Experiments and observations made with a view to point out the errors of the present received theory of electricity and which tend in their progress to establish a new system, on principles more ...

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London, 1780

ETH-Bibliothek Zürich

Shelf Mark: Rar 2291

Persistent Link: https://doi.org/10.3931/e-rara-15218

Chapter XVI. Lines of resemblance between the electric fluid and elementary fire, or the particles of light.

CHAPTER XVI.

Lines of resemblance between the electric fluid and elementary fire, or the particles of light.

IN the preceding pages I have uniformly ſuppoſed the electric fluid to be elementary fire, united with a pure inflammable matter, which is the phlogiſton of the chemiſts. How far theſe ſubtle effluvia reſemble each other, may be worth an inquiry, as philoſophers have been much divided in their opinions on this head.

Whether fire be coeval with bodies, and of an abſolute ingenerable nature, or merely the effect of motion, will probably be beſt diſcovered by examining whether it has any of the properties of a body, or whether it be ſubject to any of the general laws of matter, or acts in any caſe as other bodies do.

The particles of light, or elementary fire, defined.

Pure etherial fire I take to be a ſubtle, moveable, penetrating body, originally ſuch, collected, but not produced, by friction, nor by any alteration of other bodies.

By body, in this caſe, I mean ſolid, maſſy, impenetrable particles, ſo hard as never to wear, or break in pieces; no ordinary power being able to divide what God himſelf made one in the firſt creation. See Newton's Optics, p. 375 and 376.

As the electric fluid or phlogiſton may be conſidered as an aſſociation of ſolid, hard, impenetrable particles, of different ſubftances; it may be defined, an extended folid body, of itfelf utterly paffive and inactive, indifferent either to motion or reft, but capable of any fort of motion, and of affuming any form.

1. The electric fluid, and the particles of light, are not only bodies in motion, but they may be made to give motion to other bodies by their refiftance; which is one of the properties of matter [1].

EXPERIMENT *with the folar rays.*

" Take a flender iron needle, and fuftain it on the point of " a pivot; and oppofe one end of it to the focus of a large burn- " ing glafs," fo as to crofs the pencil of rays; and the needle will be driven fwiftly round.

Boerhaave's Chemiftry by Shaw, p. 251.

EXPERIMENT *with the electric fluid.*

Take a long needle, and fuftain it on the point of a pivot fixed in a glafs ftand. Place the ftand with the needle at the end of the conductor, and oppofite to a fharp wire projecting from it. Let the point of the needle crofs the pencil of rays as they iffue from the fharp piece of wire, and take care that the needle may

[1] Beccaria's Treatife, &c. p. 239.

The electric fluid tends to explode, in every direction, the parts of the refifting fubftances through which it paffes, in an inverfe ratio to the refiftance, or force, that fupports thofe bodies in thofe directions; or, the electric fire difplaces the parts of the bodies it meets with, not by ftriking againft their furfaces, as ivory or chalk balls do in experiments on the collifion of bodies, but by traverfing, that is, by penetrating through the pores of fuch bodies, and by exerting in its paffage its expanfive force, condenfing and driving forwards what fire it finds inherent within thofe bodies, and experiencing at the fame time a re-action from them equal to its own action.

turn

turn freely on its center, without ſtriking againſt the wire. When the apparatus is thus prepared, turn the cylinder of the machine, and as the electric fluid iſſues from the end of the wire, it will drive round the needle upon the pivot with a conſiderable velocity.

If the ſolar rays, and the electric fluid, have both of them theſe properties of a body, viz. of moving, reſiſting, and giving motion, we may ſafely conclude them to be ſolid and palpable ſubſtances.

2. Fire incorporates with ſolid bodies, and increaſes their weight.

An EXPERIMENT *to prove that Fire has Weight.*

From the Academic Obſervation concerning Magnetic Affinities, by M. A. Burgman, *Profeſſor of Philoſophy in the Univerſity of* Groningen.

In anſwer to this queſtion, Whether fire be poſſeſſed of gravity? which has been much debated among modern philoſophers, we have the following trials with ſteel filings, to ſhow it increaſes the weight of metals in calcining them.

	grs.
1. An ounce, or 480 grains, of ſteel filings being put into a crucible and heated, but not all red hot, increaſed in weight — —	3
In the 2d calcination, the whole maſs having obtained a white heat, the ounce increaſed — —	34
In the 3d calcination — — —	50
In the 4th ditto — — —	18
In the 5th ditto — — —	15
In the 6th ditto — — —	7
In the 7th ditto — — —	6
In the 8th ditto — — —	9
In the 9th, in a new crucible — — —	5
In the 10th and 11th, one grain each — —	2
Total grains	149

This experiment was repeated ſeveral times with the ſame ſucceſs.

Mr. Boyle, in ſeveral experiments, does not doubt but fire and flame are poſſeſſed of gravity, and that they incorporate with other bodies, and increaſe their weight.

To obviate ſome ſcruples which might be entertained on this ſubject, he expoſed two ounces of ſteel filings in a glaſs retort over the flame of ſulphur for three hours and a half, and then taking out the melted filings with the calx, and weighing them, they acquired an addition of four grains and a half.

He repeated the ſame experiment, and, notwithſtanding the filings were expoſed to ſo thin a body as the flame of ſulphur, in a little more than three hours they acquired eleven grains and a half.

 An

An EXPERIMENT *in Electricity, with the Hydrostatic Balance, to show that the electric fluid appears to have weight.*

Place the hydrostatic balance on a stool with glass legs, with the glass bubble at one end of the beam, and the bucket at the other. Balance them with pieces of tin foil. Fix a bended wire in the conductor, to lead the electric fluid from it to the tin foil in the bucket; and, to prevent the resistance of the electric effluvia causing the bucket to preponderate, let there be a slip of tin foil hanging over the side of the bucket, so as to be in contact with the wire, that it may conduct the electric effluvia, without either a spark or a star, to the pieces of tin foil. When the apparatus is ready, turn the cylinder of the machine, and the tin foil will weigh down the glass bubble. If the bucket does not preponderate by the gravity of the electric fluid, it must by its resistance; and in either case, it proves the electric fluid to be a substance, and that it acts as other bodies do.

It is the opinion of some [a], that the phlogiston, or the electric fluid, is not only exempt from the general law of matter, but that they have a power of diminishing the specific weight of those bodies into which they enter, as a constituent part or prin-

[a] Leslie's Philosophical Inquiry into the Cause of Animal Heat, p. 201.
In the general account given of phlogiston (p. 119.) it was alledged, that it is not only exempt from the common laws of gravity, but is even possessed of a power, which we shall never be able to explain, of diminishing the specific weight of the compound into which it enters as a principle. That the electric fluid is possessed of a similar power, appears from all those experiments in which the reduction of metallic calxes is effected by it; for metals are well known to weigh more in their calcined than in their malleable state.

ciple. The Abbé Nollet's experiments are confidered as a ftrong proof in favour of this doctrine [3].

All that can be gathered by the diminution of the weight of fowls, animals, and even of men and women, after being electrified for four or five hours, is, that the electric effluvia increafed the infenfible perfpiration, and they loft many grains of their weight, by the juices paffing off through the pores of the fkin, more than they were wont to lofe when they were not electrified.

Notwithftanding moft metals, in the act of calcination, emit, by the violence of the heat, a vifible quantity of fumes, yet inftead of their becoming lighter, as it might reafonably be expected, they generally are increafed in their weight from ten to twelve pounds in each hundred weight. This excefs or augmentation of weight in metallic calcination, is not allowed by fome to arife from any addition of matter, but from a diminution, viz. by being deprived of its phlogifton [4].

They

[3] Prieftley's Hift. of Electricity, p. 136.

The Abbé chofe feveral pairs of animals of different kinds, cats, pigeons, chaffinches, fparrows, &c. All thefe he put into feparate wooden cages, and weighed them. One of each pair he electrified for five or fix hours together, and then weighed them again. The refult was, that the electrified cat was commonly fixty-five or feventy grains lighter than the other; the pigeon from thirty-five to thirty-eight grains, and the chaffinch or fparrow fix or feven grains. In order to have nothing to charge upon the difference that might arife from the temperament of the individuals he happened to pitch upon, he repeated the fame experiments, by electrifying that animal of each pair which had not been electrified before; and notwithftanding fome fmall varieties, the electrified animal was conftantly lighter than the other in proportion.

[4] See Town and Country Magazine, p. 78. a letter figned J. Cook.
See alfo Leflie's Philofophical Inquiry, p. 107.

To folve this ftrange change of gravity from the operation of fire, there is but one way offered, that I know of, but which to me is very abfurd, and fit only to be laughed at, They ſolve this phænomenon by ſuppoſing a ſubtle, elaſtic, and impelling fluid, which conſtantly acts on the groſs particles of matter, by preſſing them from the circumference to the center; and, as calcined bodies have fewer pores than they had before their calcination, it is imagined that this impulſive æther preſſes upon the ſolid parts of the body, and thereby increaſes its weight.

This doctrine, however ingenious it may appear, is abſolutely contrary to the opinion of Sir Iſaac Newton; who ſays in expreſs terms (Principia, vol. ii. p. 223.) "The weights of bo-"dies do not depend upon their forms and textures. For if "the weights could be altered with their forms, they would be "greater or leſs, according to the variety of forms in equal mat-"ter; altogether againſt experience.

"Univerſally, all bodies about the earth gravitate towards the "earth; and the weights of all, at equal diſtances from the earth's "center, are as the quantities of matter which they ſeverally "contain. This is the quality of all bodies within the reach

at; that is, that fire, as a corporal ſubſtance, adds of itſelf both bulk and weight to bodies when calcined, and to ſolid ones more abundantly.

It appears that this increaſe of gravity is wholly owing to the alteration or change of the arrangement in the conſtituent particles of the body calcined; for the heat of fire exhaling the looſer particles by ſmoke, cauſes a new change in the texture of the body while calcining, whereby the ſolid and remaining particles approach nearer, or cloſe to one another: What muſt naturally follow, but that the weight, which is always as the ſolidity, muſt certainly increaſe accordingly?

The more ſolidity groſs bodies poſſeſs, the fewer are their pores, or interſtices between their component particles; the fewer vacuities they have, the fewer open and free paſſages they afford this univerſal ſubtile fluid; the more ſolid particles it impinges, the more impreſſions or blows they receive therefrom, the more they are impelled towards the center of that ſolid body; which very action of impulſe is weight of gravity, or the very thing inquired after.

" of

"of our experiments, and therefore to be affirmed of all bodies "whatfoever. If the æther, or any other body, were either al- "together void of gravity, or were to gravitate lefs in propor- "tion to its quantity of matter; then, becaufe (according to "Ariftotle, Des Cartes, and others) there is no difference be- "twixt that and other bodies, but in mere form of matter, by "a fucceffive change from form to form, it might be changed "at laft into a body of the fame condition with thofe which "gravitate moft in proportion to their quantity of matter; and "on the other hand, the heavieft bodies acquiring the firft form "of that body, might by degrees quite lofe their gravity. And "therefore the weights would depend upon the forms of bodies, "and with thofe forms might be changed; contrary to what is "before afferted."

Thofe who argue againft this great man's reafoning, ought to be fatisfied whether light or fire be of a material fubftance; for if it be, it is poffeffed of gravity, and then it may add weight to other bodies. There are but few, I imagine, who doubt of the materiality of the elements or principles of matter. Air, water, and earth, we know, are poffeffed of gravity, and why not the corpufcles of fire?

The particles of light, like other particles of matter, may be attracted, ftopped, and turned in any direction, and they may be reflected and refracted; which is as ftrong a proof as we can wifh, that they have fubftance, and if fubftance, then weight [6].

If

[6] Newton's Optics, p. 364.

The rays of light feem to be hard bodies, for otherwife they would not retain different properties in their different fides. And therefore hardnefs may be reckoned the property of all uncompounded matter. At leaft this feems to be as evident as the universal

If the materiality of fire be granted, there will be but little difficulty in explaining the phænomenon of calcined bodies being augmented in their weight, notwithſtanding they emit viſible vapour in the crucible, while they are calcining.

As the imperfect metals are ſuppoſed to contain a conſiderable quantity of ſulphur [7], may not this inflammable matter evaporate, or be carried off by the particles of the fire? Does not the calx which remains, ſtill contain, I may ſay, an infinite number of the fiery corpuſcles, after the phlogiſton is evaporated? It is clear it does, by the heat of the calx. If a greater degree of heat be added, the calx then vitrifies, or turns to glaſs, and the weight increaſes, probably in proportion to the quantity of metal, the ſtrength of the fire, and the length of time it is kept in the act of vitrifying.

But the particles of fire are ſaid to be the moſt ſolid, and conſequently the heavieſt of all corpuſcular bodies; it is therefore a rational doctrine to ſuppoſe, that the abſorption of the fire may more than counterpoiſe the diminution of the phlogiſtic matter. Sir Iſaac Newton ſays (ſee his 3d Rule) that the argument from appearances concludes with more force for the univerſal gravitation of all bodies, than for their impenetrability;

univerſal impenetrability of matter. For all bodies, ſo far as experience reaches, are either hard or may be hardened, and we have no other evidence of univerſal impenetrability, beſides a large experience, without an experimental exception.

[7] Shaw's Boerhaave's Chemiſtry, p. 63.

The tenacity or force of coheſion in the parts of gold, which appears ſcarce leſs than infinite, depends altogether on its being freed from ſulphur; for mix but one ſingle grain of ſulphur with a thouſand grains of gold, and the maſs ceaſes to be malleable, till all the ſulphur hath been evaporated. Hence we have a ſtrong preſumption, that the leſs tenacious metals, tin, copper, and iron, contain a great deal of ſulphur.

lity; therefore, if we admit fire to be a material ſubſtance, we muſt admit it to have weight.

As the electric fluid and fire have theſe properties, to reſiſt and put in motion other bodies, and probably to increaſe their weight, we cannot fairly draw any other concluſion from our experiments, than that fire, when within the ſphere of the earth's influence, gravitates like other ſubſtances.

3. The electric fluid, and elementary fire, not only agree in being bodies in motion, and in having weight, but they are the ſmalleſt of all the known corpuſcles in nature.

This may eaſily be proved by a variety of plain and ſimple experiments.

EXPERIMENT.

Take a thin plate of the denſeſt metal, and place it perpendicularly upon a plane, where you can collect and throw the ſun's rays upon it, by the aſſiſtance of a large lens. Place your finger on the other ſide of the plate, and oppoſite to the place where the rays of light ſtrike the metal, and you will ſoon be ſenſible that the particles of light, or, which is the ſame thing, elementary fire, will penetrate it with the greateſt eaſe.

It is the ſame with the electric fluid; the moſt ſolid metals prove not the leaſt obſtruction to it.

Air, water, oils, and the moſt volatile ſpirits, may be confined in certain veſſels; but fire will eſcape in ſpight of every precaution we can take. If any liquid be heated, and confined in a glaſs veſſel, and another, filled with any cold mixture, be placed in contact with it, the heat from the warmer will flow to the colder liquid, till an equilibrium takes place.

As fire, or the ſolar particles, paſs, as well as the electric effluvia,

fluvia, (see p. 253. foregoing) through the denseſt bodies, we muſt allow them the moſt minute of any corpuſcles yet diſcovered.

Notwithſtanding the particles of the ſolar rays, while exiſting ſeparately, and in their natural ſtate, may be more pure than the phlogiſton, or the electric fluid, yet there are ſome properties in which they appear to anſwer each other.

1. Both elementary fire, and the electric fluid, may be preſent in the greateſt abundance, without any ſenſible degree of heat.

While the rays of light paſs in a parallel direction, they do not yield a heat ſufficient to thaw ſnow, in the middle of a clear day, even under the equator. This, however ſtrange, is moſt certainly true. We are told that the high mountains in the torrid zone, and even under the equator, are continually covered with ſnow, notwithſtanding the ſun is ſometimes vertical, and a greater number of fiery particles muſt ſtrike upon a given ſpace than in higher latitudes, and there cannot be any want of elementary fire.

ELECTRICITY.

If you ſaturate highly-rectified ſpirits of wine with the electric effluvia, it will not take fire, nor ſhow any ſenſible alteration in its heat, unleſs the electric fluid be collected by preſenting a conducting body near it, and then it will burſt into a flame.

I never could diſcover that the electric fluid would raiſe the quickſilver in a thermometer, by hanging it upon the conductor of the electrical machine, and condenſing the electric fluid upon it; which ſhows it may be preſent in the greateſt abundance without any ſenſible degree of heat. It is plain that electricity, in common with light, does not produce either heat or flame, unlefs its force be collected, and a proper direction given to it, and upon a fubftance proper for the purpofe.

2. But elementary fire, and the electric fluid, may be prefent in all bodies without being difcovered; for they are not feen unlefs in motion, and then they muft ftrike the eye in right lines.

This is obvious from a variety of inftances, which may be cited to prove the fact.

We know the fun is fixed in the center of our planetary fyftem, diffufing his rays around him as far as the fphere of Saturn. When the fun is beneath our horizon, he emits his rays to all the planets, and we fee them fhine with a borrowed light, when they are reflected back to us in right lines[8]; yet we fee nothing of the rays of the fun, as they are paffing through that fpace of the heavens which is to us veiled in darknefs.

If the electric fluid be condenfed on an infulated body, and a fharp needle or pin held within four or five inches of it, the electric fluid will pafs off without being feen between the point and the infulated body, notwithftanding there are an almoft infinite number of rays converging to the point, and where they all center; if the room be made dark they may be feen.

It is needlefs to multiply experiments to prove fuch facts as are known to every experimental philofopher; but it is neceffary to mention the fimilarity between the elementary fire and

[8] Gravefend's Elements, &c.

Fire entering the eye in right lines, gives a motion to the optic fibres at the bottom of the eye, and thus excites the idea of light. That light can have no other motion but a rectilinear one, appears from the ftopping or intercepting it, by a body directly interpofed between the luminary and the eye, &c.

the

the electric fluid, under different heads, that the young electrician may be made acquainted with it without reading and comparing all the authors who have wrote on this subject.

3. Notwithstanding the elementary and the electric fire, when vague and indeterminate, pass on undiscovered, yet they may be made visible not only by light but by colour. Sir Isaac Newton has demonstrably proved [a], that a ray of light consists of seven other distinct rays, *viz.* red, orange, yellow, green, blue, indigo, and violet; and each of these, for aught we know, may consist of as many rays more.

The colours may be easily exhibited, by fixing a prism against a small hole in a window-shutter, in such a position that the rays of the sun may fall upon it; and the different colours will be cast in their natural order on the opposite part of the room.

The same appearance may easily be exhibited with the electric fluid. Fix a prism parallel to the horizon in a stand, in

[a] Newton's Optics, p. 108.

If the sun's light consisted of but one sort of rays, there would be but one colour in the whole world, nor would it be possible to produce any new colour by reflections and refractions; and by consequence the variety of colours depends upon the composition of light.

If, says he, at any time I speak of light and rays as coloured, or endued with colours, I would be understood to speak not philosophically and properly, but according to such conceptions as vulgar people, in seeing all these experiments, would be apt to frame; for the rays, to speak properly, are not coloured. In them there is nothing else than a certain power and disposition to stir up a sensation of this or that colour. For as sound in a bell, or musical string, or other sounding body, is nothing but that motion propagated from the object, and in the sensorium it is a sense of that motion under the form of sound; so colours in the object are nothing but a disposition to reflect this or that sort of rays more copiously than the rest; in the rays they are nothing but the disposition to propagate this or that motion into the sensorium, and in the sensorium they are sensations of those motions under the forms of colours.

such

fuch a pofition that the electric effluvia may be feen through it while iffuing from the cylinder of the electrical machine. Let a perfon, while the cylinder is turning round, rub the middle of it with his hand; and the fire, if ftrong, will ftream down from his fingers, and give a beautiful appearance of the prifmatic colours to the perfon looking through the prifm. I had this experiment performed in the prefence of Mr. Pitt, and his fon, who were giving lectures in philofophy at this place; and they, with fome other gentlemen prefent, confeffed they never faw the feven primary colours ftronger nor clearer in their lives. Some time after I had made this experiment, I found Dr. Prieftley had attempted a fimiliar experiment, by taking the fpark at the conductor; but I apprehend this method of viewing the colours to be preferable, as it gives an opportunity of feeing them paffing in a continued ftream.

4. The particles of elementary fire, and the electric effluvia, not only agree in colour, but in motion; for their velocity exceeds all bodies on which experiments have been made. The particles of light, according to fome of our eminent philofophers, move about 980809933 feet in a fecond, and the electric effluvia are fo quick in their motions that they have hitherto baffled every attempt to afcertain their velocity [10].

It

[10] Hift. de l'Acad. A. D. 1719. c. 5.

Since the fun is diftant from the earth 24000 of the earth's femi-diameters, and the femi-diameter of the earth is 19615782 feet, according to the meafure of fome late geometricians; the diftance of the fun from the earth will be 470788768000 feet. Thefe are defcribed by light within eight minutes thirteen feconds, fo that 980809933 feet are defcribed in the fpace of one fecond. A cannon-ball fhot oft with the greateft violence defcribes 600 feet in one fecond; fo that the velocity of light will be to that of a cannon-ball as 1634683 to 1, very nearly.

Suppofe the cannon-ball to weigh 10lb. or 76,800 grains; this weight, multiplied by

It cannot be proved, that the electric effluvia move with ſo great a velocity as the particles of light; yet by the experiments which have been made, and the concluſions drawn from them, it appears that the rapidity of their motion cannot be exceeded by any known bodies, unleſs by the corpuſcular parts of light. In order to aſcertain the abſolute velocity of the electric fluid at a certain diſtance, if any, Dr. Watſon invented an apparatus for that purpoſe [11].

When bodies move at the rate of 980809933 feet in a ſecond, it is in vain for man to attempt to meaſure their velocity by any conductor he can fix up, the diſtance will be too ſmall to draw any certain concluſions from ſuch trials.

5. The electric fluid and the elementary fire, when collected, will each of them not only melt metals, but reduce them, and likewiſe other ſubſtances, to ſcoriæ, calxes, and even glaſs.

by the ſquare of its velocity gives 2672188510489 its force. If a particle of light weighed only $\frac{1}{34794121}$ part of a grain, it would have nearly the ſame force as the cannon-ball of 10lb. Since the light of the ſun ſhining upon the very tender leaves of flowers does not injure them in the leaſt, it follows, that the ſubtilty is almoſt infinitely leſs than any aſſigned part of a grain.

[11] Prieſtley's Hiſt. of Electricity, p.

Dr. Watſon, with ſeveral gentlemen, met on Auguſt 5th, 1748, at Shooter's Hill, when it was agreed to make an electric circuit of two miles, by ſeveral turnings of the wire in the ſame field. The middle of this circuit they contrived to be in the ſame room with the machine, where an obſerver took in each hand one of the extremities of the wires, each of which was a mile in length. In this excellent diſpoſition of the apparatus, in which the time between the exploſion and the ſhock might have been obſerved to the greateſt exactneſs, the phial was diſcharged ſeveral times, but the obſerver always felt himſelf ſhocked at the very inſtant of making the exploſion. Upon this the gentlemen were fully ſatisfied, that, through the whole length of the wire, which was 12276 feet in length, the velocity of the electric matter was inſtantaneous.

The

The effects of the ſun's rays on certain bodies placed in the focus of a large reflecting mirror, are ſo well atteſted by gentlemen of veracity, that we cannot doubt the truth of them. Dr. Harris and Dr. Deſaguliers relate the following things of Villette's mirror, *viz.*

A ſilver ſixpence is melted in — —	7″ 30‴
A King George's halfpenny in — —	16
It runs with a hole in — —	34
Tin melts in — — —	3
Caſt iron in — — —	16
A foſſil ſhell calcines in — —	7
A piece of Pompey's pillar, in the black part, vitrifies in — — — —	50
In the white part in — — —	54
Bones calcine in — — —	4
Vitrify in — — — —	33

The aſbeſtos vitrifies, as all other bodies will do, if kept a ſufficient time in the focus.

From ſeveral experiments which have been made at ſundry times, and by different perſons, the diſcharge of an electric battery ſeems to act with as much power upon metals as the ſolar rays when reflected by a mirror.

Dr. Franklin (Letters, p. 67.) ſays, "We melted gold, ſilver, " and copper, in ſmall quantities, by the electrical flaſh.

" A ſlip of leaf-gold, or Dutch metal, cut in narrow ſtrips, " and placed between two ſmooth pieces of glaſs, and placed " in the circuit, the metal appeared not only to have been " melted, but vitrified, or otherwiſe ſo driven into the pores " of the glaſs as to be protected by it from the action of the

 " ſtrongeſt

" ſtrongeſt aqua-fortis, or aqua-regia." The Abbé Nollet, with three large jars, melted iron wire 16 parts of a line thick; and the ſmall globules, he ſays, were like the pieces which fall upon white paper, when you ſtrike with a flint againſt a ſteel; they conſiſt of iron nearly reduced to a ſtate of ſcoriæ.

He farther adds, that copper, tin, lead, and iron, are by the electric ſpark reduced to ſcoriæ, to calxes, and even to glaſs.

Mr. Canton, ſays Dr. Prieſtley, in his Hiſtory of Electricity, p. 647. has ſince clearly proved the calcination of pure gold and ſilver, by the heat of electric exploſions, producing numberleſs moſt beautiful globules of tranſparent glaſs, and alſo others tinged with all the variety of colours from thoſe metals. He has alſo made it probable, that the black duſt, mentioned in this ſection, is the calx or glaſs of the metal, reduced to ſmaller particles than the laws of optics to produce colours.

I know that ſome philoſophers conteſt the reality of the vitrification of gold, and as I have never accompliſhed it myſelf, I reſt the matter upon the experiments performed with Villette's and Iſchirnhauſen's mirrors, and Mr. Canton's and ſome other electricians machines.

6. But the electric fluid, and the elementary fire, not only produce ſimilar effects in melting and calcining metals; they alſo act nearly the ſame on the animal ſyſtem, and the vegetable creation, by accelerating the motion of the blood, and of the ſap in trees, plants, and flowers.

Though we do not perhaps know how animal heat is generated, and kept up to a certain degree above the temperature of the circumambient air; yet it is certain that elementary fire is the primary cauſe of the motion of the blood. Every animal expoſed to a very cold air, will loſe ſome of his natural heat,

heat, and if the cold be intenſe the circulation will grow languid, and in a little time the body will become ſtiff and motionleſs. Fire can render the moſt ſolid bodies fluid; and by the want of it the moſt fluid bodies become ſolid. Hence it is obvious all motion depends upon a certain degree of heat.

Electricity communicated to inſulated perſons for a conſiderable time, *viz.* good part of an hour, promotes perſpiration, and quickens the motion of the blood: I have ſeen this in more inſtances than one.

A poor girl about 15 years of age, of an hereditary ſcrophulous habit, loſt the uſe of her right ſide by a ſtroke of the palſy. She was alſo deprived of her taſte, her ſmell, her ſpeech, and her ſenſes were very much impaired by the ſtroke. After the common methods of treating ſuch diſorders had been tried without any ſucceſs, the gentleman who attended her was deſirous of ſeeing what electricity would do; as there were no hopes of relief from medicines. We began to electrify her on the 28th of June 1778, and though we were not ſucceſsful in our attempt, it may be of ſome ſervice to communicate each day's operation, and the ſymptoms which appeared, as it may encourage others to try, who, with better ſubjects, may have more ſucceſs.

June 28th. The patient being placed upon a ſmall table with glaſs legs, and connected by a chain to the conductor, we drew ſparks for an hour, and gave her 20 ſhocks from a large jar about half charged.

EFFECTS.

She had a very weak, languid pulſe, the lame ſide cold, her eyes very thick, and ſhe took but little notice of any thing.

June

June 29th. The patient being inſulated, we drew ſparks from different parts of the lame ſide three quarters of an hour, and gave her 30 ſhocks.

EFFECTS the ſame.

June 30th. We drew ſparks for an hour and a quarter, and gave her 40 ſhocks, with the ſtrength of the ſhocks increaſed one fifth.

EFFECTS.

After drawing ſparks from the lame ſide ſome time, and giving the patient ſeveral ſhocks, the arm and leg began to grow warm; her pulſe was rather quicker than it had been; ſhe raiſed her hand about half-way up to her mouth, and ſtraightened two of her fingers, which ſhe had not been able to move ſince ſhe firſt received the ſtroke.

July 1ſt. The ſame operations as on the preceding day, only, as the weather was very rainy, and the electricity rather weak, we gave her forty ſhocks.

EFFECTS.

After receiving ſeveral ſhocks, a natural warmth diffuſed itſelf quite over the affected limbs; ſhe raiſed her hand to her breaſt, lifted up her foot, her ſenſes were quicker than they had hitherto been, and ſhe endeavoured more to ſpeak, but did not articulate many words.

July 2d. This day we drew ſparks as uſual, for an hour and a half, and gave her 50 ſhocks.

EFFECTS.

E F F E C T S.

When the patient was firſt placed upon the board, the arm, leg, and foot of the lame ſide were cold; ſhe appeared quite ſtupid, and much worſe than on the preceding day. After receiving 17 or 18 ſhocks, the natural warmth returned, ſhe ſpake ſeveral words, and appeared quite revived.

July 3d. Repeated the ſame number of ſhocks as on the preceding day, and drew ſparks from the lame ſide, in different parts, for an hour.

E F F E C T S.

The patient, notwithſtanding it was only the ſixth day, ſo far recovered the uſe of the muſcular part of her neck, as to ſupport her head, and turn it with eaſe, after it had laid upon her right and lame ſhoulder near ſeven weeks, unleſs it was ſupported by a ſtay.

She ſhook her head, to expreſs her diſapprobation to the ſhocks, and with ſome difficulty ſpake ſeveral words. Before we finiſhed giving her the ſhocks, a kindly warmth ſucceeded, attended with a gentle perſpiration and a chearful countenance.

July 4th. Gave the patient 60 ſhocks, but not above one third ſo ſtrong as uſual, and continued, with drawing of ſparks, near two hours.

E F F E C T S.

When the patient was brought into the room ſhe appeared very ill, her lips and face were pale, her eyes thick, and ſhe was very drowſy; after about 20 ſhocks the drowſineſs went off,

5

off, and ſhe began to ſpeak, and was very chatty, but not very intelligible; her caſe became an intermitting one, one day better than another.

July 5th. The operations the ſame as uſual.

EFFECTS.

The patient much better, the contractions conſiderably abated, ſhe almoſt extended her arm, ſpake ſeveral words, and knew every one in the room.

July 6th. Continued the operations for an hour, but gave her only 30 ſhocks, and they much weaker than uſual.

EFFECTS.

To-day the patient was very ill, pulſe ſlow and weak, very drowſy, and could neither move hand nor foot when brought into the room. After a few ſhocks, the warmth returned into her lame ſide, the veins filled, and ſhe had 100 pulſations in a minute. In other reſpects ſhe was much the ſame.

July 7th. This day we gave her only 12 weak ſhocks, and drew ſparks about half an hour.

EFFECTS.

When we drew ſparks from the arm, the patient, for the firſt time, rubbed it up and down with her well hand, as if ſhe felt a pricking in it. After receiving a few ſhocks from the ſhoulder to the fingers, ſhe had ſeveral ſpaſms in her arm; but ſhe could not ſpeak plain enough to inform us what pain ſhe felt, therefore we deſiſted for this time.

July 8th. Only drew ſparks for half an hour.

EFFECTS.

The patient was quite ſenſible when brought into the room, and ſeemed to be under terrible apprehenſions at the ſight of the electrical machine. She trembled very much. Every ſpark drawn from a tendon put her fingers in motion, which were generally bent inward; and ſhe had the uſe of her arm from the ſhoulder to the elbow.

As the patient was ſo much terrified at the ſight of the electrical machine, we, out of tenderneſs to her, continued two or three days only drawing ſparks for an hour; but from the time we left off giving ſhocks, we loſt ground conſiderably; the contractions and the ſtupor increaſed; and, as there was but little or rather no hope of ſucceſs, we gave over all farther trial. In a few days ſhe was quite an idiot, loſt all uſe of her lame ſide, and in about a month ſhe died.

If the patient had been of a good habit of body, there is ſome reaſon to conclude, by the effects which the ſhocks and the drawing of ſparks produced, that by perſeverance ſhe might have been reſtored; but in all ſuch caſes it requires patience and time.

I have, in ſeveral inſtances, ſucceeded in rheumatiſms in a few days; and ſometimes the firſt half-dozen ſhocks have been found ſufficient in recent complaints.

As every thing which tends to relieve the ſufferings of mankind is intereſting to the public, I ſhall mention in this place a very ſingular caſe of a child, which was ſuppoſed to have loſt the uſe of his legs and thighs by a fever.

A fine healthy boy was taken with a fever about the time he was expected to begin to prove the uſe of his legs, and after his recovery from it, upon trying him to walk, they found him incapable of ſtanding, and they ſuppoſed the fever fallen in his legs. His friends had all the advice they could procure of the faculty; they tried every noſtrum, hot and cold bathing; but inſtead of growing better, his legs were worſe. At the age of four years and a half his legs were waſted and cold, they ſeldom had any natural warmth; the circulation was very languid, and they both felt and looked like a periſhing limb. The right leg was very much contracted, the muſcles and tendons rigid and hard; while the left leg was relaxed, neither could he even move his toes. In this ſituation he was brought to me to be electrified, by the advice of a ſurgeon; as they had already tried every thing they could think of without the leaſt effect, electricity was preſcribed among the reſt. I was apprehenſive, upon firſt ſeeing of him, there might be ſome defect in the ſpine, which cauſed a palſy in the lower extremities; and, notwithſtanding it appeared to be a loſt caſe, at the entreaties of his friends, I began with him, without the leaſt hopes of ſucceſs. As his legs were waſted and cold, I firſt drew ſparks from different parts of his legs, to endeavour to quicken the circulation; and this I continued near an hour every day, and gave him five or ſix weak ſhocks with a two-ounce phial from his back down each leg. This was continued 12 or 14 days, without any perceivable alteration; but by perſevering, in about a month the circulation increaſed, his legs acquired a natural warmth, and we had ſome hopes. As the tendons of his right leg were conſiderably

ſiderably contracted, I drew ſparks from the places where they were the moſt rigid and hard; and in a little time they began to relax, his legs grew, and gained ſtrength. In about two months I brought his right leg ſtraight, and he could ſupport himſelf, with a little aſſiſtance, upon it; and there was every favourable ſymptom I could wiſh. Notwithſtanding his left leg grew, it did not gain ſtrength like the other, nor could I, by drawing of ſparks, ever gain the point to make him move the toes of his left foot, while he was brought to me. I cannot offer any reaſon why the parents of the child thought proper to diſcontinue the operations; but I ſhall always think, if they had been purſued, the child would have had one leg reſtored, at leaſt, but probably both, as his legs began to fill up and feel firm.

I make not the leaſt doubt, by the little experience I have had in applying electricity to remove obſtructions and contractions, but that it will in general be found ſalutary, eſpecially if the patient be young, and has reſolution to continue the operation, in obſtinate diſorders, once a day for ſeveral weeks.

The elementary, and the electric fire, not only quicken the circulation in the human fabric, they alſo promote it in vegetation.

That the concurrence of heat is neceſſary in the vegetable creation, is obvious both from the foreſt and the field, the orchard and the garden. In the autumn, when the heat of the ſun is gradually upon the decline, we ſee its effects upon the plants remitted, and vegetation ſlackens by degrees. Its failure is firſt diſcernible in lofty trees, which require a more intenſe heat to raiſe the water charged with nouriſhment to their tops, than the humble ſhrub. For want of heat, they loſe their nouriſhment and ſhed their leaves. As the heat returns the ſucceeding spring, they all recruit again, and are furnished with new verdure. Those which require the least degree of heat to raise the water, with the phlogistic matter, vegetate, blossom, and bear fruit very early in the spring. A constant succession follows, and the teeming earth clothes in their best attire every plant, shrub, and flower, from the creeping bramble to the towering oak.

Invariable experience has taught us that vegetation is impeded, or hastened, in proportion to the heat of the sun; and different climates show us how necessary heat is to promote the circulation of the juices in plants. In high northern latitudes, at Greenland and Iceland, there is but little herbage, a few low stunted shrubs, but no trees; while in warmer climates large and thick woods are produced.

If we can depend upon the experiments of Mr. Maimbray, the Abbé Nollet, and several others, the electric fluid, as well as the elementary fire, promotes vegetation, by communicating motion to the sap of shrubs and flowers [12].

[12] Priestley's History of Electricity, p. 135.

Mr. Maimbray electrified two myrtle-trees during the whole month of October, 1746, when they put forth small branches and blossoms sooner than other shrubs of the same kind which had not been electrified.

The Abbé Nollet, considering all organized bodies as assemblages of capillary tubes, filled with a fluid, concluded that the electric matter might communicate motion to the sap of vegetables; he therefore took two garden-pots, filled them with the same kind of earth, and sowed them with the same kind of seeds. He kept them constantly in the same place, and took the same care of them, except that one of the two was electrified, fifteen days together, for two or three, and sometimes four hours a day. The consequence was, that the electrified pot always shewed the sprouts of its seeds two or three days sooner than the other. It also threw out a greater number of shoots, and those longer in a given time; which made him believe that the electric virtue helped to open and display the germs, and thereby to facilitate the growth of plants.

But

But the elementary fire, and the electric fluid, not only produce similar effects on animals and vegetables, by accelerating the motion of the blood and sap, by the stimulus they accumulate in those fluids, but they likewise augment the evaporation of liquids, where they are open to the atmosphere.

That the ascent of vapour is promoted by heat, and the rays of the sun have a powerful influence over the watery particles, to raise them in the atmosphere, is evident by liquids evaporating faster in a hot than in a cold season, more in the day than in the night. All heat rarifies bodies, and cold condenses them. Hence it follows, that the liquid particles which are passing into a state of solution in a hot summer's day, are frequently condensed by the cold of the evening, and return in drops upon the plants and flowers, in what we call dew [13].

Electricity has been found, by many accurate experiments, to augment the natural evaporation or solution of all fluids, except mercury, which is too heavy, and the oil of olives, which is too viscous, to suffer any diminution of their particles, like volatile spirits or liquids, which fly off from the main bulk with a small degree of rarefaction. Electrical evaporation will be greater in a square vessel, than in a round one, because the electric effluvia collect in the angles of such vessels, and pass off in streams, car-

[13] Hugh Hamilton's Essay on the Ascent of Vapours, p. 46.

Heat promotes, and cold in some measure stops or checks, both solution and evaporation. Very hot water will dissolve salt sooner, and in a greater quantity, than cold water; and if a strong solution of salt be made in hot water, the water when cold will let go some of the salt before dissolved, which will fall to the bottom in small particles, or shoot into crystals. Just so will water evaporate faster in warm than in cold air; and the aqueous vapours suspended in the air during the heat of the day, fall down at night, and form themselves into drops of dew; or, if the night be very cold, appear next morning crystalized in a hoar-frost.

rying

rying a larger proportion of the fluid with them, than when they are equally diſperſed over the ſurface of circular veſſels.

The following obſervations are the reſult of a ſet of experiments made by the Abbé Nollet on electric evaporation [14].

1. Electricity tends to promote the evaporation and ſolution of all liquids; for all fluids which were tried, ſuffered a diminution both of bulk and weight, which could not be aſcribed to any other cauſe than the diſſipating of the watery particles by the electric fire.

2. The electric fluid augments the evaporation of volatile ſpirits, ſuch as ſpirits of ſal ammoniac, more than ſpirits of wine; and this ſuffers a greater loſs than common water, and water more than vinegar, or the ſolution of nitre.

3. The electric fluid acts with more power on liquids contained in metal veſſels, than in glaſs.

4. Electricity does not force the particles of fluids through the pores, either of metal or glaſs; notwithſtanding, it has been aſſerted by ſome, that it ſo divides odorous ſubſtances, that their exhalations penetrate glaſs as eaſily as the magnetic particles.

Thoſe who do not chuſe to take any thing upon the word of another, may eaſily ſatisfy themſelves with regard to the evaporation of fluids, by procuring a few electricity cylindrical tin veſſels, about two inches deep, and filled with water up to their brims, and accurately weighed; if, after being electrified ſeveral hours, they are weighed again, and found to be diminiſhed in their weight, it is reaſonable to conclude they have ſuffered a diminution of their particles by evaporation.

8. Beſides the foregoing affinities, the particles of light, or elementary fire, and the electric effluvia, are attracted by other bodies.

[14] The Abbé Nollet's Recherches, p. 327.

It has been proved by repeated trials, that the rays of light, in their paſſage near the edge of bodies, whether opake or tranſparent, as pieces of metals, the edges of knives, broken glaſſes, and many other ſubſtances, are diverted out of the right lines, and always inflected or bent towards other bodies.

This action of bodies on light is found to exert itſelf at a ſenſible diſtance, though it always increaſes as the diſtance is diminiſhed, as appears very ſenſibly in the paſſage of a ray between the edges of two thin planes at different apertures; in which there is ſomething very peculiar, the attraction of one edge being increaſed as the other is brought nearer it [15].

An electric pencil of rays paſſing from a point, or the edge or angle of a veſſel, may be made to inflect either upwards, downwards, or ſideways, accordingly as you place the edge of the knife to receive it, as it is paſſing from the point, and the action of the knife will be ſtrongeſt at the leaſt diſtance. If the edge of the knife be placed too near, the pencil of rays will collect, and paſs off in a ſpark.

EXPERIMENT.

Screw a ſmall metal rod, ſix or ſeven inches long, more or leſs, into the end of the conductor, with a ſharp point to the projecting end of it. At a convenient diſtance, to be fixed on

[15] See Newton's Optics, p. 300, &c.

From the experiments and obſervations mentioned in the preceding pages, he aſks, p. 313, Do not bodies act upon light at a diſtance, and by their action bend its rays; and is not this action (cæteris paribus) ſtrongeſt at the leaſt diſtance?

Are not the rays of light, in paſſing by the edges and ſides of bodies, bent ſeveral times backwards and forwards, with a motion like that of an eel? And do not the three fringes of coloured light ariſe from three ſuch bendings?

by trial, place the edge of a knife upon a conducting ſtand, rather below the level of the point of the wire. When your apparatus is properly adjuſted, if you turn the cylinder, and cauſe a pencil of rays to paſs off from the point of the metal rod, the pencil of rays will be inflected, or bent downward. If it be fixed above the point, the pencil will be bent upward, and ſhow that the action of bodies on an electric pencil of rays, is ſimilar to the action of bodies on a ray of light. An electric pencil of rays may be made to converge, diverge, or to paſs from one body to another in direct lines, accordingly as you vary your apparatus. If a blunted metal point be fixed in the end of the conductor, and another point of the ſame ſize be fixed near it, to receive the pencil of rays, the electric fluid will paſs from point to point in ſtraight lines; as may be ſeen in a dark room, if the electricity be ſtrong.

If the point which received the pencil of rays be taken away, and a metal knob fixed in its place, then the rays will diverge, and ſpread upon the ſurface of the knob.

If you remove the blunted metal rod from the conductor, and fix any circular metal cup, of about two inches diameter, upon a wire in the end of the conductor, and let the ball be fixed at a proper diſtance, but pointing to the center of the cup; if you turn the cylinder, the rays iſſuing from the rim of the cup will then converge and enter the ball, and paſs away by the ſtand which ſupports it.

If there be neither knob, nor point, nor any thing elſe placed near the pencil of rays to attract them, the rays will then diverge, and be diſſipated in the air; which is a clear proof that bodies act upon the electric fluid ſimilarly to their acting on the rays of light.

9. But

9. But bodies not only act upon the rays of light and electricity; for the electric and the solar rays may be made to act forcibly upon bodies, as may be seen by their setting fire to gunpowder, and some volatile and inflammable matter.

It is well known that the rays of the sun, collected by a good lens, will not only produce a fusion of metals, as has been already shown, but they will set fire to gunpowder, and any combustible matter placed in the focus of the glass.

Electricity will produce the same effect. There are a variety of methods of firing gunpowder by electricity; but as the following is attended with but little trouble, I have chose it in preference to the rest.

Fill the tube of a quill with gunpowder, and stop up each end of the tube with a bit of cork. Insert two wires, one at each extremity, so that their ends within the quill may be about one fifth of an inch from each other. This done, send the charge of a jar through the wires, by forming a communication between the outside and inside of the jar; and the spark passing between the ends of the wires in the quill, will set fire to the gunpowder.

If the gunpowder be mixed with steel filings, it may be fired with a small jar.

The great similarity there is between light, phlogiston, and the electric fluid, has led electricians to suppose they are only different modifications of the same principle.

I cannot help remarking here, that if the electric fluid be solar fire (and that it is so is highly probable) what must become of the favourite hypothesis, viz. that glass will not admit the electric effluvia through its pores? when glass is one of the best transparent compositions yet discovered, to let the rays of light pass through it[16].

It may be worth while, for those who have time and opportunity to pursue this kind of amusement, to compare the action of bodies on the electric fluid and elementary fire, and vice versa, through every possible case where they can be compared; I flatter myself they would find that their actions could only be accounted for from the affinity of their principles.

As I am in pursuit of truth, and am neither prejudiced to my own, or any philosopher's hypothesis, any farther than as it appears to me to be consistent with the laws of nature, and the reason of things, I cannot conclude this chapter without starting an objection, which may appear on the first view to overthrow the whole of what I have advanced, to show that the sun is the source of elementary fire, as well as of the phlogiston and the electric fluid.

We are informed in the Mosaic account of the creation, that the earth was without form and void, and darkness was upon the face of the deep, and the spirit of God moved upon the face of the waters. And God said, Let there be light, and there was light. And God saw the light, that it was good; and God divided the light from the darkness. And God called the light day, and the darkness he called night: and the evening and the morning were the first day.

[16] Philos. Trans. 1778. part ii. p. 134.

Mr. Henly says, " As the rays of the sun, concentered by a powerful burning-" glass, will produce a fusion of metals, and instantly reduce a number of substances " presented to the focus to a calx; as the same effect is in many cases produced by a " stroke of lightning; and as the colours of the electric fluid and solar light are equally " divisible by the prism; is there not a high degree of probability in the supposition, " that light, fire, phlogiston, and electricity, are only different modifications of one " and the same principle?"

Here

Here light is created before the ſun. This has led ſome to ſuppoſe [17], that as light was antecedent to the ſun, it muſt not only be

[17] Nature Diſplayed, vol. iii. p. 409. 3d edit.

Light is viſibly pre-exiſtent to luminous bodies. This may ſeem a paradox at firſt ſight, but it is not therefore a leſs evident truth.—By light we do not mean that ſenſation which we experience in ourſelves, on the preſence of any illumined body, but that inconceivably ſubtle matter, which makes an impreſſion on the organs of ſight, and paints on the optic nerve thoſe objects, from the ſurface of which it was reflected to us. Light then, taken in this ſenſe, is a body quite different from the ſun, and independent on it, and might have exiſted before it, ſeeing now it does exiſt in its abſence, as well as when preſent. It is diffuſed from one end of the creation to the other, traverſes the whole univerſe, forms a communication between the moſt remote ſpheres, penetrates into the inmoſt receſſes of the earth, and only waits to be put into proper motion, to make itſelf viſible. Light is to the eye what the air is to the ear. Air may not improperly be called the body of ſound, and it does equally exiſt all round us, though there be no ſonorous body to put it in motion; ſo likewiſe the light does equally extend at all times from the moſt diſtant fixed ſtars to us, though it then only ſtrikes our eyes, when impelled by the ſun, or ſome other maſs of fire.

The difference betwixt the propagation of ſound and light, conſiſts in this, that the air, which is the vehicle of ſound, being beyond all compariſon more denſe than the vehicle of light, its motion is much ſlower. Hence we may account for that common phænomenon, why we do not hear the ſound of the firſt ſtroke of a hammer, when at a diſtance from it, till it is at the point of giving the following blow; whereas light is propagated with incredible ſwiftneſs, though at ſome ſmall diſtance of time between its receiving the impulſe, and its communicating it to us; ſeven minutes, according to Sir Iſaac Newton's calculation, being ſufficient from the fixed ſtars down to us. This difference of velocity between the progreſſive motion of light, and that of ſound, is ſenſibly demonſtrated by firing a gun in a large open plain, where the ſpectator, at a great diſtance from it, will perceive the flaſh a conſiderable time before he hears the noiſe. The body of light, therefore, does either exiſt independently of the luminous body, and only waits to receive a direct impulſe from it, in order to act upon the organs of viſion; or we muſt ſuppoſe that every luminous body, whether it be the ſun, a candle, or a ſpark, does produce this light from itſelf, and project it to a great diſtance from its own body. There is no medium between theſe two be a diſtinct ſubſtance from all other, as much as air is from water; but they conſider it as an intermediate fluid, which fills the whole univerſe, and, without changing its place, by a ſucceſ-

two ſuppoſitions, and either the one or the other muſt be true. But, to aſſert the latter, is to aſſert a very great improbability; for if a ſpark, which is ſeen in every part of a large room, fifty cubic feet in dimenſions, emits from its own ſubſtance a quantity of light ſufficient to fill the whole room, then there muſt iſſue from that ſpark, which is but a point, a body, the contents of which are fifty cubic feet. How incredible the ſuppoſition!

Suppoſe the lanthorn on the light-houſe of Meſſina to be ſeen only eight cubic leagues, of which itſelf is the centre; it will follow, that an eye placed in any point of thoſe eight cubic leagues will diſcern it, and, conſequently, ſo much ſpace will be filled with the light of it. Now, how incredible, that a little fire, ſome few inches in diameter, ſhould diffuſe round it a ſubſtance capable of filling eight cubic leagues!—Suppoſe the lanthorn concealed, and the light immediately diſappears; let it be uncovered the moment after, and it will inſtantly be ſeen as far as before, and conſequently fill eight cubic leagues of ſpace with freſh light; then how many times eight cubic leagues of luminous matter will all the ſucceſſive inſtants of illumination produce in one night's time? Sure nothing was ever more inconceivable!

On the contrary, how ſimple and natural is it to ſuppoſe, that, as the air exiſted before the bell that put it in motion, and cauſed it to vibrate into ſound, ſo, in like manner, the light exiſted round the fire of Meſſina, before the lanthorn was illuminated, and only waited to be put in motion by the fire, in order to make an impreſſion on the eyes of the mariners? The ſun and ſtars do, by the ſame means, make themſelves viſible, without ſuffering any diminution of their ſubſtance, by continual emanations of luminous matter into thoſe vaſt regions of ſpace through which they behold them; God having placed between thoſe luminous globes and us, the body of that light which we ſee, and which is impreſſed on the organs of viſion by their action and influence; but does not proceed from them, nor owe its exiſtence to them.—The account of Moſes, therefore, as to this particular, is agreeable to truth, as well as a uſeful leſſon of caution, when he informs us, that God, and not the ſun, was the author and parent of light, and that it was created by his almighty fiat before there was a ſun to dart it upon one part of the earth, and a moon to reflect it on the other.

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ſive, though extremely ſwift impulſe, conveys the action of the ſun to the moſt remote part of our planetary ſyſtem.

By this theory, the ſun is conſidered no more than the exciter of light, as it whirls on its axis; and the Newtonian ſyſtem, which ſuppoſes it the ſole ſource of light and heat, by emitting particles from its body, is intirely exploded.

I cannot conceive, for my own part, that the Moſaic account of the creation (to which I pay the higheſt veneration) leads us to draw any ſuch concluſion; nor does it in my opinion contradict the Newtonian ſyſtem of light and colours.

On the firſt day of the creation, Moſes ſays, the Almighty created the light; that is, as I underſtand it, he formed the particles of light, ſolid bodies, and divided them from the darkneſs. They were ſeparated from the rude indigeſted heap of matter, and had a place allotted them in infinite ſpace, and probably round their Creator, as he is light, and in him is no darkneſs.

The light thus created, and placed by itſelf, might remain during the three firſt days of the creation like an atmoſphere in the upper regions of ſpace, while the Almighty was preparing the firmament, by ſeparating the waters from the waters, collecting them together for the ſeas, and forming the globe of earth, with every tree, plant, ſhrub, and flower, which grows thereon. As ſoon as the firmament was prepared, and the vegetable creation ſpake into being, Infinite Wiſdom prepared the ſun to cheriſh and preſerve, with his prolific rays, the vegetable world. God ſaid, "Let there be lights in the firmament in the heaven, to divide the day from the night; and "let them be for ſigns, and for ſeaſons, and for days, and for

" years.

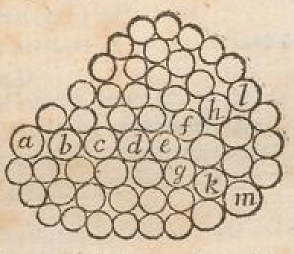
"years. And God made two great lights, the greater light to "rule the day, and the leſſer light to rule the night; he made "the ſtars alſo." Does this account of the creation by Moſes imply, that when the Almighty made not only the ſun, which is placed in the center of our planetary ſyſtem, but alſo other ſuns to other ſyſtems, that he made them of a different ſubſtance, or nature, or with different properties from the light which he created on the firſt day? He might collect that light into large, denſe, and compact bodies, and place them in the center of different ſyſtems, to diffuſe their kindly influence to every thing which has life, breath, and being. It is certain, that Infinite Wiſdom does nothing in vain, and more is vain when leſs will ſerve.

If the light which was created the firſt day would, when collected into a cloſe, denſe, and compact body, enlighten the different planets in our ſolar ſyſtem, and warm and cheriſh the various and almoſt infinite objects in the animal and vegetable world, there could be no occaſion to create ſuch an immenſe body as the ſun, different in its nature and properties from the light already formed. We cannot collect from the Moſaic account of the creation, that after the formation of the heavens and the earth, that the light immediately intermixed with the air, and filled every part of the univerſe; for it appears to have been ſeparate and diſtinct from all other matter, 'till the ſun was made: as ſoon as this immenſe body of light and heat was placed in the center of the ſolar ſyſtem, it began to diffuſe its ſalutary rays as far as the orb of Saturn, and to enlighten and cheriſh every thing placed in the intermediate ſpace. As no particle of matter formed by the hand of the Creator can ever be be annihilated, it is reaſonable to conclude, that the phlogiſton, or the electric fluid now found impriſoned in all bodies, is derived immediately from the ſun. The ſimilarity there is between the electric fluid and light, ſeems to confirm this ſuppoſition, and appears to me more reaſonable, than to ſuppoſe light an intermediate fluid, which fills the univerſe, and that by an exceſſive, though extremely ſwift preſſure, conveys the action of the ſun to the eye, as the air does that of ſound to the ear.

But the doctrine of an intermediate fluid being acted on by impulſes from the ſun, appears to contradict the known and eſtabliſhed laws of light; which has been proved by Newton [18] to move in direct lines; and a preſſure is not propagated through a fluid in rectilinear directions, unleſs where the particles of the fluid lie in right lines.

To enter any farther into this ſubject would carry me far

[18] Newton's Principia, vol. ii. Propoſition 41. p. 163.



If the particles *a*, *b*, *c*, *d*, *e*, lie in a right line, the preſſure may be indeed directly propagated from *a* to *e*; but then the particle *e* will urge the obliquely-poſited particles *f*, and *g*, obliquely, and thoſe particles *f*, and *g*, will not ſuſtain this preſſure, unleſs they be ſupported by the particles *h*, and *k*, lying beyond them; but the particles that ſupport them, are alſo preſſed by them; and thoſe particles cannot ſuſtain that preſſure, without being ſupported by, and preſſing upon, thoſe particles that lie ſtill farther, as *l*, and *m*, and ſo on in finitum. Therefore the preſſure, as ſoon as it is propagated to particles that lie out of right lines, begins to deflect towards one hand and the other, and will be propagated obliquely in finitum; and after it has begun to be propagated obliquely, if it reaches more diſtant particles lying out of the right line, it will deflect again on each hand; and this it will do as often as it lights on particles that do not lie exactly in a right line. Q. E. D.

Cor. If any part of a preſſure, propagated through a fluid from a given point, be intercepted by any obſtacle, the remaining part, which is not intercepted, will deflect into the ſpace behind the obſtacle.

beyond my firſt deſign; I ſhall therefore cloſe this treatiſe with aſſuring the candid and inquiſitive reader, that I am ſo far from requiring implicit belief to what I have offered, that I deſire every part may be fairly examined; and if I have been deceived myſelf, either in making my experiments, or in the concluſions drawn from them, I ſhall readily acknowledge any errors pointed out to me.

THE END.