE

Hypothesis

OF

Alcali and Acidum.

CHAP. I.

I Presume, it will not be difficult to discern, that much of what has been said about the *Imperfection of the vulgar Chymical Doctrine concerning Qualities*, may with easie variations be applied to some other *Hypotheses* that are of kin to that Doctrine, and particularly to their
A 2 Theory,

4 Reflections upon the Hypothesis

Theory, that would derive both the Qualities of Bodies and the rest of the *Phænomena* of Nature from what they call *Acidum* and *Alkali*. For though these two differences may be met with in a great number and variety of bodies, and consequently the Consideration of them may frequently enough be of good use, (especially to Spagyrist, and Physitians, when they are conversant about the secondary and (if I may so call them) Chymical Causes and Operations of divers mixt bodies;) yet I confess I cannot acquiesce in this *Hypothesis* of *Alkali* and *Acidum*, in the latitude, wherein I find it urged and applied by the Admirers of it, as if it could be usefully substituted in the place of *Matter* and *Motion*.

The *Hypothesis*, being in a sort subordinate to that of the *tria prima*, in ascribing to *two contrary saline Principles* what vulgar Chymists do to their *Salt, Sulphur, and Mercury*; most of the objections we have made against the vulgar Chymical Doctrine, may,

may, as I lately intimated, be applied, by a little variation, to this, and therefore I shall need but to touch upon the main things that keep me from acquiescing in this *Hypothesis*.

CHAP. II.

AND *first*, it seems precarious to affirm, that in all bodies, or even in all the sensible parts of mixts, *Acid* and *Alcalizate* parts are found; there not having been, that I know, any Experimental Induction made of particulars any thing near numerous enough to make out so great an assertion, and in divers bodies, wherein Experience is vouch'd for the inexistence of these Principles, that Inexistence is indeed proved not by direct and clear experience, but upon a supposition, that such and such effects flow from the operations of the assumed Principles.

6 Reflections upon the Hypothesis

Some Spagyrist, when they see *Aqua fortis* dissolve Filings of Copper, conclude from thence, that the Acid spirits of the *Menstruum* meet in the metal with an *Alkali* upon which they work; which is but an unsafe way of arguing, since good Spirit of Urin, which they take to be a volatile *Alkali*, and which will make a great Conflict with *Aqua fortis*, will, as I have elsewhere noted, dissolve filings of Copper both readily enough and more genuinely than the Acid liquor is wont to do. So when they see the Magistery of Pearl or Coral, made by dropping oil of Tartar into the solutions of those bodies made with Spirit of Vinegar, they ascribe the Precipitation to the fixt *Alkali* of the *Tartar*, that mortifies the Acidity of the spirit of Vinegar; whereas the Precipitation would no less insue, if, instead of Alcalizat oil of Tartar, we imploy that highly acid liquor which they call *Oleum Sulphuris per Campanam*.

I think also it may be doubted, whether those, I reason with, are so certain as they suppose, that at least when they can manifestly discover an Acid, for instance, in a body, the operation of that body upon another, which they judge to abound with an *Alkali*, must be the effect of a Conflict between those two jarring Principles, or, if I may so call them, *Duelists*. For an Acid body may do many things, not simply as an acid, but on the score of a Texture or modification, which endows it with other Qualities as well as Acidity, whose being associated with those other Qualities in some cases may be but accidental to the effect to be produced; since by one or more of these other Qualities the body may act in cases, where Prejudice may make a Chymist consider nothing but Acidity. Thus when some Chymists see an acid *Menstruum*, as *Aqua fortis*, Spirit of Salt, oil of Vitriol, &c. dissolve Iron, they presently ascribe the effect to an Acidity of the liquors, whereas well dephlegmed

2 Reflections upon the Hypothesis

Urinous Spirits, which they hold to have a great Antipathy to Acids, will, as I have tried in some of them, readily enough dissolve crude Iron even in the Cold. And on the other side, *Mercury* will not work on the filings of Iron, though this be so open a metal that even weak liquors will do it; and yet if one should urge, that Quicksilver readily dissolves Gold in Amalgamation, he may expect to be told, according to their Doctrine, that *Mercury* has in it an occult acid, by which it performs the solution; whereas it seems much more probable, that *Mercury* has Corpuscles of such a shape and size as fit them to insinuate themselves into the Commensurate Pores they meet with in Gold, but make them unfit to enter readily the Pores of Iron, to which Nature has not made them congruous; as on the other side the saline Corpuscles of *Aqua fortis* will easily find admission into the Pores of Iron, but not into those of Gold, to which they do not correspond as they do to the others.

And

And when a knife, whose blade is touched with a Load-stone, cuts bread and takes up filings of Iron, it does neither of them upon the score of *Alkali* and *Acidum*, but the one upon the visible shape and the stiffness of the blade, and the other upon the latent Contrivance or change of Texture produced by the operation of the Load-stone in the particles that compose the Steel.

This may perhaps be farther illustrated by adding, that when blew *Vitriol*, being beaten and finely searched, makes a white powder, that whiteness is a quality which the powder has not as being of a *Vitriolate* Nature. For *Rock-Crystal* or *Venice-glass* being finely beaten will have the same operation on the Eye, but it proceeds from the transparency of the body and the minuteness, multitude and confus'd situation of the *Corpuscles* that make up the Powder. And therefore, if other bodies be brought by *Comminution* into parts endow'd with such *Mechanical*

10 Reflections upon the Hypothetical affections, as we have named; these aggregates will act upon the organs of Sight as white bodies.

CH A P. III.

AND this leads me to another Exception against the *Hypothesis* of the Duellists, which is, that the Framers of it seem *arbitrarily* to have assigned Provinces or Offices to each of their two Principles, as the *Chymists* do to each of their *tria prima*, and the *Peripateticks* to each of their *Four Elements*. For 'tis not enough to Say, that an *Acid*, for instance, as such, performs these things, and an *Alkali* so many others, that they divide the Operations and *Phenomena* of nature, or at least (as some, more cautious, are content to say) of mixt bodies between them; since Assertions of such great moment ought not to be advanc'd or received without
sus-

sufficient Proof. And perhaps the very distribution of Salts into *Acids* and *Alcalies* hath somewhat of arbitrary in it, since others may, without assuming much more, take the freedom to distribute them otherwise, there being not only several things wherein Acids and Alcalies agree, but also several things wherein Salts of the same denomination widely differ. As, for Instance, some Alkalies, according to those I reason with, are, like salt of Tartar, fixt, and will endure the violence of the fire; others, like salt of Urin or Harts-horn, are exceedingly fugitive, and will be driven up with a scarce sensible degree of Heats; some, as salt of Tartar, will precipitate the solution of Sublimate into an Orange-tawny; others, as spirit of Blood and Harts-horn, precipitate such a solution into a milky substance. Oil of Tartar will very slowly operate upon filings of Copper, which Spirit of Urin and Harts-horn will readily dissolve in the Fire.

12 Reflections upon the Hypothesis

And among *Acids* themselves the difference is no less if not much greater. Some of them will dissolve bodies that others will not, as *Aqua fortis* will dissolve Silver and Mercury, but leave Gold untouched; or as *Aqua Regis*, though made without *Sal Armoniac* that dissolves Gold readily, will dissolve Mercury but scurvily, and Silver not at all. And this may happen, when the *Menstruum* that will not dissolve the body is reputed much stronger than that which does; as dephlegm'd spirit of Vinegar will dissolve Lead, reduc'd to minute parts in the cold; which is an effect that Chymists are not wont to expect from Spirit of Salt. Nay, which is more, one Acid will precipitate what another has dissolved, and contrarily; as spirit of Salt will precipitate Silver out of spirit of Nitre. And I found oil of Vitriol to precipitate bodies of divers kinds, Minerals and others, out of some acid *Menstruums*, particularly spirit of Vinegar.

To this might be added the Properties, peculiar to some particular Acids, as that *Spirit of Nitre* or *Aqua fortis* will dissolve Camphire into an Oil, and coagulate common oil into a consistent and brittle substance like Tallow; and, though it will both corrode Silver, Copper, Lead, and Mercury, and keep them dissolved, it will quickly let fall almost the whole body of Tin, very soon after it has corroded as much as it can of it. By all which, and some other like Instances, I am induc'd to question, whether the *Acidum* and *Alkali*, we are speaking of, have the simplicity that Philosophy requires in Principles; and shall be kept from wondering, if others shall think it as free for them to constitute other Principles, as 'tis for the Learned men I reason with, to pitch upon *Acidum* and *Alkali*.

And some perhaps will be bold to say, that, since the former of those Principles comprehend such a number of bodies, that are, many of them, very differing, and some of them directly
 contrary

4 Reflections upon the Hypothesis
contrary in their operations, it seems
a slight and not Philosophical Ac-
count of their Nature, to define an
Acid by its Hostility to an Alkali,
which (they will say) is almost as if
one should define a *Man* by saying,
that he is an Animal that is at enmity
with the Serpent; or a *Lyon*, that he
is a fourfooted beast that flies from a
Crowing Cock.

CHAP. IV.

BUT although one of the chiefest
Conditions that Philosophers
may justly require in Principles, is,
that, being to explain other things,
they should be very clear themselves;
yet I do not much wonder, that the
Definitions given us of *Acidum* and
Alkali should be but unaccurate and
superficial, since I find not, that they
have themselves any clear and deter-
minate Notion or sure marks, where-
by to know them distinctly, without
which

which Chymists will scarce be able to form clear and settled Notions of them. For to infer, as is usual, that, because a body dissolves another, which is dissoluble by this or that known acid, the Solvent must also be acid; or to conclude, that, if a body precipitates a dissolved metal out of a confessedly acid Menstruum, the Precipitant must be an Alkali, to argue thus, I say, 'tis unsecure; since, not to repeat what I said lately of Copper, I found, that filings of Spelter will be dissolved as well by some Alcalies, (as spirit of Sal Armoniac) as by Acids. And bodies may be precipitated out of acid Menstruums, both by other Acids, and by liquors, where there appears not the least *Alkali*: As I have found, that a solution of Tin-glass, made in *Aqua fortis*, would be precipitated both by Spirit of Salt and by common or rain water. And as for the other grand way that Chymists employ, to distinguish Acids and Alcalies, namely by the Heat, Commotion, and bubbles that are excited, upon

16 Reflections upon the Hypothesis upon their being put together, that may be no such certain sign as they presume, they having indeed a dependance upon particular Contextures and other Mechanical affections, that Chymists are not wont to take any notice of. For almost any thing that is fitted variously and vehemently to agitate the minute parts of a body, will produce Heat in it; and so, though water be neither an Acid nor an Alcalizate liquor, yet it would quickly grow very hot, not only with the highly acid Oil of Vitriol, but (as I have more than once purposely tried and found) with the fiery Alcalizat Salt of Tartar. And 'tis to be noted, that neither in the one nor the other of these Incalescent mixtures, there is produced any such visible or audible conflict, as, according to the Doctrine of the Chymists I reason with, one would expect. And as for the production of bubbles, especially if accompanied with a hissing noise, neither is that such a certain sign as Chymists imagine: For
the

the production of bubbles is not a necessary effect or concomitant of Heat excited by Conflicts, but depends very much upon the peculiar Disposition of Bodies put together to extricate, produce, or intercept particles of Air, (or *Steams*, for the time equivalent to them;) and therefore as Oil of Vitriol, mixt in a due proportion with fair water, may be brought to make the water too hot to be held in ones hand, without exciting bubbles; so I have found by trials purposely made, that Alcalizat Spirit of Urine drawn from some kinds of Quicklime, being mixt with Oil of Vitriol moderately strong, would produce an intense Heat, whilest it produced either no manifest bubbles at all, or scarce any, though the Urinous Spirit was strong, and in other Trials operated like an *Alkali*; and although also with Spirit of Urin, made *per se* the common way, the oil of Vitriol will produce a great hissing and a multitude of conspicuous bubbles.

18 Reflections upon the Hypothesis

On the other side I have sometimes, though not so constantly, found, that some Acid Spirits, especially that of Verdigrease made *per se*, would, when poured upon Salt of Tartar, make a Conflict with it, and produce a copious froth, though we observed it not to be accompanied with any manifest Heat. And I elsewhere mention two bodies, upon whose putting together numerous bubbles would, for a long time, and not without noise, be generated, and succeed one another, though I could perceive no Heat at all to accompany this Tumult.

As for the *Tast*, which by many is made a great Touchstone, whereby to know Acids and Alcalies, I consider that there is a multitude of mixt bodies, wherein we can so little discern by the *Tast*, which of the Principles is Predominant, that this Sense would not oblige one to suspect, much less to conclude, there were one grain of either of them to be found there; such bodies are Diamonds and Rubies, and
most

most Gems, besides many ignobler Stones, and Gold and Silver and Mercury, and I know not how many other bodies. On the other side, there are bodies that abound with Acid or Alcalizat Salts, which either have no Taste, or a quite differing one from that of the Chymical Principle. As though Venice-glass be in great part composed of a fixt *Alcali*; yet to the Tongue it is insipid, and Crystals of Lune and of Lead made with *Aqua fortis*, and containing great store of the Acid particles of the *Menstruum*, have nothing of Acidity in the mouth, the latter having a saccharine sweetness, and the former an extream bitterness. And even in Vegetable substances that have a manifest Taste, 'tis not so easie to know by that, whether it be the Acid or the Alcalizat Principle that is predominant in them; as in the Essential oils of Spices and other Vegetables. And in the gross Empereumatical Oils of Woods, and even in high Rectified Spirit of Wine,

20 Reflections upon the Hypothesis
which therefore some will have to be
an Alcalizat liquor, and others list it
among Acids, though I did not find it
neither to be destroyed or much al-
tered by being put upon Coral or salt
of Tartar, as would happen to an acid
Menstruum, nor yet by being digested
with and distilled from sea Salt, as
might be probably expected from an
Alcalizat one: And among those very
bodies which their Tasts perswade
Chymists to reckon amongst Acids, one
may (according to what I formerly
noted) observe so great a difference
and variety of relishes, that, perhaps
without being too severe, I may say,
that if I were to allow Acids to be
One Principle, it should be only in
some such Metaphysical sense, as that
wherein Air is said to be One Body,
though it consist of the associated ef-
fluvia of a multitude of Corpuscles
of very differing Natures, that agree
in very little save in their being mi-
nute enough to concur to the Com-
position of a fluid aggregate, consist-
ing

ing of flying parts. But having dwelt longer than I intended on One Objection, 'tis time that I proceed to those that remain.

CH A P. V.

ANother particular, I am unsatisfied with in the *Hypothesis* of *Alkali* and *Acidum*, is, that 'tis in divers cases either needless or useless to explain the *Phænomena* of Qualities, there being several of these produced, destroyed, or altered, where there does not appear any accession, recess, or change of either of those two Principles; as when fluid water by hard beating is turn'd into consistent froth, and when transparent red Coral is, barely by being beaten and sifted finely, changed into a white and opacous powder; and as when a very flexible piece of fine silver being hammer'd is brought to have a brisk spring, and after a while will, instead

22 Reflections upon the Hypothesis of continuing malleable, crack or cleave under the hammer; and as when (to dispatch and omit other instances) a sufficiently thin leaf of Gold, held between the Light and the Eye, appears green.

Another thing (of kin to the former,) that I like not in the Doctrine of *Acidum* and *Alcali*, is, that though the Patrons of it, whilst they would seem to constitute but two Principles, are fain (as I lately intimated) to make I know not how many differing sorts of Acids, besides some variety of Alkalies; yet their Principles are too few and narrow to afford any satisfactory explication of the *Phænomena*. For I fear, 'twill be very difficult for them to give a Rational Account of Gravity, Springiness, Light, and Emphatical Colours, Sounds, and some other Qualities that are wont to be called manifest; and much more of several that are confest to be occult, as Electricity, and Magnetism; in which last I see not, how the affirming that
there

there is in the Magnet an Acid and an Alkali, and that these two are of contrary Natures, will help to explain, how a Load-stone does, as they speak, attract the same end of a poised needle with one of its Poles, which 'twill drive away with the other, and determine that needle when freely placed, to point North and South, and enable it to communicate by its bare touch the same Properties, and abundance of other strange ones, to another piece of Steel. But I forbear to alledge particular Examples referable to the several Qualities above-mentioned, whether manifest or hidden, because that in great part is already done in our Notes about particular Qualities, in which 'twill appear how little able the employing of *Alkali* and *Acidum* will be to afford us an account of many things. And though I enlarge not here on this objection, yet I take it to be of that importance, that, though there were no other, this were enough to shew that

24 Reflections upon the Hypothesis
the Hypothesis that is liable to it, is
Insufficient for the explication of
Qualities; and therefore 'twill not I
presume be thought strange that I
add, that, as for those that would ex-
tend this narrow Chymical Doctrine
to the whole object of Natural Philo-
sophy, they must do more than I ex-
pect they will be able before they can
make me their Profelyte, there being
a multitude of *Phænomena* in nature
(divers whereof I elsewhere take no-
tice of in reference to the Chymists
Philosophy) in which what *Acidum*
and *Alcali* have to do, I confess I do
not understand,

CHAP.

CHAP. VI.

THE last thing (which comprizes several others) that seems to me a defect in the Doctrine of *Alkali* and *Acidum*, is, that divers if not most of those very things that are pretended to be explicated by them, are not satisfactorily explicated, some things being taken into the explications that are either not fundamental enough or not clearly intelligible, or are chargeable with both those Imperfections.

And first I am dissatisfied with the very fundamental Notion of this Doctrine, namely a supposed Hostility between the tribe of Acids and that of Alkalies, accompanied, if you will have it so, with a friendship or sympathy with bodies belonging to the same tribe or Family. For I look upon Amity and Enmity as Affecti-
ons of Intelligent Beings, and I have
not

26 Reflections upon the Hypothesis

not yet found it explained by any, how those Appetites can be placed in Bodies Inanimate and devoid of knowledge, or of so much as Sense. And I elsewhere endeavour to shew, that what is called Sympathy and Antipathy between such bodies does in great part depend upon the actings of our own Intellect, which, supposing in every body an innate appetite to preserve it self both in a defensive and an offensive way, inclines us to conclude, that that body, which, though designlessly destroys or impairs the state or texture of another body, has an Enmity to it, though perhaps a slight Mechanical change may make bodys, that seem extreamly hostile, seem to agree very well and cooperate to the production of the same effects. As if the acid spirit of Salt and the volatile *Alkali* (as they will have it) that is commonly called Spirit of Urine be put together, they will, after a short though fierce conflict, upon a new contexture unite together

gether into a Salt, little, if at all, differing from Sal Armoniac, in which the two reconciled Principles will amicably join in cooling of water, dissolving some metalline bodys, and producing divers other effects. And so, if upon a strong solution of Salt of Potashes or of Salt of Tartar, good Spirit of Nitre be dropt in a due proportion, after the Heat and Tumult and Ebullition are over, the Acid and the Alkalizat Salts will convene into such a Concretion as Salt-peter, which is taken to be a natural body, either homogeneous, or at least consisting of parts that agree very friendly together, and conspire to constitute the particular kind of Salt that Chymists call Nitre.

But the Sympathy and Antipathy that is said to be betwixt Inanimate bodys, I elsewhere more particularly consider, and therefore I shall now add in the second place, That the Explications made of *Phenomena* according to the Doctrine of *Alkali*
and

28 Reflections upon the Hypothesis
and *Acidum* do not, in my apprehension, perform what may be justly expected from Philosophical Explications. 'Tis said indeed, that the *Acidum* working on the *Alkali*, or this upon that, produces the effect proposed; but that is only to tell us, what is the Agent that operates, and not the Manner of the operation, or the means and process whereby it produces the effect proposed, and 'tis this *modus* that Inquisitive Naturalists chiefly desire to learn. And if it be said, that it is by the mutual hostility of the Principles that the effect is produced, it may be answered, that besides, that that hostility it self is not, as we have just now observed, a thing clear, if so much as Intelligible; this is so general and indeterminate a way of explicating things, as can afford little or no satisfaction to a searching and cautious Naturalist, that considers how very numerous and very various the *Phænomena* of Qualities are.

CHAP.

CHAP. VII.

TO clear up and to countenance what I have been now saying, I shall only take notice of some few obviqus Phænomena of one of the most familiar Operations wherein Acidum and Alkali are supposed to be the grand Agents. 'Tis known to the very Boys of Chymists, that *Aqua Regis* will dissolve Gold, Copper, and Mercury, and that with these metals, especially with the second, it will produce an intense degree of heat. If now the Cause of this Heat be demanded, it may be expected, that the Patrons of the Dullists will answer, that 'tis from the action of the Acid salts of the Menstruum upon the Alkali they meet with in the Metalls. But not to mention how many things are here presumed, not proved; nor that I know some Acid Menstruums, and
some

30 Reflections upon the Hypothesis

some much more evidently Alkali-
zate Bodys than these Metals are,
which yet do not upon their mix-
tures produce any sensible heat; not,
I say, to mention these, it is easie to
discern, that this answer names in-
deed two supposed efficientes of Heat,
but does not explicate or declare
how these Agents produce that Qua-
lity, which depends upon a certain
vehement and various agitation of
the singly insensible parts of Bodys,
whether the Duellists, or any other,
though very differing, Causes put
them into a motion so modified.
And therefore Gold and Copper by
bare Concussion may be brought to
an intense degree of heat without
the accession of any acid parts to
work upon them. But then fur-
ther, when we are told, that *Aqua
Regis* by its Acidity working on the
Metalline Alkali makes a dissolution
of the Metal; I am told indeed
what they think to be the Agent in
this change, but not at all satisfied
how

how this Agent effects it ; for, Copper being a very hard metal, and Gold generally esteemed by Chymists the closest and compactest Body in nature; I would gladly know, by what power and way such weak and probably either brittle or flexible bodies as acid Salts, are enabled with that force to disjoin such solid and closely coherent Corpuscles as make up the visible masses of Copper and Gold, nay, and scatter them with that violence as perhaps to toss up multitudes of them into the air. And since in the dissolution of these Metals there is another Phænomenon to be accounted for, as well as the forcing of the parts asunder, namely the sustentation of the Metal in the Menstruum, the Chymists would have much informed me, if they had well explained, how their Acidum and Alkali is able to sustain and give fluidity to the Corpuscles of the dissolved Metal, which though it be but
Copper

32 Reflections upon the Hypothesis

Copper, is nine times as heavy as a bulk of water equal to it, and if it be Gold, is nineteen times heavier than the Liquor that must keep it from sinking; and at least divers times heavier in specie than the Salts, that are mingled with the aqueous parts, can make the Menstruum composed of them both. Whereas Trial has assured me, that, if a piece of Wax or any other such matter be made by less than the hundredth part heavier than an equal bulk of Water, it will, when thoroughly immersed, fall to the bottom and rest there. I might also ask a further Question about these Dissolutions, as why, whereas *Aqua Regis* dissolves Mercury without being much changed in colour by it, Gold retains its own Citrinity or yellowness in the solvent, and the solution of Copper is of a colour, which being greenish-blew is quite differing from that of the metal that affords it, as well as from that of the solvent? And I might

might recruit these with other Queries not impertinent, but that these may suffice (for a sample) on this Occasion, and allow me to conclude this Chapter, by representing One thing which I would gladly recommend and inculcate to you, namely, that *Those Hypotheses do not a little hinder the progress of Humane knowledge that introduce Morals and Politicks into the Explications of Corporeal Nature, where all things are indeed transacted according to Laws Mechanical.*

CHA P. VIII.

I Might easily have been more copious in the Instances annexed to the foregoing Animadversions, but that, being desirous to be short as well as clear, I purposely declined to make use of divers others, that seemed proper to be employed, and indeed might safely enough have been so, because those I have *mentioned*, and especially those, (which make a great part of them) that are Mechanical, are not liable to the same exceptions, that I foresaw might be made to elude the force of the Examples I *passed by*. And though I think I could very well make those foreseen Objections appear groundless or unsatisfactory; yet that could scarce be done without engaging in Controversies that would prove more tedious than I judged them necessary.

And

And yet, although what I have said in this Excursion be but a part of what I could say, I would not be thought to have forgot what I intimated at the beginning of it. For though the Reasons I alledged keep me from acquiescing in the Doctrine of *Alcali* and *Acidum*, as 'tis propos'd under the notion of a Philosophical *Hypothesis*, such as the Cartesian or Epicurean, which are each of them alledged by their embracers to be Mechanical, and of a very Catholick extent; yet I deny not, that the Consideration of the Duellists (or the two jarring Principles of *Alcali* and *Acidum*) may be of good use to Spagyrist and Physitians, as I elsewhere further declare. Nor do I pretend by the past discourse that questions one Doctrine of the Chymists, to beget a general contempt of their Notions, and much less of their Experiments. For the operations of Chymistry may be misapplied by the erroneous

36 Reflections upon the Hypothesis
roneous Reasonings of the Artists
without ceasing to be themselves
things of great use, as being appli-
cable as well to the Discovery or
Confirmation of solid Theories, as
the production of new *Phenomena*,
and beneficial effects. And though
I think, that many *Notions* of *Para-*
celsus and *Helmont* and some other
Eminent Spagyriste are unsolid, and
not worthy the veneration that their
Admirers cherish for them; yet di-
vers of the *Experiments*, which ei-
ther are alledged to favour these
notions, or on other accounts are to
be met with among the followers of
these men, deserve the curiosity if
not the esteem of the Industrious In-
quirers into Natures Mysteries.
And looking upon Chymistry in-
gross as a Discipline subordinate to
Physiques, even Mechanical Philo-
sophers may justly, in my opinion,
think favourably of it, since, what-
ever Imperfections, or, if they please,
Extravagancies there may be in
the

the Principles and Explications of *Paracelsus* or other Leading Artists, these faults of the Theoretical part may be sufficiently compensated by the Utilities that may be derived from the Practical part. And this I am the rather induced to say, because the Experiments, that Chymistry furnishes, may much assist a Naturalist to rectifie the Erroneous Theories that oftentimes accompany Them, and even those (Mistakes) that are endeavour'd to be evinc'd by them.

And (to conclude) Chymistry seems to deal with men in reference to Notions , as it does in reference to Metals , assisting wary men to detect the Errors , unto which it may have misled the unwary : For the same Art that has taught some to impose on others, (and perhaps themselves first) by blanching Copper, imitating Gold, &c: does also supply Say-masters
and

and Refiners, with the Means, by the Cupel, Cements, *Aqua fortis*, &c. to examine, whether Coins be true or false, and discover Adulterate Gold and Silver to be Counterfeit.

FINIS.



REVISED EDITION

AND

NOTES

ON

The Mechanical Principles

AND

PROPERTIES

OF

VOLATILITY.

By

ROBERT BOYLE

Esq. of the Middle Temple

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a purpose. I saw indeed, that divers of the Chymists had by a diligent and laudable employment of their pains and industry, obtain'd divers Productions, and lighted on several Phænomena considerable in their kind, and indeed more numerous, than, the narrowness and sterility of their Principles consider'd, could well be expected. But I observed too, that the generality of those that busie themselves about Chymical Operations; some because they practise Physick; and others because they either much wanted, or greedily coveted money, aimed in their Trials but at the Preparation of good Medicines for the humane body, or to discover the ways of curing the Diseases or Imperfections of Metals, without referring their Trials to the advancement of Natural Philosophy in general; of which most of the Alchymists seem to have been so incurious, that not onely they did not institute Experiments
for

for that purpose, but overlookt and despis'd those undesign'd ones that occur'd to them whilst they were prosecuting a preparation of a Medicine, or a Transmutation of Metals. The sense I had of this too general omission of the Chymists, tempted me sometimes to try, whether I could do any thing towards the repairing of it by handling Chymistry; not as a Physician, or an Alchymist, but as a meer Naturalist, and so by applying Chymical Operations to Philosophical purposes. And in pursuance of these thoughts, I remember I drew up a Scheme of what I ventur'd to call a *Chymia Philosophica*, not out of any affectation of a splendid Title, but to intimate, that the Chymical Operations, there treated of, were not directed to the usual scopes of Physicians, or Transmuters of Metals, but partly to illustrate or confirm some Philosophical Theories by such Operations; and partly to explicate those Opera-

tions by the help of such Theories.

But before I had made any great progress in the pursuit of this design, the fatal Pestilence that raged in *London*, and in many other parts of *England*, in the years 1664 and 65, obliging me among the rest to make several removes; which put me upon taking new measures, and engaging me in other employments of my time, made me so long neglect the Papers I had drawn up, that at last I knew not where to finde them, (though I hope they are not yet mislaid beyond recovery,) which I was the less troubled at, because the great difficulties, to be met with in such an undertaking, did not a little discourage me, such a Task requiring as well as deserving a Person better furnished, than I had reason to think my self, with Abilities, Leisure, Chymical Experiments, and Conveniences, to try as many more as should appear needful. But yet
to

to break the Ice for any that may hereafter think fit to set upon such a Work , or to shorten my own Labour, if I should see cause to resume it my self, I was content to throw in among my Notes about other Particular Qualities , some Experiments and Observations about some of those, that I have elsewhere call'd *Chymical Qualities*, because 'tis chiefly by the Operations of Chymists, that men have been induced to take special notice of them. Of these Notes I have assigned to some Qualities more, and to some fewer, as either the nature or importance of the Subject seemed to require, or my Leisure and other Circumstances would permit. And though I have not here handled the Subjects they belonged to, as if I intended such a *Chymia Philosophica* as I lately mentioned, because my design did not make it necessary, but did perhaps make it impertinent for me to do so, yet in some of the larger
Notes

Notes about *Volatility* and *Fixtness*, and especially about *Precipitation*, I have given some little *Specimens* of the Theoretical part of a Philosophical Account of those Qualities or Operations, that I hope will not be wholly useless. I know, it may be objected, that I should have employed for Instances some more considerable Experiments, if not *Arcana*; but though possibly I am not altogether unfurnished with such, yet aiming rather to promote Philosophy, than appear a Possessor of elaborate Processes, I declined several Experiments that required either more skill, or more time, or more expence than could be well expected from most Readers, and chose rather to employ such Experiments as may be more easily or cheaply tried, and, which is mainly to be consider'd, being more simple, are more clearly intelligible, and more fit to have Notions and Theories built upon them; especially considering, that

that the Doctrine of Qualities being it self conversant about some of the Rudimental parts, if I may so call them, of Natural Philosophy, it seemed unfit to employ intricate Experiments, and whose Causes were liable to many disputes, to settle a Theory of them. In short, my design being to hold a Taper not so much to Chymists as to the Naturalists, 'twas fit I should be less solicitous to gratifie the former than to inform the later.

FINIS.

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EXPERIMENTS,

AND

NOTES,

About

The Mechanical Origine

AND

PRODUCTION

OF

VOLATILITY.

CHAP. I.

AS far as I have yet observed, the Qualifications or Attributes, on whose account a portion of matter is found to be *Volatile*, are chiefly four; whereof the three former most regard the single Corpuscles

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4 Of the Mechanical Origine

as such; and the last, the manner of their Union in the aggregate or body they make up.

But before I enter upon particulars, give me leave to advertise you here once for all, That in the following Notes about *Volatility* and *Fixt-ness*, when I speak of the Corpuscles or minute parts of a body, I doe not mean strictly either the Elementary parts, such as Earth and Water, or the Hypostatical Principles, such as Salt, Sulphur, or Mercury; for these things come not here into consideration: But onely such Corpuscles, whether of a simple, compounded or decomposed Nature, as have the particles they consist of so firmly united, that they will not be totally disjoyned or dissipated by that degree of Fire or Heat, wherein the matter is said to be volatile or to be fixt. But these combined particles will in their aggregate either ascend, or continue unraised *per modum Unius* (as they speak) or as one indivisible Corpuscle. As in a Corpuscle of Sal Armo-
niac,

niac, whether it be a natural or factitious thing, or whether it be perfectly similar, or compounded of differing parts, I look upon the intire Corpuscle as a volatile portion of matter; and so I doe on a Corpuscle of Sulphur, though experience shews when 'tis kindled, that it has great store of acid Salt in it, but which is not extricated by bare sublimation: And so Colcothar of Vitriol falls under our consideration as a fixt body, without inquiring what cupreous or other mineral and not totally fixt parts may be united with the Earthly ones; since the fires, we expose it to, do not separate them.

And this being premised in the general, I now proceed to some particulars. And first to make a volatile body, the parts should be very small. For, *ceteris paribus*, those that are so, are more easily put into motion by the action of the fire and other Agents, and consequently more apt to be elevated, when, by the determination of the movent, the situation

6 Of the Mechanical Origine

of the neighbouring bodies, or other Mechanical Circumstances, the agitated Corpuscles can continue their motion with less resistance upwards than any other way, (as either downwards or horizontally.) And if, as 'tis highly probable, that which in light bodies, or at least in most of them, is wont to pass for *positive* Levity, be but a less degree of gravity than that of those contiguous bodies that raise them; it will happen, that in very many cases, (for I say not in all) the great proportion of the surface of a Corpuscle to its bulk, (which is usually greater in the lesser particles) by making it more apt to be wrought on, either by the air agitated by the fire, or by the *effluvia* of kindled fuell, or by the impulse of the shaken Corpuscles of the body it self, will much facilitate the elevation of such a minute particle, by exposing a greater portion of it to the action of the agent, as it will oftentimes also facilitate the renewed sustentation of such a small body in the
air,

air, which resists more the descent of particles whose surfaces are large, than of others of the same gravity and bulk : As a leaf of paper displayed will much longer hover in the Air, than if it were reduced into a ball or pellet. That this minuteness of particles may dispose them to be carried upwards, by the impulse of other bodies and that of the agitated Air, is very obvious to be observed : As we see, that Horses in a high-way, though they be not able with the strokes of their feet to make stones, or gravel, or clods of Earth fly up, yet they will easily raise clouds of dust oftentimes mingled with the smaller grains of sand. And where Timber is sawing, the same wind that will not in the least move the beams, and scarce at all move the chips, will easily carry up the Saw-dust into the Air. And we see in our Chimneys, that the smoak readily ascends, whilst even small clods of soot, which is but an aggregate of the particles of smoak, fall headlong down.

CHAP. II.

THE next qualification requisite in the corpuscles of Volatile bodies is, that they be not too solid or heavy. For if they be so, though their bulk be very small, yet, unless other Circumstances do much compensate their weight, 'twill be very difficult to elevate them, because of the great disproportion of their specific gravity to that of the Air, (which contributes to sustain and even raise many sorts of volatile parts) and to the strength of the igneous effluvia or other agents that would carry them up. Thus we see, that filings of Lead or Iron, and even Minium (which is the calx of Lead) though the grains they consist of be very small, will not easily be blown up like common dust, or meal, or other powders made of less ponderous materials.

A third Qualification to be desired in the corpuscles that should make up

and Production of Volatility. 9

up a Volatile body is, that they be conveniently shaped for motion. For if they be of branched, hook'd, or other very irregular or inconvenient figures, they will be apt to be stopt and detained by other bodies, or entangled among themselves, and consequently very difficult to be carried upwards, in regard that, whilst they are thus fastened either to one another, or to any stable body, each single Corpuscle is not onely to be considered, as having its own peculiar bulk, since its cohesion with the other corpuscle or body that detains it, makes them fit to be look'd upon *per modum Unius*; that degree of heat they are exposed to being presumed incapable of disjoyning them. And this may be one Reason, why Water, though it be specifically heavier than Oil, yet is much more easily brought to exhale in the form of vapours than is Oil, whose corpuscles by the lasting stains they leave on cloath, wood, wool, &c. (which water will but transiently moisten, not
Linn. stain)

10 Of the Mechanical Origine
stain) seems to be of very intangling
figures.

The fourth and last qualification
requisite in a Volatile body is, that
the parts do loosely adhere, or at
least be united in such a manner, as
does not much indispose them to be
separated by the fire in the form of
fumes or vapours.

For he that considers the matter,
will easily grant, that, if the contex-
ture of the corpuscles, whereof a bo-
dy consists, be intricate, or their co-
hesion strong, their mutual implica-
tion, or their adherence to each o-
ther, will make one part hinder ano-
ther from flying separately away, and
their conjunction will make them too
heavy or unweildy to be elevated to-
gether, as intire though compounded
parts. Thus we see, that in Spring,
or the beginning of Summer, a wind,
though not faint, is unable to carry
off the lightest leaves of trees, be-
cause they stick fast to the bows and
twigs on which they grow, but in
Autumn, when that adhesion ceases,
and

and Production of Volatility. 11

and the leaves sit but loosely on, a wind no stronger than that they resisted before, will with ease blow them off, and perhaps carry them up a good way into the Air. But here note, that it was not without some cause, that I added above, that in a fluid body, the parts should at least be united in such a manner, as does not much indispose them to be separated. For 'tis not impossible, that the parts of a body may, by the figures and smoothness of the surfaces, be sufficiently apt to be put into motion, and yet be indisposed to admit such a motion as would totally separate them and make them fly up into the Air. As, if you take two pieces of very flat and well-polished marble or glass, and lay them one upon the other, you easily make them slide along each others surfaces, but not easily pull up one of them, whilst the other continues its station. And when Glass is in the state of fusion, the parts of it will easily slide along each other, (as is usual in those of other

ther

12 Of the Mechanical Origine
ther fluids) and consequently change
places, and yet the continuity of
the whole is not intirely broken, but
every corpuscle does somewhere
touch some other corpuscle, and
thereby maintain the cohesion that
indisposes it for that intire separation
accompanied with a motion upwards
that we call avolation. And so,
when Salt-peter alone, is in a Cruci-
ble exposed to the fire, though a ve-
ry moderate degree of it will suffice
to bring the Salt to a state of fusion,
and consequently to put the corpu-
sles that compose it into a restless
motion; yet a greater degree of heat,
than is necessary to melt it, will not
extricate so much as the Spirits, and
make them fly away.

CHAP. III.

THE foregoing Doctrine of the
Volatility of bodies may be
as well illustrated as applied, if we
proceed to deduce from it the gene-
rall

and Production of Volatility. 13

all ways of Volatilization of bodies, or of introducing volatility into an assigned portion of matter. For these wayes seem not inconveniently reducible to five, which I shall severally mention, though Nature and Art do usually imploy two or more of them in conjunction. For which Reason I would not, when I speak of one of these wayes, be understood as if, excluding the rest, I meant that no other concurred with it.

The first of the five ways or means of Volatilizing a body is, to reduce it into minute parts, and, *cæteris paribus*, the more minute they are the better.

That the bringing a body into very minute parts may much conduce to the volatilizing of it, may be gathered from the vulgar practice of the Chymists, who when they would sublime or distill Antimony, Sal Armoniac, Sea-salt, Nitre, &c. are wont to beat them to powders to facilitate their receiving a further comminution by the action of the fire.

And

14 Of the Mechanical Origine

And here I observe, that in some bodies this comminution ought not to be made onely at first, but to be continued afterwards. For Chymists find by experience, though perhaps without considering the reason of it, that Sea-salt and Nitre, will very hardly afford their Spirits in Distillations, without they be mingled with powdered clay or bole, or some such other additament, which usually twice or thrice exceeds the weight of the Salt it self: Although these additaments, being themselves fixt, seem unlikely to promote the volatilization of the bodies mixt with them, yet by hindering the small grains of Salt to melt together into one lump or masse, and consequently by keeping them in the state of Comminution, they much conduce to the driving up of the Spirits or the finer parts of the Salts by the operation of the fire.

But to prosecute a little what I was saying of the Conduciveness of bringing a body into small parts to
the

and Production of Volatility. 15
the volatilization of it, I shall add,
that in some cases the Comminution
may be much promoted by employ-
ing Physical, after Mechanical, ways;
and that, when the parts are brought
to such a pitch of exiguity, they may
be elevated much better than before.
Thus, if you take filings of *Mars*, and
mix them with *Sal Armoniack*, some
few parts may be sublimed; but if,
as I have done, you dissolve those fi-
lings in good Spirit of Salt instead of
Oil of Vitriol, and having coagula-
ted the solution, you calcine the gree-
nish Crystals or *vitriolum Martis* that
will be afforded, you may with ease,
and in no long time, obtain a *Crocus
Martis* of very fine parts; so that I
remember, when we exquisitely min-
gled this very fixt powder with a
convenient proportion of *Sal Armo-
niac*, and gradually press'd it with a
competent fire, we were able to ele-
vate at the first Sublimation a consi-
derable part of it; and adding a like,
or somewhat inferiour, proportion of
fresh *Sal Armoniac* to the *Caput Mor-
tuum*,

tuum, we could raise so considerable a part of that also, and in it of the *Crocus*, that we thought, if we had Conveniency to pursue the operation, we should, by not many repeated Sublimations, have elevated the whole *Crocus*, which (to hint that upon the by,) afforded a Sublimat of so very astringent a *Tast*, as may make the trial of it in stanching of blood, stopping of fluxes, and other cases, where potent astringion is desired, worthy of a Physicians Curiosity.

CHAP. IV.

THE second means to volatilize bodies is, to rub, grind, or otherwise reduce their corpuscles to be either smooth, or otherwise fitly shaped to clear themselves, or be disintangled from each other.

By reason of the minuteness of the corpuscles, which keeps them from being separately discernible by the
 Eye,

and Production of Volatility. 17

Eye, 'tis not to be expected, that immediate and ocular Instances should be given on this occasion; but that such a change is to be admitted in the small parts of many bodies, brought to be volatile, seems highly probable from the account formerly given of the requisites or conditions of Volatility, whose introduction into a portion of matter will scarce be explicated without the intervention of such a change. To this second Instrument of Volatilization, in concurrence with the first, may probably be referred the following Phænomena: In the two first of which there is employed no additional volatile Ingredient; and in the fourth, a fixt body is disposed to volatility by the operation of a Liqueur, though this be carefully abstracted from it.

1. If Urine freshly made be put to distill, the Phlegm will first ascend, and the Volatile salt will not rise till that be almost totally driven away, and then requires a not inconsiderable degree of fire to elevate it. But,

18 Of the Mechanical Origine

if you putrefie or digest Urine, though in a well-closed Glass-Vessel, for seven or eight weeks, that gentle warmth will make the small parts so rub against, or otherwise act upon, one another, that the finer ones of the Salt will perhaps be made more slender and light, and however will be made to extricate themselves so far as to become volatile, and, ascending in a very gentle heat, leave the greatest part of the phlegm behind them.

2. So, if Must, or the sweet juice of Grapes, be distilled before it have been fermented, 'tis observed by Chymists, and we have tried the like in artificial Wine made of Raisins, that the phlegm, but no ardent Spirit, will ascend. But when this Liqueur is reduced to Wine by fermentation, which is accompanied with a great and intestine commotion of the justling parts, hitting and rubbing against one another, whereby some probably come to be broken, others to be variously ground and subtilized, the
more

and Production of Volatility. 19

more subtile parts of the Liqueur being extricated, or some of the parts being, by these operations, brought to be subtile, they are qualified to be raised by a very gentle heat before the phlegm, and convene into that fugitive Liqueur, that Chymists, for its activity, call Spirit of Wine. Nor is it onely in the slighter Instances afforded by Animals and Vegetables, that Volatility may be effected by the means lately mentioned: For experience hath assured me, that 'tis possible, by an artificial and long digestion, wherein the parts have leisure for frequent justlings and attritions, so to subtilize and dispose the corpuscles even of common Salt for Volatility, that we could make them ascend in a moderate fire of Sand without the help of Bole, Oil of Vitriol, or any Volatilizing additament; and, which is more considerable, the Spirit would in rising precede the Phlegm, and leave the greatest part thereof behind it.

This intestine commotion of parts

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capable

20 Of the Mechanical Drigine

capable of producing Volatility in the more disposed portions of a body, though it be much more easie to be found in Liqueurs, or in moist and soft bodies, yet I have sometimes, though rarely, met with it in dry ones. And particularly I remember, that some years ago having, for trial sake, taken Mustard-seed, which is a body pregnant with subtile parts, and caused it to be distilled *per se* in a Retort, I had, as I hoped, (without any more ado,) a great many grains of a clear and figured Volatile salt at the very first distillation: which Experiment having, for the greater security, made a second time with the like success, I mentioned it to some Lovers of Chymistry, as what I justly supposed they had not heard of. I leave it to farther Inquiry, whether, in a body so full of Spirits as Mustard-seed, the action and re-action of the parts among themselves, perhaps promoted by just degrees of fire, might not suffice to make in them a change equivalent in order to Volatilization,
and

and the yielding a Volatile Salt, to that which we have observed Fermentation and Putrefaction to have made in the juice of Grapes, Urine, and some other bodies. How far the like success may be expected in other Trials, I cannot tell; especially not having by me any Notes of the events of some Attempts which that Inquiry put me upon: Onely I remember in general, that, as some trials, I made with other Seeds, and even with Aromatick ones, did not afford me any Volatile Salt; so the success of other trials made me now and then think, that some subjects of the Vegetable kingdom, whence we are wont to drive over acid Spirits, but no dry Salt, may be distilled with so luckily regulated a heat, as to afford something, though but little, of Volatile Salt; and that perhaps more bodies would be found to doe so, were they not too hastily or violently prest by the fire, whereby such saline schematisms of the desired parts of the matter are (by being dissipated or

confounded) destroyed or vitiated, as in a slow, dextrous, or fortunate way of management would come forth, not in a liquid, but a saline form. Of which Observation we may elsewhere mention some Instances, and shall before the close of this Paper name one, afforded us by crude Tartar.

3. Though Silver be one of the fixedst bodies that we know of, yet that 'tis not impossible but that, chiefly by a change of Texture, it may strangely be disposed to Volatility, I was induced to think by what I remember once happened to me. A Gentleman of my acquaintance, studious of Chymical *Arcana*, having lighted on a strange Menstruum, which he affirmed, and I had some cause to believe, not to be corrosive, he abstracted it from several metalls, (for the same Liquour would serve again and again,) and brought me the *Remainders*, with a desire that I would endeavour to reduce those of Lead and Silver into the pristine metalls

tals again, which he had in vain attempted to doe: whereupon, though I found the white Calx of Lead reducible, yet when I came to the Calx of Silver, I was not able to bring it into a body; and having at length melted some Lead in a gentle fire, to try whether I could make it swallow up the *Calx*, in order to a farther operation, I was not a little surprized to find, that this mild heat made the *Calx* of Silver presently fly away and sublime in the form of a *farina volatilis*, which whitened the neighbouring part of the Chimney, as well as the upper part of the Crucible.

4. From that which Chymists themselves tell us, I think we may draw a good Argument *ad hominem*, to prove, that Volatility depends much upon the texture and other Mechanical affections of a body. For divers of those Hermetick Philosophers (as they are called) that write of the *Elixir*, tell us, that when their Philosophick Mercury or grand Solvent, being sealed up together with a

24 Of the Mechanical Origine

third or fourth part of Gold in a glass-Egg, is kept in convenient degrees of fire, the whole matter, and consequently the Gold, will, by the mutual operation of the included Substances, be so changed, that not onely 'twill circulate up and down in the glass, but, in case the digestion or decoction should be broken off at a certain inconvenient time, the Gold would be quite spoil'd, being, by the past and untimely-ended operation, made too Volatile to be reducible again into Gold: whereas, if the decoction be duly continued unto the end, not onely the Gold, but all the Philosophical Mercury or *Menstruum* will be turned into a Sulphur or powder of a wonderfully fixt nature. I know, there are several Chrysopeans, that speak much otherwise of this Operation, and tell us, that the Gold employed about it must be Philosophick Gold: But I know too, that there are divers others (and those too none of the least candid or rational) that speak of it as I have done; and That
is

is sufficient to ground an Argument on towards all those that embrace Their doctrine. And in this case 'tis considerable, that 'tis not by any superadded additament, that the most fixt body of Gold is made volatile, but the same massy matter, consisting of Gold and Philosophick Mercury, is, by the change of texture produced or occasioned by the various degrees and operations of fire upon it, brought to be first Volatile, and then extremly fixt. And having said this in reference to one tribe of the Modern Spagyrist; to another of them, the *Helmontians*, I think I can offer a good Argument *ad hominem* from the Testimony and Experiments of the Founder of their Sect.

5. The acute *Helmont*, among other prodigious powers that he ascribes to the Alkahest, affirms, that, by abstracting it frequently enough, it would so change all tangible bodies, and consequently stones and metals, that they might be distilled over into Liquours equiponderant
to

26 *Of the Mechanical Origine*
to the respective bodies that afforded them, and having all the Qualities of Rain-water; which if they have, I need not tell you that they must be very Volatile. And I see not how those that admit the Truth of this strange Alkahestical operation, can well deny, that Volatility depends upon the Mechanical affections of matter, since it appears not, that the Alkahest does, at least in our case, work upon bodies otherwise than Mechanically. And it must be confessed, that the same material parts of a portion of corporeal substance, which, when they were associated and contexed (whether by an *Archeus*, seed, form, or what else you please,) after such a determinate manner, constituted a solid and fixt body, as a Flint or a lump of Gold; by having their Texture dissolved, and (perhaps after being subtilized) by being freed from their former implications or firm cohesions, may become the parts of a fluid body totally Volatile.

CHAP.

CHAP. V.

THE fourth means of making a body Volatile is, by associating the particles to be raised with such as are more Volatile than themselves, and of a figure fit to be fastened to them, or are at least apt, by being added to them, to make up with them corpuscles more disposed than they to Volatility. This being the grand Instrument of Volatilization, I shall spend somewhat the more time about it: But I shall first here a little explain the last clause, (that I may not be obliged to resume it elsewhere,) by intimating, that 'tis not impossible, that the particles of an additament, though not more volatile than those of the body 'tis mixt with, and perhaps though not volatile at all, will yet conduce to volatilize the body wherewith 'tis mingled. For the particles of the additament may be of such figures, and so associated with those of the body to be elevated,

as

28 Of the Mechanical Origine

as in this to enlarge the former pores, or produce new ones, by intercepting little cavities (for they must not be great ones) between the particles of a body to be raised, and those of the additament. For, by these and other such ways of association, the corpuscles, resulting from the combination or coalition of two or more of these differing particles, may, without becoming too big and unwieldy, become more conveniently shaped, or more light in proportion to their bulk, and so more easily buoyed up and sustained in the air, (as when the Lid of a Copper-box being put on, makes the whole box emerge and swim in water, because of the intercepted cavity, though neither of the parts of the box would doe so,) or otherwise more fitted for avolation than the particles themselves were before their being joined to those of the additament.

By two things chiefly the corpuscles of the additament may contribute to the elevation of a body. For
first,

and Production of Volatility. 29

first, the parts of the former may be much more disposed for avolation than is necessary to their own Volatility. As when in the making of Sal Armoniac, the saline particles of Urine and of Soot are more fugitive than they need be to be themselves sublimed, and thereby are advantaged to carry up with them the more sluggish corpuscles whereof Sea-salt consists. And *next*, they may be of figures so proper to fasten them well to the body to be elevated, that the more fugitive will not be driven away or disjoyned from the more fixt by such a degree of Heat as is sufficient to raise them both together : To which effect the congruity or figuration is as well required, as the lightness or volatility of the particles of the additament. And therefore some of the fugitivest bodies that we know, as Spirit of Wine, Camphire, &c. will not volatilize many bodies which will be elevated by far less fugitive additaments ; because the corpuscles of Spirit of Wine stick
not

not to those of the body they are mingled with, but, easily flying up themselves, leave those behind them, which they did rather barely touch than firmly adhere to : Whereas far less fugacious Liquours, if they be indowed with figures that fit them for a competently firm cohesion with the body they are mingled with, will be able to volatilize it. Of which I shall now give you some Instances in bodies that are very ponderous, or very fixt, or both.

And I shall begin with Colcothar, though it being a vitriolate *calx*, made by a lasting and vehement fire, 'tis (consequently) capable of resisting such a one. This being exquisitely ground with an equal weight of Sal Armoniac, which is it self a Salt but moderately volatile, will be in good part sublimed into those yellow Flowers, which we have elsewhere more particularly taught to prepare, under the name of *Ens primum Veneris* ; in which, that many vitriolate corpuscles of the Colcothar are really ele-

and Production of Volatility. 31

elevated, you may easily find by putting a grain or two of that reddish Substance into a strong infusion of Galls, which will thereby immediately acquire an inky colour.

Steel also, which, to deserve that name, must have endured extraordinary violences of the fire, and greater than is needfull to obtain other metalls from their Mother Earth; Steel it self, I say, being reduced to filings, and diligently ground with about an equal weight of Sal Armoniac, will, if degrees of fire be skilfully administred, (for 'tis easie to err in that point,) without any previous calcination or reduction to a *Crocus*, suffer so much of the metall to be carried up, as will give the Sal Armoniac a notable colour, and an ironish tast.

And here it will be proper to observe, for the sake of practical Chymists, that the Quantity or Proportion of the Volatile additament is to be regarded; though not so much as its Nature, yet more than it is wont
to

to be : And divers bodies, that are thought either altogether unfit for Sublimation, or at least incapable to have any considerable portion of them elevated, may be copiously enough sublimed, if a greater proportion of the additament, than we usually content our selves with, be skillfully imployed. And in the newly-mentioned Instance of Filings of Steel, if, in stead of an equal weight of *Sal Armoniac*, the treble weight be taken, and the operation be duly managed, a far greater quantity of the metall may be raised, especially if fresh *Sal Armoniac* be carefully ground with the *Caput Mortuum*. And *Sal Armoniac* may perhaps be compounded with such other bodies, heavier than it self, as may qualifie it, when it is thus clogged, to elevate some congruous bodies better than it would of it self alone. And I shall venture to add this farther Advertisement, That if, besides the plenty of the additament, there be a sufficient fitness of its particles to lay hold

and Production of Volatility. 33

hold on those of the body to be wrought on, Mineral bodies, and those ponderous enough, may be employed to volatilize other heavy bodies. And I am apt to think, that almost, if not more than almost, all Metalls themselves may by copious additaments and frequent Cohobations be brought to pass through the neck of the Retort in distillation; and perhaps, if you melt them not with equal parts, but with many parts of *Regulus of Antimony*, and then proceed as the hints now given will direct you, you will not find cause to despise what I have been saying.

You know what endeavours have been, and are still fruitlessly, employed by Chymists to elevate so fixt a body as *Salt of Tartar* by additaments. I shall not now speak much of the enterprize in generall, designing chiefly to tell you on this occasion, that, whereas frequent experience shews, that *Sal Armoniac* being abstracted from *Salt of Tartar*, not only the

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Salt

34 Of the Mechanical Origin

Salt of Tartar is left at the bottom, but a good part of the Sal Armoniac is left behind with it; I suspected the cause might be, that Sal Armoniac, by the operation of the Alkaly of Tartar, is reduced into Sea-salt, and Urinous or fuliginous Salt, as 'twas at first composed of those differing Ingredients; and that by this means the volatil Salt being loosened or disintangled from the rest, and being of a very fugacious Nature, flies easily away it self, without staying long enough to take up any other Salt with it. And therefore, if this *Analysis* of the Sal Armoniac could be prevented, it seemed not impossible to me, that some part of the Salt of Tartar, as well as of Colcothar and Steel, might be carried up by it: And accordingly having caused the Ingredients to be exceedingly well dryed, and both nimbly and carefully mixt, and speedily exposed to the fire, I have sometimes had a portion of Salt of Tartar carried up with the Sal Armoniac: but this happened

pened so very rarely, that I suspected some peculiar fitness for this work in some parcels of Sal Armoniac, that are scarce but by the effect to be discerned from others. But however, what has happened to us may argue the Possibility of the thing, and may serve to shew the volatilizing efficacy of Sal Armoniac; which is a Compound, that I elsewhere recommend, and doe it now again, as one of the usefulest Productions of vulgar Chymistry.

And since I have mentioned the Volatilization of *Salt of Tartar*, presuming your Curiosity will make you desire my Opinion about the Possibility of it, I shall propose to you a distinction, that perhaps you doe not expect, by saying, that I think there is a great deal of difference between the making a Volatile Salt of Tartar, and the making Salt of Tartar Volatile. For, though this seem to be but a Nicety, yet really it is none; and it is very possible, that a man may from Tartar obtain a Volatile salt,

36 Of the Mechanical Engine

and yet be no wise able to volatilize that Tartareous Salt, that has been once by the incineration of the Tartar brought to fixt Alkaly. I have in the *Sceptical Chymist* summarily delivered a way, by which both I, and some Spagyristes that learned it of me, obtained from a mixture of Antimony, Nitre, and crude Tartar, a Volatil salt, which in probability comes from the last named of those three bodies; but experience carefully made has assured me, that without any additament, by a distillation warily and very slowly made, (inso-much that I have spent near a week in distilling one pound of matter) very clean Tartar, or at least the Crystals of Tartar, may, in conveniently shaped Vessels, be brought to afford a Substance that in Rectification will ascend to the upper part of the Vessel, in the form of a Volatil Salt, as if it were of Urine or of Harts-horne; of which (Tartareous) Salt, I keep some by me: But this operation requires not onely a dexterous,

terous, but a patient distiller.

But now as to the making a fixt Alkaly of Tartar become Volatil, I take it to be another, and have found it to be a far more difficult, work; the common Processes of performing it being wont to promise much more than they can make good; which I may justly say of some other, that private men have vaunted for great *Arcana*, but upon triall have satisfied me so little, that I have divers times offered pretenders to make Salt of Tartar Volatil, that without at all inquiring into their Processes, I would lay good wagers, that they could not doe what they pretended; not onely as divers Philosophical Spagyristis require, without any visible additament, but by any additament whatever; provided I were allowed to bring the Salt of Tartar my self, and to examine the Success, not by what may appear in the Alembic and Receiver, but by the weight of what would remain in the bottom. For I have convinced some of the more Ingenuous Artists,

38 *Of the Mechanical Dzigine*
tists, that the Salt that sublimed was not indeed the Alkaly of Tartar, but somewhat that was by the operation produced, or rather extricated out of the additaments. But yet I would not be thought to affirm, that 'tis not possible to elevate the fixt Salt of Tartar. For sometimes I have been able to doe it, even at the first Distillation, by an artificial additament perhaps more fixt than it self; but, though the operation was very gratefull to me, as it shewed the Possibility of the thing, yet the paucity of the Salt sublimed and other Circumstances, kept me from much valuing it upon any other account. And there are other wayes, whereby Experience has assured me, that Salt of Tartar may be raised. And if one of them were not so uncertain, that I can never promise before hand that it will at all succeed, and the other so laborious, difficult and costly, that few would attempt or be able to practice it, I should think them very valuable things; since by the former,

mer way most part of the Salt of Tartar was quickly brought over in the form of a Liquor, whose piercing smell was scarce tolerable; and by the latter way some Salt of Tartar of my own, being put into a Retort, and urged but with such a fire as could be given in a portable Sand-furnace, there remained not at the bottom near one half of the first weight, the additament having carried up the rest, partly in the form of a Liquor, but chiefly in that of a white Sublimate, which was neither ill-sented, nor in taste corrosive, or alcalizat, but very mild, and somewhat sweetish. And I doe not much doubt, but that by other wayes the fixt Alkaly of Tartar may be elevated, especially if, before it be exposed to the last operation of the fire, it be dextrously freed from the most of those Earthy and Viscous parts, that I think may be justly suspected to clog and bind the truly saline ones.

But I have too long digrest, and therefore shall intimate onely upon

40 Of the Mechanical Origine

the by, that even the spurious *Sal Tartari* volatilized that is made with Spirit of Vinegar, may, if it be well prepared, make amends for its Emphyreumatical smell and tast, and may, notwithstanding them, in divers cases be of no despicable use, both as a Medicine, and a Menstruum.

CHAP. VI.

BEfore I draw towards a Conclusion of these Notes about Volatility, perhaps it will not be amiss, to take notice of a Phænomenon, which may much surprise, and sometimes disappoint those that deal in Sublimations, unless they be forewarned of it. For though it be taken for granted, and for the most part may justly be so, that by carefully mingling what is sublimed with what remains, and re-subliming the mixture, a greater quantity of the body to be sublimed may be elevated the second time than was the first, and

and Production of Volatility. 41

and the third time than the second, and so onwards; yet I have not found this Rule alwayes to hold, but in some Bodies, as particularly in some kinds of dulcified Colcothar, the Sal Armoniac, would at the first Sublimation carry up more of the fixed powder, than at the second or third. So that I was by several Tryalls perswaded, when I found a very well and highly coloured powder elevated, to lay it by for use, and thereby save my self the labour of a prosecution, that would not onely have proved useless, but prejudicial. And if I misremember not, by often repeated Cohobations, (if I may so call them) of Sal Armoniac upon crude or Mineral Antimony, though the Sublimate that was obtained by the first Operation, was much of it variously, and in some places richly, coloured; yet afterwards, the Salt ascended from time to time paler and paler, leaving the Antimony behind it. Which way of making some Minerals more fixt and fusible I conceive

42 Of the Mechanical Origine

ceive may be of great use in some Medicinal Preparations, though I think it not fit to particularize them in this place: Where my chief intent was, to mention the Phenomenon it self, and invite you to consider, whether it may be ascribed to this, that by the reiterated action of the fire, and grinding together of the body to be raised, either the corpuscles of the Sal Armoniac, or those of the other body, may have those little hooked or equivalent particles, whereby they take hold of one another, broken or worn off; and whether the indisposedness of the Colcotharine or Antimonial parts to ascend, may not in some cases be promoted by their having, by frequent attritions, so smoothed their Surfaces that divers of them may closely adhere, like pieces of polished Glass, and so make up Clusters too unweildy to be so raised, as the single corpuscles they consist of, were. Which change may dispose them to be at once less Volatil and more Fusible. Which
Con-

and Production of Volatility. 43

Conjectures I mention to excite you to frame better, or at least to make amends for my omission of examining these, by trying whether the Sal Armoniac grown white again will be as fit as it was at first to carry up fresh bodies; and also by observing the weight of the unelevated part, and employing those other wayes of *examen*, which I should have done, if I had not then made Sublimations for another end, than to clear up the Doctrine of Volatility.

And here it may be profitable to some Chymists, though not necessary to my Subject, to intimate, that Sublimations may be useful to make very fine Comminutions of divers bodies. That those that are elevated are reduced to a great fineness of parts, is obvious to be observed in many Examples, whence it has been anciently, not absurdly, said, that Sublimations are the Chymists Pestles, since (as in Flowers of Sulphur and Antimony) they do really resolve the eleva-

44 **Of the Mechanical Drigine**
elevated bodies into exceeding fine
Flower, and much finer than Pestles
and Mortars are wont to bring them
to. But that which I intend in this
Paragraph is not a thing so obvious,
since 'tis to observe, that sometimes
even bodies so fixt as not at all to a-
scend in Sublimation, may yet be re-
duced by that operation into pow-
ders extreamly fine. For exemplify-
ing of which, I shall put you in mind,
that though Spagyrist's complain much
of the Difficulty of making a good
Calx of Gold, and of the Imperfe-
ction of the few ordinary processe
prescribed to make it, (which would
be more complained of, but that
Chymical Physicians seldom attempt
to prepare it,) yet we are informed by
triall, that by exactly grinding a thick
amalgam of Gold and Mercury with a
competent weight, (at least equal to
its own) of finely powdered Sulphur,
we may, by putting the mixture to su-
blime in a conveniently shaped Glas,
by degrees of fire obtain a Cinaber
that will leave behind it a finer Calx
of

and Production of Volatility. 45
of Gold than will be had by some far
more difficult processes.

But 'tis now time to draw towards
a Conclusion of our Notes about Vo-
latility; which Quality depends so
much upon the contexture of the
corpuscles that are to be raised to-
gether, that even very ponderous
bodies may serve for volatilizing ad-
ditaments, if they be disposed to fa-
sten themselves sufficiently to the bo-
dies they are to carry up along with
them. For, though *Lead* be, save
one, the heaviest solid we know
of, and though *Quick-silver* be the
heaviest body in the world, except
Gold; yet trialls have assured us,
that *Quick-silver* it self being united
by Amalgamation with a small pro-
portion of *Lead*, will by a fire that
is none of the violentest, and in close
Vessels, be made to carry over with it
some of the *Lead*. As we clearly found
by the increased weight of the *Quick-*
silver that passed into the Receiver;
which, by the way, may make us
cautious how we conclude *Quick-*
silver

46 Of the Mechanical Origine

silver to be pure, meerly from its having been distilled over.

There remains but one body more heavy than those I come from naming, and that is *Gold*; which, being also of a fixity so great that 'tis indeed admirable, I doe not wonder that not onely the more wary Naturalists, but the more severe among the Chymists themselves should think it incapable of being volatilized. But yet, if we consider, how very minute parts Gold may be rationally supposed to consist of, and to be divisible into, me thinks it should not seem impossible, that, if men could light on Volatil Salts endowed with figures fit to stick fast to the corpuscles of the Gold, they would carry up with them bodies, whose solidity can scarce be more extraordinary than their minuteness is : And in effect, we have made more than one *Menstruum*, with which some particles of Gold may be carried up. But when I employed that which I recommended to you formerly under the
name

and Production of Volatility. 47

name of *Menstruum peracutum* (which consists mainly, and sometimes onely, of Spirit of Nitre, several times drawn from Butter of Antimony,) I was able, without a very violent fire, in a few hours to elevate so much crude Gold, as, in the neck of the Retort, afforded me a considerable Quantity of Sublimate, which I have had red as blood, and whose consisting partly of Gold manifestly appeared by this, that I was able with ease to reduce that metall out of it.

In reckoning up the Instruments of Volatilization, we must not quite leave out the mention of the *Air*, which I have often observed to facilitate the elevation of some bodies even in close Vessels; wherein, though to fill them too full be judged by many a Compendious practise, because the steams have a less way to ascend, yet Experience has several times informed me, that, at least in some cases, they take wrong measures, and that (to pass by another Cause of their disappointment) a large proportion

48 *Of the Mechanical Origine*
tion of Air, purposely left in the Vessels, may more than compensate the greater space that is to be ascended by the vapours or exhalations of the matter that is to be distilled or sublimed. And if, in close Vessels, the presence of the Air may promote the ascension of bodies, it may well be expected, that the elevation of divers of them may be furthered by being attempted in open Vessels, to which the Air has free access. And if we may give any credit to the probable Relations of some Chymists, the Air does much contribute to the volatilization of some bodies that are barely, though indeed for no short time, exposed to it. But the account on which the Air by its bare presence or peculiar operations conduces to the Volatilization of some bodies, is a thing very difficult to be determined, without having recourse to some Notions about Gravity and Levity, and of the Constitution of the corpuscles that compose the Air; which I take to be both very numerous and

and Production of Volatility. 49

no less various. And therefore I must not in these occasional Notes lanch out into such a Subject, though; for fear I should be blamed for too much slighting my old acquaintance the *Air*, I durst not quite omit the power it has to dispose some bodies to Volatility.

A moderate attention may suffice to make it be discerned, that in what hath been hitherto delivered, I have for the most part considered the small portions of matter, to be elevated in Volatilization, as intire Corpuscles: And therefore it may be now pertinent, to intimate in a Line or two, that there may be also Cases; where-in a kind of Volatilization, improperly so called, may be effected, by making use of such additaments as break off or otherwise divide the particles of the corpuscles to be elevated, and by adhering to, and so clogging, one of the particles to which it proves more congruous, inable the other, which is now brought to be more light or disingaged, to ascend. This

D

may

50 Of the Mechanical Origine
may be illustrated by what happens,
when Sal Armoniac is well ground
with *Lapis Calaminaris* or with some
fix'd Alkali, and then committed to
distillation : For the Sea-salt, that
enters the Composition of the Sal
Armoniac, being detained by the
stone or the Alkali, there is a divorce
made between the common Salt and
the urinous and fuliginous Salts, that
were incorporated with it, and being
now disingaged from it, are easily e-
levated. I elsewhere mention, that
I have observed in Man's Urine a
kind of native Sal Armoniac, much
less Volatile than the fugitive that is
sublim'd from Man's Blood, Hart-
horn, &c. and therefore supposing,
that a separation of parts may be
made by an Alkali, as well in this Salt
as in the common factitious Sal Ar-
moniac, I put to fresh Urine a con-
venient proportion (which was a
plentifull one) of Salt of Pot-ashes
(that being then at hand) and distil-
ling the Liquor, it yielded, accor-
ding to expectation, a Spirit more Vo-
latile

and Production of Volatility. 51

latile than the Phlegm, and of a very piercing taste; which way of obtaining a Spirit without any violence of fire, and without either previously abstracting the Phlegm, (as we are said to do in fresh Urine) or tediously waiting for the fermentation of stale Urine, I taught some Chymists, because of the usefulness of Spirit of Urine; which being obtained this innocent way, would probably be employed with much less suspicion of corrosiveness, than if in the operation I had made use of Quick-lime. Another Illustration of what I was not long since saying, may be fetch'd from the Experiment of making Spirit of Nitre by mixing Salt-peter with Oil of Vitriol, and distilling them together: For the Oil does so divide or break the corpuscles of the Nitre, that the now-disposed particles of that Salt, which amount to a great portion of the whole, will be made easily enough to ascend even with a moderate fire of Sand, and sometimes without any

52 *Of the Mechanical Engine*
fire at all, in the form of Spirits, exceeding unquiet, subtle, and apt to moak away.

To which Instances of this imperfect kind of Volatilization more might be added, but that you may well think, I have detain'd you but too long already with indigested Notes about *one* Quality.

CHAP. VII.

THe last means of Volatilizing bodies is, the operation of the Fire or some other actual Heat : But of this, which is obvious, it would be superfluous to discourse. Onely this I shall intimate, that there may be bodies, which, in such degrees of fire as are wont to be given in the vulgar operations of Chymists, will not be elevated, which yet may be forced up by such violent and lasting fires, as are employed by the Melters of Ores, and Founders of Guns, and sometimes by Glafs-makers. And on
this

this Consideration I shall here observe to you, since I did not doe it at my entrance on these Notes, that Chymists are wont to speak, and I have accordingly been led to treat, of Volatility and Fixity in a popular sense of those Terms. For if we would consider the matter more strictly, I presume we should find that Volatility and Fixity are but relative Qualities, which are to be estimated, especially the former of them, by the degree of fire to which the body, whereto we ascribe one or other of those Qualities, is exposed; and therefore it is much more difficult than men are aware of, to determine accurately, when a body ought to be accounted Volatile and when not; since there is no determinate degree of Heat agreed on, nor indeed easie to be devised, that may be as a standard, whereby to measure Volatility and Fixtness: And 'tis obvious, that a body, that remains fixt in one degree of fire, may be forced up by another. To which may be added, agree-

agreeably to what I lately began to observe, that a body may pass for absolutely fixt among the generality of Chymists, and yet be unable to persevere in the fires of Founders and Glass-makers: Which brings into my mind, that not having observed, that Chymists have examined the Fixity of other bodies than metalline ones by the Cupel, I had the Curiosity to put dry Salt of Tartar upon it, and found, as I expected, that in no long time it manifestly wasted in so vehement a heat, wherein also the Air came freely at it, (though Quick-lime, handled after the same way, lost not of its weight,) and having well mixed one ounce of good Salt of Tartar with treble its weight of Tobacco-pipe Clay, we kept them but for two, or at most three hours, in a strong fire; yet the Crucible being purposely left uncovered, we found the Salt of Tartar so wasted, that the remaining mixture (which was not flux'd) afforded us not near a quarter of an ounce of Salt. And indeed I
scarce

scarce doubt, but that in strictness divers of those bodies that pass for absolutely fixt, are but semi-fixt, or at least but comparatively and relatively fix'd, that is, in reference to such degrees of fire, as they are wont to be expos'd to in the Distillations, Sublimations, &c. of Chymists; not such as are given in the raging fires of Founders, and Glas-makers. And perhaps even the fires of Glas-makers and Say-masters themselves are not the most intense that may possibly be made in a short time, provided there be but small portions of matter to be wrought on by them. And in effect, I know very few bodies, besides Gold, that will persevere totally fixt in the vehementest degrees of fire that Trials have made me acquainted with. And I elsewhere tell you, that, though Tin, in our Chymical Reverberatories themselves, is wont to be reduced but into a *Calx* that is reputed very fixt; yet in those intense fires, that a *Virtuoso* of my acquaintance uses in his Tin-Mines, there is
not

56 Of the Mechanical Dzigine
not seldom found quantities of Tin
carried up to a notable height in the
form of a whitish powder, which,
being in good masses forced off from
the places to which it had fastened it
self, does by a skillful reduction yield
many a pound weight of good mal-
leable metal, which seemed to me to
be rather more, than less, fine than
ordinary Tin.

Postscript,

*Relating to Page 15. of this Tract; and
here annext for their sakes, who have
a mind to repeat the Experiment there
delivered, that so they may know the
quantities employed in it.*

With two parts of this *Crocus* we
ground very well three parts of Sal
Armoniac, and having sublimed them in a
strong fire, we took off the high coloured
Sublimat, and put in either an equal weight,
or a weight exceeding it by half, to the Caput
Mortuum, we found after the second Subli-
mation, which was also high coloured, that
of an ounce of *Crocus* we had raised six
drams, that is, three quarters of the whole
weight.

F I N I S.

EXPERIMENTAL

N O T E S

O F

The Mechanical Origine

O R

PRODUCTION

O F

F I X T N E S S.



L O N D O N,

Printed by *E. Flesher*, for *R. Davis*
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SECTION

CHAPTER

PART

ARTICLE

SECTION

ARTICLE

SECTION



OF
The Mechanical Origine
OR
PRODUCTION
OF
FIXTNESS.

CHAP. I.

F*IXITY* being the opposite Quality to Volatility, what we have discoursed about the latter, will make the nature of the former more easily understood, and upon that account allow me to make somewhat the quicker dispatch of what I have to say of it.

4 Of the Mechanical Origine

The Qualifications that conduce most to the *Fixity* of a portion of matter, seem to be these.

First, the *grossness* or the bulk of the corpuscles it consists of. For if these be too big, they will be too unwieldy and unapt to be carried up into the Air by the action of such minute particles as those of the Fire, and will also be unfit to be buoyed up by the weight of the Air; as we see, that Vapours, whilst they are such, are small enough to swim in the Air, but can no longer be sustained by it, when they convene into drops of rain or flakes of snow. But here it is to be observed, that when I speak of the corpuscles that a fixt body consists of, I mean not either its Elementary or its Hypostatical Principles, as such, but onely those very little masses or clusters of particles, of what kind soever they be, that stick so firmly to one another, as not to be divisible and dissipable by that degree of fire in which the body is said to be fixt; so that each of those little Concretions,

ons, though it may it self be made up of two, three, or more particles of a simpler nature, is considered here *per modum Unius*, or as one intire corpuscle. And this is one Qualification conducive to the Fixtness of a body.

The *next* is the *ponderousness* or solidity of the corpuscles it is made up of. For if these be very solid, and (which solid and compact bodies usually are) of a considerable *specifick* gravity, they will be too heavy to be carried up by the *effluvia* or the action of the fire, and their ponderousness will make them as unwieldy, and indisposed to be elevated by such Agents, as the grossness of their bulk would make bigger corpuscles, but of a proportionably inferiour specifick weight. On which account the *calces* of some metals and minerals, as Gold, Silver, &c. though, by the operation of Solvents, or of the fire, or of both, reduced to powders exceedingly subtile, will resist such vehement fires, as will easily drive

6 Of the Mechanical Origine

up bigger, but less heavy and compact, corpuscles, than those *calces* consist of.

The *third* Qualification that conduces to the Fixity of a body, belongs to its *Integral parts*, not barely as they are several parts of it, but as they are aggregated or contexed into one body. For, the Qualification, I mean, is the ineptitude of the component corpuscles for avolation, by reason of their branchedness, irregular figures, crookedness, or other inconvenient shape, which intangles the particles among one another, and makes them difficult to be extricated; by which means, if one of them do ascend, others, wherewith 'tis complicated, must ascend with it; and, whatever be the account on which divers particles stick firmly together, the aggregate will be too heavy or unwieldy to be raised. Which I therefore take notice of, because that, though usually 'tis on the roughness and irregularity of corpuscles, that their cohesion depends; yet it
some-

or Production of Fixtness. 7

Sometimes happens, that the smoothness and flatness of their surfaces makes them so stick together, as to resist a total divulsion; as may be illustrated by what I have said of the cohesion of polished marbles and the plates of glass, and by the fixity of glass it self in the fire.

From this account of the Causes or Requisites of Fixity, may be deduced the following means of giving or adding Fixation to a body, that was before either Volatile, or less fixt. These means may be reduced to two general Heads; *First*, the action of the Fire, as the parts of the body, exposed to it, are thereby made to operate variously on one another. And *next*, the association of the particles of a volatile body with those of some proper additament: Which term, [*of proper*] I rather imploy than that, one would expect, [*of fixt*]; because 'twill ere long appear, that, in certain cases, some volatile bodies may more conduce to the fixation of other volatile bodies, than some fixt

8 Of the Mechanical Origine

ones doe. But these two Instruments of Fixation being but general, I shall propose four or five more particular ones.

CHAP. II.

AND *first*, in some cases it may conduce to Fixation, that, either by an additament, or by the operation of the fire, the parts of a body be brought to touch each other in large portions of their surfaces. For, that from such a contact there will follow such a mutual cohesion, as will at least indispose the touching corpuscles to suffer a total divulsion, may appear probable from what we lately noted of the cohesion of pieces of marble and glass, and from some other *Phænomena* belonging to the History of *Firmness*, from which we may properly enough borrow some instances, at least for illustration, in the Doctrine of *Fixtness*, in regard that usually, though not always, the

or Production of Firmness. 9

the same things that make a body *Firm*, give it some degree of *Fixity*, by keeping it from being dissipated by the wonted degrees of Heat, and Agitation it meets with in the Air. But to return to the contact we were speaking of, I think it not impossible, (though you may perhaps think it strange.) that the bare operation of the Fire may, in some cases, procure a *Cohesion* among the particles, (and consequently make them more *Fixt*,) as well as in others disjoyn them, and thereby make them more *Volatile*. For, as in some bodies, the figures and sizes of the corpuscles may be such, that the action of the fire may rub or tear off the little beards or hooks, or other particles that intangle them, and by that means make it more easie for the corpuscles to be disingaged and fly upwards; so in other bodies, the size and shape of the corpuscles may be such, that the agitation, caused by the fire, may rub them one against the other, so as by mutual attrition to grind, as 'twere, their

sur-

10 **Of the Mechanical Origine**
surfaces, and make them so broad
and smooth, if not also so flat, as that
the contact of the corpuscles shall
come to be made according to a large
portion of their superficies, from
whence will naturally follow a firm
Cohesion. Which I shall illustrate
by what we may observe among those
that grind glasses for Telescopes and
Microscopes. For, these Artificers,
by long rubbing a piece of glass a-
gainst a metalline Dish or concave
Vessel, do by this attrition at length
bring the two bodies to touch one
another in so many parts of their
congruous surfaces, that they will
stick firmly to one another, so as
sometimes to oblige the Work-man
to use violence to disjoyn them.
And this instance (which is not the
sole I could alleage) may suffice to
shew, how a Cohesion of corpuscles
may be produced by the mutual ad-
aptation of their congruous surfa-
ces. And if two grosser corpuscles, or
a greater number of smaller, be thus
brought to stick together, you will
easily

or Production of Firtness. 11

easily believe, their Aggregate will prove too heavy or unwieldy for a-
volution. And to shew, that the fire
may effect a lavigation in the surfa-
ces of some corpuscles, I have some-
times caused *Minium*, and some o-
ther *calces*, that I judged convenient,
to be melted for a competent time,
in a vehement fire conveniently ad-
ministr'd; whereby, according to
expectation, that which was before
a dull and incoherent powder, was
reduced into much grosser corpuscles,
multitudes of whose grains appea-
red smooth, glittering, and almost
specular, like those of fine litharge
of gold; and the masses that these
grains compos'd, were usually solid
enough and of difficult fusion. And
when we make glass of Lead *per se*,
(which I elsewhere teach you how
to doe,) 'tis plain, that the particles
of the Lead are reduced to a great
smoothness; since, wheresoever you
break the glass, the surfaces, produ-
ced at the crack, will not be jagged,
but smooth, and considerably specu-
lar.

12 **Of the Mechanical Origine**
lar. Nor do I think it impossible, that, even when the fire does not make any great attrition of the Corpuscles of the body to be fixt, it may yet occasion their sticking together, because by long tumbling them up and down in various manners, it may at length, after multitudes of revolutions and differing occurrsions, bring those of their surfaces together, which, by reason of their breadth, smoothness, or congruity of figure, are fit for mutual cohesion; and when once they come to stick, there is no necessity, that the same causes, that were able to make them pass by one another, when their contact was but according to an inconsiderable part of their surfaces, should have the same effect now, when their contact is full; though perhaps, if the degree of fire were much increased, a more vehement agitation would surmount this cohesion, and dissipate again these clusters of coalescent corpuscles.

These conjectures will perhaps appear

pear less extravagant, if you consider what happens in the preparation of Quick-silver præcipated *per se*. For there, running Mercury, being put into a conveniently shaped Glass, is exposed to a moderate fire for a considerable time : (For I have sometimes found six or seven weeks to be too short a one.) In this degree of fire the parts are variously tumbled, and made many of them to ascend, till convening into drops on the sides of the glass, their weight carries them down again ; but at length, after many mutual occurrsions, if not also attritions, some of the parts begin to stick together in the form of a red powder, and then more and more Mercurial particles are fastened to it, till at length all, or by much the greater part of the Mercury, is reduced into the like *Præcipitate*, which, by this cohesion of the parts, being grown more fixt, will not with the same degree of Heat be made to rise and circulate, as the Mercury would before ; and yet, as I elsewhere note,

I have

14 Of the Mechanical Origin

I have found by trial, that, with a greater and competent degree of heat, this *Præcipitate per se*, would, without the help of any volatilizing additament, be easily reduced into running Mercury again. Chymists and Physicians, who agree in supposing this *Præcipitate* to be made without any additament, will perchance scarce be able to give a more likely account of the consistency and degree of Fixity that is obtained in the Mercury; in which, since nobody is added to it, there appears not to be wrought any but a *Mechanical* change. And though, I confess, I have not been without suspicions, that in Philosophical strictness this *Præcipitate* may not be made *per se*, but that some penetrating igneous particles, especially saline, may have associated themselves with the Mercurial Corpuscles; yet even upon this supposition it may be said, that these particles contribute to the effect that is produced, but by facilitating or procuring, by their opportu-
tune

tune Interposition, the mutual Cohesion of Corpuscles that would not otherwise stick to one another.

Perhaps it will not be altogether impertinent to add, on this occasion, that, as for the generality of Chymists, as well others as *Helmontians*, that assert the Transmutation of all metallis into Gold by the Philosopher's Stone, we think, they may grant it to be probable, that a new and fit Contexture of the parts of a volatile body may, especially by procuring a full contact among them, very much contribute to make it highly fixt. For, to omit what is related by less credible Authors, 'tis averred, upon his own trial, by *Helmont*, who pretended not to the Elixir, that a grain of the powder, that was given him, transmuted a pound (if I mis-remember not) of running Mercury; where the proportion of the Elixir to the Mercury was so inconsiderable, that it cannot reasonably be supposed, that every Corpuscle of the Quick-silver, that before was volatile, was made extremely

16 Of the Mechanical Origine

creamy fixt meerly by its Coalition with a particle of the powder, since, to make one grain suffice for this Coalition, the parts it must be divided into must be scarce conceivably minute, and therefore each single part not likely to be fixt it self, or at least more likely to be carried up by the vehemently agitated Mercury, than to restrain that from avolation; whereas, if we suppose the Elixir to have made such a commotion among the corpuscles of the Mercury, as (having made them perhaps somewhat change their figure, and expelled some inconvenient particles,) to bring them to stick to one another, according to very great portions of their surfaces, and intangle one another, it will not be disagreeable to the Mechanical Doctrine of Fixity, that the Mercury should endure the fire as well as Gold, on the score of its new Texture, which, supposing the story true, appears to have been introduced, by the new colour, specifick gravity, Indissolubleness in Aqua fortis,

fortis, and other Qualities wherein Gold differs from Mercury, especially Malleableness, which, according to our Notes about that Quality, usually requires that the parts, from whose union it results, be either hooked, branched, or otherwise adapted and fitted to make them take fast hold of one another, or stick close to one another. And since, in the whole mass of the factitious Gold, all save one grain must be materially the same body, which, before the projection was made, was Quick-silver, we may see how great a proportion of volatile matter may, by an inconsiderable quantity of fixing additament, acquire such a new Disposition of its parts, as to become most fixt. And however, this Instance will agree much better with the Mechanical Doctrine about Fixity, than with that vulgar Opinion of the Chymists, (wherewith 'twill not at all comply,) That if, in a mixture, the volatile part do much exceed the fixt, it will carry up that,

18 Of the Mechanical Origine
or at least a good portion thereof,
with it; and on the contrary. But
though this Rule holds in many cases,
where there is no peculiar indisposi-
tion to the effect that is aimed at; yet
if the Mechanical affections of the
bodies be ill suited to such a purpose,
our Philosophical Experiment mani-
festly proves, that the Rule will not
hold, since so great a multitude of
grains of Mercury, in stead of carry-
ing up with them one grain of the
Elixir, are detained by it in the stron-
gest fire. And thus much for the first
way of fixing Volatile Bodies.

CHAP. III.

THE *second* way of producing
Fixity, is by expelling, brea-
king, or otherwise disabling those
volatile Corpuscles that are too in-
disposed to be fixt themselves, or are
fitted to carry up with them such par-
ticles as would not, without their
help, ascend. That the Expulsion
of

of such parts is a proper means to make the aggregate of those that remain more fixt, I presume you will not put me solicitously to prove; and we have a manifest instance of it in *Soot*, where, though many active parts were by the violence of the fire and current of the air carried up together by the more volatile parts; yet, when Soot is well distilled in a Retort, a competent time being given for the extricating and avolation of the other parts, there will at the bottom remain a substance that will not now fly away, as it formerly did. And here let me observe, that the recesses of the fugitive corpuscles may contribute to the fixation of a body, not barely because the remaining matter is freed from so many unfixt, if not also volatilizing, parts; but, as it may often happen, that upon their recesses the pores or intervals, they left behind them, are filled up with more solid or heavy matter, and the body becomes, as more homogeneous, so more close and compact. And

whereas I intimated, that, besides the expulsion of unfit corpuscles, they may be otherwise disabled from hindering the fixation of the masse they belong to, I did it, because it seems very possible, that in some cases they may, by the action of the fire, be so broken, as with their fragments to fill up the pores or intervals of the body they appertained to; or may make such coalitions with the particles of a convenient additament, as to be no impediment to the Fixity of the whole masse, though they remain in it. Which possibly you will think may well happen, when you shall have perused the Instances annexed to the *fourth* way of fixing bodies.

The *third* means of fixing, or lessening the Volatility of, bodies, is by preserving that rest among the parts, whose contrary is necessary to their Volatilization. And this may be done by preventing or checking that Heat, or other motion, which external Agents strive to introduce
into

into the parts of the proposed body. But this means tending rather to hinder the actual avolation of a portion of matter, or, at most, procure a temporary abatement of its volatility, than to give it a stable fixity, I shall not any longer insist on it.

The *fourth* way of producing Fixity in a body, is by putting to it such an appropriated Additament, whether *fixt* or *volatile*, that the Corpuscles of the body may be put among themselves, or with those of the additament, into a complicated state, or intangled contexture. This being the usual and principal way of producing Fixity, we shall dwell somewhat the longer upon it, and give Instances of several degrees of Fixation. For, though they do not produce that quality in the strictest acceptation of the word, *Fixity*; yet 'tis usefull in our present inquiry, to take notice, by what means that volatility comes to be *gradually* abated, since that may facilitate our understanding, how the Volatility

22 Of the Mechanical Origine
of a body comes to be *totally* abated, and consequently the body to be fixt.

CHAP. IV.

AND *first* we find, that a fixt ad-
ditament, if its parts be conveniently shaped, may easily give a degree of fixity to a very volatile body. Thus *Spirit of Nitre*, that will of it self easily enough fly away in the Air, having its saline particles associated with those of *fixt Nitre*, or *salt of Tartar*, will with the Alkaly compose a salt of a Nitrous nature, which will endure to be melted in a Crucible without being deprived even of its Spirits. And I have found, that the spirits of Nitre, that abound in *Aqua fortis*, being concoagulated with the Silver they corrode, though one would not expect that such subtile Corpuscles should stick fast to so compact and solid a body as Silver; yet Crystals, produced by their
Coali-

Coalition, being put into a Retort, may be kept a pretty while in fuſion, before the metal will let go the Nitrous ſpirits. When we poured *Oil of Vitriol* upon the *Calx* of Vitriol, though many Phlegmatick and other Sulphureous particles were driven away by the excited Heat; yet the ſaline parts, that combined with the fixt ones of the Colcothar, ſtuck faſt enough to them, not to be eaſily driven away. And if *Oil of Vitriol* be in a due proportion dropt upon *Salt of Tartar*, there reſults a *Tartarum vitriolatum*, wherein the acid and alkalizate parts cohere ſo ſtrongly, that 'tis not an ordinary degree of fire will be able to diſjoyn them. Inſomuch that divers Chymiſts have (though very erroneouſly) thought this compounded Salt to be indeſtructive. But a leſs heavy liquour than the ponderous *Oil of Vitriol* may by an Alkaly be more ſtrongly detained than that *Oil* it ſelf; experience having aſſured me, that *Spirit of Salt* being dropt to ſatiety upon a fixt

B 4 *Alkaly,*

Alkaly, (I used either that of Nitre or of Tartar,) there would be made so strict an union, that, having, without additaments, distilled the resulting salt with a strong and lasting fire, it appeared not at all considerably to be wrought upon, and was not so much as melted.

But 'tis not the bare Mixture or Commission of Volatile particles with Fixt ones, (yea though the former be predominant in quantity,) that will suffice to elevate the latter. For, unlesse the figures of the latter be congruous and fitted to fasten to the other, the volatile parts will fly away in the Heat, and leave the rest as fixt as before: as when sand or ashes are wetted or drenched with water, they quickly part with that water, without parting with any degree of their Fixity. But on the other side, it is not always necessary, that the body, which is fitted to destroy, or much abate, the volatility of another substance, should be it self fixt. For, if there be a skilful

or lucky coaptation of the figures of the particles of both the bodies, theſe particles may take ſuch hold of one another, as to compoſe corpufcles, that will neither by reaſon of their ſtrict union be divided by Heat; nor by reaſon of their reſulting groſſneſs be elevated even by a ſtrong fire, or at leaſt by ſuch a degree of Heat as would have ſufficed to raiſe more indispoſed bodies than either of the ſeparate Ingredients of the mixture. This obſervation, if duly made out, does ſo much favour our Doctrine about the *Mechanical* Origine of Fixation, and may be of ſuch uſe, not onely to *Chymiſts*, in ſome of their operations, but to *Philoſophers*, in aſſigning the cauſes of divers *Phænomena* of Nature, that it may be worth while to exemplifie it by ſome Inſtances.

The firſt whereof I ſhall take from an uſual practice of the Chymiſts themſelves: which I the rather doe, to let you ſee, that ſuch known Experiments are too often over-looked
by

by them that make them, but yet may hint or confirm Theories to those that reflect on them. The Instance, I here speak of, is that which is afforded by the vulgar Preparation of *Bezoardicum Minerale*. For, though the rectified *Butter* or *Oil* of *Antimony* and the *Spirit* of *Nitre*, that are put together to make this white *Præcipitate*, are both of them distilled liquours; yet the copious powder, that results from their Union, is, by that Union of volatile parts, so far fixt, that, after they haveedulcorated it with water, they prescribe the calcining of it in a *Crucible* for five or six hours: which operation it could not bear, unless it had attained to a considerable fixation. This discourse supposes with the generality of *Chymists*, that the addition of a due quantity of *Spirit* of *Nitre*, is necessary to be employed in making the *Bezoardicum Minerale*. But if it be a true *Observation*, which is attributed to the Learned *Guntherus Billichius*, (but which I had no *Furnace*

at

at hand to examine when I heard of it,) if, I say, it be true, that a *Bezoardicum Minerale* may be obtained, without spirit of Nitre, barely by a slow evaporation, made in a Glasse-dish, of the more fugitive parts of the Oil of Antimony; this Instance will not indeed be proper in this place, but yet will belong to the *second* of the foregoing ways of introducing Fixity. I proceed now to alleage other particulars in favour of the above-mentioned Observation.

If you take strong *Spirit of Salt*, that, when the Glass is unstopt, will smoak of it self in the cold air, and satiate it with the volatile *Spirit of Urine*, the superfluous moisture being abstracted, you will obtain by this preparation (which, you may remember, I long since communicated to you, and divers other *Virtuosi*.) a compounded Salt, scarce, if at all, distinguishable from *Sal Armoniac*, and which will not, as the Salts it consists of will doe, before their coalition, easily fly up of it self into the
air,

28 Of the Mechanical Origine
air, but will require a not despicable
degree of fire to sublime it.

Of these semivolatile Compositi-
ons of Salt I have made, and else-
where mentioned, others, which I
shall not here repeat, but passe on to
other Instances pertinent to our pre-
sent design.

I lately mentioned, that the Vola-
tility of the spirits of Nitre may be
very much abated, by bringing them
to coagulate into Crystalls with
particles of corroded Silver; but I
shall now add, that I guessed, and by
trial found, that these Nitrous spi-
rits may be made much more fixt by
the addition of the Spirit of Salt,
which, if it be good, will of it self
smoak in the Air. For, having dis-
solved a convenient quantity of Cry-
stalls of Silver in distilled water, and
precipitated them, not with a *solution*
of Salt, but the *spirit* of Salt; the
phlegm being abstracted, and some
few of the looser saline particoles;
though the remaining masse were
prest with a violent fire that kept
the

the Retort red-hot for a good while; yet the Nitrous and Saline ſpirits would by no means be driven away from the Silver, but continued in fuſion with it; and when the maſſe was taken out, theſe Spirits did ſo abound in it, that it had no appearance of a Metal, but looked rather like a thick piece of Horn.

The next Inſtance I ſhall name is afforded us by that kind of *Turbith*, which may be made by *Oil of Vitriol*, in ſtead of the *Aqua fortis* imploied in the common *Turpethum Minerale*. For, though Oil of Vitriol be a diſtilled liquour, and Mercury a body volatile enough; yet, when we abſtracted four or five parts of Oil of Vitriol from one of Quick-ſilver, (eſpecially if the operation were repeated,) and then waſhed off as much as we could of the ſaline particles of the Oil of Vitriol; yet thoſe that remained adhering to the Mercury made it far more fixt, than either of the liquours had been before, and enabled it even in a Crucible to endure ſuch a degree
of

30 Of the Mechanical Engine
of fire, before it could be driven a-
way, as, I confess, I somewhat won-
dered at. The like *Turbith* may be
made with Oil of Sulphur *per Campa-*
nam. But this is nothing to what
Helmont tells us of the operation of
his *Alkabeft*, where he affirms, that
that *Menstruum*, which is volatile e-
nough, being abstracted from running
Mercury, not onely coagulates it, but
leaves it fixt, so that it will endure
the brunt of fires acuated by Bellows,
(*omnem follium ignem.*) If this be
certain, it will not be a slender proof,
that *Fixity* may be *Mechanically* pro-
duced; and however, the Argument
will be good in reference to the *Hel-*
montian Spagyrist. For if, as one
would expect, there do remain
some particles of the *Menstruum* with
those of the metal, it will not be de-
nied, that two volatile substances
may perfectly fix one another.
And if, as *Helmont* seems to think,
the *Menstruum* be totally abstracted,
this supposition will the more favour
our Doctrine about *Fixity*; since, if
there

there be no material additament left with the Quick-ſilver, the Fixation cannot ſo reaſonably be aſcribed to any thing, as to ſome new Mechanical modification, and particularly to ſome change of Texture introduced into the Mercury it ſelf.

And that you may think this the leſs improbable, I will now proceed to ſome Inſtances, whereof the firſt ſhall be this; That, having put a mixture made of a certain proportion of two dry, as well as volatile, bodies, (*viz.* Sal Armoniac, and Flower or very fine powder of Sulphur,) to half its weight of common running Mercury, and elevated this mixture three or four times from it, (in a conveniently ſhaped, and not over-wide, glaſs) the Mercury, that lay in the bottom in the form of a ponderous and ſome-what purpliſh powder, was, by this operation, ſo fixt, that it long endured a ſtrong fire, which at length was made ſo ſtrong, that it melted the Glaſs, and kept it melted, without being ſtrong enough to force up the
Mer-

32 Of the Mechanical Dzigine

Mercury : which, by some trials, not so proper to be here mentioned, seemed to have its salivating and e-metick powers extraordinarily infringed, and sometimes quite suppressed. But this onely upon the bye. In all the other Instances, (wherewith I shall conclude these Notes,) I shall employ one *Menstruum*, Oil of Vitriol, and shew you the efficacy of it in fixing some parts of volatile bodies with some parts of it self; by which examples it may appear, that a Volatile body may not onely lessen the volatility of another body, as in the lately mentioned case of our spirituouse *Sal Armoniac*; but that two Substances, that apart were volatile, may compose a third, that will not onely be less volatile, but considerably (if not altogether) fixt.

We mixed then, by degrees, about equal parts of *Oil of Vitriol* and *Oil of Turpentine* : and though each of them single, especially the latter, will ascend with a moderate fire in a Sand-furnace; yet, after the Distillation

lâtion was ended, we had a considerable quantity, sometimes (if I misremember not) a fifth or sixth part, of a *Caput Mortuum* black as a Coal, and whereof a great part was of a scarce to be expected fixtness in the fire.

To give a higher proof of the disposition, that Oil of Vitriol has to let some of its parts grow fixt by combination with those of an exceeding volatile additament, I mixed this liquour with an equal or double weight of highly rectified *Spirit of Wine*, and not onely after, but sometimes without, previous digestion, I found, that the fluid parts of the mixture being totally abstracted, there would remain a pretty quantity of a black Substance so fixt as to afford just cause of wonder.

And because *Camphire* is esteemed the most fugitive of consistent bodies, in regard that, being but laid in the free air, without any help of the fire, it will fly *all* away; I tried, what Oil of Vitriol abstracted from

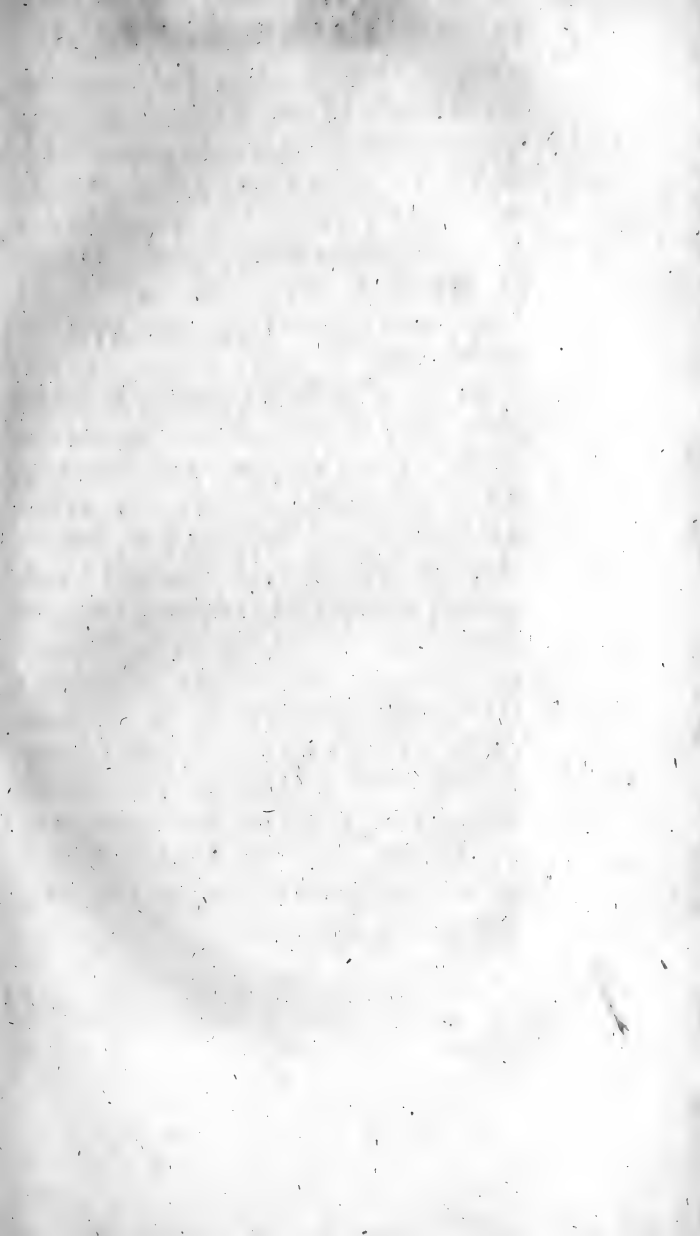
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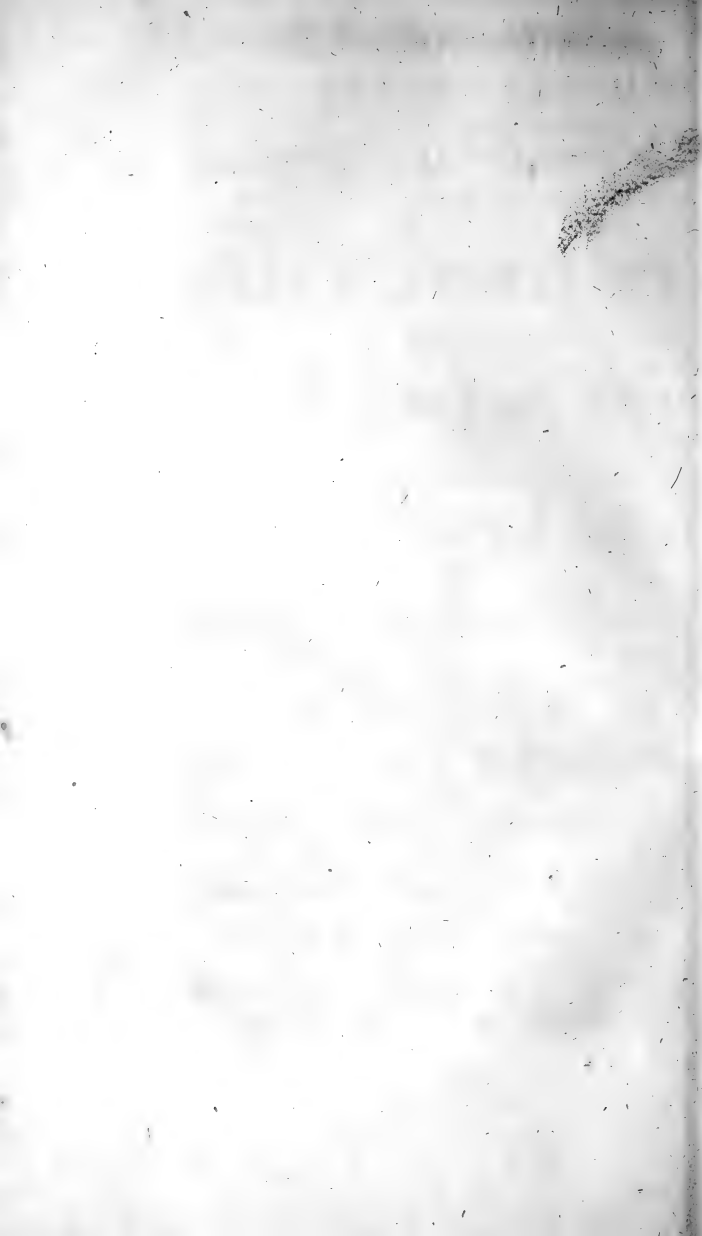
Cam-

Camphire would doe; and found at the bottom of the Retort a greater quantity than one would expect of a Substance as black as pitch, and almost as far from the volatility as from the colour of *Camphire*, though it appeared not, that any of the Gum had sublim'd into the neck of the Retort.

From all which Instances it seems manifestly enough to follow, that in many cases there needs nothing to make associated particles, whether volatile or not, become fixt, but either to implicate or intangle them among themselves, or bring them to touch one another according to large portions of their surfaces, or by both these ways conjoynly, or by some others, to procure the firm Cohæ- sion of so many particles, that the resulting Corpuscles be too big or heavy to be, by the degree of fire wherein they are said to be fixt, driven up into the Air.

F I N I S.





Experiments and Notes
ABOUT THE
MECHANICAL ORIGINE
OR
PRODUCTION
OF
CORROSIVENESS
AND
CORROSIBILITY.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,

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Experiments and Notes
 ABOUT THE
 MECHANICAL PRODUCTION
 OF
 CORROSIVENESS
 AND
 CORROSIBILITY.

SECT. I.

About the Mechanical Origine of Corrosiveness.

I Do not in the following Notes treat of *Corrosiveness* in their strict sense of the word, who ascribe this Quality only to Liquors, that are notably acid or sowre, such as *Aqua fortis*, Spirit of Salt, Vinegar,
 A 2 Juice

2 Of the Mechanical Origine of Juice of Lemons, &c. but, that I may not be oblig'd to overlook Urinous, Oleous, and divers other Solvents, or to coin new names for their differing Solutive Powers, I presume to employ the word *Corrosiveness* in a greater latitude, so as to make it almost equivalent to the *Solutive* power of Liquors, referring other Menstruums to those that are Corrosive or fretting, (though not always as to the most proper, yet) as to the principal and best known *species*; which I the less scruple here to do, because I have * elsewhere more distinctly enumerated and sorted the Solvents of bodies.

* This refers to an Essay of the Authors about the Usefulness of Chymistry to, &c.

The Attributes that seem the most proper to qualify a Liquor to be Corrosive, are all of them Mechanical, being such as are these that follow:

• *First*, That the Menstruum consist of, or abound with, Corpuscles not

Corrosibleness or Corrosibility. 3

too big to get in at the Pores or Commissures of the body to be dissolved; nor yet be so very minute as to pass through them, as the beams of Light do through Glass; or to be unable by reason of their great slenderness and flexibility to disjoyn the parts they invade.

Secondly, That these Corpuscles be of a shape fitting them to insinuate themselves more or less into the Pores or Commissures above-mentioned, in order to the dissociating of the solid parts.

Thirdly, That they have a competent degree of solidity to disjoyn the Particles of the body to be dissolved; which Solidity of Solvent corpuscles is somewhat distinct from their bulk, mention'd in the first Qualification; as may appear by comparing a stalk of Wheat and a metalline Wire of the same *Diame-ter*, or a flexible wand of Osier of the bigness of ones little finger, with a rigid rod of Iron of the same length and thickness.

4 Of the Mechanical Origine of

Fourthly, That the Corpuscles of the Menstruum be agile and advantaged for motion, (such as is fit to disjoyn the parts of the invaded body) either by their shape, or their minuteness, or their fitness to have their action befriended by adjuvant Causes; such as may be (*first*) the pressure of the Atmosphere, which may impell them into the Pores of bodies not fill'd with a Substance so resisting as common Air: As we see, that water will by the prevalent pressure of the Ambient, whether Air or Water, be raised to the height of some inches in capillary Glasses, and in the pores of Sponges, whose consistent parts being of easier cession than the sides of Glass-pipes, those Pores will be enlarged, and consequently those sides disjoyn'd, as appears by the dilatation and swelling of the Sponge: And (*secondly*) the agitation, that the intruding Corpuscles may be fitted to receive in those Pores or Commisures by the transcurfion of some
subtile

Corrosiveness or Corrosibility. 5

subtile ethereal matter; or by the numerous knocks and other pulses of the swimming or tumbled Corpuscles of the Menstruum it self, (which being a fluid body, must have its small parts perpetually and variously moved) whereby the engaged Corpuscles, like so many little Wedges and Leavers, may be enabled to wrench open, or force asunder the little parts between which they have insinuated themselves. But I shall not here prosecute this Theory, (which, to be handled fully, would require a discourse apart) since these Conjectures are propos'd but to make it probable in the general, That the *Corrosiveness* of bodies may be deduced from Mechanical Principles: But whether best from the newly propos'd ones, or any other, need not be anxiously consider'd in these Notes, where the things mainly intended and rely'd on, are the Experiments and *Phænomena* themselves.

EXPER. I.

TIs obvious, that, though the recently exprest Juice of Grapes be sweet, whilst it retains the Texture that belongs to it as 'tis new, (especially if it be made of some sorts of Grapes that grow in hot Regions,) yet after fermentation, 'twill, in tract of time, as 'twere spontaneously, degenerate into Vinegar, *In which* Liquor, to a multitude of the more solid Corpuscles of the Must, their frequent and mutual Attritions may be supposed to have given edges like those of the blades of swords or knives; and *in which*, perhaps, the confused agitation that preceded, extricated, or, as it were, unsheathed some acid particles, that (deriv'd from the sap of the Vine, or, perchance more originally, from the juice of the Earth) were at first in the Must, but lay conceal'd, and as it were sheathed, among

Corrosiveness or Corrosibility. 7

among the other particles where-
with they were associated, when
they were prest out of the Grapes.
Now this Liquor, that by the fore-
mentioned (or other like) Mecha-
nical Changes is become Vinegar,
does so abound with Corpuscles,
which, on the account of their edges,
or their otherwise sharp and pene-
trative shape, are Acid and Corro-
sive, that the better sort of it will,
without any preparation, dissolve
Coral, Crabs-eyes, and even some
Stones, *Lapis stellaris* in particular,
as also *Minium*, (or the *Calx* of
Lead) and even crude Copper, as
we have often tried. And not one-
ly the distill'd Spirit of it will do
those things more powerfully, and
perform some other things that meer
Vinegar cannot; but the saline par-
ticles, wont to remain after Distil-
lation, may, by being distill'd and
cohobated *per se*, or by being skil-
fully united with the foregoing Spi-
rit, be brought to a *Menstruum* of
no small efficacy in the dissolution,
and

8 Of the Mechanical Origine of
and other preparations of metalline
bodies, too compact for the meet
Spirit it self to work upon.

From divers other sweet things
also may Vinegar be made; and even
of Honey, skilfully fermented with
a small proportion of common wa-
ter, may be made a Vinegar strong-
er than many of the common Wine-
vinegars; as has been affirmed to
me by a very candid Physician,
who had occasion to deal much in
Liquors.

EXPER. II.

Not onely several dry Woods,
and other Bodies that most of
them pass for insipid, but Honey
and Sugar themselves afford by Di-
stillation Acid Spirits that will dis-
solve Coral, Pearls, &c. and will al-
so corrode some Metals and metal-
line Bodies themselves; as I have often
found by Trial. So that the vio-
lent Operation of the fire, that de-
troys

Corrosiveness or Corrosibility. 9

stroys what they call the *Form* of the distill'd body, and works as a Mechanical Agent by agitating, breaking, dissipating, and under a new constitution reassembling the parts, procures for the Distiller an Acid Corrosive Menstruum; which *whether* it be brought to pass by making the Corpuscles rub one another into the figure of little sharp blades, *or* by splitting some solid parts into sharp or cutting Corpuscles, *or* by unsheathing, as it were, some parts, that, during the former Texture of the body, did not appear to be acid; *or* whether it be rather effected by some other Mechanical way, may in due time be further considered.

EX-

EXPER. III.

TIs observ'd by Refiners, Goldsmiths and Chymists, that *Aqua Fortis* and *Aqua Regia*, which are Corrosive Menstruums, dissolve Metals, the former of them Silver, and the latter Gold, much more speedily and copiously when an external heat gives their intestine motions a new degree of Vehemency or Velocity, which is but a mechanical thing; and yet this superadded measure of Agitation is not onely in the abovemention'd Instances a powerfully assistant Cause in the Solutions made by the lately mention'd Corrosive Liquors, but is that without which some Menstruums are not wont sensibly to corrode some bodies at all, as we have tried in keeping Quick-silver in three or four times its weight of Oyl of Vitriol; since in this Menstruum I found not the Mercury to be dissolved or corroded,

Corrosiveness or Corrosibility. 11

roded, though I kept it a long time in the Cold: Whereas, when the Oyl of Vitriol was excited by a convenient heat, (which was not faint) it corroded the Mercury into a fine white *Calx* or powder, which, by the affusion of fair water, would be presently turn'd into a yellowish *Calx* of the colour and nature of a Turbith. I remember also, that having for trials sake dissolv'd in a weak Spirit of Salt, a fourth part of its weight of fine Crystals of Nitre, we found, that it would not in the cold (at least during a good while that we waited for its operation) dissolve Leaf-gold; but when the *Menstruum* was a little heated at the fire, the Solution proceeded readily enough. And in some cases, though the external heat be but small, yet there may intervene a brisk heat, and much cooperate in the dissolution of a Body; as, for instance, of Quick-silver in *Aqua Fortis*. For it is no prodigy to find, that when a full proportion of that fluid Metal has been
been

12 Of the Mechanical Origine of
been taken, the Solution, though at
first altogether liquid, and as to sense
uniform, comes to have after a
while a good quantity of coagula-
ted or crySTALLIZ'd matter at the bot-
tom, of which the cause may be,
that in the very act of Corrosion
there is excited an intense degree of
heat, which conferring a new de-
gree of agitation to the Menstruum,
makes it dissolve a good deal more,
than afterwards, when the Conflict
is over, it is able to keep up.

EXPER. IV.

WE have observed also, that
Agitation does in some ca-
ses so much promote the Dissolutive
power of Saline bodies, that though
they be not reduc'd to that subtilty
of parts, to which a strong Distil-
lation brings them; yet they may in
their grosser and cruder form have
the power to work on Metals; as I
elsewhere shew, that by barely boil-
ing

Corrosiveness or Corrosibility. 13

ing some Solutions of Salts of a convenient structure, as Nitre, Sal Armoniac, &c. with foliated Gold, Silver, &c. we have corroded these Metals, and can dissolve some others. And by boiling crude Copper (in Filings) with Sublimate and common water, we were able, in no long time, to make a Solution of the Metal.

EXPER. V.

Sometimes also, so languid an Agitation, as that which seems but sufficient to keep a Liquor in the state of fluidity, may suffice to give some dry bodies a corroding power, which they could not otherwise exercise; as in the way of writing ones name (or a *Motto*) upon the blade of a knife with common Sublimate: For, if having very thinly overlaid which side you please with Beeswax, you write with a bodkin or some pointed thing upon it; the
Wax

14 Of the Mechanical Origine of
Wax being thereby removed from
the strokes made by the sharp bo-
dy, 'tis easie to etch with Sublimate;
since you need but strew the pow-
der of it upon the place bared of
the Wax, and wet it well with
meer common water; for strong
Vinegar is not necessary. For after
a while all the parts of the blade
that should not be fretted, being
protected by the Case or Film of
Wax, the Sublimate will corrode
onely where way has been made
for it by the bodkin, and the Let-
ters will be more or less deeply in-
graven (or rather etch'd) accord-
ing to the time the Sublimate is suf-
fer'd to lye on. And if you aim
onely at a legible impression, a few
minutes of an hour (as four or five)
may serve the turn.

EX-

EXPER. VI.

THis brings into my mind an Observation I have sometimes had occasion to make, that I found more useful than common, and it is, That divers Bodies, whether distill'd or not distill'd, that are not thought capable of dissolving other Bodies, because in moderate degrees of heat they will not work on them, may yet by intense degrees of heat be brought to be fit Solvents for them. To which purpose I remember, that having a distill'd Liquor, which was rather sweet to the taste, than either acid, lixivate or urinous, though for that reason it seem'd unfit to work on Pearls, and accordingly did not dissolve them in a considerable time, wherein they were kept with it in a more than ordinarily warm digestion; yet the Glass being for many hours (amounting perhaps to some days) kept in such

16 Of the Mechanical Origine of
an heat of sand as made the Liquor
boil, we had a Dissolution of Pearls,
that uniting with the Menstruum
made it a very valuable Liquor.
And though the Solvents of crude
Gold, wont to be employed by
Chymists, are generally distill'd Li-
quors that are acid, and in the lately
mention'd Solvent, made of crude
Salts and common water, Acidity
seem'd to be the predominant quali-
ty (which makes the use of Soluti-
ons made in *Aqua Regia*, &c. sus-
pected by many Physicians and Chy-
mists;) yet fitly chosen Alcalizate
Bodies themselves, as repugnant as
they use to be to Acids, without
the help of any Liquor will be en-
abled by a melting Fire in no long
time to penetrate and tear asunder
the parts even of crude Gold; so
that it may afterwards be easily ta-
ken up in Liquors that are not acid,
or even by water it self.

EXPER. VII.

THe Tract about Salt-peter, that gave occasion to these Annotations, may furnish us with an eminent Instance of the Production of Solvents. For, though pure Salt-peter it self, when dissolv'd in water, is not observ'd to be a Menstruum for the Solution of the Metals hereafter to be named, or so much as of Coral it self; yet, when by a convenient Distillation its parts are split, if I may so speak, and by Attrition, or other Mechanical ways of working on them, reduc'd to the shapes of Acid and Alcalizate Salts, it then affords two sorts of Menstruums of very differing natures, which betwixt them dissolve or corrode a great number and variety of Bodies; as the Spirit of Nitre without addition is a Solvent for most Metals, as Silver, Mercury, Copper, Lead, &c. and also divers Mineral Bodies, as

18 Of the Mechanical Origine of
Tin-glafs, Spelter, *Lapis Calaminaris*,
&c. and the fixed Salt of Nitre operates upon Sulphureous Minerals, as common Sulphur, Antimony, and divers other Bodies, of which I elsewhere make mention.

EXPER. VIII.

BY the former Trials it has appear'd, that the increase of Motion in the more penetrating Corpuscles of a Liquor, contributes much to its Solutive power; and I shall now adde, that the Shape and Size, which are Mechanical affections, and sometimes also the Solidity of the same Corpuscles does eminently concur to qualifie a Liquor to dissolve this or that particular body. Of this, even some of the more familiar practices of Chymists may supply us with Instances. For there is no account so probable as may be given upon this supposition, why *Aqua Fortis*, which will dissolve Silver, without
medling

Corrosibleness or Corrosibility. 19

medling with Gold, should, by the addition of a fourth part of its weight of Sal Armoniac, be turn'd into *Aqua Regia*, which, without medling with Silver, will dissolve Gold. But there is no necessity of having recourse to so gross and compounded a Body as Sal Armoniac to enable *Aqua Fortis* to dissolve Gold: For, the Spirit of common Salt alone being mingled in a due proportion, will suffice for that purpose. Which (by the way) shews, that the Volatile Salt of Urine and Soot, that concur to the making up of Sal Armoniac, are not necessary to the dissolution of Gold, for which a Solvent may be made with *Aqua Fortis* and crude Sea-salt. I might adde, that the Mechanical affections of a *Menstruum* may have such an interest in its dissolutive power, that even Mineral or Metalline Corpuscles may become useful Ingredients of it, though perhaps it be a distill'd Liquor; as might be illustrated by the Operations of some compounded Solvents, such as

20 Of the Mechanical Origine of
is the Oyl of Antimony made by re-
peated Rectifications of what Chy-
mists call its *Butter*, which, whatever
some say to the contrary, does
much abound in Antimonial Sub-
stance.

EXPER. IX.

BUt I shall return to our *Aqua Re-*
gia, because the mention I had
occasion to make of that Solvent
brought into my mind what I de-
vis'd, to make it probable, that a
smaller change, than one would
lightly imagine, of the bulk, shape,
or solidity of the Corpuscles of a
Menstruum may make it fit to dis-
solve a Body it would not work on
before. And this I the rather at-
tempted, because the warier sort of
Chymists themselves are very shy
of the inward use or preparations
made of Gold by the help of *Aqua*
Fortis, because of the odious stink
they find, and the venenosity they
suspect

Corrosibenefits or Corrosibility. 21

suspect in that corrosive Menstruum :
Whereas Spirit of Salt we look up-
on as a much more innocent Liquor,
whereof, if it be but diluted with
fair water or any ordinary drink,
a good Dose may be safely given in-
wardly, though it have not wrought
upon Gold or any other body, to
take off its acrimony. But, whether
or no this prove of any great use in
Physick, wherein perhaps, if any
quantity of Gold be to be dissol-
ved, a greater proportion of Spirit
of Nitre would be needed; the suc-
cess will not be unfit to be men-
tion'd in reference to what we were
saying of Solvents. For, whereas
we find not that our *Spirit of Salt*
here in *England* will at all dissolve
crude Gold, we found, that by put-
ting some Leaf-gold into a conveni-
ent quantity of good Spirit of Salt,
when we had dropt-in Spirit of Ni-
tre (shaking the Glass at each drop,)
till we perceived, that the mixture
was just able in a moderate heat to
dissolve the Gold, we found, that

22 Of the Mechanical Origine of
we had been oblig'd to employ but
after the rate of twelve drops of the
latter Liquor to an ounce of the for-
mer ; so that, supposing each of these
drops to weigh a grain, the fortieth
part of Spirit of Nitre being added,
served to turn the Spirit of Salt into
a kind of *Aqua Regia*. But to know
the proportion otherwise than by
guess, we weigh'd six other drops of
the same Spirit of Salt, and found
them to amount not fully to three
grains and an half: Whence it ap-
peared, that we added but about a
seventieth part of the Nitrous Spirit
to that of Salt.

The Experiments that have been
hitherto recited, relate chiefly to the
Production of Corrosive Menstru-
ums ; and therefore I shall now adde
an account of a couple of Trials,
that I made manifestly to lessen or
quite to destroy Corrosiveness in
Liquors very conspicuous for that
quality.

EXPER. X.

WHereas one of the most corrosive Menstruums, that is yet known, is *Oyl of Vitriol*, which will fret in pieces both divers Metals and Minerals, and a great number and variety of animal and vegetable bodies; yet if you digest with it for a while onely an equal weight of highly rectified Spirit of Wine, and afterwards distill the mixture very warily, (for else the Experiment may very easily miscarry,) you may obtain a pretty deal of Liquor not corrosive at all, and the remaining substance will be reduc'd partly *into* a Liquor, which, though acid, is not more so than one part of good Oyl of Vitriol will make ten times as much common water, by being well mingled with it; *and* partly *into* a dry substance that has scarce any taste at all, much less a corrosive one.

EX-

EXPER. XI.

ANd though good *Aqua Fortis* be the most generally employed of corrosive Menstruums, as being capable of dissolving or corroding, not onely many Minerals, as Tinglass, Antimony, Zinke, &c. but all Metals except Gold, (for, though it make not a permanent Solution of crude Tin, it quickly frets the parts asunder, and reduces it to an immalleable substance;) yet to shew, how much the power of *corroding* may be taken away by changing the Mechanical Texture of a Menstruum, even without seeming to destroy the fretting Salts, I practis'd (and communicated to divers *Virtuosi*) the following Experiment, elsewhere mentioned to other purposes.

We took equal parts of good *Aqua Fortis*, and highly dephlegm'd Spirit of Wine, and having mingled them warily and by degrees, (with-

Corrosiveness or Corrosibility. 25

(without which caution the Operation may prove dangerous,) we united them by two or three Distillations of the whole mixture; which afterwards we found not to have the least fretting taste, and to be so deprived of its corrosive nature, that it would not work upon Silver, though by Precipitation or otherwise reduc'd to very small parts; nay, it would scarce sensibly work in a good while on Filings of Copper, or upon other bodies, which meer Vinegar, or perhaps Rhenish wine will corrode. Nay, I remember, that with another Spirit, (that was not Urinous) and afterwards with *Alkool* of Wine we shew'd a more surprising *Specimen* of the power of either destroying or debilitating the Corrosiveness of a *Menstruum*, and checking its Operation. For, having caused a piece of Copper-plate to be put into one ounce of *Aqua Fortis*, when this Liquor was eagerly working upon the Metal, I caus'd an ounce of the *Alkool* of Wine, or the

26 Of the Mechanical Origine of
the other Spirit to be poured, (which
it should warily be) upon the agitated
mixture; whose effervescence, at the
first instant, seemed to be much in-
creased, but presently after was
checked, and the Corrosiveness of
the Menstruum being speedily dis-
abled or corrected, the remaining
Copper was left undissolved at the
bottom.

Nor are these the onely acid Men-
struums that I have many years since
been able to correct by such a way:
For I applied it to others, as Spirit
of Nitre, and even *Aqua Regis* it
self; but it has not an equal opera-
tion upon all, and least of all (as
far as I can remember) upon Spirit
of Salt; as on the other side strong
Spirit of Nitre was the *Menstruum*
upon which its effects were the most
satisfactory.

Most of the Chymists pretend,
that the Solutions of bodies are per-
form'd by a certain Cognation and
Sympathy between the Menstruum
and the body it is to work upon.
And

Corrosiveness or Corrosibility. 27

And it is not to be denied, that in divers Instances there is, as it were, a Consanguinity between the Menstruum and the body to be dissolved; as when Sulphur is dissolved by Oyls whether exprest or distill'd: But yet, as the opinion is generally propos'd, I cannot acquiesce in it partly because there are divers Solutions and other *Phænomena*, where it will not take place, and partly because even in those instances wherein 'tis thought most applicable, the effect seems to depend upon Mechanical Principles.

EXPER. XII.

AND first, 'twill be difficult to shew, what Consanguinity there is between Sal Gem, and Antimony, and Iron, and Zinke, and Bread, and Camphire, and *Lapis Calaminaris*, and flesh of divers kinds, and Oyster-shells, and Harts-horn, and Chalk, and Quick-lime; some of which belong

28 Of the Mechanical Origine of
ong to the Vegetable , some to the
Mineral , and some to the Animal
Kingdom ; and yet all of them and
divers others (as I have tried) may,
even without the assistance of exter-
nal Heat, be dissolved or corroded
by one single Mineral Menstruum,
Oyl of Vitriol. And which is not
to be neglected on this occasion,
some of them may be bodies , sup-
posed by Chymists to have an Anti-
pathy to each other in point of Cor-
rosion or Dissolution.

EXPER. XIII.

I Observe also, that a Dissolution
may be made of the same body
by *Menstruums* , to which the Chy-
mists attribute (as I just now ob-
served they did to some Bodies) a
mutual Antipathy, and which there-
fore are not like to have a Sympathy
with the same third body ; as I found
by trial, that both *Aqua Fortis* , and
Spirit of Urine , upon whose mix-
ture

Corrosiveness or Corrosibility. 29

ture there insues a conflict with a great effervescence, will each of them apart readily dissolve crude Zinke, and so each of them will, the Filings of Copper. Not to mention, that pure Spirit of Wine and Oyl of Vitriol, as great a difference as there is between them, in I know not how many respects, and as notable a heat as will insue upon their Commixture, will each of them dissolve Camphire; to which may be added other instances of the like nature. As for what is commonly said, that Oyls dissolve Sulphur, and Saline Menstruums Metals, because (as they speak) *simile simili gaudet*: I answer, That where there is any such similitude, it may be very probably ascribed, not so much, with the Chymists that favour *Aristotle*, to the essential forms of the bodies that are to work on each other, nor, with the meer Chymists, to their Salt, or Sulphur, or Mercury, as such; but to the congruity between the pores and figures of the Menstruum, and
the

30 Of the Mechanical Origine of
the body dissolved by it, and to
some other Mechanical Affections of
them.

EXPER. XIV.

FOR Silver, for example, not on-
ly will be dissolved by Nitre
which they reckon a Salt, but be a-
malgam'd with, and consequently
dissolved by, Quicksilver, and also
by the operation of Brimstone, be
easily incorporated with that Mine-
ral which Chymists are wont to ac-
count of so oleaginous a nature, and
insoluble in *Aqua Fortis*.

EXPER. XV.

AND as for those Dissolutions
that are made with Oylie and
inflammable Menstruums, of com-
mon Sulphur and other inflammable
bodies, the Dissolution does not
make for them so clearly as they
imagine.

Corrosiveness or Corrosibility. 31

imagine. For if such Menstruums operate, as is alledged, upon the account of their being, as well as the bodies they work upon, of a sulphureous nature, whence is it that highly rectified Spirit of Wine, which according to them must be of a *most sulphureous* nature, since being set on fire 'twill flame all away without leaving one drop behind it, will not (unless perhaps after a tedious while) dissolve even Flowers of Brimstone, which essential as well as express'd Oyls will easily take up; as Spirit of Wine it self also will do almost in a trice, if (as we shall see anon) by the help of an Alkali the Texture of the Brimstone be alter'd, though the onely thing that is added to the Sulphur being an incombustible substance, is nothing near of so sulphureous a nature as the Flowers, and need have no Consanguinity upon the score of its Origine with Spirit of Wine, as 'tis alledged that Salt of Tartar has; since I have tried, That fixt Nitre,

32 Of the Mechanical Origine of
employ'd instead of it, will do the
same.

EXPER. XVI.

THe mention of *Nitre* brings in-
to my mind, that the Salt-pe-
ter being wont to be lookt upon by
Chymists as a very inflammable bo-
dy, ought, according to them, to
be of a very sulphureous nature;
yet we find not that 'tis in Chymical
Oyls, but in water, readily dissol-
ved. And whereas Chymists tell
us, that the Solutions of Alcalys,
such as Salt of Tartar, or of Pot-
ashes in common Oyls, proceed
from the great cognation between
them, I demand, whence it happens,
that Salt of Tartar will by boiling
be dissolved in the exprest Oyl of
Almonds, or of Olives, and be re-
duc'd with it to a soapy body, and
that yet with the essential Oyl of Ju-
niper or Aniseeds, &c. where what
they call the Sulphur is made pure
and

Corrosiveness or Corrosibility. 33

and penetrant, being freed from the earthy, aqueous and feculent parts, which Distillation discovers to be in the exprest Oyls, you may boil Salt of Tartar twenty times as long without making any Soap of them, or perhaps any sensible Solution of the Alkaly. And Chymists know, how difficult it is, and how unsuccessfully 'tis wont to be attempted to dissolve pure Salt of Tartar in pure Spirit of Wine, by digesting the not peculiarly prepar'd Salt in the cognate Menstruum. I will not urge, that, though the most conspicuous mark of Sulphur be inflammability, and is in an eminent degree to be found in Oyl as well as Sulphur; yet an Alkaly and water which are neither singly, nor united inflammable, will dissolve common Sulphur.

EXPER. XVII.

BUt to make it probable against the Chymists, (for I propose it but as an argument *ad hominem*) that the Solution of Sulphur in express Oyls depends upon somewhat else besides the abundance of the second Principle in both the bodies; I will adde to what I said before, an affirmation of divers Chymical Writers themselves, who reckon *Aqua Regis*, which is plainly a Saline Menstruum, and dissolves Copper, Iron, Coral, &c. like Acid Liquors, among the Solvents of Sulphur, and by that power among other things distinguish it from *Aqua Fortis*. And on the other side if, there be a Congruity betwixt an express Oyl and another body, though it be such as, by its easie Dissolubleness in Acid Salts, Chymists should pronounce to be of a saline nature, an express Oyl will readily enough work upon it,

Corrosiveness or Corrosibility. 35

it ; as I have tried by digesting even crude Copper in Filings with Oyl of sweet Almonds, which took up so much of the metal as to be deeply coloured thereby, as if it had been a Corrosive Liquor: Nay, I shall adde, that even with Milk, as mild a Liquor as 'tis, I have found by Trial, that without the help of fire a kind of Dissolution may, though not in few hours, be made of crude Copper, as appear'd by the greenish blew colour the Filings acquired, when they had been well drenched in the Liquor, and left for a certain time in the Vessel, where the air had very free access to them.

EXPER. XVIII.

BESIDES the Argument *ad hominem*, newly drawn from *Aqua Regia*, it may be proper enough to urge another of the same kind upon the generality of the *Helmontians* and *Paracelsians*, who admit what the Heads of their Sects deliver concerning the Operations of the *Alkabeft*. For whereas 'tis affirm'd, that this irresistible *Menstruum* will dissolve all tangible bodies here below, so as they may be reduc'd into insipid water; as on the one side 'twill be very hard to conceive how a specificated Menstruum that is determin'd to be either Acid, or Lixivate, or Urinous, &c. should be able to dissolve so great a variety of Bodies of differing and perhaps contrary natures, in some whereof Acids, in other Lixivate Salts, and in others Urinous are predominant; so on the other side, if the *Alkabeft* be not a speci-

Corrosiveness or Corrosibility. 37

specified Menstruum, 'twill very much disavour the Opinion of the Chymists, that will have some Bodies dissoluble onely by Acids as such, others by fixt Alkalys, and others again by Volatile Salts; since a Menstruum, that is neither Acid, Lixivate, nor Urinous, is able to dissolve bodies, in some of which one, and in others another of those Principles is predominant: So that, if a Liquor be conveniently qualified, it is not necessary that it should be either Acid to dissolve Pearl or Coral, or Alkalizate to dissolve Sulphur. But upon what Mechanical account an analyzing Menstruum may operate, is not necessary to be here determin'd. And I elsewhere offer some thoughts of mine about it.

EXPER. XIX.

IF we duly reflect upon the known process that Chymists are wont to employ in making *Mercurius dulcis*, we shall find it very favourable to our *Hypothesis*. For though we have already shewn in the V. Experiment, and 'tis generally confest, that common Sublimate made of Mercury is a highly corrosive body; yet, if it be well ground with near an equal weight of Quicksilver, and be a few times sublimed, (to mix them the more exactly) it will become so mild, that 'twill not so much as taste sharp upon the tongue; so that Chymists are wont to call it *Mercurius dulcis*: And yet this Dulcification seems to be performed in a Mechanical way. For most part of the Salts, that made the Sublimate so Corrosive, abide in the *Mercurius dulcis*; but by being compounded with more Quicksilver, they

Corrosiveness or Corrosibility. 39

they are diluted by it, and (which is more considerable) acquire a new Texture, which renders them unfit to operate, as they did before, when the fretting Salts were not joyn'd with a sufficient quantity of the Mercury to inhibit their corrosive activity. It may perhaps somewhat help us to conceive, how this change may be made, if we imagine, *that* a company of meer Knife-blades be first fitted with Hafts, which will in some regard lessen their wounding power by covering or casing them at that end which is design'd for the handle; (though their insertion into those Hafts, turning them into Knives, makes them otherwise the fitter to cut and pierce) and *that* each of them be *afterwards* sheathed, (which is, as it were, a hasting of the Blades too;) for then they become unfit to cut or stab, as before, though the Blades be not destroyed: Or else we may conceive these Blades without Hafts or Sheaths to be tied up in bundles,
or

40 Of the Mechanical Origine of
or as it were in little taggots with
pieces of wood, somewhat longer
than themselves, opportunely pla-
ced between them. For neither in
this new Constitution would they
be fit to cut and stab as before. And
by conceiving the edges of more or
fewer of the Blades to be turn'd in-
wards, and those that are not, to
have more or less of their points
and edges to be sheath'd, or other-
wise cover'd by interpos'd bodies,
one may be help'd to imagine, how
the genuine effects of the Blades
may be variously lessen'd or diversifi'd.
But, whether these or any other
like changes of Disposition be fancy'd,
it may by Mechanical Illustrations
become intelligible, how the
Corrosive Salts of common Subli-
mate may lose their efficacy, when
they are united with a sufficient
quantity of Quicksilver in *Mercurius
dulcis*: In which new state the
Salts may indeed in a Chymical
phrase be said to be satiated; but
this Chymical phrase does not ex-
plicate

Corrosiveness or Corrosibility. 41

licate how this Saturation takes away the Corrosiveness from Salts that are still actually present in the sweet Mercury. And by Analogy to some such Explications as the above propos'd, a possible Account may be render'd, why fretting Salts do either quite lose their sharpness, as Alkalies, whilst they are imbodied with Sand in common Glass; or lose much of their Corrosive Acidity, as Oyl of Vitriol does when with Steel it composes *Vitriolum Martis*; or else are transmuted or disguis'd by conjunction with some corroded bodies of a peculiar Texture, as when *Aqua Fortis* does with Silver make an extremely bitter Salt or Vitriol, and with Lead one that is positively sweet almost like common *Saccharum Saturni*.

EX-

EXPER. XX.

TO shew, how much the Efficacy of a Menstruum may depend even upon such seemingly slight Mechanical Circumstances as one would not easily suspect any necessity of, I shall employ an Experiment, which though the unpractis'd may easily fail of making well, yet, when I tried it after the best manner, I did it with good success. I put then upon Lead a good quantity of well rectified *Aqua Fortis*, in which the Metal, as I expected, continued undissolved; though, if the Chymists say truly that the dissolving power of the *Menstruum* consists onely in the acid Salts that it abounds with, it seems naturally to follow, that the more abundance of them there is in a determinate quantity of the Liquor, it should be the more powerfully

Corrosiveness or Corrosibility. 43

fully able to dissolve Metalline and Mineral bodies. And in effect we see, that, if Corrosive Menstruums be not sufficiently dephlegmed, they will not work on divers of them. But, notwithstanding this plausible Doctrine of the Chymists, conjecturing that the Saline Particles that swam in our *Aqua Fortis* might be more throng'd together, than was convenient for a body of such a Texture of Saline parts, and such intervals between them, I diluted the Menstruum by adding to it what I thought fit of fair water, and then found, that the desired Congruity betwixt the Agent and the Patient emerged, and the Liquor quickly began to fall upon the Metal and dissolve it. And if you would try an Experiment to the same purpose, that needs much less circumspection to make it succeed, you may, instead of employing Lead, reiterate what I elsewhere mention my self to have tried with
Silver,

44 Of the Mechanical Origine of Silver, which would not dissolve in too strong *Aqua fortis*, but would be readily fallen upon by that Liquor, when I had weaken'd it with common water.

And this it may suffice to have said at present of the power or faculty that is found in some bodies of Corroding or Dissolving others. Whereof I have not found among the *Aristotelians*, I have met with, so much as an Offer at an Intelligible account. And I the less expect the vulgar Chymists will from their Hypostatical Principles afford us a Satisfactory one, when, besides the Particulars that from the nature of the things and *Helmont's* Writings have been lately alledg'd against their *Hypothesis*, I consider, how slight accounts they are wont to give us even of the familiar *Phænomena* of Corrosive Liquors. For if, for example, you ask a vulgar Chymist why *Aqua fortis* dissolves Silver and Copper,

tis

Corrosiveness or Corrosibility. 45

'tis great odds but he will tell you, 'tis because of the abundance of fretting Salt that is in it, and has a cog-nation with the Salts of the Metal. And if you ask him, why Spirit of Salt dissolves Copper, he will tell you 'tis for the same reason; and yet, if you put Spirit of Salt, though very strong, to *Aqua fortis*, this Li- quor will not dissolve Silver, be- cause upon the mixture, the Liquors acquire a new Constitution as to the Saline Particles, by vertue of which the mixture will dissolve, instead of Silver, Gold. Whence we may ar- gue against the Chymists, that the Inability of this compounded Liquor to work on Silver does not proceed from its being weaken'd by the Spi- rit of Salt; as well because, accord- ing to them, Gold is far the more compact metal of the two, and re- quires a more potent Menstruum to work upon it, as because this same compounded Liquor will readily dis- solve Copper. And to the same pur- pose

46 Of the Mechanical Origine of
pose with this Experiment I should
alledge divers others, if I thought
this the fittest place wherein I could
propose them.

SECT.

SECT. II.

*About the Mechanicall
Origine of C O R R O -
S I B I L I T Y.*

C*orrosibility* being the quality that answers *Corrosiveness*, he that has taken notice of the Advertisement I formerly gave about my use of the Term *Corrosiveness* in these Notes, may easily judge, in what sense I employ the name of the other Quality; which (whether you will stile it Opposite or Conjugate) for want of a better word, I call *Corrosibility*.

See the beginning of the first Section.

This *Corrosibility* of Bodies is as well as their *Corrosiveness* a Relative thing; as we see, that Gold, for instance, will not be dissolved by

D by

48 Of the Mechanical Origine of
by *Aqua fortis*, but will by *Aqua
Regis*; whereas Silver is not solu-
ble by the latter of these Menstru-
ums, but is by the former. And this
relative Affection, on whose ac-
count a Body comes to be corrod-
ible by a *Menstruum*, seems to consist
chiefly in *three* things, which all of
them depend upon Mechanical Prin-
ciples.

Of these Qualifications the *first*
is, that the Body to be corroded be
furnish'd with Pores of such a big-
ness and figure, that the Corpuscles
of the Solvent may enter them, and
yet not be much agitated in them
without giving brisk knocks or
shakes to the solid parts that make
up the walls, if I may so call them,
of the Pores. And 'tis for want of
this condition, that Glass is penetra-
ted in a multitude of places, but not
dissipated or dissolv'd by the incident
beams of Light, which permeate its
Pores without any considerable re-
sistance; and though the Pores and
Commissures of a Body were less
mi-

Corrosibeness and Corrosibility. 49

minute, and capable of letting in some grosser Corpuscles, yet if these were, for want of solidity or rigidity, too flexible, or were of a figure incongruous to that of the Pores they should enter, the Dissolution would not insue; as it happens when pure Spirit of Wine is in the cold put upon Salt of Tartar, or when *Aqua fortis* is put upon powder of Sulphur.

The *second* Qualification of a Corrodible Body is, that its consistent Corpuscles be of such a Bulk and Solidity, as does not render them incapable of being disjoyn'd by the action of the insinuating corpuscles of the Menstruum. Agreeable to this and the former Observation is the practice of Chymists, who oftentimes, when they would have a Body to be wrought on by a Menstruum otherwise too weak for it in its crude estate, dispose it to receive the action of the Menstruum by previously opening it, (as they speak) that is, by enlarging the Pores, making

50 Of the Mechanical Origine of
king a comminution of the Corpu-
scles, or weakening their Cohesion.
And we see, that divers Bodies are
brought by fit preparations to be re-
soluble in Liquors that would not
work on them before. Thus, as was
lately noted, Lime-stone by Cal-
cination becomes (in part) disso-
luble in water; and some Metalline
Calces will be so wrought on by Sol-
vents, as they would not be by the
same Agents, if the preparation of
the Metalline or other Body had not
given them a new Disposition. Thus,
though crude Tartar, especially in
lumps, is very slowly and difficultly
dissoluble in cold water, yet when
'tis burnt it may be presently dissol-
ved in that Liquor; and thus,
though the Filings and the Calx of
Silver will not be at all dissolv'd by
common water or Spirit of Wine;
yet if by the interposition of the
Saline Particles of *Aqua Fortis*, the
Lunar Corpuscles be so disjoyn'd, and
suffer such a comminution as they do
in Crystals of Lune, the Metal thus
pre-

Corrosiveness and Corrosibility. 51

prepared and brought with its Saline Additament into a new Texture will easily enough dissolve, not only in water, but, as I have tried, in well rectified Spirit of Wine. And the like Solubility I have found in the Crystals of Lead made with Spirit of Verdigrease, or good distill'd Vinegar, and in those of Copper made with *Aqua Fortis*.

The *last* Disposition to Corrosibility consists in such a cohesion of the parts, whereof a Body is made up, as is not too strict to be superable by the action of the *Menstruum*. This Condition, though of kin to the former, is yet somewhat differing from it, since a body may consist of parts either bulky or solid, which yet may touch one another in such small portions of their Surfaces, as to be much more easily dissociable than the minute or less solid parts of another Body, whose contact is more full and close, and so their Cohesion more strict.

25 Of the Mechanical Origine of

By what has been said it may seem probable, that, as I formerly intimated, the Corrosibility of Bodies is but a Mechanical Relation, resulting from the Mechanical Affections and Contexture of its parts, as they intercept Pores of such sizes and figures as make them congruous to those of the Corpuscles of the *Menstruum*, that are to pierce between them, and disjoyn them.

That the Quality, that disposes the body it affects to be dissolv'd by Corrosive and other Menstruums, does (as hath been declared) in many cases depend upon the Mechanical Texture and Affections of the body in reference to the Menstruum that is to work upon it, may be made very probable by what we are in due place to deliver concerning the Pores of Bodies and Figures of Corpuscles. But yet in compliance with the design of these Notes, and agreeably to my custom on other Subjects, I shall subjoyn a few Experiments on this occasion also.

E X.

EXPER. I.

IF we put highly rectified Spirit of Wine upon crude Sulphur, or even Flowers of Sulphur, the Liquor will lie quietly thereon, especially in the cold, for many hours and days without making any visible Solution of it; and if such exactly dephlegmed Spirit were put on very dry Salt of Tartar, the Salt would lie in an undissolved powder at the bottom: and yet, if before any Liquor be employed, the Sulphur be gently melted, and then the Alkali of Tartar be by degrees put to it, and incorporated with it; as there will result a new Texture discoverable to the eye by the new colour of the Composition, so there will emerge a disposition that was not before in either of the Ingredients, to be dissolved by Spirit of Wine; insomuch, that though the mixture be kept till it be quite cold,

54 Of the Mechanical Origine of
or long after too, provided it be
carefully secur'd from the access of
the air, the Spirit of Wine being
put to it, and shaken with it, will, if
you have gone to work aright, ac-
quire a yellow Tincture in a minute
of an hour; and perhaps in less
than half a quarter of an hour a
red one, being richly impregnated
with sulphureous Particles discover-
able by the Smell, Taste, and divers
Operations.

EXPER. II.

[T]Is known to several Chy-
mists, that Spirit of Salt
does not dissolve crude Mercury in
the cold; and I remember, I kept
them for a considerable time in no
contemptible heat without finding
any Solution following. But I sup-
pose, many of them will be gratified
by an Experiment once mention'd
to me by an Ingenious German Gen-
tleman, namely, That if Mercury
be

Corrosiveness and Corrosibility. 55

be precipitated *per se*, that is, reduc'd to a red powder without additament, by the meer operation of the fire, the Texture will be so chang'd, that the above-mention'd Spirit will readily dissolve it; for I found it upon Trial to do so; nay, sometimes so readily, that I scarce remember that I ever saw any *Menstruum* so nimbly dissolve any Metalline body whatsoever.]

EXPER. III.

THe former Experiment is the more remarkable, because, that though Oyl of Vitriol will in a good heat corrode Quicksilver, (as we have already related in the first Section,) yet I remember I kept a Precipitate *per se* for divers hours in a considerable degree of Heat, without finding it to be dissolved or corroded by the Menstruum. And yet having, for trials sake, put another parcel of the same Mercurial powder

56 Of the Mechanical Origine of
der into some *Aqua fortis*, or Spirit of
Nitre, there insued a speedy Dissol-
ution even in the cold.

And that this Disposition to be
dissolved by Spirit of Salt, that
Mercury acquires by being turned in-
to Precipitate *per se*, that is, by being
calcin'd, is not meerly the effect of
the operation of the fire upon it, but
of some change of Texture pro-
duced by that Operation; may be
probably argued from hence, that,
whereas Spirit of Salt is a very pro-
per *Menstruum*, as I have often tri-
ed, for the dissolving of Iron or
Steel; yet, when that Metal is re-
duced by the action of the fire (e-
specially if a kind of Vitrification,
and an irroration with distill'd Vi-
negar have preceded) to *Crocus
Martis*, though it be thereby
brought to a very fine powder, yet
I found not, that, as Spirit of Salt
will readily and with heat and noise
dissolve Filings of *Mars*, so it would
have the same or any thing near
such an Operation upon the *Crocus*;
but

Corrosiveness and Corrosibility. 57

but rather, after a good while, it would leave in the bottom of the Glass a considerable, if not the greatest, part of it scarce, if at all, sensibly alter'd. And the Menstruum seem'd rather to have extracted a Tincture, than made an ordinary Solution; since the colour of it was a high yellow or reddish, whereas *Mars*, dissolved in Spirit of Salt, affords a green Solution. Whether by repeated Operations with fresh Menstruum further Dissolutions might in time be made, I had not occasion to try, and it may suffice for our present purpose, that *Mars* by the operation of the fire did evidently acquire, not, as Mercury had done, a manifest facility, but on the contrary, a great indisposition to be dissolved by Spirit of Salt.

To second this Experiment, we vary'd it, by employing, instead of Spirit of Salt, strong Oyl of Vitriol, which being pour'd on a little *Crocus Martis* made *per se*, did not, as that *Menstruum* is wont to do up-
on

58 Of the Mechanical Origine of
on Filings of crude *Mars*, readily
and manifestly fall upon the powder
with froth and noise, but (on the con-
trary) rested for divers hours calm-
ly upon it, without so much as
producing with it any sensible
warmth.

EXPER. IV.

IT agrees very well with our Do-
ctrine about the dependance of
the Corrosibility of Bodies upon
their Texture, that from divers Bo-
dies, whilst they are in conjunction
with others, there result masses, and
those homogeneous as to sense, that
are easily dissoluble in Liquors, in
which a great part of the matter, if
it were separated from the rest,
would not be at all dissolved. Thus
we see, that common Vitriol is ea-
sily dissolved in meer water; where-
as if it be skilfully calcin'd, it will
yield sometimes near half its first
weight of insipid Colcothar, which
not

Corrosiveness and Corrosibility. 59

not onely is not soluble in water, but which neither *Aqua Fortis* nor *Aqua Regis*, though sometimes they will colour themselves upon it, are able (as far as I have tried) to make Solutions of. We see likewise, that simple water will, being boild for a competent time with Harts-horn, dissolve it and make a Jelly of it: And yet, when we have taken Harts-horn thoroughly calcin'd to whiteness, not onely we found that common water was no longer a fit Solvent for it, but we observed, that when we put Oyl of Vitriol it self upon it, a good part of the white powder was even by that Corrosive Menstruum left undissolved.

EX-

EXPER. V.

IN the *Fifteenth* of the foregoing Experiments I refer to a way of making the Flower or Powder of common Sulphur become *easily dissoluble*, which otherwise 'tis far from being, in highly rectified Spirit of Wine. Wherefore I shall now adde, that 'tis quickly perform'd by gently melting the Sulphur, and incorporating with it by degrees an equal or a greater weight of finely powder'd Salt of Tartar, or of fixt Nitre: For if the mixture be put warm into a Mortar that is so too; and as soon as 'tis reduc'd to powder, be put into a Glass, and well shaken with pure Spirit of Wine, it will, (as perhaps I may have elsewhere observed,) in a few minutes acquire a yellow colour, which afterwards will grow deeper, and manifest itself by the smell and effects to be a real Solution of Sulphur;
and

Corrosiveness and Corrosibility. 61

and yet this Solubleness in Spirit of Wine seems procur'd by the change of Texture, resulting from the Commixtion of meer Salt of Tartar, which Chymists know, to their trouble, to be it self a body almost as difficult as Sulphur to be dissolved in phlegmless Spirit of Wine, unless the Constitution of it be first alter'd by some convenient additament. Which last words I adde, because, though Spirit of Verdigrease be a Menstruum that uses to come off in Distillation much more intirely than other acid Menstruums from the bodies it has dissolved; yet it will serve well for an additament to open (as the Chymists speak) the body of the Salt of Tartar. For this purpose I employ Spirit of Verdigrease, not made first with Spirit of Vinegar, and then of Wine, after the long and laborious way prescribed by *Basilius* and *Zwelfer*, but easily and expeditiously by a simple Distillation of crude Verdigrease of the better sort. For when you have
with

62 Of the Mechanical Origine of
with this Liquor (being, if there
be need, once rectified) dissolv'd as
much good Salt of Tartar, as 'twill
take up in the cold, if you draw off
the Menstruum *ad siccitatem*; the
remaining dry Salt will be manifestly
alter'd in Texture even to the eye,
and will readily enough in high recti-
fied Spirit of Wine afford a Soluti-
on, which I have found consider-
able in order to divers uses that
concern not our present Discourse.

EXPER. VI.

TO the Consideration of the Fol-
lowers of *Helmont* I shall
recommend an Experiment of that
famous Chymist's, which seems to
sute exceeding well with the Do-
ctrine propos'd in this Section. For
he tells us, that, if by a subtle Men-
struum to which he ascribes that
power, Quicksilver be devested (or
depriv'd) of its external Sulphur, as
he terms it, all the rest of the fluid
Metal,

Corrosiveness and Corrosibility. 63

Metal, which he wittily enough stiles, the Kernel of Mercury, will be no longer corrosible by it. So that upon this Supposition, though common Quicksilver be observ'd to be so obnoxious to *Aqua Fortis*, that the same quantity of that Liquor will dissolve more of it, than of any other Metal; yet, if by the deprivation of some portion of it the *latent Texture* of the Metal be alter'd, though not (that I remember) the *visible appearance* of it; the Body that was before so easily dissolved by *Aqua Fortis*, ceases to be at all dissoluble by it.

EXPER. VII.

AS for those Chymists of differing Sects, that agree in giving credit to the strange things that are affirm'd of the Operations of the *Alkabeft*, we may in favour of our Doctrine urge them with what is deliver'd by *Helmont*, where he asserts,

64 Of the Mechanical Origine of
feris, that all solid Bodies, as Stones,
Minerals, and Metals themselves, by
having this Liquor duly abstracted
or distill'd off from them, may be
changed into Salt, equiponderant
to the respective bodies whereon the
Menstruum was put. So that sup-
posing the *Alkabeſt* to be totally ab-
stracted, (as it seems very proba-
ble to be, since the weight of the
body whence 'twas drawn off is not
alter'd;) what other change than of
Texture can be reasonably imagin'd
to have been made in the transmuted
bodies? and yet divers of them,
as Flints, Rubies, Saphyrs, Gold,
Silver, &c. that were insoluble be-
fore, some of them in any known
Menstruums, and others in any but
Corrosive Liquors, come to be capa-
ble of being dissolv'd in common
water.

EX.

EXPER. VIII.

TIs a remarkable *Phænomenon*, that suits very well with our opinion about the interest of Mechanical Principles in the Corrosive Power of Menstruums, and the Corrosibility of bodies, that we produc'd by the following Experiment: This we purposely made to shew, after how differing manners the same body may be dissolv'd by two Menstruums, whose minute parts are very differingly constituted and agitated. For whereas 'tis known, that if we put large grains of Sea-salt into common water, they will be dissolved therein calmly and silently without any appearance of conflict; If we put such grains of Salt into good Oyl of Vitriol, that Liquor will fall furiously upon them, and produce for a good while a hissing noise with fumes, and a great store of bubbles, as if a potent Menstru-

66 Of the Mechanical Origine of
um were corroding some stubborn
metal or mineral. And this Expe-
riment I the rather mention, because
it may be of use to us on divers other
occasions. For else 'tis not the
onely, though it be the remarkablest,
that I made to the same purpose.

EXPER. IX.

FOr, whereas *Aqua Fortis* or *Aqua
Regis*, being pour'd upon Filings
of Copper, will work upon them
with much noise and ebullition, I
have tried, that good Spirit of Sal Ar-
moniac or Urine, being put upon the
like Filings, and left there without
stopping the Glass, will quickly be-
gin to work on them, and quietly dis-
solve them almost as water dis-
solves Sugar. To which may be
added, that even with Oyl of Tur-
pentine I have, though but slowly,
dissolved crude Copper; and the
Experiment seemed to favour our
Conjecture the more, because ha-
ving tried it several times, it ap-
pear'd,

Corrosibeness and Corrosibility. 67
pear'd, that common unrectified Oyl
would perform the Solution much
quicker than that which was puri-
fied and subtiliz'd by rectification;
which though more subtle and pe-
netrant, yet was, it seems, on that
account less fit to dissolve the Metal,
than the grosser Oyl whose particles
might be more solid or more advan-
tageously shap'd, or on some other
Mechanical account better qualified
for the purpose.

EXPER. X.

TAKE good Silver, and, having
dissolv'd it in *Aqua Fortis*, precipitate
it with a sufficient quantity
of good Spirit of Salt; then having
wash'd the Calx, which will be very
white, with common water, and dri-
ed it well, melt it with a moderate
fire into a fusible Mass, which will be
very much of the nature of what
Chymists call *Cornu Lunæ*, and which
they make by precipitating dissolv'd

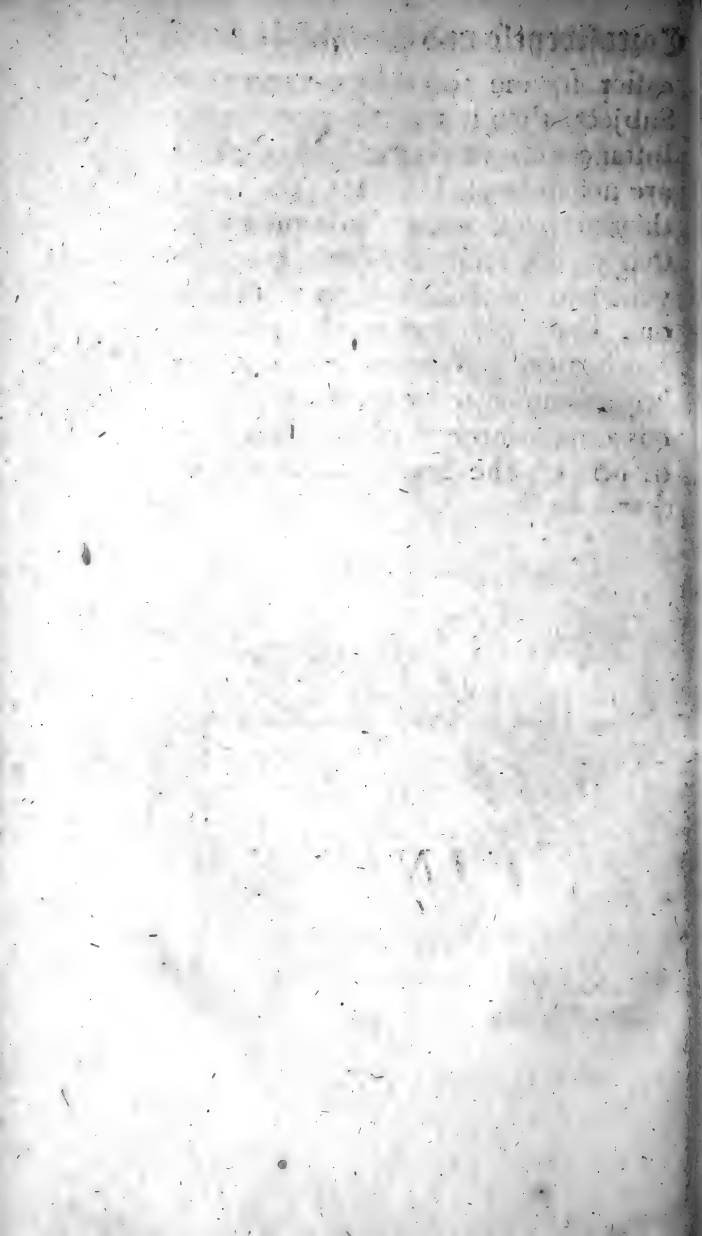
68 Of the Mechanical Origin of Silver with a bare Solution of common Salt made in common water. And whereas both Spirit of Salt and Silver dissolv'd in *Aqua Fortis* will each of them apart readily dissolve in simple water, our *Luna Cornea* not onely will not do so, but is so indispos'd to Dissolution, that I remember I have kept it in Digestion, some in *Aqua fortis*, and some in *Aqua Regia*, and that for a good while, and in no very faint degree of heat, without being able to dissolve it like a Metal, the Menstruums having indeed ting'd themselves upon it, but left the Composition undissolv'd at the bottom.

With this Instance (of which sort more might be afforded by Chymical Precipitations) I shall conclude what I design'd to offer at present about the *Corrosibility* of Bodies, as it may be consider'd in a more general way. For as to the Disposition that Particular Bodies have of being dissolved in, or of resisting, Determinate Liquors, it were much easier

Corrosiveness and Corrosibility. 69

easier for me to enlarge upon that Subject, than it was to provide the Instances above recited. And these are not so few, but that 'tis hop'd they may suffice to make it probable, that in the Relation betwixt a Solvent and the Body it is to work upon, that which depends upon the Mechanical affections of one or both, is much to be consider'd, and has a great interest in the operations of one of the bodies upon the other.

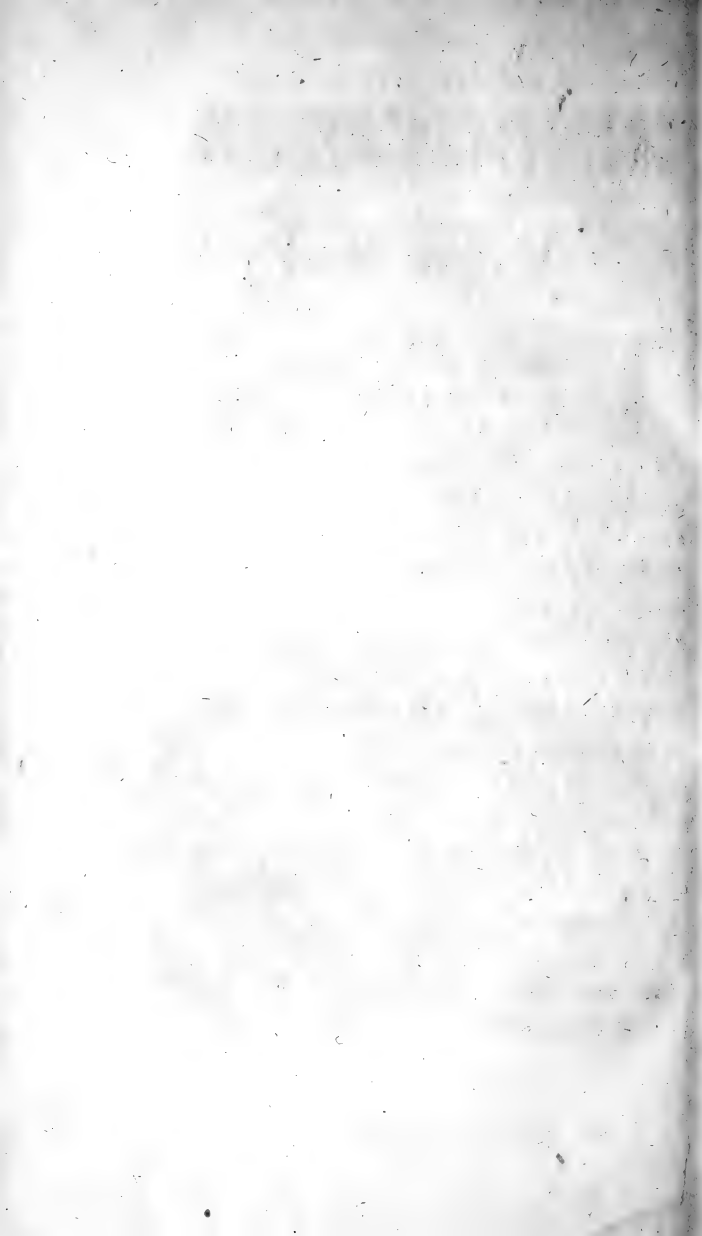
FINIS.



OF THE
MECHANICAL
CAUSES
OF
CHYMICAL
PRECIPITATION.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Flesher*, for *R. Davis*
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THough I shall not deny, that, in Grammatical strictness, Precipitation should be reckon- ed among Chymical Operations, not Qualities, yet I did not much scruple to insert the following Discourse among the Notes about Particular Qua- lities, because many, if not most, of the Phænomena, mentioned in the en- suing Essay, may be considered as de- pending, some of them, upon a power, that certain bodies have to cause Pre- cipitation, and some upon such a Dis- position to be struck down by others, as may, if men please, be called Pre- cipitability. And so these differing Affections may with (at least) tole- rable Congruity be referred to those that we have elsewhere stiled Chy- mical Qualities.

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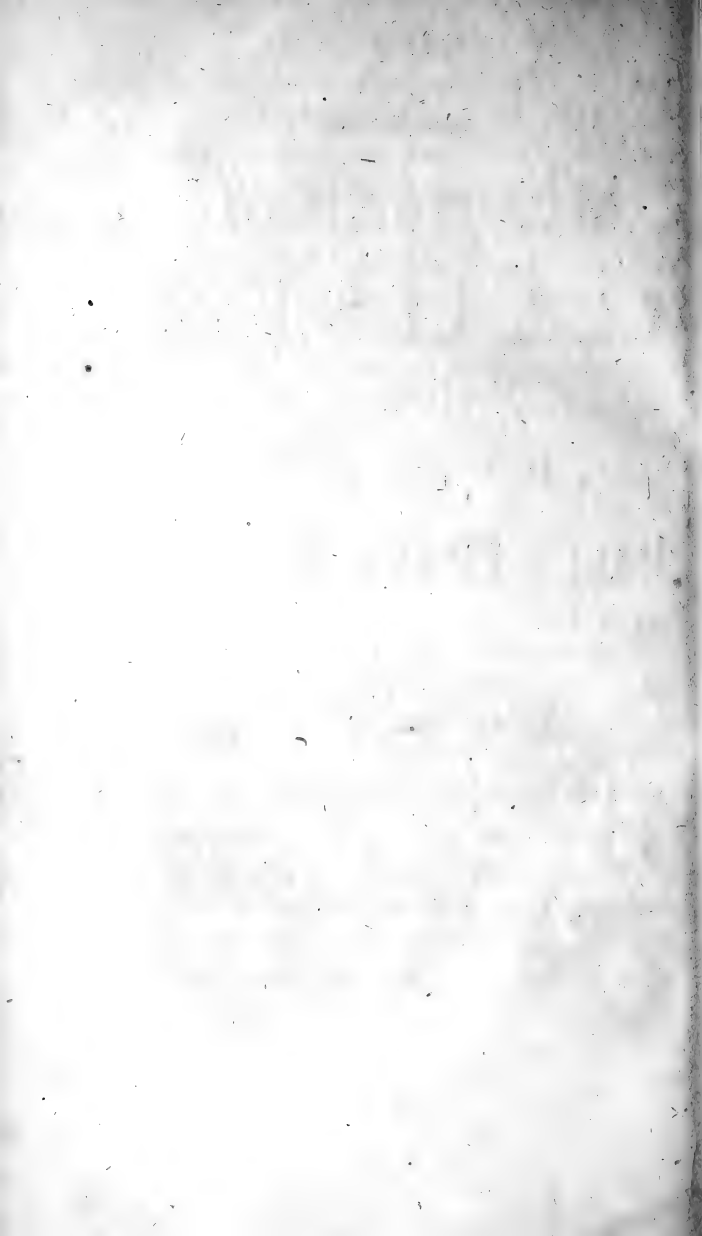
But though I hope, I may in these few Lines have said enough concerning the name given to these Attributes, yet perhaps it will be found in time, that the things themselves may deserve a larger Discourse than my little leisure would allow them. For that is not a causeless Intimation of the Importance of the subject, wherewith I conclude the following Tract, since besides that many more Instances might have been particularly referred to the Heads treated of in the Insuing Essay, there are improper kinds of Precipitation (besides those mentioned in the former part of the Discourse) to which one may not incongruously refer divers of the Phænomena of Nature, as well in the greater as in the lesser world, whereof either no Causes at all, or but improper ones are wont to be given. And besides the simple Spirits and Salts usually employed by Chymists, there are many compounded and decomposed bodies not only factitious but natural, (and some such as one would scarce suspect) that may in congruous subjects produce
such

Advertisement.

Such Precipitations, as I speak of. And the Phænomena and Consequents of such operations may in divers cases prove conducive both to the Discovery of Physical Causes, and the Production of useful effects; though the particularizing of such Phænomena do rather belong to a History of Precipitations, than to such a Discourse as that which follows, wherein I proposed not so much to deliver the latent Mysteries, as to investigate the Mechanical Causes of Precipitation.

A 3

OF



(I)

OF THE

MECHANICAL

CAUSES

OF

CHEMICAL

PRECIPITATION.

CHAP. I.

BY Precipitation is here meant such an agitation or motion of a heterogeneous liquor, as in no long time makes the parts of it subside, and that usually in the form of a powder or other consistent body.

A 4

As

2 Of the Mechanical Causes

As, on many occasions, Chymists call the substance that is made to fall to the bottom of the liquor, the *Precipitate*; so for brevity sake we shall call the body that is put into the liquor to procure that subsiding, the *Precipitant*; as also that which is to be struck down, the *Precipitable substance or matter*, and the liquor wherein it swims before the separation, the *Menstruum* or *Solvent*.

When a hasty fall of a heterogeneous body is procured by a *Precipitant*, the Operation is called *Precipitation* in the proper or strict sense: But when the separation is made without any such addition, or the substance, separated from the fluid part of the liquor, instead of subsiding emerges, then the word is used in a more comprehensive, but less proper, acceptation.

As for the Causes of Precipitation the very name it self in its Chymical sense having been scarce heard of in the Peripatetic Schools, it is not to be expected, that they should have given

of Chymical Precipitation. 3

an account of the Reasons of the thing. And 'tis like, that those few *Aristotelians*, that have, by their converse with the laboratories or writings of Chymists, taken notice of this Operation, would, according to their custom on such occasions, have recourse for the explication of it to some secret sympathy or antipathy between the bodies whose action and reaction intervenes in this Operation.

But if this be the way proposed, of accounting for it, I shall quickly have occasion to say somewhat to it in considering the ways proposed by the Chymists, who were wont to refer Precipitation, *either*, as is most usual, to a sympathy betwixt the *Precipitating* body and the *Menstruum* which makes the Solvent run to the embraces of the *Precipitant*, and so let fall the particles of the body sustained before; *or* (with others) to a great antipathy or contrariety between the acid salt of the *Menstruum* and the fixed salt of the Oil, or solution of cal-

4 Of the Mechanical Causes

calcined Tartar, which is the most general and usual *Precipitant* they employ.

But I see not, how either of these causes will either reach to all the *Phaenomena* that have been exhibited, or give a true account even of some of those, to which it seems applicable. For first, in Precipitations, wherein what they call a *sympathy* between the liquors, is supposed to produce the effect, this admired sympathy does not (in my apprehension) evince such a mysterious occult Quality as is presumed, but rather consists in a greater congruity as to bigness, shape, motion and pores of the minute parts between the *Menstruum* and the *Precipitant*, than between the same Solvent and the body it kept before dissolved. And though this sympathy rightly explained may be allowed to have an interest in some such Precipitations as let fall the dissolved body in its pristine nature and form, and only reduced into minute powder; yet I find not, that in the generality

of Chymical Precipitation. 5

rality of Precipitations this Doctrine will hold ; For in some that we have made of Gold and Silver in proper Menstruums, after the subsiding matter had been well washed and dried, several Precipitates of Gold made, some with oil of Tartar, which abounds with a fixed salt, and is the usual Precipitant, and some with an Urinous Spirit, which works by Vertue of a salt highly fugitive or Volatile, I found the powder to exceed the weight of the Gold and Silver I had put to dissolve ; and the Eye it self sufficiently discovers such Precipitates not to be meer metalline powders, but Compositions, whose consisting, not (as hath been by some body suspected) of the combined Salts alone, but of the metalline parts also, may be strongly concluded not only from the ponderousness of divers of them in reference to their bulk, but also manifestly from the reduction of true malleable metals from several of them.

CHAP.

CHAP. II.

THE other *Chymical* way of explicating Precipitations may, in a right sence, be made use of by a Naturalist on some particular occasions. But I think it much too narrow and defective, as 'tis in a general way proposed, to be fit to be acquiesced in. For first 'tis plain, that 'tis not only Salt of Tartar and other fixed Alcalies that precipitate most bodies that are dissolved in acid Menstruums; as in making of *Aurum fulminans*, oil of Tartar precipitates the Gold out of *Aqua Regis*: But acid liquors themselves do on many occasions no less powerfully precipitate metals and other bodies out of one another. Thus spirit of Salt, (as I have often tried) precipitates Silver out of *Aqua fortis*: The corrosive Spirit of Nitre copiously precipitates that white powder whereof they make *Bezoardicum Minerale*: Spirit or
oil

of Chymical Precipitation. 7

oil of Sulphur made by a glass-bell precipitates Corals, Pearls, &c. dissolved in Spirit of Vinegar, as is known to many Chymists, who now use this *Oleum Sulphuris per Campanam*, to make the Magistery of Pearls, &c. for which vulgar Chymists imploy *Oleum Tartari per deliquium*.

I have sometimes made a *Menstruum*, wherein though there were both Acid and Alcalizate Salts; yet I did not find, that either acid Spirits or oil of Tartar, or even Spirit of Urine would precipitate the dissolved substances.

And I have observed, *both* that Salts of a contrary nature will precipitate bodies out of the same Menstruum, as not only Salt of Tartar, but Sea-salt being dissolved, will precipitate each other, and each of them apart will precipitate Silver out of *Aqua fortis*; and that even, where there is a confessed contrariety betwixt two liquors, it may be so ordered, that neither of them shall precipitate what

8 Of the Mechanical Causes

is dissolved by the other; of which I shall have occasion to give ere long a remarkable instance.

But it will best appear, that the abovementioned Theories of the Peripateticks and Chymists are at least insufficient to solve the *Phenomena* (many of which were probably not known to most of them, and perhaps not weigh'd by any,) if we proceed to observe the *Mechanical* ways, by which Precipitations may be accounted for; whereof I shall at present propose some Number, and say somewhat of each of them apart; not that I think all of them to be equally important and comprehensive, or that I absolutely deny, that any one of them may be reduced to some of the other; but that I think, it may better elucidate the subject, to treat of them severally, when I shall have premised, that I would not thence infer, that though, for the most part, Nature does principally effect Precipitations by one or other of these ways, yet in divers cases she
may

of Chymical Precipitation. 9

may not employ two or more of them about performing the operation.

To precipitate the Corpuscles of a metal out of a Menstruum, wherein being once thoroughly dissolved it would of it self continue in that state, the two general ways that the nature of the thing seems to suggest to him that considers it, are, *either* to add to the weight or bulk of the dissolved Corpuscles, and thereby render them unfit to accompany the particles of the Menstruum in their motions; *or* to weaken the sustaining power of the Menstruum, and thereby disable it to keep the metalline particles swimming any longer: which falling of the deserted parts of the metal or other bodie, does oftentimes the more easily insue, because in many cases, when the sustaining particles of the Menstruum come to be too much weakned, that proves an occasion to the metalline Corpuscles, disturbed in the former motion that kept them separate, to make occurrences and coalitions among themselves,

10 Of the Mechanical Causes

selves, and their fall becomes the effect, though not equally so, of both ways of Precipitation; as on the other side, there are several occasions on which the same Precipitant, that brings the swimming particles of the metal to stick to one another, does likewise, by mortifying or disabling the saline Spirits or other parts of the solvent, weaken the sustaining power of that liquor.

CHAP. III.

TO descend now to the distinct Considerations about these two ways: The first of the most general Causes of Precipitation is such a Cohæſion procured by the Precipitant in the solution, as makes the compounded corpuscles, or at least the associated particles of the dissolved body, too heavy to be sustained, or too bulky to be kept in a state of fluidity by the liquor.

That

of Chymical Precipitation. 11

That in many Precipitations there is made a coalition betwixt the small parts of the Precipitant and those of the dissolved metal, or other body; and frequently also with the saline spirits of the Menstruum, may be easily shewn by the weight of the Precipitate, which though carefully washed and dryed, often surpasses; and sometimes very considerably, that of your crude metal that was dissolved; of which we lately gave an instance in *Aurum fulminans* and precipitated Silver; & we may yet give a more conspicuous one, in that which Chymists call *Luna Cornea*: For, if having dissolved Silver in good *Aqua fortis*, you Precipitate it with the solution of Sea-salt in fair water, and from the very white Precipitate wash the loose adhering salts, the remaining powder, being dryed and slowly melted, will look much less like a metalline body than like a piece of horn, whence also it takes its name; so considerable is

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12 Of the Mechanical Causes

the additament of the saline to the metalline particles.

And that part of such additaments is, retained, may not only be found by weighing, but in divers cases may be argued from what is obvious to the Eye: as if you dissolve Mercury in *Aqua fortis*, and into the philtreated solution drop spirit of Salt, or salt-water, or an urinous spirit, as of Sal Armoniac, you will have a very white Precipitate; but if instead of any of these, you drop in deliquated salt of Tartar, your Precipitate will be of a brick or orange colour. From which experiment and some others I would gladly take a rise to perswade Chymists and Physitians, that 'tis not so indifferent, as those seem to think who look on Precipitation but as a kind of Comminution, by what means the precipitation is performed. For by reason of the strict adhesion of divers saline particles of the precipitant and the solvent, the precipitated body, notwithstanding all the wonted ablutions

ons

of Chymical Precipitation. 13

ons, may have its qualities much diversified by those of the particles of the liquors, when these are fitted to stick very fast to it. Which last words I add, because, though that sometimes happens, yet it does not always, there being a greater difference than every body takes notice of between Precipitations; as you will be induced to think, if you precipitate the solution of Silver with Copper, with spirit of *Sal Armoniac*, with salt water, with oil of Tartar, with quick-silver, with crude Tartar and with Zink. And in the lately proposed Example, you will think it probable, that 'tis not all one, whether to dissolved Mercury or Silver, you imploy the subtile distilled Spirits of Salt, or the gross body, whether in a dry form, or barely dissolved in common water. And thus much of the Conduciveness of weight to the striking down the Corpuscles of a dissolved Body.

That also the *Bulk* of a body may very much contribute to make it

14 Of the Mechanical Causes

sink or swim in a liquor, appears by obvious instances. Thus Salt or Sugar, being put into water either in lumps or even in powder that is but gross, falls at first to the bottom, and lies there, notwithstanding the Air that may be intercepted between its parts or externally adhere to it. But when by the insinuating action of the water it is dissolved into minute particles, these are carried up and down with those of the liquor and subside not. The like happens, when a piece of silver is cast into *Aqua fortis*, and in many other cases.

On the other side I have several times observed, that some bodies that had long swam in a Menstruum, whilst their minute parts were kept from convening in it, did afterwards by the coalition of many of those particles into bodies of a visible bulk coagulate and subside, (though sometimes, to hinder the evaporation of the Menstruum, the vessels were kept stopt.) Of this I elsewhere mention divers examples; and

of Chymical Precipitation. 15

and particularly in urinous and animal spirits, well dephlegm'd, I have found, that after all had for a considerable time continued in the form of a perfect liquor, and as to sense homogeneous, store of solid corpuscles, convening together, settled at the bottom of the glasses in the form of saline Crystals. Having also long kept a very red solution of Sulphur first unlock'd, (as they speak) made with highly rectified spirit of urine, I observed, that at length the Sulphureous particles, making little concretions between themselves, totally subsided and left the liquor almost devoid of tincture. By which you may see, that 'twas not impertinent to mention (as I lately did) among the subordinate causes of Precipitation, the associating of the particles of a dissolved body with one another. Of which I elsewhere give a notable Example in the shining powder that I obtained from Gold dissolved in a peculiar Menstruum, without any Precipi-

tant, by the coalition of the metalline particles, to which a tract of time gave opportunity to meet and adhere in a convenient manner.

If in what the Chymists call *Precipitate per se*, the Mercury be indeed brought to lose its fluidity, and become a powder without being compounded with any additional body, (which doubt I elsewhere state and discourse of) it will afford us a notable instance to prove, that the coalitions of particles into clusters of the self same matter will render them unfit for the motion requisite to fluidity. For in this odd precipitation by fire, wherein the same Menstruum is both the Liquor and the Precipitate, being notall made at once, the Corpuscles that first disclose themselves by their redness, are rejected by those of the Mercury that yet remains fluid, as unable to accompany them in the motions that belong to Mercury as such.

CHAP. IV.

BEfore I dismiss that way of Precipitating, that depends upon the unwieldiness which the Precipitant gives to the body it is to strike down, it may not be impertinent, especially in reference to the foregoing part of this Paper, to consider, that perhaps in divers cases the Corpuscles of a dissolved body may be made unfit to be any longer sustained in the Menstrum, though the Precipitant adds very little to their bulk, or at least much more to their specific weight than to it. For I have elsewhere shewn, that in divers solutions made of bodys by acid Menstruums, there are either generated or extricated many small Aerial particles; and it will be easily granted, that these may be small enough to be detained in the pores of the liquor and be invisible there, if we consider, what a multitude of aerial and formerly imperceptible bubbles

18 Of the Mechanical Causes

is afforded by common water in our Pneumatical Receivers, when the incumbent air that before pressed the liquor, is pumpt out. And if the Corpuscles of the dissolved body have any little Cavities or pores fit to lodge Aerial particles, or have asperous surfaces, between whose prominent parts the generated air may conveniently lie; in such cases, I say, these Invisible bubbles may be lookt upon, as making with the solid Corpuscles they adhered to, little aggregates much lighter *in specie* than the Corpuscles themselves would be; and consequently if the Precipitant consist of particles of such a size and shape as are fit to expel these little bubbles, and lodge themselves in the cavities possessed by them before, there will be produced new aggregates composed of the Corpuscles of the dissolved body and the particles of the Precipitant; which aggregates though they do take up very little or perhaps not at all more room (taking that word in a popular sense) than those,

of Chymical Precipitation. 19

those, whereof the Aerial bubbles made a part, will yet be Specifically heavier than the former Aggregates were, and may thereby overcome the sustaining power of the Menstruum.

One thing more may be fit to be taken notice of before we pass on further, namely, that 'tis upon the score of the Specific gravity of a body, and not barely upon the action of the Precipitant, that an aggregate or a Convention of particles does rather fall to the bottom than rise to the top. For, though the Agents that procured the Coalition, make the cluster of particles become of a bulk too unwieldy to continue in the liquor as parts of it; yet if each of them be lighter *in specie* than an equal bulk of the Menstruum, or if they so convene as to intercept a sufficient number of little bubbles or aerial Corpuscles between them, and so become lighter than as much of the Menstruum as they take up the room of, they will not be precipitated
but

but emerge; as may be seen in the Preparation of those Magisteries of Vegetables, I elsewhere mention; where some deeply colour'd plants being made to tinge plentifully the Lixivium they are boyled in, are afterwards by the addition of Alum made to curdle, as it were, into coloured Concretions, which being (totally or in part) too big to swim as they did before they conven'd, and too light in comparison of the Menstruum to subside, emerge to the top and float there. An easier and neater Example to the same purpose I remember I shewed by dissolving Camphire in highly rectified spirit of Wine, 'till the solution was very strong. For though the Camphire, when put in Lumps into the spirit, sunk to the bottom of it; yet, when good store of water, (a liquor somewhat heavier in *Specie* than Camphire,) was poured upon the solution, the Camphire quickly concreted and returned to its own nature, and within a while emerged to the top of the mingled liquors and floated

of Chymical Precipitation. 21

floated there. These particulars I was willing to mention here, that I might give an instance or two of those precipitations, that I formerly spake of as improperly so called. And here I must not decline taking notice of a Phenomenon, that sometimes occurs in Precipitations, and at first sight may seem contrary to our Doctrine about them. For now and then it happens, that after some drops of the Precipitant have begun a Precipitation at the top or bottom of the Solvent, one shakes the vessel, that the Precipitant may be the sooner diffused through the other liquor, but then they are quickly surprized to find, that instead of hastning the compleat Precipitation, the matter already precipitated disappears, and the solvent returns to be clear, or, as to sense, as uniform, as it was before the Precipitant was put into it. But this *Phenomenon* does not at all cross our Theory. For, when this happens, though that part of the Solvent, to which the Precipitant reaches, is disabled

22 Of the Mechanical Causes

disabled for Reasons mentioned in this Discourse to support the dissolved body, yet this quantity of the Precipitant is but small in proportion to the whole bulk of the solvent. And therefore, when the agitation of the vessel disperses the clusters of loosely concreted particles through the whole liquor, (which is seldom so exactly proportioned to the body it was to work on, as to be but just strong enough to dissolve it) that greater part of the Liquor, to which before the shaking of the vessel the Precipitant did not reach, may well be lookt upon as a fresh Menstruum, which is able to mortifie or overpower the small quantity of the Precipitant that is mingled with it, and so to destroy its late operation on the body dissolved, by which means the solution returns, as to sense, to its former state. Which may be illustrated by a not unpleasant Experiment, I remember I have long since made by precipitating a brick-coloured powder out of a strong solution of Sublimate

of Chymical Precipitation. 23

mate made in fair water. For this subsiding matter, being laid to dry in the Philter, by which 'twas separated from the water, would retain a deep but somewhat dirty colour; and if then, putting it into the bottom of a wine glass, I poured upon it, either clear oil of Vitriol, or some other strong acid Menstruum, the Alcalizat particles being disabled and swallowed up by some of the acid ones of the Menstruum, the other acid ones would so readily dissolve the residue of the powder, that in a trice the colour of it would disappear and the whole mixture be reduced into a clear Liquor, without any sediment at the bottom.

Thus much may suffice at present about the first general way of Precipitating Bodies out of the Liquors they swam in.

CHAP.

CHAP. V.

THE other of the two principal ways, by which Precipitations may be effected, is the disabling of the Solvent to sustain the dissolved body.

There may be many instances, wherein this second way of effecting Precipitations may be associated by Nature with the first way formerly proposed; but notwithstanding the cases, wherein Nature may (as I formerly noted) employ both the ways therein, yet in most cases they sufficiently differ, in regard that in the former way the subsiding of the dissolved body is chiefly, if not only, caused by the additional weight as well as action of the external Precipitant; whereas in most of the instances of the later way, the effect is produced *either* without salt of Tartar, *or* any such Precipitant, *or* by some other quality of the Precipitant

tant *more than* by its weight, or at least *besides* the weight it adds: Though I forget not, that I lately gave an example of a shining powder of Gold, that fell to the bottom of a Menstruum without the help of an External Precipitant: But that was done so slowly, that it may be disputed, whether it were a true Precipitation; and I alledged it not as such, but to shew, that the increased bulk of Particles may make them unfit to swim in Menstruums, wherein they swam whilst they were more minute. And the like answer may be accommodated to the Precipitate *per se* newly mentioned.

This premised, I proceed now to observe, that the general way, I last proposed, contains in it several subordinate wayes, that are more particular; of which I shall now mention the chief that occur to me, and though but briefly, illustrate each of them by examples. And first a Precipitation may be made, if the saline or other dissolving particles of the
Menstru-

26 Of the Mechanical Causes

Menstruum are mortified or rendred unfit for their former function, by particles of a Precipitant that are of a contrary nature.

Thus Gold and some other minerals, being dissolved in *Aqua Regis*, will be precipitated with spirit of urine and other such liquors abounding with volatile and salino-sulphureous Corpuscles, upon whose account it is that they act; whence these salts themselves, though cast into a Menstruum in a dry form, will serve to make the like Precipitations. And I the rather on this occasion mention Urinous spirits than Salt of Tartar, because those volatile particles add much less of weight to the little Concretions, which compose the Precipitated powder.

Upon instances of this kind, many of the modern Chymists have built that Antipathy betwixt the Salts of the solvent and those of the Menstruum, to which they ascribe almost all Precipitations. But against this I have represented something already,
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and shall partly now, and partly in the sequel of this discourse add some farther reasons of my not being satisfied with this Doctrine. For, besides that 'tis insufficient to reach many of the *Phænomena* of Precipitations, (as will ere long be shown,) and besides that 'tis not easie to make out, that there is any real antipathy betwixt inanimate bodies; I consider,

I. That some of those Menstruums, to which this Antipathy is attributed, do after a short commotion (whereby they are disposed to make convenient occurrsions and coalitions) amicably unite into concretions participating of both the Ingredients; as I have somewhere shewn by an Example purposely devis'd to make this out; to do which I dropped a clear solution of fixed Nitre, instead of the usual one of common salt, upon a solution of silver, in *Aqua-fortis*: For the saline particles of the Solvent and those of the Precipitant, will, as I have elsewhere recited,

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28 Of the Mechanical Causes

recited, for the most part friendly unite into such Crystals of Nitre for the main, as they were obtained from: And though this notion of the Chymists, if well explained, be applicable to far more instances than the proposers of it seemed to have thought on, and may be made good use of in Practice; yet I take it to be such as is not true Universally, and, where it is true, ought to be explicated according to Mechanical Principles. For, if the particles of the Menstruum and those of the Precipitant be so framed, that upon the action of the one upon the other, there will be produced Corpuscles too big and unwieldy to continue in the state of fluidity, there will insue a Precipitation: But if the constitution of the corpuscles of the Precipitating and of the Dissolved body be such, that the Precipitant also it self is fit to be a Menstruum to dissolve that body in; then, though there be an union of the Salts of the Precipitant

of Chymical Precipitation. 29

tant and the metal (or other *Solutum*) and perhaps of the solvent too, yet a Precipitation will not necessarily follow, though the saline particles of the two liquors seemed, by the heat and ebullition excited between them upon their meeting, to exercise a great and mutual antipathy. To satisfie some Ingenious men about this particular, I dissolved *Zink* or *Speltar* in a certain urinous spirit; (for, there are more than one that may serve the turn;) and then put to it a convenient quantity of a proper acid spirit; but though there would be a manifest conflict thereby occasioned betwixt the two liquors; yet the speltar remained dissolved in the mixture. And I remember, that for the same purpose I devised another Experiment, which is somewhat more easie and more clear. I dissolved Copper calcined *per se*, or even crude, in strong spirit of salt; (for unless it be such, it will not be so proper,) and having put to it by degrees a

30 *Of the Mechanical Causes*

good quantity of spirit of Sal-Armoniack or fermented Urine, though there would be a great commotion with hissing and bubbles produced, the Copper would not be precipitated, because this Urinous spirit will as well as the Salt, (and much more readily) dissolve the same metal, and it would be kept dissolved notwithstanding their operation on one another; the intervening of which, and their action upon the metalline corpuscles, may be gathered from hence, that the green solution, made with spirit of salt alone, will by the supervening urinous spirits be changed either into a blewish green, or, if the proportion of this spirit be very great, into a rich blew almost like ultramarine. And from these two Experiments we may probably argue, that when the Precipitation of a metal &c. insues, it is not barely on the account of the supposed Antipathy betwixt the Salts, but because the causes of that seeming Antipathy do

do likewise upon a Mechanical account dispose the Corpuscles of the confounded liquors so to cohere, as to be too unwieldy for the fluid part.

CHAP. VI.

A Nother way, whereby the dissolving particles of a Menstrum may be rendred unfit to sustain the dissolved body, is to present them another that they can more easily work on.

A notable Experiment of this you have in the common practice of *Refiners*, who, to recover the Silver out of *Lace* and other such mixtures wherein it *abounds*, use to dissolve it in *Aqua fortis*, and then in the solution leave Copper plates for a whole night (or many hours.) But if you have a mind to see the Experiment without waiting so long, you may

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32 Of the Mechanical Causes

employ the way, whereby I have often quickly dispatched it. As soon then as I have dissolved a convenient quantity, which needs not be a great one, of Silver in cleansed *Aqua fortis*, I add twenty or twenty five times as much of either distilled water or rain water; (for though common water will sometimes do well, yet it seldom does so well;) and then into the clear solution I hang by a string a clean piece of Copper, which will be presently covered with little shining plates almost like scales of fish, which one may easily shake off and make room for more. And this may illustrate what we formerly mentioned about the subsiding of metalline corpuscles, when they convene in liquors, wherein, whilst they were dispersed in very minute parts, they swam freely. For in this operation the little scales of Silver seemed to be purely metalline, and there is no saline Precipitant, as Salt of Tartar or of Urine, imployed to make them subside.

of Chymical Precipitation. 33

subside. Upon the same ground, Gold and Silver dissolved in their proper Menstruums may be precipitated with running Mercury; and if a Solution of blew Vitriol (such as the Roman, East-Indian, or other of the like colours) be made in water, a clean plate of Steel or Iron being immersed in it, will presently be overlaid with a very thin case of Copper-which after a while will grow thicker; but does not adhere to the iron so loosely as to be shaken off, as the Precipitated silver newly mentioned may be from the Copper-plates whereto it adheres. And that in these operations the saline particles may really quit the dissolved body, and work upon the Precipitant, may appear by the lately mentioned practice of *Refiners*, where the *Aqua-fortis*, that forsakes the particles of the silver, falls a working upon the copper-plates employed about the Precipitation, and dissolves so much of them as to acquire the greenish

34 Of the Mechanical Causes

blew colour of a good solution of that metal. And the Copper we can easily again without salts obtain by Precipitation out of that liquor with iron, and that too, remaining dissolved in its place, we can precipitate with the tasteless powder of another Mineral.

Besides these two ways of weakening the Menstruum, namely, by mortifying its saline particles or seducing them to work on other bodies, and to forsake those they first dissolved, there are some other ways of weakening the Menstruum.

A Third way of effecting this, is by lessening or disturbing the agitation of the solvent. And indeed since we find by experience, that some liquors when they are heated, will either dissolve some bodies they would not dissolve at all when they were cold, or dissolve them more powerfully or copiously when hot than cold; 'tis not unreasonable to suppose, that what considerably lessens

sens that agitation of the parts of the Menstruum that is necessary to the keeping the dissolved body in the state of fluidity, should occasion the falling of it again to the bottom. In slow operations I could give divers examples of the precipitating power of Cold; there being divers solutions and particularly that of Amber-greece, that I had kept fluid all the Summer, which in the Winter would subside. And the like may be sometimes observed in far less time in the solutions of Brimstone made in certain oleaginous Menstruums; and I have now & then had some solutions, and particularly one of *Benzoin* made in spirit of wine, that would surprize me with the turbidness (which begins the state of Precipitation) it would acquire upon a sudden change of the weather towards Cold, though it were not in the winter season.

Another way of weakening the Menstruum and so causing the Precipitation of a body dissolved in it, is
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36 Of the Mechanical Causes

the diluting or lessening the tenacity of it, whether that tenacity proceed from viscosity or the competent number and constipation of the parts.

Of this we have an instance in the Magisteries (as many Chymists are pleased to call them) of Jalap, Benzoin, and of divers others, Resinous and Gummous bodies dissolved in spirit of wine. For by the affusion of common water, the Menstruum being too much diluted is not able to keep those particles in the state of fluidity, but must suffer them to *subside*, (as they usually do in the form of white powder,) or, (as it may happen sometimes,) make some parts emerge. Examples also of this kind are afforded us by the common preparations of *Mercurius Vite*. For though in oil of Antimony, made by the Rectification of the butter, the saline particles are so numerous and keep so close to one another, that they are able to sustain the Antimonial

Of Chymical Precipitation. 37

nial Corpuscles they carried over with them in Distillation, and keep them together with themselves in the form of a liquor; yet when by the copious affusion of the water, those sustaining particles are separated and removed to a distance from each other, the Antimonial Corpuscles and the Mercurial (if any such there were,) being of a ponderous nature, will easily subside into that Emetic powder, which, (when well washed) the Chymists flatteringly enough call *Amercurius Vite*.

But here I must interpose an advertisement, which will help to shew us, how much Precipitations depend upon the Mechanical contextures of bodies. For, though not only in the newly recited examples, but in divers others, the affusion of water, by diluting the salts and weakening the Menstruum, makes the metall or other dissolved body fall precipitately to the bottom; yet if the saline particles of the solvent, and
those

38 Of the Mechanical Causes

those of the body be fitted for so strict an union, that the Corpuscles resulting from their Coalitions will not so easily be separated by the particles of water, as suffer themselves to be carried up and down with them, whether because of the minuteness of these compounded Corpuscles, or because of some congruity betwixt them and those of the water; they will not be precipitated out of the weakened solution, but still continue a part of it; as I have tryed partly with some solution of Silver and Gold, made in acid Menstruums, but much more satisfactorily in solutions of Copper, made in the urinous spirit of Sal Armoniac. For, though that blew solution were diluted with many thousand times as much distilled water as the dissolved metal weighed; yet its swimming Corpuscles did by their colour manifestly appear to be dispersed through the whole liquor.

CHAP.

CHAP. VII.

BUT, to prosecute our former discourse, which we broke off after the mention of *Mercurius Vite*, 'twill now be seasonable to add, that we have made divers other Precipitations, by the bare affusion of water, out of solutions, and sometimes out of distilled liquors; which, for brevity sake, I here omit, that I may hasten to the last way I shall now stay to mention.

Another way then, whereby Precipitations of bodies may be produced by debilitating the Menstruum they swim in, is by lessening the proportion of the Solvent to the *Solutum*, without any evaporation of the liquor. These last words I add, because that, when there is an obstruction or any other expulsion of the Menstruum by heat, if
it

41 Of the Mechanical Causes

it be total, 'tis called Exsiccation, as when dry salt of Tartar is obtained from the filtrated *Lixivium* of the calcined Tartar; and though the evaporation be not total, yet the effects of it are not wont to be reckoned amongst Precipitations. And although the way, I am about to propose, if it be attentively considered, has much affinity with the foregoing, and the *Phanomena* may perhaps in some sort be reduced to them; yet the instances that I shall name, having not, that I know, been thought of by others, and being such as every one would not deduce from what I have been mentioning, I shall add a word of the inducements I had to make the tryals, as well as of the success of them.

Considering then, that Water will not dissolve Salts indefinitely, but when it has received its due proportion, 'twill then dissolve no more, but, if they be put into it, let them
fall

of Chymical Precipitation. 40

fall to the ground and continue undissolved; and that if when water is satiated, any of the liquor be evaporated or otherwise wasted, it will in proportion let fall the salt it had already taken up; I concluded, that if I could mingle with water any liquor, with which its particles would more readily associate than with those of Salt, the depriving the solution of so many of its aqueous particles would be equivalent to the evaporation of as much water or thereabouts, as they, by being united, could compose. Wherefore making a *lixivium* of distilled water or clean rain-water, and of Salt of Tartar so strong, that if a grain more were cast in it, it would lie undissolved at the bottom; I put a quantity of this fiery Lixivium into a slender cylindrical vessel, till it had therein reached such a height as I thought fit; then taking as much as I thought sufficient of strong spirit of wine, that
would

42 Of the Mechanical Causes

would burn every drop away, that so it might have no flegm nor water of its own, I poured this upon the saline solution, and shaking the liquors pretty well together to bring them to mix as well as I could, I laid the tube in a quiet place, and afterwards found, as I expected, that there was a pretty quantity of white salt of Tartar fallen to the bottom of the vessel, which salt had been meerly forsaken by the aqueous particles that sustained it before, but forsook it to pass into the Spirit of wine, wherewith they were more disposed to associate themselves; which I concluded, because having, before I poured on this last named liquor, made a mark on the glass to shew how far the *lixivium* reached, I found (what I looked for) that after the Precipitation, the *Lixivium*, that remained yet strong enough to continue unmixed with the incumbent spirit, had its surface not where the mark shewed it had been

been before, but a considerable distance beneath it, the spirit of wine having gained in extent what it lost in strength by receiving so many aqueous particles into it. I chose to make this tryal rather with a *Lixivium* of Salt of Tartar than with oyl of Tartar *per Deliquium*, because in this last named liquor the aqueous and saline particles are more closely combined and therefore more difficult to be separated than I thought they would be in a *Lixivium* hastily made, though very strong. And though by much agitation I have sometimes obtained some salt of Tartar from the above-mentioned oil; yet the experiment succeeded nothing near so well with that liquor as with a *Lixivium*.

I made also the like tryal with exceedingly dephlegmed spirit of wine, and as strong a Brine as I could make of common salt dissolved without heat in common water; and I thereby obtained no despicable proportion of finely figured salt, that

D

was

44 Of the Mechanical Causes

was let fall to the bottom. But this experiment, to be successful, requires greater care in him that makes it, than the former needs.

To confirm, and somewhat to vary this way of Precipitation, I shall add, that having made a clear solution of choice Gum Arabic in common water, and poured upon it a little high rectified spirit of wine, on this occasion there was also made, and that in a trice, a copious precipitation of a light and purely white substance not unpleasant to behold. And for further Confirmation I dissolved a full proportion of Myrrhe in fair water, and into the filtrated solution, which was transparent, but of a high brown colour, I dropt a large proportion (which Circumstance is not to be omitted) of carefully dephlegm'd spirit of wine, which according to expectation made a copious Precipitate of the Gum. And these instances I the rather set down in this place, because they seem to show, that
simple

of Chymical Precipitation. 45

simple water is a real Menstruum, which may have its dissolving and sustaining virtue weakened by the accession of Liquors, that are not doubted to be much stronger than it.

By specifying the hitherto mentioned wayes, whereby Precipitations may be Mechanically performed and accounted for, I would by no means be thought to deny, that there may be some omitted here, which either others that shall consider the matter with more attention, or I my self, if I shall have leisure to do it, may think on. For I propose these but as the chief that occur to my present thoughts; and I forbear to add more instances to exemplifie them, because I would not injure some of my other papers, that have a greater right to those Instances. Only this I shall note in general, that the Doctrine and History of Precipitations, if well delivered, will be a thing of more extent and moment than seems hitherto to have been imagined; since *not only* several of

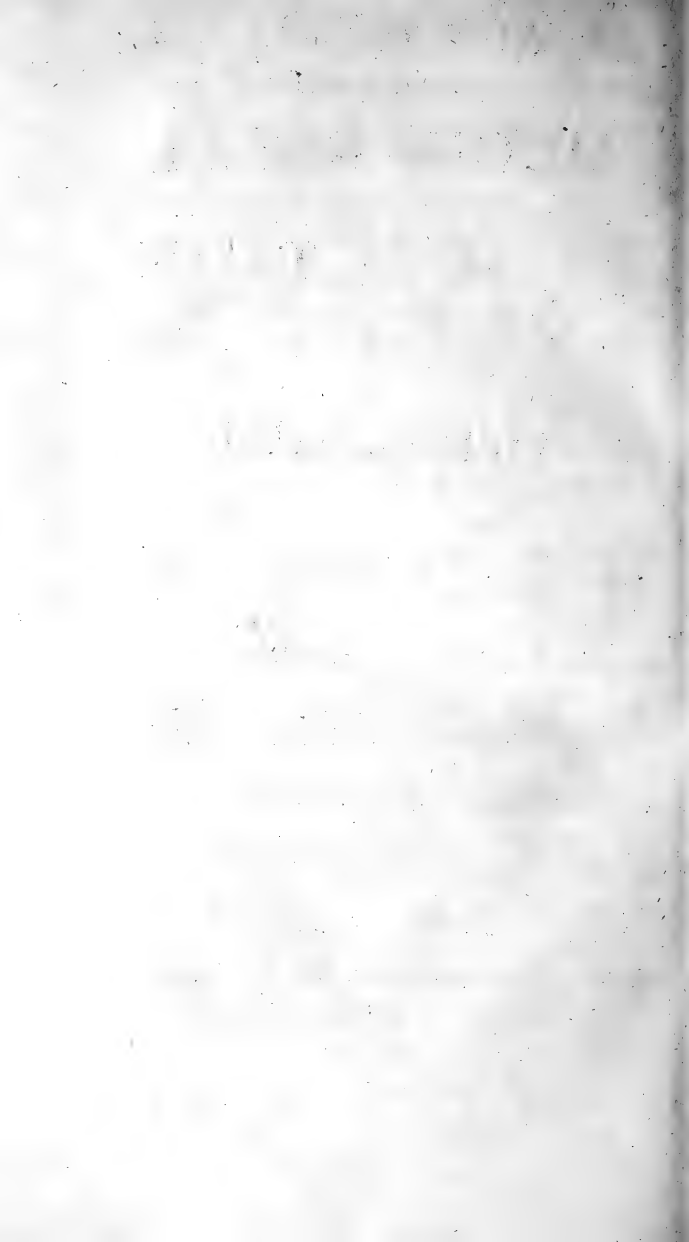
the changes in the blood and other liquors and juices of the humane body may thereby be the better understood; and they prevented, or their ill consequences remedied; *but* in the practical part of Mineralogy divers usefull things may probably be performed by the assistance of such a Doctrine and History. To keep which conjecture from seeming extravagant, I shall only here intimate, that 'tis not alone in bodies that are naturally or permanently liquid, but in those solid and ponderous bodies, that are for a short time made so by the violence of the fire, that many of the things suggested by this Doctrine may have place. For whilst divers of those Bodies are in fusion, they may be treated as liquors; and metalls, and perhaps other heterogeneous bodies may be obtained from them by fit though dry Precipitants, as in some other writings I partly did, and may elsewhere yet further, declare.

F I N I S.

Experiments and Notes
ABOUT THE
MECHANICAL
PRODUCTION
OF
Magnetism.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Fleisher*, for *R. Davis*
Bookseller in *Oxford.* 1676.



ADVERTISEMENT

Concerning the following

NOTES

About OCCULT

QUALITIES.

THE following Papers (about Magnetism and Electricity) would appear with less disadvantage, if the Author's willingness and Promise, that this Tome should be furnished with notes about some Occult Qualities, as well as about divers sorts of those that are presumed to be Manifest, did not prevail with him to let the ensuing Notes appear without those about the Pores of Bodies and Figures of Corpuscles, that should have preceded them, and some others that should have

Advertisement.

accompanied them. But the Author chose rather to venture these Papers abroad in the Condition, such as 'tis, they now appear in, than make those already printed about manifest Qualities stay longer for Accessions, which some troublesome Accidents will not suffer him to hasten to the press; and without which, he now fears this Tome may swell to a more than competent Bulk.

EXPE.

Experiments and Notes
 ABOUT THE
 Mechanical Production
 OF
 MAGNETICAL
 QUALITIES.

THough the vertues of the *Loadstone* be none of the least famous of *Occult* Qualities, and are perhaps the most justly admired; yet I shall venture to offer something to make it probable, that some, even of these, may be introduced into bodies by the production of *Mechanical* changes in them.

To make way for what I am to deliver to this purpose, it will be ex-

2 Of the Mechanical Production

pedient to remove that general and settled prejudice, that has kept men from so much as thinking of any Mechanical account of Magnetisms, which is a belief, that these Qualities do immediately flow from the *Substantial Form* of the Loadstone, whose abstruse nature is disproportionate to our understandings. But

for my part, I confess, I see no necessity of admitting this supposition; for I see, that a piece of Steel fitly shaped and well excited, will, like a Loadstone, have its determinate Poles, and with them point at the North and South; it will draw other pieces of Iron and Steel to it, and which is more, communicate to them the same kind, though not degree, of attractive and directive vertue it had it self, and will possess these faculties not as light and transient impressions, but as such settled and durable Powers that it may retain them for many years, if the Loadstone, to which it has been
duly

duly applied, were vigorous enough: Of which sort I remember I have seen one (and made some tryals with it) that yielded an income to the owner, who received money from Navigators and others for suffering them to touch their needles, swords, knives &c. at his excellent Magnet. Now, in a piece of steel or iron thus excited, 'tis plain, that the Magnetic operations may be regularly performed for whole years by a body, to which the form of a Loadstone does not belong, since, as it had its own form before, so it retains the same still, continuing as malleable, fusible &c. as an ordinary piece of the same metal unexcited: so that, if there be introduced a fit disposition into the internal parts of the metal by the action of the Loadstone, the metal, continuing of the same *species* it was before, will need nothing save the continuance of that acquired disposition to be capable of performing Magnetical Operations; and if this disposition or inter-

4 of the Mechanical Production
nal constitution of the excited iron
be destroyed, though the form of
the metal be not at all injured, yet
the former power of Attraction
shall be abolished,
EXPER. II. as appears when an
excited iron is made
red hot in the fire, and suffered to
cool again.

And here give me leave to take
notice of what I have elsewhere re-
lated to another purpose, namely
that a Loadstone
EXPER. III. may (as I have
more than once
tryed) be easily deprived by ig-
nition of its Power of sensibly at-
tracting Martial bodies, and yet be
scarce, if at all, visibly changed, but
continue a true Loadstone in other
capacities, which, according to the
vulgar Philosophy ought to depend
upon its *Substantial Form*, and the
Loadstone thus spoiled may, not-
withstanding this Form, have its
Poles altered at pleasure like a
piece

piece of Iron; as I have elsewhere particularly declared.

And I will confirm what I have been saying with an experiment that you do not perhaps expect; namely, that though it be generally taken for granted (without being contradicted that I know of by any man) that, in a sound Loadstone, that has never been injured by the fire, not only the attractive Power, but the particular Vertue that it has to point constantly, when left to itself, with one of its determinate extremes to one determinate pole, flows immediately from the substantial or at least essential Form; yet this Form remaining undestroyed by Fire, the Poles may be changed, and that with ease and speed. For among my notes about Magnetical Experiments, whence I borrow some passages of this paper, I find the following Account.

Ex-

EXPER. IV.

TO shew that the virtue that a Loadstone hath by this determinate Pole or Extream to attract, for example, the South-end of a poised needle, and with the opposite extream or Pole the North-end of the same needle, I made among other tryals the following Experiment.

Taking a very small fragment of a Loadstone, I found, agreeably to my conjecture, that by applying sometimes one Pole, sometimes the other, to that pole of (a small but) a very vigorous Loadstone that was fit for my purpose, I could at pleasure, in a few minutes, change the Poles of the little fragment, as I tryed by its operations upon a needle freely poised; though by applying a fragment a pretty deal bigger, (for in it self it appeared very small,) I was not able in far more hours than I employed minutes before, to make any sensible change of the Poles.

This

This short Memorial being added to the preceding part of this discourse, will, I hope, satisfy you, that how unanimously so ever men have deduced all magnetick operations from the form of the Loadstone; yet some internal change of pores or some other Mechanical alterations or inward disposition, either of the excited Iron or of the Loadstone it self, may suffice to make a body capable or incapable of exercising some determinate magnetical operations; which may invite you to cast a more unprejudiced eye upon those few particulars, I shall now subjoin to make it probable, that even Magnetical Qualities may be Mechanically produced or altered.

EXPER. V.

I Have often observed in the Shops of Artificers, as Smiths, Turners of metals &c. that, when hardened and well tempered tools are well heated by Attrition, if
whilest

8 Of the Mechanical Production

whilest they are thus warmed you apply them to filings or chips, as they call them, or thin fragments of Steel or Iron, they will take them up, as if the instruments were touched with a Loadstone: but *as* they will not do so, unless they be thus excited by rubbing till they be warmed, by which means a greater commotion is made in the inner parts of the Steel *so* neither would they retain so vigorous a Magnetism as to support the little fragments of Steel that stuck to them after they were grown cold again. Which may be confirmed by what, if I much misremember not, I shewed some Acquaintances of yours; which was, that, by barely rubbing a conveniently shaped piece of Steel against the floor till it had gained a sufficient heat, it would whilest it continued so, discover a manifest, though but faint attractive power, which vanished together with the adventitious Heat.

EX-

EXPER. VII.

WE elsewhere observe, which perhaps you also may have done, that the Iron bars of windows, by having stood very long in an erected posture, may at length grow Magnetical, so that, if you apply the North point of a poised and excited Needle to the bottom of the Bar, it will drive it away, & attract the Southern; and if you raise the magnetick needle to the upper part of the Bar, and apply it as before, this will draw the Northern extrem, which the other end of the bar expelled; probably because, as 'tis elsewhere declared, the bar is intract of time, by the continual action of the Magnetical *effluvia* of the Torqueous Globe, turned into a kind of Magnet, whose lower end becomes the North-pole of it, and the other the Southern. Therefore according to the Magnetical Laws, the former must expel the Northern extrem

10 Of the Mechanical Production
stream of the Needle, and the later
draw it.

EXPER. VIII.

I Have found indeed, and I question not but other observers may have done so too, that, if a bar of Iron, that has not stood long in an erected posture, be but held perpendicular, the forementioned experiment will succeed, (probably upon such an account as that I have lately intimated :) But then this virtue, displayed by the extrems of the bar of Iron, will not be at all permanent, but so transient, that, if the bar be but inverted and held again upright, that end which just before was the uppermost, and drew the north-end of the needle, will now, being lowermost, drive it away, which, as was lately observed, will not happen to a bar which has been some years or other competent time kept in the same Position. So that,
since

since length of time is requisite to make the verticity of a bar of Iron so durable & constant, that the same extremum will have the same virtues in reference to the Magnetical needle, whether you make it the upper end or the lower end of the bar, it seems not improbable to me, that by length of time the whole Magnetick virtue of this Iron may be increased, and consequently some degree of attraction acquired.

And by this Consideration I shall endeavour to explicate that strange thing, that is reported by some Moderns to have happened in *Italy*, where a bar of Iron is affirmed to have been converted into a Loadstone, whereof a piece was kept among other rarities in the curious *Aldrovandus* his *Museum Metallicum*. For considering the greatness of its Specific Gravity, the malleableness and other properties, wherein Iron differs from Loadstone, I cannot easily believe, that, by such a way as is mentioned, a metal should be turned
into

12 Of the Mechanical Production
into a stone. And therefore, having
consulted the book it self, whence
this Relation was borrowed, I found
the story imperfectly enough delive-
red: The chiefest and clearest thing
in it being, that at the top of the
Church of *Arimini* a great iron-bar,
that was placed there to support a
Cross of an hundred pound weight,
was at length turned into a Load-
stone. But whether the reality of
this transmutation was examined,
and how it appeared that the frag-
ment of the Loadstone presented to
Aldrovandus was taken from that
bar of Iron, I am not fully satisfied
by that Narrative. Therefore, when
I remember the great resemblance I
have sometimes seen in colour, be-
sides other manifest Qualities, be-
twixt some Loadstones and some
course or almost rusty Iron, I am
tempted to Conjecture, that those
that observed this Iron-bar when
broken to have acquired a strong
Magnetical virtue, which they
dreamed not that tract of time might
com-

communicate to it, might easily be persuaded, by this virtue and the resemblance of colour, that the Iron was turned into Loadstone: especially they being prepossess'd with that *Aristotelian* Maxim, whence our Author would explain this strange *Phænomenon*, that *inter Symbolum habentia facilis est transmutatio*.

But, leaving this as a bare conjecture, we may take notice, that what virtue an oblong piece of Iron may need a long tract of time to acquire, by the help onely of its position, may be imparted to it in a very short time, by the intervention of such a nimble agent, as the fire. As may be often, though not always, observed in Tongs, *EXPER. IX* and such like Iron Utensils, that, having been ignited, have been set to cool, leaning against some wall or other prop, that kept them in an erected posture, which makes it probable that the great commotion of the parts, made by the vehement heat of the fire, disposed

B the

14 **Of the Mechanical Production**
the Iron, whilst it was yet soft, and
had its pores more lax, and parts
more pliable, disposed it, I say, to re-
ceive much quicker impressions from
the Magnetical *effluvia* of the Earth,
than it would have done, if it had
still been cold.

E X P E R. X. And 'tis very ob-
servable to our
present purpose, what differing ef-
fects are produced by the operation
of the fire, upon two Magnetick bo-
dies according to their respective
constitutions. For, by keeping a
Loadstone red-hot, though you cool
it afterwards in a perpendicular po-
sture, you may deprive it of its for-
mer power of manifestly attracting :
But a bar of Iron being ignited, and
set to cool perpendicularly, does
thereby acquire a manifest verticity.
Of which differing events I must not
now stay to inquire, whether or no
the true reason be, That the peculiar
Texture or internal constitution that
makes a Loadstone somewhat more
than an ordinary Ore of Iron, (which
metal,

metal, as far as I have tried, is the usual ingredient of Loadstones) being spoiled by the violence of the fire, this rude Agent leaves it in the condition of common Iron, or perhaps of ignited Iron-ore: whereas the fire does soften the Iron it self (which is a metal not an Ore) agitating its parts, and making them the more flexible, and by relaxing its pores, disposes it to be easily and plentifully pervaded by the Magnetical steams of the Earth, from which it may not improbably be thought to receive the verticity it acquires; and this the rather, because, as I have often tryed, and

elsewhere mention- *EXPER. XI.*
ed, if an oblong

Loadstone, once spoil'd by the fire, be thorowly ignited and cooled either perpendicularly, or lying horizontally North and South, it will, as well as a piece of Iron handled after the same manner, be made to acquire new poles, or change the old ones, as the skilful experimenter pleases.

But whatever be the true cause of the disparity of the fires operation upon a sound Loadstone and a bar of Iron, the effect seems to strengthen our conjecture, That Magnetical operations may much depend upon Mechanical Principles. And I hope you will find further probability added to it, by some Phænomena recited in another paper, to which I once committed some promiscuous Experiments and Observations Magnetical.

EXPER. XII.

IF I may be allowed to borrow an Experiment from a little Tract * that yet lyes by me, and has been seen but by two or three friends, it may be added to the instances already given about the production of Magnetism. For in that Experiment I have shewn, how having brought a good piece of a certain kind of English Oker, which yet perhaps was no
fitter

* *Relating to the Magnetism of the Earth.*

fitter than other, to a convenient shape, though, till it was altered by the fire, it discovered no Magnetical Quality; yet after it had been kept red-hot in the fire and was suffered to cool in a convenient posture, it was enabled to exercise Magnetical operations upon a pois'd Needle.

EXPER. XIII.

AS for the Abolition of the Magnetical vertue in a body endow'd with it, it may be made without destroying the Substantial or the Essential Form of the body, and without sensibly adding, diminishing, or altering any thing in reference to the Salt, Sulphur and Mercury, which Chymists presume Iron and Steel, as well as other mixt bodies, to be composed of. For it has been sometimes observed, that the bare continuance of a Loadstone it self in a contrary position to that, which, when freely placed, it seems to effect, has either corrupted or sensibly lessened the vertue of it. What I formerly observed to this purpose, I elsewhere relate, and since that having a Loadstone, whose vigor was look'd upon by skilful persons as very extraordinary, and which, whilst it was in an Artificers hand, was therefore held at a high rate, I was careful, being
by

18 **Of the Mechanical Production**
by some occasions call'd out of *London*, to
lock it up, with some other rarities, in a
Cabinet, whereof I took the key along
with me, and still kept it in my own
Pocket. But my stay abroad proving much
longer than I expected, when, being re-
turned to *London*, I had occasion to make
use of this Loadstone for an Experiment,
I found it indeed where I left it, but so
exceedingly decayed, as to its attractive
power, which I had formerly examin'd
by weight, by having lain almost a year in
an inconvenient posture, that if it had not
been for the circumstances newly related,
I should have concluded that some body
had purposely got it out in my absence,
and spoiled it by help of the fire, the ver-
tue being so much impaired, that I cared
little to employ it any more about confi-
derable Experiments.

EXPER. XIV. And this corruption of
the Magnetical vertue,
which may in tract of time be made in a
Loadstone it self, may in a trice be made
by the help of that Stone in an excited
Needle. For 'tis observ'd by Magnetical
Writers, and my own Trials purposely
made have assured me of it, that a well
pois'd Needle, being by the touch of a
good Loadstone, excited and brought to
turn one of its ends to the North and the
other

other to the South, it may by a contrary touch of the same Loadstone be deprived of the faculty it had of directing its determinate extreame to determinate Poles. Nay, by another touch (or the same, and even without immediate Contact, if the Magnet be vigorous enough) the Needle may presently have its direction so changed, that the end, which formerly pointed to the North pole, shall now regard the South, and the other end shall instead of the Southern, respect the Northern pole.

EXPER. XV.

AND to make it the more probable, that the change of the Magnetism communicated to Iron may be produc'd at least in good part by Mechanical operations, procuring some change of texture in the Iron; I shall subjoyn a notable Experiment of the ingenious Doctor *Power*, which when I heard of, I tryed as well as I could; and though, perhaps for want of conveniency, I could not make it fully answer what it promised, yet the success of the trial was considerable enough to make it pertinent in this place, and to induce me to think, it might yet better succeed with him, whose Experiment, as far as it concerns my present purpose, imports, that
if

if a Puncheon, as Smiths call it, or a Rod of Iron, be, by being ignited and suffered to cool North and South, and hammered at the ends, very manifestly endow'd with Magnetical vertue, this vertue will in a trice be destroyed, by two or three smart blows of a strong hammer upon the middle of the oblong piece of Iron.

But *Magnetism* is so fertile a Subject, that if I had now the leisure and conveniency to range among Magnetical Writers, I should scarce doubt of finding, among their many Experiments and Observations, divers that might be added to those above delivered, as being easily applicable to my present Argument. And I hope you will find farther probability added to what has been said, to shew, *that Magnetical operations may much depend upon Mechanical Principles*, by some *Phænomena* recited in another Paper, to which I once committed some promiscuous Experiments and Observations Magnetical.

F I N I S.

Experiments and Notes
ABOUT THE
MECHANICAL ORIGINE
OR
PRODUCTION
OF
Electricity.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Fleisher*, for *R. Davis*
Bookseller in *Oxford.* 1675.

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ABOUT THE
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Experiments and Notes

ABOUT THE

MECHANICAL ORIGINE

OR

PRODUCTION

OF

Electricity.

That 'tis not necessary to believe Electrical Attraction (which you know is generally listed among Occult Qualities) to be the effect of a naked and solitary Quality flowing immediately from a Substantial Form ; but that it may rather be the effect of a Material Effluvium, issuing from, and returning to, the Electrical Body (and

2 Of the Mechanical Origine
perhaps in some cases assisted in its
Operation by the external air) seems
agreeable to divers things that may
be observ'd in such Bodies and their
manner of acting.

There are differing *Hypotheses*
(and all of them Mechanical, pro-
pos'd by the Moderns) to solve the
Phænomena of Electrical Attraction.
Of these Opinions the First is that
of the learned Jesuite *Cabeus*, who,
though a Peripatetick and Commen-
tator on *Aristotle*, thinks the draw-
ing of light Bodies by Jet, Amber,
&c. may be accounted for, by suppo-
sing, that the Steams that issue, or, if
I may so speak, sally, out of Amber,
when heated by rubbing, discuss and
expell the neighbouring air; which
after it has been driven off a little
way, makes as it were a small whirl-
wind, because of the resistance it
finds from the remoter air, which
has not been wrought on by the E-
lectrical Steams; and that these,
shrinking back swiftly enough to the
Amber, do in their returns bring a-
long

long with them such light bodies as they meet with in their way. On occasion of which *Hypothesis* I shall offer it to be consider'd, Whether by the gravity of the Atmospheric Air, surmounting the Specifick Gravity of the little and rarifi'd Atmosphere, made about the Amber by its emissions, and comprising the light Body fasten'd on by them, the Attraction may not in divers cases be either caused or promoted.

Another *Hypothesis* is that proposed by that Ingenious Gentleman Sir *Kenelm Digby*, and embraced by the very Learned Dr. *Browne*, (who seems to make our *Gilbert* himself to have been of it) and divers other sagacious men. And according to this *Hypothesis*, the Amber, or other Electrick, being chaf'd or heated, is made to emit certain Rayes or Files of unctuous Steams, which, when they come to be a little cool'd by the external air, are somewhat condens'd, and having lost of their former agitation, shrink back to the

A 3

body

4 Of the Mechanical Dorigine

body whence they fallied out, and carry with them those light bodies, that their further ends happen to adhere to, at the time of their Retraction: As when a drop of Oyl or Syrup hangs from the end of a small stick, if that be dextrously and cautiously struck, the viscous substance will, by that impulse, be stretch'd out, and presently retreating, will bring along with it the dust or other light bodies that chanced to stick to the remoter parts of it.

And this way of explaining Electrical Attractions is employ'd also by the Learned *Gassendus*, who addes to it, that these Electrical Rays (if they may be so call'd) being emitted several ways, and consequently crossing one another, get into the pores of the Straw, or other light body to be attracted, and by means of their Decussation take the faster hold of it, and have the greater force to carry it along with them, when they shrink back to the Amber

ber whence they were emitted.

A third *Hypothesis* there is, which was devised by the Acute *Cartesius*, who dislikes the Explications of others, chiefly because he thinks them not applicable to Glass, which he supposes unfit to send forth *Effluvia*, and which is yet an Electrical body; and therefore attempts to account for Electrical Attractions by the intervention of certain particles, shap'd almost like small pieces of Ribbond, which he supposes to be form'd of this subtile matter harbour'd in the pores or crevices of Glass. But this *Hypothesis*, though ingenious in it self, yet depending upon the knowledge of divers of his peculiar Principles, I cannot intelligibly propose it in few words, and therefore shall refer you to himself for an account of it: which

*Princip. part 4.
Art. 184.*

I the less scruple to do, because though it be not unworthy of the wonted Acuteness of the Authour, yet he seems himself to doubt, whether

6 Of the Metaphysical Origin

ther it will reach all Electrical Bodies; and it seems to me, that the reason why he rejects the way of explicating Attraction by the Emission of the finer parts of the attractant (to which *Hypothesis*, if it be rightly proposed, I confess myself very inclinable) is grounded upon a mistake, which, though a Philosopher may, for want of Experience in that Particular, without disparagement fall into, is nevertheless a mistake. For whereas our excellent Author says, that *Electrical Effluvia*, such as are supposed to be emitted by Amber, Wax, &c. cannot be imagin'd to proceed from Glass, I grant the Supposition to be plausible, but cannot allow it to be true. For as solid a body as Glass is, yet if you but dextrously rub for two or three minutes a couple of pieces of Glass against one another, you will find that Glass is not onely capable of emitting *Effluvia*, but such ones as to be odorous, and sometimes to be rankly stinking.

But

But it is not necessary, that in this Paper, where I pretend not to write Discourses but Notes, I should consider all that has been, or I think may be, said for and against each of the above-mentioned *Hypotheses*; since they all agree in what is sufficient for my present purpose, namely, that Electrical Attractions are not the Effects of a meer Quality, but of a Substantial Emanation from the attracting Body: And 'tis plain, that they all endeavour to solve the *Phenomena* in a Mechanical way, without recurring to Substantial Forms, and inexplicable Qualities, or so much as taking notice of the Hypostatical Principles of the Chymists. Wherefore it may suffice in this place, that I mention some *Phenomena* that in general make it probable, that Amber, &c. draws such light Bodies, as pieces of Straw, Hair, and the like, by vertue of some Mechanical Affections either of the attracting or of the attracted Bodies, or of both the one and the other.

1. The

8. Of the Mechanical Drigine

1. The first and most general Observation is, That Electrical Bodies draw not unless they be warm'd; which Rule though I have now and then found to admit of an Exception, (whereof I elsewhere offer an account,) yet, as to the generality of common Electricks, it holds well enough to give much countenance to our Doctrine, which teaches the effects of Electrical Bodies to be perform'd by Corporeal Emanations. For tis known, that Heat, by agitating the parts of a fit Body, sollicites it as it were to send forth its *Effluvia*, as is obvious in odoriferous Gums and Perfumes, which, being heated, send forth their fragrant steams, both farther and more copiously than otherwise they would.

2. Next, it has been observ'd, that Amber, &c. warm'd by the fire, does not attract so vigorously, as if it acquire an equal degree of heat by being chaf'd or rub'd: So that the modification of motion in the internal parts, and in the Emanations of
the

the Amber, may, as well as the degree of it, contribute to the Attraction. And my particular Observations incline me to adde, that the effect may oftentimes be much promoted, by employing both these ways successively; as I thought I manifestly found when I first warm'd the Amber at the fire, and presently after chaf'd it a little upon a piece of cloth. For then a very few rubbings seem'd to excite it more than many more would otherwise have done: As if the heat of the fire had put the parts into a general, but confus'd, agitation; to which 'twas easie for the subsequent Attrition (or Reciprocation of Pressure) to give a convenient modification in a Body whose Texture disposes it to become vigorously Electrical.

3. Another Observation that is made about these Bodies, is, That they require Tersion as well as Attrition; and though I doubt whether the Rule be infallible, yet I deny not but that weaker Electricks require

10 **Of the Mechanical Origine**

quire to be as well wip'd as chaf'd; and even good ones will have their Operation promoted by the same means. And this is very agreeable to our Doctrine, since Tersion, besides that it is, as I have sometimes manifestly known it, a kind or degree of Attrition, frees the Surface from those adherences that might choak the pores of the Amber, or at least hinder the emanation of the steams to be so free and copious as otherwise it would be.

4. 'Tis likewise observ'd, That whereas the Magnetical Steams are so subtile, that they penetrate and perform their Operation through all kind of Mediums hitherto known to us; Electrical Steams are like those of some odoriferous Bodies, easily check'd in their progress, since 'tis affirm'd by Learned Writers, who say they speak upon particular Trial, that the interposition of the finest Linnen or Sarsnet is sufficient to hinder all the Operation of excited Amber upon a Straw or Feather plac'd

plac'd never so little beyond it,

5. It has been also observed, that the effects of Electrical Attraction are weaken'd if the air be thick and cloudy; and especially if the South-wind blows: And that Electricks display their vertue more faintly by night than by day, and more vigorously in clear weather, and when the winds are Northerly. All which the Learned *Kircherus* asserts himself to have found true by experience; insomuch that those bodies that are but faintly drawn when the weather is clear, will not, when 'tis thick and cloudy, be at all moved.

6. We have also observed, That divers Concretes, that are notably Electrical, do abound in an effluvi-able matter (if I may so call it) which is capable of being manifestly evaporated by heat and rubbing. Thus we see, that most Resinous Gums, that draw light bodies, do also, being moderately solicited by heat, (whether this be excited by the fire, or by Attrition or Contusi-
on)

on) emit steams. And in pieces of Sulphur conveniently shaped, I found upon due Attrition a Sulphureous stink. And that piece of Amber which I most employ, being somewhat large and very well polish'd, will, being rub'd upon a piece of woollen cloth, emit steams, which the nostrils themselves may perceive; and they sometimes seem to me not unlike those that I took notice of, when I kept in my mouth a drop or two of the diluted Tincture (or Solution of the finer parts) of Amber made with Spirit of Wine, or of Sal Armoniac.

7. It agrees very well with what has been said of the corporeal Emanations of Amber, that its attractive power will continue some time after it has been once excited. For the Attrition having caus'd an intestine commotion in the parts of the Concrete, the heat or warmth that is thereby excited ought not to cease, as soon as ever the rubbing is over, but to continue capable of emitting

Effluvia

Effluvia for some time afterwards, which will be longer or shorter according to the goodness of the Electric, and the degree of the Antecedent commotion: which joyn'd together may sometimes make the effect considerable, insomuch that in a warm day, about noon, I did with a certain body, not much, if at all, bigger than a Pea, but very vigorously attractive, move to and fro a Steel Needle freely poysed, about three minutes (or the twentieth part of an hour) after I had left off rubbing the Attrahent.

8. That it may not seem impossible, that Electrical *Effluvia* should be able to insinuate themselves into the pores of many other bodies, I shall adde, that I found them subtile enough to attract not onely Spirit of Wine, but that fluid aggregate of Corpuscles we call Smoak. For having well lighted a Wax-taper, which I prefer'd to a common Candle to avoid the stink of the snuff, I blew out the flame; and, when the smoak ascend-

14 **Of the Mechanical Engine**
ascended in a slender stream, held, at a convenient distance from it, an excited piece of Amber or a chafed Diamond, which would manifestly make the ascending smoak deviate from its former line, and turn aside, to beat, as it were, against the Electric, which, if it were vigorous, would act at a considerable distance, and seemed to smoak for a pretty while together.

9. That 'tis not in any peculiar Sympathy between an Electric and a body whereon it operates, that Electrical Attraction depends, seems the more probable, because Amber, for instance, does not attract onely one determinate sort of bodies, as the Loadstone does Iron, and those bodies wherein it abounds; but as far as I have yet tried, it draws indifferently all bodies whatsoever, being plac'd within a due distance from it, (as my choicest piece of Amber draws not onely Sand and Mineral Powders, but Filings of Steel and Copper, and beaten Gold it self)

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provided they be minute or light enough, except perhaps it be fire: I employ the word *perhaps*, because I am not yet so clear in this point. For having applied a strong Electric at a convenient distance to small fragments of ignited matter, they were readily enough attracted, and shin'd, whilst they were sticking to the body that had drawn them: But when I look'd attentively upon them, I found the shining sparks to be, as it were, cloath'd with light ashes, which, in spite of my diligence, had been already form'd about the attracted Corpuscles, upon the expiring of a good part of the fire; so that it remain'd somewhat doubtful to me, whether the ignited Corpuscles, whilst they were totally such, were attracted; or whether the immediate objects of the Attraction were not the new form'd ashes, which carried up with them those yet unextinguished parts of fire, that chanc'd to be lodg'd in them. But, as for flame, our Countreyman

16 Of the Mechanical Origin

Gilbert delivers as his Experiment, That an Electric, though duly excited and applied, will not move the flame of the slenderest Candle. Which some will think not so easie to be well tried with common Electricks, as Amber, hard Wax, Sulphur, and the like unctuous Concretes, that very easily take fire: Therefore I chose to make my Trial with a rough Diamond extraordinarily attractive, which I could, without injuring it, hold as near as I pleas'd to the flame of a Candle or Taper; and though I was not satisfid that it did either attract the flame, as it visibly did the smoak, or manifestly agitate it; yet granting that *Gilbert's* Assertion will constantly hold true, and so, that flame is to be excepted from the general Rule, yet this exception may well comport with the *Hypothesis* hitherto countenanc'd, since it may be said, as 'tis, if I mistake not, by *Kirkerus*, that the heat of the flame dissipates the *Effluvia*, by whose means the Attracti-

traction should be perform'd. To which I shall adde, that possibly the Celerity of the motion of the Flame upwards, may render it very difficult for the Electrical Emanations to divert the Flame from its Course.

10. We have found by Experiment, That a vigorous and well excited piece of Amber will draw, not onely the powder of Amber, but less minute fragments of it. And as in many cases one contrary directs to another, so this Trial suggested a further, which, in case of good success, would probably argue, that in Electrical Attraction not onely *Effluvia* are emitted by the Electrical body, but these *Effluvia* fasten upon the body to be drawn, and that in such a way, that the intervening viscus strings, which may be supposed to be made up of those cohering *Effluvia*, are, when their agitation ceases, contracted or made to shrink inwards towards both ends, almost as a highly stretch'd Lute-string does when 'tis permitted to retreat into

18 Of the Mechanical Origine

shorter Dimensions. But the Conjecture it self was much more easie to be made than the Experiment requisite to examine it. For we found it no easie matter to suspend an Electric, great and vigorous enough, in such a manner, that it might, whilst suspended, be excited, and be so nicely poised, that so faint a force as that wherewith it attracts light bodies should be able to procure a Local Motion to the whole Body it self. But after some fruitless attempts with other Electricks, I had recourse to the very vigorous piece of polish'd Amber, formerly mention'd, and when we had with the help of a little Wax suspended it by a silken thread, we chafed very well one of the blunt edges of it upon a kind of large Pin-cushion cover'd with a course and black woollen stuff, and then brought the Electric, as soon as we could, to settle notwithstanding its hanging freely at the bottom of the string. This course of rubbing on the edge of the Amber we pitch'd
upon

upon for more than one reason; for if we had chafed the flat side, the Amber could not have approached the body it had been rub'd on without making a change of place in the whole Electric, and, which is worse, without making it move (contrary to the nature of heavy bodies) somewhat upwards; whereas the Amber having, by reason of its suspension, its parts counterpoised by one another; to make the excited edge approach to another body, that edge needed not at all ascend, but onely be moved horizontally, to which way of moving the gravity of the Electric (which the string kept from moving downwards) could be but little or no hinderance. And agreeably to this we found, that if, as soon as the suspended and well rubb'd Electric was brought to settle freely, we applied to the chafed edge, but without touching it, the lately mention'd Cushion, which, by reason of its rough *superficies* and porosity, was fit for the Electrical

20 Of the Mechanical Origine

Effluvia to fasten upon, the edge would manifestly be drawn aside by the Cushion steadily held, and if this were slowly removed, would follow it a good way; and when this body no longer detain'd it, would return to the posture wherein it had settled before. And this power of approaching the Cushion by vertue of the operation of its own steams, was so durable in our vigorous piece of Amber, that by once chasing it, I was able to make it follow the Cushion no less than ten or eleven times. Whether from such Experiments one may argue, that 'tis but, as 'twere, by accident that Amber attracts another body, and not this the Amber; and whether these ought to make us question, if Electricks may with so much propriety, as has been hitherto generally supposed, be said to *Attract*, are doubts that my Design does not here oblige me to examine.

Some other *Phænomena* might be added of the same Tendency with those

those already mention'd, (as the advantage that Electrical Bodies usually get by having well polish'd or at least smooth Surfaces,) but the Title of this Paper promising some *Experiments* about the *Production* of Electricity, I must not omit to recite, how I have been sometimes able to produce or destroy this Quality in certain bodies, by means of alterations, that appear'd not to be other than Mechanical.

EXPER. I.

ANd first, having with a very mild heat slowly evaporated about a fourth part of good Turpentine, I found, that the remaining body would not, when cold, continue a Liquor, but harden'd into a transparent Gum almost like Amber, which, as I look'd for, proved Electrical.

EXPER. II.

SEcondly, by mixing two such liquid Bodies as *Petroleum* and strong Spirit of Nitre in a certain proportion, and then distilling them till there remained a dry mass, I obtain'd a brittle substance as black as Jet; and whose Superficies (where it was contiguous to the Retort) was glossie like that Mineral when polished; and as I expected I found it also to resemble Jet, in being endowed with an Electrical Faculty.

EXPER. III.

THirdly, Having burnt Antimony to ashes, and of those ashes, without any addition, made a transparent Glass, I found, that, when rubb'd, as Electrical Bodies ought to be to excite them, it answer'd my expectation, by manifesting a not inconsiderable Electricity. And this is the worthier of notice, because, that as a
Vitrum

Vitrum Antimonii, that is said to be purer than ordinary, may be made of the *Regulus* of the same Mineral, in whose preparation you know a great part of the Antimonial Sulphur is separated and left among the *Scoria*; so Glass of Antimony made without additament, may easily, as experience has inform'd us, be in part reduc'd to a *Regulus*, (a Body not reckon'd amongst Electrical ones.) And that you may not think, that 'tis onely some peculiar and fixt part of the Antimony that is capable of *Vitrification*, let me assure you, that even with the other part that is wont to flye away, (namely the Flowers) an Antimonial Glass may without an addition of other Ingredients be made.

EXPER. IV.

FOURTHLY, The mention of a Vitrified Body brings into my mind, that I more than once made some Glass of Lead *per se*, (which

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24 Of the Mechanical Origine

I found no very easie work) that also was not wholly destitute of an Electrical Vertue, though it had but a very languid one. And it is not here to be overlook'd, that this Glass might easily be brought to afford again malleable Lead, which was never reckon'd, that I know of, among Electrical Bodies.

EXPER. V.

Fifthly, Having taken some Amber, and warily distill'd it, not with Sand or powder'd Brick, or some such additament as Chymists are wont to use, for fear it should boyl over or break their Vessels; but by its self, that I might have an un-mixed *Caput mortuum*; Having made this Distillation, I say, and continued it till it had afforded a good proportion of phlegm, Spirit, Volatile Salt, and Oyl, the Retort was warily broken, and the remaining matter was taken out in a lump, which, though it had quite lost its colour being burnt

burnt quite black, and though it were grown strangely brittle in comparison of Amber, so that they who believe the vertue of attracting light Bodies to flow from the substantial form of Amber, would not expect it in a Body so changed and deprived of its noblest parts: Yet this *Caput mortuum* was so far from having lost its Electrical Faculty, that it seemed to attract more vigorously than Amber it self is wont to do before it be committed to Distillation.

And from the foregoing Instances afforded us by the Glas of Antimony, we may learn, that when the form of a Body seems to be destroyed by a fiery *Analysis* that dissipates the parts of it, the remaining substance may yet be endowed with Electricity, as the *Caput mortuum* of Amber may acquire it; as in the case of the Glas of Antimony made of the *Calx* and of the Flowers. And from the second Example above-mentioned, and from common Glas which is Electrical, we may also learn,

learn, that Bodies that are neither of them apart observed to be endowed with Electricity, may have that Virtue result in the compounded substance that they constitute, though it be but a factitious Body.

To the foregoing Experiments, whose Success is wont to be uniform enough, I shall adde the Recital of a surprising *Phænomenon*, which, though not constant, may help to make it probable, that Electrical Attractions need not be suppos'd still to proceed from the substantial, or even from the essential Form of the Attractant; but may be the effects of unheeded, and, as it were, fortuitous Causes. And however, I dare not suppress so strange an Observation, and therefore shall relate that which I had the luck to make of an odd sort of Electrical Attraction (as it seem'd,) not taken notice of (that I know of) by any either Naturalist or other Writer, and it is this.

EXPER. VI.

That false Locks (as they call them) of some Hair , being by curling or otherwise brought to a certain degree of driness, or of stiffness , will be attracted by the flesh of some persons , or seem to apply themselves to it , as Hair is wont to do to Amber or Jet excited by rubbing. Of this I had a Proof in such Locks worn by two very Fair Ladies that you know. For at some times I observed , that they could not keep their Locks from flying to their Cheeks , and (though neither of them made any use , or had any need of Painting) from sticking there. When one of these Beauties first shew'd me this Experiment, I turn'd it into a Complementary Raillery , as suspecting there might be some trick in it, though I after saw the same thing happen to the others Locks too. But as she is no ordinary *Virtuosa*, she ve-
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ry ingeniously remov'd my suspicions, and (as I requested) gave me leave to satisfy my self further, by desiring her to hold her warm hand at a convenient distance from one of those Locks taken off and held in the air. For as soon as she did this, the lower end of the Lock, which was free, applied it self presently to her hand: which seem'd the more strange, because so great a multitude of Hair would not have been easily attracted by an ordinary Electrical Body, that had not been considerably large, or extraordinarily vigorous. This repeated Observation put me upon inquiring among some other young Ladies, whether they had observed any such like thing, but I found little satisfaction to my Question, except from one of them eminent for being ingenious, who told me, that sometimes she had met with these troublesome Locks; but that all she could tell me of the Circumstances, which I would have been inform'd about, was, that they seem'd to her

to

to flye most to her Cheeks when they had been put into a somewhat stiff Curle, and when the Weather was frosty*.

* Some years after the making the Experiments about the Production of Electricity, having a desire to try, whether in the Attractions made by Amber, the motions excited by the air had a considerable Interest, or whether the Effect were not due rather to the Emission and Retraction of Effluvia, which being of a viscous nature may consist of Particles either branch'd or hookt, or otherwise fit for some kind of Cohesion, and capable of being stretch'd, and of shrinking again, as Leather Thongs are: To examine this, I say, I thought the fittest way, if 'twere practicable, would be, to try, whether Amber would draw a light Body in a Glass whence the air was pumpt out. And *though* the Trial of this seem'd very difficult to make, and we were somewhat discouraged by our first attempt, wherein the weight of the ambient air broke our Receiver, which chanced to prove too weak, when the internal air had been with extraordinary diligence pumpt out; yet having a vigorous piece of Amber, which I had caus'd to be purposely turn'd and polish'd
for

30 **Of the Mechanical Origine**
for Electrical Experiments, I afterwards
repeated the Trial, and found, that in
warm Weather it would retain a manifest
power of attracting for several minutes
(for it stirred a pois'd Needle after above
 $\frac{1}{4}$ of an hour) after we had done rubbing
it. Upon which encouragement we sus-
pended it, being first well chafed, in a
Glas Receiver that was not great, just over
a light Body; and making haste with our
Air-Pump to exhaust the Glas, when the
Air was withdrawn, we did by a Contri-
vance let down the suspended Amber till it
came very near the Straw or Feather, and
perceived, as we expected, that in some
Trials, upon the least Contact it would lift
it up; and in others, for we repeated the
Experiment, the Amber would raise it
without touching it, that is, would attract
it.

You will probably be the less
dispos'd to believe, That Electrical
Attractions must proceed from the
Substantial Forms of the Attrahents,
or from the Predominancy of this or
that Chymical Principle in them; if I
acquaint you with some odd Trials
wherein the Attraction of light Bo-
dies

dies seem'd to depend upon very small circumstances. And though forbearing at present, to offer you my thoughts about the cause of these surprising *Phenomena*, I propose it onely as a Probleme to your self and your curious Friends, yet the main circumstances seeming to be of a Mechanical Nature, the recital of my Trials will not be impertinent to the Design and Subject of this Paper.

EXPER. VII.

I Took then a large and vigorous piece of Amber conveniently shaped for my purpose, and a downy feather, such as grows upon the Bodies, not Wings or Tails of a somewhat large Chicken: Then having moderately excited the Electrick, I held the Amber so near it, that the neighbouring part of the feather was drawn by it and stuck fast to it; but the remoter parts continued in their former posture. This done, I applyed my fore-finger to these erected
 C downy

downy feathers, and immediately, as I expected, they left their preceeding posture, and applied themselves to it as if it had been an Electrical Body. And whether I offered to them my nail, or the pulpy part of my finger, or held my finger towards the right hand or the left, or directly over, these downy feathers that were near the little Quill did nimbly, and, for ought appear'd, equally turn themselves towards it, and fasten themselves to it. And to shew that the steams that issued out of so warm a Body as my finger were not necessary to attract (as men speak) the abovementioned feathers, instead of my finger, I applied to them, after the same manner, a little Cylindrical Instrument of Silver, to which they bowed and fastened themselves as they had done to my finger, though the tip of this Instrument were presented to them in several postures. The like success I had with the end of an Iron Key, and the like also with a cold piece of polish'd black Marble; and sometimes the

the feathers did so readily and strongly fasten themselves to these extraneous and unexcited Bodies, that I have been able (though not easily) to make one of them draw the feather from the Amber it self.

But it is diligently to be observ'd, that this unusual attraction happened onely whilst the electrical operation of the excited Amber continued strong enough to sustain the feathers. For afterwards, neither the approach of my finger, nor that of the other bodies, would make the downy feathers change their posture. Yet as soon as ever the Amber was by a light affriction excited again, the feather would be disposed to apply it self again to the abovementioned Bodies.

And lest there should be any peculiarity in that particular feather, I made the Trials with others (provided they were not long enough to exceed the sphere of activity of the Amber) and found the Experiment to answer my expectation.

34 Of the Mechanical Origine

I made the Experiment also at differing times, and with some months, if not rather years, of interval, but with the like success.

And lest you should think these *Phenomena* proceed from some peculiarity in the piece of Amber I employed, I shall add, that I found uniformity enough in the success, when, in the place of Amber, I substituted another Electrick, and particularly a smooth mass of melted Brimstone.

These are the *Phenomena* I thought fit to mention at present of this unusual way of drawing light bodies, and with this Experiment I should conclude my Notes about Electricity, but that I think it will not be amiss before I take leave of this Subject, to give this Advertisement, That the event of Electrical Experiments is not always so certain as that of many others, being sometimes much varied by seemingly slight circumstances, and now and then by some that are altogether over-look'd. This Observation may receive credit from some of
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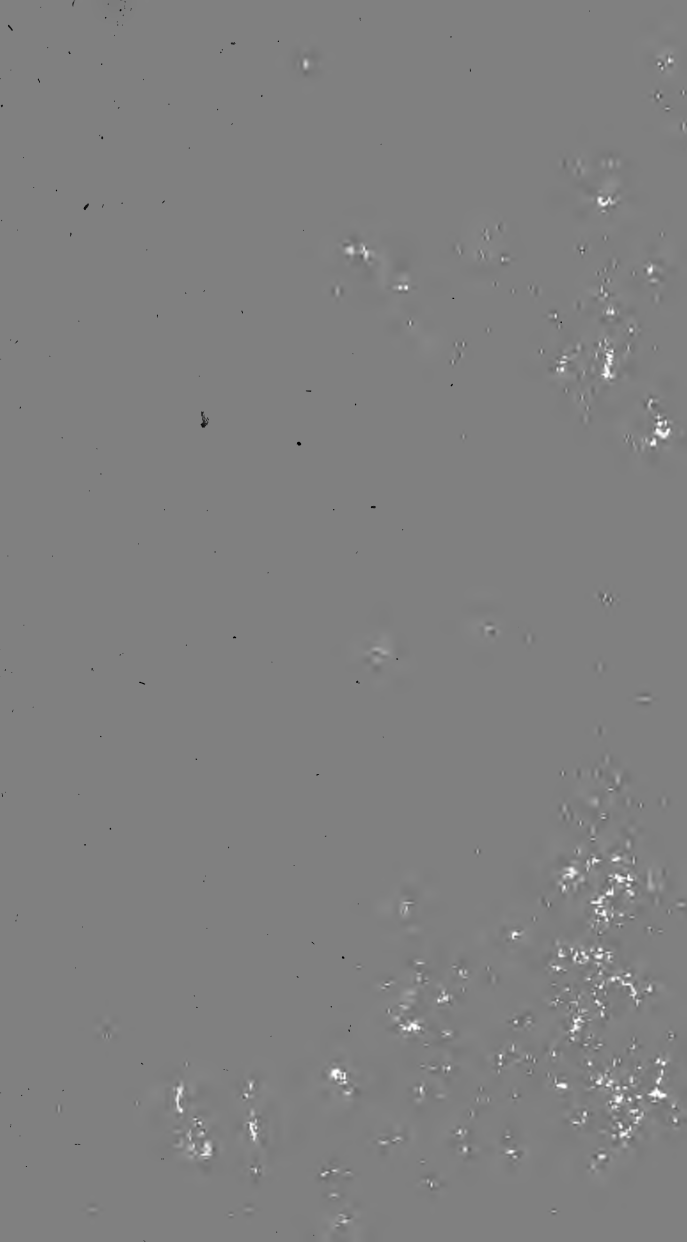
the particulars above recited (especially concerning the interest of the weather, &c. in *Electrical Phenomena*.) But now I shall add, that, not onely there may happen some variations in the success of Trials made with *Electrical Bodies*, but that it is not so certain as many think, whether some particular *Bodies* be or be not *Electrical*. For the inquisitive *Kircherus* reckons *Cryfall* among those *Gems* to whom Nature has denied the attractive power we are speaking of; and yet I remember not, that, among all the trials I have made with native *Cryfall*, I have found any that was destitute of the power he refuses them. Also a late most learned *Writer* reciting the *Electricks*, reckon'd up by our industrious *Countryman Gilbert*, and increasing their number by some observed by himself, (to which I shall now add, besides white *Saphyrs*, and white *English Amethysts*, the almost *Diaphanous spar* of *Lead Ore*) denies *Electricity* to a couple of transparent *Gems*, the *Cornelion* and the *Emerald*. And I do the less wonder he should do so to the former, because I have my self in vain tried to make any attraction with a piece of *Cornelion* so large and fair, that 'twas kept for a rarity; and yet with divers other fine *Cornelions* I have been able to attract some light bodies very manifestly,

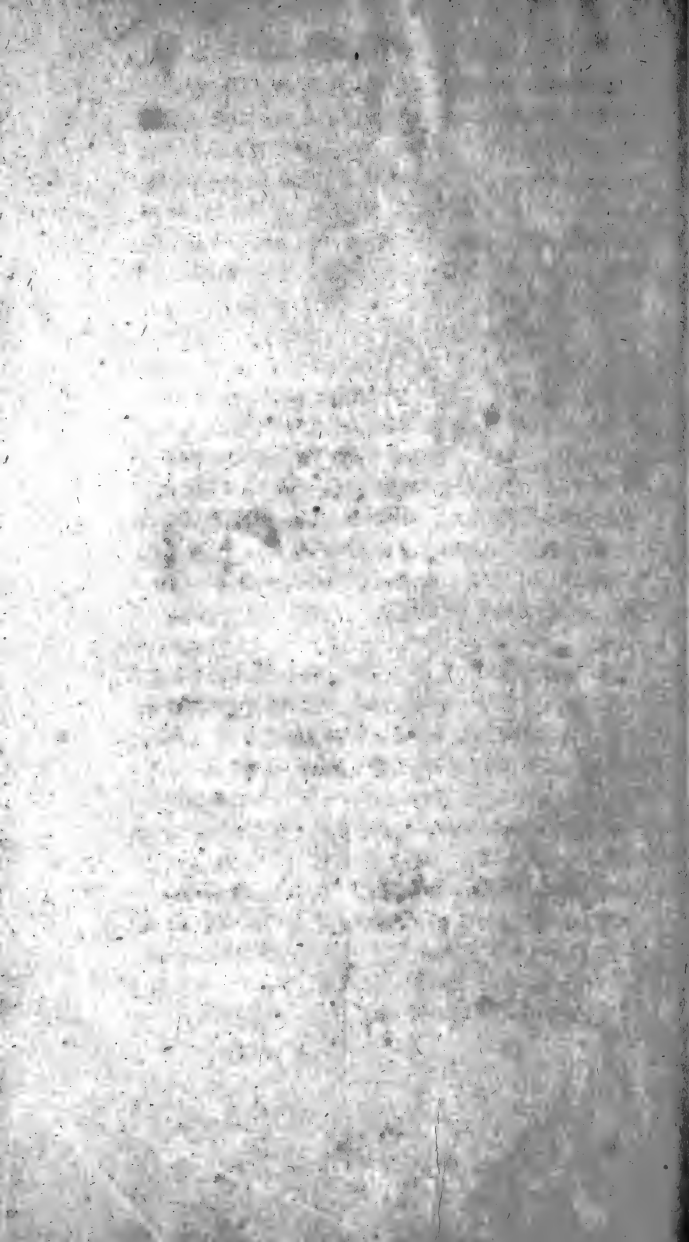
ly, if not briskly; and I usually wear a Cornelian Ring, that is richly enough endowed with Electricity. But as for Emeralds, as I thought it strange that Nature should have denied them a Quality she has granted to so many other Diaphanous Gems, and even to Crystal, so I thought the assertion deserved an *Examen*, upon which I concluded, that at least it does not universally and constantly hold true. I had indeed seen in a Ring a Stone of price and great lustre, which, though green, I found to be, (as I guess'd it would prove) vigorously enough Electrical. But this Experiment, though seemingly conclusive, I did not look upon as a fair trial, because the Stone was not a true Emerald, but, which is rare, a green Saphir. And I learned by inquiry of the skillful Jeweller that cut it, that it was so far from having the softness of an Emerald, that he found it harder than blew Saphyrs themselves, which yet are Gems of great hardness, and by some reputed second to none, but Diamonds. Without therefore concluding any thing from this Experiment, save that, if the assertion I was to examine were true, the want of an Electrical faculty might be thought a Concomitant rather of the peculiar Texture of the Emerald than of its green colour, I proceeded

to make trial with three or four Emeralds, whose being true was not doubted, and found them all somewhat, though not equally, endow'd with Electricity, which I found to be yet more considerable in an Emerald of my own, whose colour was so excellent, that by skilful persons 'twas look'd on as a rarity. And though, by this success of my inquiry, I perceived I could not, as else I might have done, shew the Curious a new way of judging of true and false Emeralds, yet the like way may be, though not always certain, yet oftentimes of use, in the estimating whether Diamonds be true or counterfeit, especially, if, being set in Rings, the surest way of trying them cannot conveniently be employed. For whereas Glass, though it have some Electricity, seems, as far as I have observed, to have but a faint one, there are often found Diamonds that have a very vigorous one. And I do not remember I met with any Electrick of the same bulk, that was more vigorous than a rough Diamond I have, which is the same that I formerly mentioned to have moved a Needle above three minutes after I had ceased to chafe it. And this brings into my mind, that it has been observed, that Diamonds draw better whilst rough, than they do after they are cut and polish'd,

38 **Of the Mechanical Origin, &c.**
polish'd; which seeming to contradict what has been observed by others and by us also, that Amber, for instance, attracts more vigorously if the surface be made very smooth than otherwise, it induces me to conjecture, that, if this Observation about Diamonds be true, as some of my trials have now and then inclined me to think it, and if it do not in some cases considerably depend upon the loss of the (Electrical) Substance of the Stone, by its being cut and ground, the Reason may possibly be, that the great rapidness with which the Wheels that serve to cut and polish Diamonds must be mov'd, does excite a great degree of heat, (which the senses may easily discover) in the Stone, and by that and the strong concussion it makes of its parts, may force it to spend its effluvia matter, if I may so call it, so plentifully, that the Stone may be impoverish'd, and perhaps also, on the account of some little change in its Texture, be rendred lesse disposed to emit those *effluvia* that are Instruments of Electrical Attraction. But as I willingly leave the matter of Fact to further Trial, so I do the Cause of it, in case it prove true, to farther Inquiry.

FINIS.

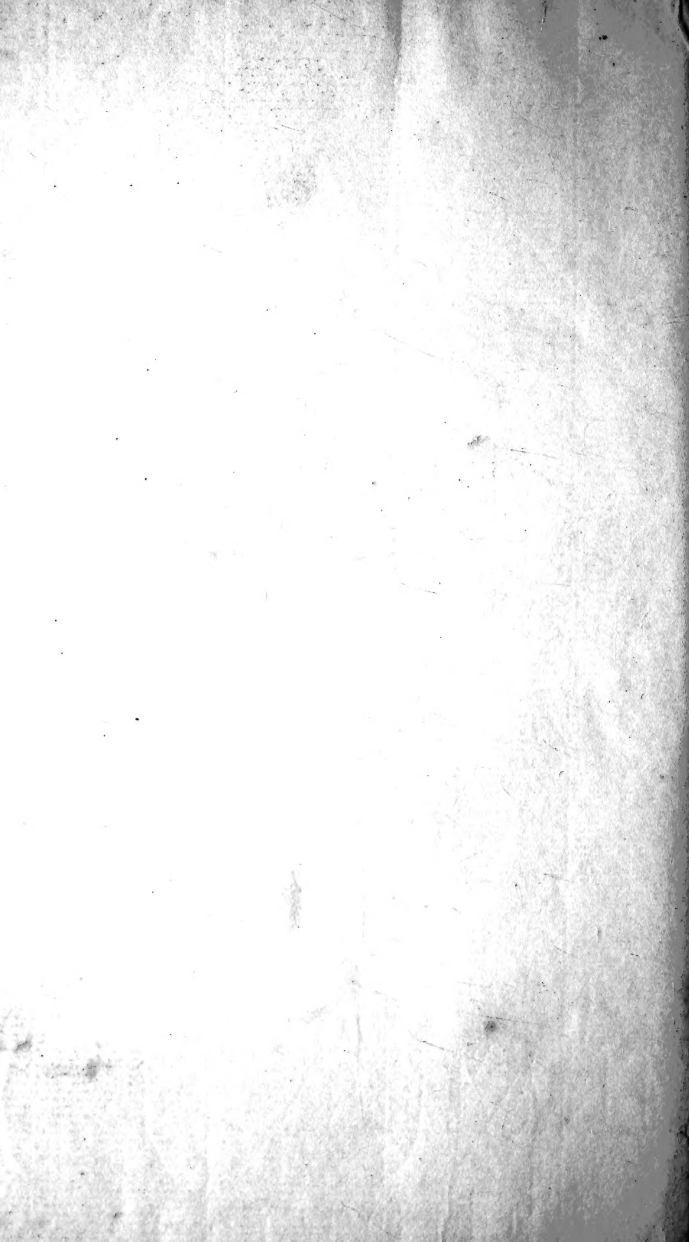












W. H. H. H.

W. H. H. H.

Dec. 14. 1878

