ARTICLES omitted.

ELECTRICITY *(Cycl.)*—A body in which *electricity* may be excited by ſome action upon that body, as rubbing, patting, or warming it, and ſometimes only expoſing it to cold and dry air, after it has been covered, is called an *electric per ſe:* ſuch are glaſs, cryſtals, and pretious ſtones; reſins, gums, ſulphur, ſealing wax, and moſt dry parts of animals, as ſilk, hair, and the like.

Electrics per ſe are alſo called original *electrics*.

A *non-electric per ſe* or ſimply a *non-electric*, is a body in which *electricity* cannot be excited by any action upon the body itſelf; or at leaſt one in which that property, if at all, is very ſlightly perceptible. Of this kind are wood, animals, living or dead, vegetable ſubſtances, water and metals.

But *non-electrics* receive *electricity*, when brought near to *electrics per ſe*, in which *electricity* has been excited.

In order to know that *non-electrics* have received the communicated *electricity*, they muſt be inſulated; that is, they muſt not be ſuſpended from, or ſupported by any bodies, but what are *electrics per ſe:* for if one *non-electric* be touched by another, and this by a third, *&c.* all the *electricity* received by the firſt will go to the ſecond, and from this to the third *&c.* till at laſt it be loſt upon the ground. But if ſeveral *non-electrics* touching one another, are at laſt terminated by *electric* bodies, in that reſpect they make but one body, and receive and retain *electricity* for ſome time. However it muſt be obſerved, that bodies ſlightly *non-electric*, ſuch as dry wood, may ſerve for ſupporters to thoſe bodies which are very highly *non-electric*, as metals.

Electricity may be communicated to *non-electrics* by applying a glaſs tube or globe, excited by friction, to one end of thoſe bodies; and there are ſeveral ways of finding when the *non-electrics* have received the *electricity*. Thus, if an iron bar be ſuſpended horizontally by two ſilken ſtrings that are very dry, and the rubbed tube be applied, or brought near to one of the ends of the bar, and then ſome leaf-gold, or leaf-braſs, or any other light bodies, placed upon a ſmall ſtand, or a plate, be brought near the other end, they will be alternately attracted and repelled by the bar. Likewiſe, if the finger be brought near the end, or other part, of the bar, the *electrical* effluvia will give a very ſenſible and ſometimes painful ſtroke, with a ſnapping noiſe, and produce a flaſh of light. If the communicated *electricity* ſhould prove too faint to be tried this way, a ſmall flaxen thread, ſuſpended by a ſtick, may be brought near the body that has been *electrified*; and if the *electricity* has been communicated, even in a ſmall degree, the thread will be attracted without deſtroying the *electricity* received by the body till after ſome time. This thread Doctor Deſaguliers calls the *thread of trial.*

It is to be obſerved, that an *electric per ſe* does not receive this virtue from another *electric per ſe*, though excited, till it is become a *non-electric*; which happens when it is made wet or moiſt; and then it will be made *electric* only by communication. *Electric* bodies, in which it is difficult to excite *electricity*, may be looked upon as *non-electrics*, when their *electricity* is not excited; and then they will be in the ſame condition as *non-electrics per ſe*, and be liable to receive *electricity* by communication in the ſame manner.

From what has been ſaid, it appears that *non-electrics* are conductors of *electricity*. Water conducts it very well, but metals are the moſt convenient conductors.

Theſe things being premiſed, we ſhall here add ſome of the principal phænomena of *electricity*; that is, ſuch as ſeem to give ſome light towards a theory of this wonderful property of bodies.

1. When the *electricity* of a glaſs tube has been excited by rubbing, if you move your fingers long-wiſe from one end of the tube to the other, but without touching it, you will hear a continued ſnapping, like a diſtant noiſe of thorns burning; and if the room be darkened, you will ſee ſparks of light wherever the tube ſnaps; and likewiſe a light following the hand that rubs the tube.

2. A down feather being tied to the top of a wooden broach or ſkewer, of about ſix or ſeven inches in height, and fixed upright upon a foot, if you bring the excited tube near it, all the fibres of the feather ſtretch out towards the tube; but as ſoon as you remove the tube, the fibres of the feather turn back, and ſtick ſtrongly to the ſkewer. If you bring your finger near to the feather, while its fibres are tending towards the tube, the finger will repel them; but as ſoon as you remove the tube, they are attracted by the finger. If you cover the feather with a very dry glaſs recipient, ſuch as is uſed on the air-pump, the tube will attract the feather in the ſame manner through the glaſs: and this happens, even when the recipient has been exhauſted of its air by the pump. When the tube is rubbed near the recipient, whether it be full of air or empty, the fibres of the feather follow the motion of the hand along the tube, ariſing upon the broach or ſkewer.

3. Without making uſe of the tube, if you rub the recipient that covers the feather with both hands, the fibres of the feather will ſtretch themſelves out towards the glaſs, like the rays of a ſphere. If you rub but with one hand, the fibres will ſtretch themſelves towards that part of the glaſs which is rubbed; and when you blow againſt the glaſs, thoſe fibres will be repelled, notwithſtanding the interpoſition of the glaſs: which happens alſo, when you ſtrike the air with the hand towards the feather, without touching the recipient.

4. After the tube has been rubbed, if any aſſiſtant lets go a down feather in the air, at the diſtance of a foot or two from the tube, the feather will jump towards the tube with an accelerated motion, and adhere to it for ſome time; and then of a ſudden it will be repelled from the tube, and will fly about the air in ſuch manner, that the nearer you bring the tube to it, the more it will be repelled, till it has touched ſome other body; and then it will be drawn again by the tube; which after ſome time will drive it away again. Sometimes, when the finger is held at eight or ten inches from the tube, the feather will jump from the tube to the finger, and from the finger to the tube, thirty or forty times together.

5. If a ſtring of any kind be ſtretched horizontally, and from the ſtring you hang a thread of ſilk about three foot long, and very dry, and to the lower end of that thread you faſten a down feather; then, at the diſtance of about two or three feet, you hang up another feather, but by a flaxen thread; the rubbed tube being brought near will attract the firſt feather, which, when it has adhered to it a little while, will fly from the tube, and then be repelled by it every time the tube is brought near, till it has touched ſome other body, as in the preceding experiment, and then it will be attracted anew. But the feather, which is ſuſpended by the flaxen thread, will always be attracted at the approach of the tube, and never repelled. And if you wet the ſilken thread, the feather hanging at it will be repelled no more, but always attracted by the tube.

6. If you make uſe of a tube which is hermetically ſealed at one end, and has at the other end a braſs ferril with a ſcrew, by which means the air may be pumped out of it; if you rub the tube, after the air is exhauſted, it does not attract any more, as has already been taken notice of in the Cyclopædia, N° 7; nor does the tube give the light before mentioned, N° 2, but it gives much more light within. Then if, by opening the cock a little way which is faſtened to the tube, the air be let in ſlowly, while the tube is rubbed, the light diminiſhes; and being interrupted by the air, as it comes in, looks like lightning at a diſtance, till all the air is come in, and then there is no more light within; but the light goes all to the outſide, and the attraction returns.

7. If two ſmall boards, or two ſmall octavo books, be ſet edge wiſe, parallel to each other, and about the diſtance of ten inches aſunder, upon a ſtand of ſeven or eight inches diameter; little pieces of leaf gold, or braſs, laid upon the ſtand between thoſe boards, will not be attracted by the rubbed tube held near them, till it be brought quite between the ſaid boards, as near to the ſtand as half the diſtance of the boards from each other: that is, when the tube is ſo held, that a circle deſcribed round the axis of the tube, with the diſtance that is between that axis and the ſtand, paſſes between the boards or books without touching them. But when the rubbed tube being held horizontally, at the diſtance of a foot from the ſtand, ſeems to have no virtue, becauſe the leaf-gold has no motion, if an aſſiſtant ſnatches away the boards, all on a ſudden the pieces of gold will be attracted and repelled ſeveral times, without giving any new friction to the tube.

8. When the air is very dry, and the rubbed tube can attract the leaf-gold laid on a ſmall ſtand, to the diſtance of three foot or beyond; if the ſame leaf-gold be laid upon a table, or any large ſurface, the excited tube muſt be brought very near before it can produce its effect.

9. When the air is moiſt, the experiment, N° 4, does not ſucceed well: for after the feather in the air has been ſome time driven about by the tube, it comes back of itſelf to the tube, without having touched any other body; and ſometimes after having adhered to the tube, towards the middle of it, it flies off from it, and comes again immediately to the tube, ſticking to that part of it which is fartheſt from the hand. It happens alſo, when the air is very dry, and the tube repels the feather, after having attracted it, to the diſtance of two or three feet, that if you wet the top of the tube at the end, for the length of ſix or ſeven inches, the feather will come and ſtick to that end of the tube, without having touched any other body.

10. Having filled with water a ſmall drinking glaſs, of about an inch diameter, when you bring the rubbed tube near it, the water riſes in a little hill, accumulated at the edge of the glaſs; ſometimes jumping towards the tube in a little jet, ſo ſmall that you can hardly ſee it, though you may find the tube wholly wet with it. One may alſo obſerve, that this accumulated water riſes in the ſhape of a ſmall cone, whoſe axis is ſometimes ſtretched out horizontally towards the tube, then ſnaps and falls down again flat upon the reſt of the water. If this experiment be made in the dark, a flaſh of light accompanies the ſnapping.

11. If by means of an artificial fountain, in which air is condenſed upon the water to make it ſpout, you play a ſmall jet, of about the fortieth part of an inch diameter, upwards or downwards; the rubbed tube being brought near, the jet will bend towards the tube at the diſtance of a foot; and if the tube be brought nearer, the jet being wholly drawn away by the tube, is changed into a dew upon the tube, ſo that it adheres to the tube in little drops, provided the jet be not made to ſpout with too much force.

12. If a packthread or hempen ſtring be ſtretched horizontally to the length of about twelve hundred feet, at the end of which is ſuſpended an ivory ball of about an inch and an half in diameter; this ball will draw and repel leaf-braſs, or leaf-gold, when the rubbed tube is brought near the other end of the ſtring, and the thread of trial being brought near to the ball, is attracted by it.

In this experiment the ſupporters of the ſtring muſt be *electrics per ſe*, whether they be hair-ropes, fiddle-ſtrings, or cat-guts, ribbons, ſtrings of ſilk, glaſs tubes, long bodies of ſulphur or of reſin, *&c.* and all theſe bodies muſt be very dry. If the ſtring be wet, the experiment will ſucceed the better.

This experiment was, we believe, firſt made by the late Mr. Stephen Gray; and it might be improved, by employing an iron wire inſtead of a packthread or hempen ſtring. When an iron wire is uſed, its ſupporters might be wooden ſticks, being *non-electrics* in a ſlighter degree, as before obſerved; but *electrics* are beſt.

The conductor of *electricity*, in theſe and the like caſes, need not be ſtretched at length, but may be carried backwards and forwards in parallel or other lines, provided they be not placed too near to each other, but at a proper diſtance, as, for inſtance, three feet.

13. If two or three iron bars be ſuſpended in the ſame horizontal line, at the diſtance of ſix inches from one another, the *electricity* communicated by the rubbed tube to the end of one of the bars will go on from the one to the other quite to the end of the laſt bar, where a pricking will be felt, a noiſe heard, and a flaſh of fire ſeen. If the air is dry, the *electricity* will jump from one bar to another at a greater diſtance; but in moiſt weather, the bars muſt not hang at above an inch diſtance from each other.

Theſe experiments may be made with a glaſs tube, about three foot and an half long, an inch and an half in diameter, and about $\frac{1}{12}$ of an inch thick, open at both ends, but ſometimes hermetically ſealed at the end fartheſt from the hand. Theſe proportions are not neceſſary, but only convenient for the hand; and the glaſs of the tube ought not to be leſs than $\frac{1}{12}$ of an inch in thickneſs; for when thinner, the *electricity* is indeed ſooner excited by friction, but it does not laſt ſo long as when the tube is thicker. See *Deſaguliers*'s Diſſertation concerning *Electricity*, in his Experim. Philoſ. Vol. II. p. 316. ſeq.

The Doctor obſerves with Monſieur du Fay, that there are two ſorts of *electricity*, a reſinous, and a vitreous kind. One of the experiments, upon which this difference is eſtabliſhed, is as follows.

14. If a down feather be ſuſpended by a ſilken thread, as in the experiment N° 5, ſealing-wax, well rubbed, will produce the ſame effect as the tube, but more weakly, drawing the feather; and when once it is ſeparated from the wax, the wax repels it continually, till the feather has touched ſome other body. But the difference here is, that when the feather is in a ſtate of repulſion, in reſpect of the wax, the rubbed tube attracts it; and when the tube has given the feather its repulſive ſtate, then the rubbed wax attracts it: which ſhews, according to theſe gentlemen, that the *electricity* of glaſs is different from the *electricity* of ſealing-wax; and the like may be obſerved of other reſinous ſubſtances.

But, perhaps, this phænomenon may be accounted for, by ſuppoſing, as the truth is, that the *electrical* power of excited glaſs is ſtronger than that of ſealing-wax, and then from Mr. Ellicott's hypotheſis, hereafter mentioned, the phænomenon follows.

Doctor Deſaguliers has deduced from his experiments, that bodies which are *electric per ſe*, being excited to *electricity*, repel all other bodies that have *electricity*, but attract them as ſoon as they have loſt their *electricity*; and ſo *vice verſa*. Theſe deductions agree very well with Mr. Ellicott's mentioned below.

The Doctor conjectures alſo, that the particles of pure air are *electric* bodies, always in a ſtate of *electricity*; and that vitreous *electricity*, and from this *electricity* of the air, he conjectures, ingeniouſly, that the riſe of vapours may depend upon *electricity*. See the Diſſertation before cited.

To theſe experiments related, among others, by Dr. Deſaguliers, we muſt add from Mr. Ellicott [a], that when the tube, N° 1, is ſtrongly excited, ſparks will not only iſſue from it in ſtreams while it is rubbing, but will continue to dart out from it for a conſiderable time after the rubbing has ceaſed, and a very ſtrong offenſive ſmell will be perceived.—[a Several Eſſays towards diſcovering the Laws of *Electricity*, Lond. 1748.]

15. The ſame gentleman obſerves, that if a ball (of cork ſuppoſe, for lightneſs) be hung by a ſilk line, and the excited tube is applied to it, it will not only be attracted, but will have an attractive quality communicated to it from the tube; and if any light bodies are brought near the ball, they will be attracted by it.

16. As the tube, when ſtrongly excited, will not only attract, but afterwards repel any light bodies brought near it, in like manner the cork-ball will be endued with the ſame property; ſo that a ſmaller ball will firſt be attracted towards it, and then repelled from it, in the ſame manner as the leaf-gold in the beforementioned experiments; and on touching any other body, it will be again attracted; and this may be repeated ſeveral times, provided the ſmaller ball is much leſs than the larger one. But the effect will conſtantly grow weaker and weaker; becauſe every time the leſſer ball is attracted, it carries off with it ſome of the *electric* virtue, and is likewiſe endued with the ſame properties as the larger ball.

Mr. Gray, Monſieur du Fay, and others have obſerved, that this *electrical* quality is not only to be excited in glaſs, but in moſt ſolid bodies capable of friction, metals excepted; though in ſome it will ſcarce be ſenſible. And this *electrical* power is found to be ſtrongeſt in wax, reſins, gums and glaſs. And as glaſs is the eaſieſt procured of a proper form, it has generally been uſed in making theſe experiments. It has been further obſerved, that thoſe bodies, in which the *electrical* quality is capable of being excited the ſtrongeſt by friction, will receive the leaſt quantity of it from any other excited body, and therefore are properly made uſe of to ſupport any body deſigned to receive the *electrical* virtue. The truth of this will ſufficiently appear from the following experiments.

17. Two lines, one of ſilk, and the other of thread, being hung up, (as in the experiment, N° 5.) that of thread will be attracted by the tube at a much greater diſtance than the ſilk. If a feather, or other light body, be faſtened to each ſtring, and if the tube be brought to the feather faſtened to the ſilk, it will not only be firſt attracted and then repelled, as has been ſaid N° 5, but by the virtue communicated to the feather from the tube, the ſeveral fibres of the feather will ſtrongly repel each other. On the contrary, the feather faſtened to the thread will be ſtrongly attracted by the excited tube, and not repelled, the virtue paſſing off by the thread it is hung to. If a glaſs ball is hung to the ſilk line, it will be but weakly attracted by the tube; but one of cork or metal will be ſo much more ſtrongly.

18. Let a rod of iron be ſuſtained by ſilk lines, and by means of a glaſs ſphere (which can be more regularly and conſtantly excited than a tube) be made *electrical*, it will be found to have all the properties of the excited tube firſt mentioned. A ſtream of light will come from the end of it, if it is pointed. It will attract, repel, and communicate this virtue to any other *non-electric* body. On the approach of a *non-electric*, a ſpark of fire, with a ſnap attending it, will come from it; which ſpark will be greater or leſs, as the bodies approaching it have more or leſs of the *electrical* quality reſiding in them; and there will likewiſe be the ſame offenſive ſmell as was obſerved of the glaſs tube.

19. Let a rod of iron, pointed at one end, be ſuſpended on ſilk lines, as in the laſt experiment, and by the ſphere be made *electrical*. When the rod is ſtrongly *electrified*, a ſtream of light in diverging rays will be ſeen to iſſue from its point; and if any *non-electric* body is held a few inches from the point, the light will become viſible to a greater diſtance; and if the *non-electric* body is likewiſe pointed, a light will ſeem to iſſue from that in diverging rays, in the ſame manner as from the *electrified* rod. But if the *non-electrical* body is flat, and held at the ſame diſtance from the rod as the pointed one was, no light will be ſeen to come from it. It is alſo to be obſerved, that the effluvia from the end of the *electrified* rod ſtrike againſt the hand or face, brought near to that end, like a blaſt of wind.

20. If the *non-electric* body, whether flat or pointed, be brought nearer to the end of the rod than in the laſt experiment, there will be a ſmall ſtream of light produced, reaching quite from the *electric* to the *non-electric* body; and if brought ſtill nearer, there will iſſue a ſpark, attended with a ſmall ſnapping noiſe, which will be ſucceeded by others at equal intervals; and if the *non-electric* is held at ſome diſtance from the ſide of the rod, the point of it will frequently appear luminous, but no part of the *electrified* rod will be ſo. If it is brought nearer, there will likewiſe be

ſparks produced, at nearly equal intervals from each other, which will ſometimes appear as iſſuing from the ſide of the *electrified* rod, at others, as coming from the *non-electric*.

21. Take two plates of metal, very clean and dry, whoſe ſurfaces are nearly equal; hang one of them horizontally to the *electrified* rod, and bring under it, upon the other, any thin, light body, as leaf-ſilver, *&c.* when the upper plate is made *electrical*, the ſilver will be attracted by it; and if the under plate is held at a proper diſtance, will be perfectly ſuſpended at right angles to the plates, without touching either of them; but if they are either brought nearer together, or carried farther aſunder, the leaf-ſilver will ceaſe to be ſuſpended, and will jump up and down between them. The ſame effect will be produced, if you reverſe the experiment, by *electrifying* the bottom plate, and ſuſpending the other over it. See Mr. *Ellicott*'s Eſſays before mentioned.

22. By the experiments made in Germany, and repeated in England by Mr. Watſon, it appears, that ſpirit of wine may be ſet on fire by the power of *electricity*. This will ſucceed not only with the etherial liquor, or phlogiſton of Frobenius, and rectified ſpirit of wine, but even with common proof ſpirit. But all theſe muſt be warmed a little, ſo as to emit an inflammable vapour.

And the experiment ſucceeds equally well, whether an *electrified* perſon, or other *electrified* body, be brought near the not *electrified* ſpirit; or whether the *electrified* ſpirit be brought near a *non-electric* body.

This laſt method of firing the ſpirit is ſaid, by Mr. Watſon, to be done by the repulſive power of *electricity*. And the former, where the not *electrified* ſpirit is fired by its being brought near to a man ſtanding upon a cake of wax, or to a ſword, or bar of metal, ſuſpended by ſilk lines, is ſaid to be performed by the attractive power of *electricity*. Of theſe two kinds, the repulſive power has generally been found the ſtrongeſt.

23. Not only ſpirits of wine, but alſo ſal volatile oleoſum, dulcified ſpirit of nitre, Peony water, Daffy's elixir, Helvetius's ſtyptic, and ſome other mixtures, where the ſpirit has been very conſiderably diluted, may be fired by the power of *electricity*; and ſo may diſtilled vegetable oils, as that of turpentine, lemon, orange peels, juniper, and even thoſe which are ſpecifically heavier than water, as oil of ſaſſafras; alſo reſinous ſubſtances, ſuch as balſam capivi and turpentine; all which ſend forth, when warmed, an inflammable vapour. The inflammable vapour, produced by putting an ounce of filings of iron, an ounce of oil of vitriol, and four ounces of water into a Florence flaſk, may be fired by the ſame means; as may alſo gunpowder, if ground with a little camphor, or with a few drops of ſome inflammable chemical oil. To increaſe the ſurpriſe, theſe ſubſtances may be fired by ice, or by a drop of water, only thickened a little with the ſeeds of fleawort.

All theſe experiments have ſucceeded, though not always in damp weather, with a glaſs tube rubbed by the hand merely; but if a greater *electrical* force be excited, by means of a globe, theſe experiments will ſucceed in any weather, though not with equal eaſe.

24. If ſome oil of turpentine is ſet on fire in any veſſel, held in the hand of an *electrified* man, the thick ſmoke that ariſes therefrom, received againſt any *non-electric* of a large ſurface, held in the hand of a ſecond man ſtanding upon an *electrical* cake; this ſmoke will, at a foot diſtance from the flame, carry with it a ſufficient quantity of *electricity*, for the ſecond man to fire any inflammable vapour. The *electrical* ſtrokes have been likewiſe perceptible upon the touching the ſecond man, when the *non-electric* held in his hand has been in the ſmoke of the oil of turpentine between ſeven and eight feet above the flame. Here we find the ſmoke of an original *electric*, a conductor of *electricity*.

25. Likewiſe, if burning ſpirit of wine be ſubſtituted in the place of the oil of turpentine, and if the end of an iron rod, in the hand of the ſecond man, be held at the top of the flame, this ſecond man will kindle other warm ſpirits held near his finger. Here we find, that flame conducts the *electricity*, and does not perceptibly diminiſh its force. The like is to be obſerved of red-hot iron; and of the coldeſt mixtures that art can produce.

26. Of all the ſurpriſing phænomena of *electricity*, none ſeems to be more ſo, than the extraordinary accumulation of the *electrical* power in a phial of water, firſt diſcovered by Profeſſor Muſchenbroek of Leyden. The experiment is this: a phial of water is ſuſpended to a gun-barrel by a wire let down a few inches into the water through the cork; and this gun-barrel, ſuſpended in ſilk lines, is applied ſo near an excited glaſs globe, that ſome metallic fringes, inſerted into the gun-barrel, touch the globe in motion. Under theſe circumſtances a man graſps the phial with one hand, and touches the gun-barrel with a finger of the other; upon which he receives a violent ſhock through both his arms, eſpecially at his elbows and wriſts, and acroſs his breaſt. The experiment ſucceeds beſt *cæteris paribus*, 1°. when the air is dry. 2°. When the phial, containing the water, is of the thinneſt glaſs. 3°. When the outſide of the phial is perfectly dry. 4°. In proportion to the number of points of *non-electric* contact. Thus if you hold the phial only with your thumb and finger, the ſnap is ſmall; larger when you apply another finger, and increaſes in proportion to the graſp of your whole hand. 5°. When the water in the phial is heated, which being then warmer than the circumambient air, prevents the condenſation of the floating vapours therein upon the ſurface of the glaſs.

A gun-barrel is not neceſſary in theſe experiments; a ſword, or any other ſolid piece, or tube of metal, is equally uſeful. Mr. Watſon has given us many curious obſerva ions relating to this experiment, and has varied it a great many ways. Among other things he obſerves, that the phial may be *electrified* by applying the wire therein to the globe in motion; after which, if it is graſped in one hand, and the wire touched with a finger of the other, the ſtroke is as great as from the gun-barrel. And if you graſp the phial with your hand, and do not at the ſame time touch the wire, the acquired *electricity* of the water is not diminiſhed. So that, unleſs by accident or otherwiſe the wire is touched, the *electrified* water will retain its force many hours, may be conveyed ſeveral miles, and afterwards exert its force upon touching the wire.

To prove Mr. Watſon's aſſertion that the ſtroke is *cæteris paribus*, as the points of contact of *non-electrics* to the glaſs, Dr. Bevis wrapped up two large round bellied phials in very thin lead ſo cloſe as to touch the glaſſes every where, except their necks. Theſe were filled with water, and corked, with a ſtaple of ſmall wire running through each cork into the water. A piece of ſtrong wire about five inches long, with an eye at each end, was provided, and at each end of this, hung one of the phials of water by the ſmall ſtaple running through the cork. A ſmall wire loop was then faſtened into the lead at the bottom of each phial, and into theſe loops was inſerted a piece of ſtrong wire like the former. If then theſe phials were hung acroſs the gun-barrel and *electrified*, and a perſon ſtanding upon the floor touched the bottom wire with one hand, and the gun-barrel with the other, he received a moſt violent ſhock through both his arms and acroſs his breaſt. The *electrical* exploſion has been ſince vaſtly increaſed. But Mr. Watſon is of opinion, that the violence of the exploſion of the *electric* force accumulated in the glaſs, is not ſo much owing to the quantity of *non-electrical* matters contained in the glaſs, as to the number of points of *non-electrical* contact within the glaſs, and the denſity of the matter conſtituting thoſe points, provided this matter be in its own nature a ready conductor of *electricity*. For a cylindrical glaſs jar blown very thin, of ſixteen inches in height, and eighteen inches in circumference, having been covered both within and without with leaf-ſilver to within an inch of its top, the exploſion from this jar was equal to that from three glaſſes, each about ſeventeen inches in height, and four in diameter, and filled with fifty pounds of leaden ſhot each. The exploſion in theſe caſes is ſo violent as to become dangerous; and has been found mortal not only to ſmall birds, but even to a rat; and Mr. Franklin killed a well-grown turkey with it.

27. A very conſiderable *electrical* exploſion may be made from a plate of glaſs thus: Let a thin plate of glaſs of about a foot ſquare, be covered on both ſides with leaf-ſilver; and make this adhere to the glaſs by a very thin paſte. A margin of an inch muſt be left on both ſides; otherwiſe, upon *electrifying* this plate, the *electricity* would be prevented from being accumulated upon one of its ſurfaces, by being propagated from the ſilver on one ſide to that of the other. When the glaſs plate is thus prepared, if it be placed upon a table in ſuch a manner, that when fully *electrified* by a wire or ſuch like from the prime conductor, a perſon touches the under ſurface with a finger of one of his hands, and brings one of the fingers of the other near the upper ſurface, or near the prime conductor, he will be ſhocked in both his arms and croſs his breaſt. The ſame effect happens, if when this plate is *electrified* as before, a perſon holds it in his hand by the margin, and without touching the ſilver, preſents it, even ſome time after it has been taken from the prime conductor, to another perſon, who touches the under ſurface with his finger, and holds it there till he touches the upper ſurface with a finger of his other hand. This is an experiment contrived by Dr. Bevis, who obſerves, that though the exploſion from the glaſs plate ſilvered was occaſioned by about ſix grains of ſilver, upon which the *electricity* was accumulated, yet the exploſion was equal if not ſuperior to that from half a pint of water contained in a thin glaſs as uſual.

28. The commotion ariſing from the diſcharge of the accumulated *electricity* in the phial, may be felt by a great number of men at once. Monſieur le Monnier, at Paris, is ſaid to have communicated this ſhock through a line of men, and other *non-electrics*, meaſuring nine hundred toiſes, which is more than an Engliſh mile; and the Abbé Nollet [a] made the experiment upon 200 perſons, ranged in two parallel lines.—[a] Lettres ſur l'*Electricité*, p. 207.]

29. This *electrical* commotion has been made very ſenſible quite acroſs the river Thames, by the communication of no other medium than the water of that river; and ſpirit of wine has been fired at that diſtance.

30. The commotion has alſo been perceptible to two or more

more obſervers at conſiderable diſtances from each other, even as far as two miles.

In theſe laſt experiments, and in many others of the like nature, Mr. Watſon obſerves, that the *electrical* power, accumulated in any *non-electric* matter contained in a glaſs phial, deſcribes upon its exploſion a circuit through any line of ſubſtances *non-electrical* in a conſiderable degree; if one end thereof is in contact with the external ſurface of this phial, and the other end upon the exploſion touches either the *electrified* gun-barrel, to which the phial in charging is uſually connected, or the iron hook always fitted therein. Thus if a perſon ſtands upon a dry wooden floor with a coated phial ever ſo highly charged in one of his hands, and if another perſon, without touching the firſt, ſtands but ſix inches from him, and touches the iron hook of the phial, neither of them are ſhocked; becauſe the floor between them, though the diſtance is ſo ſhort, will not conduct the *electricity* ſufficiently quick. But if theſe two perſons tread upon a piece of wire laid between them, they each of them feel the *electrical* commotion in that arm which touches the phial and hook, and in that foot which treads upon the wire; the wire here conducting the *electricity* quick enough, which the dry floor would not. The circuit is here formed by the coated phial, its hook, ſo much of the bodies of theſe two perſons as form a curve line between the wire, the phial, and hook, and the wire between theſe perſons. If theſe perſons ſtand upon, or touch with any part of their bodies any *non-electrics*, which readily conduct *electricity*, the circuit is completed, and the effect is the ſame. Hence Mr. Watſon infers, that when the obſervers have been ſhocked at the end of two miles of wire, the *electrical* circuit is four miles; *viz.* two miles of wire, and the ſpace of two miles of the *non-electric* matter between the obſervers, whether it be water, earth, or both. So in the experiments made near Weſtminſter bridge, where the river is above 400 yards over, the circuit muſt have been above 800 yards, *viz.* above 400 yards of conducting wire laid upon the Portland ſtones of the bridge, and ſomething more than 400 yards of water. That the water made part of the circuit, and that the ſhock was not communicated from the Surry ſhore to the other ſide merely by the conducting wire, is evident from this, that if the obſerver on the Weſtminſter ſhore did not communicate with the river, either by dipping his hand, or an iron rod held therein into the river, the ſhock ariſing from the diſcharge of the phial was not at all felt by him, although the obſerver on the Surry ſide felt it as before. This circuit of the *electrical* matter has been farther confirmed by ſeveral other ingenious experiments by the ſame gentleman.

It is to be obſerved, that the commotion is equally ſtrong, whether the *electricity* is conducted by water, or dry ground. And that if the wires, between the *electrifying* machine and the obſervers, are conducted upon dry ſticks, or other ſubſtances *non-electric*, in a ſlight degree only, the effects of the *electrical* power are much greater, than when the wires in their progreſs touch the ground, moiſt vegetables, or other ſubſtances in a great degree *non-electric*.

31. It is remarkable, that if the *electrical* machine, and the man who turns the wheel thereof, be mounted upon *electrical* cakes, the *electrical* power is ſo far from being increaſed hereby, as ſome might expect, that it is, on the contrary, much diminiſhed, and ſometimes is not at all perceptible.

It was this experiment which induced Mr. Watſon to conceive, that the *electrical* power was not inherent in the glaſs, but came from the floor of the room. And, he ſays, he was confirmed in this opinion when he found, that if he touched the frame of the machine with one hand, while he ſtood upon the floor, and with a finger of the other hand touched the gun-barrel, the fire would iſſue, and the ſnapping would continue as long as he held his hand upon the machine, but would ceaſe upon his taking it off. In like manner, if the man, who turned the wheel, put one of his feet upon the floor, the other remaining upon the wax, the *electricity* at the gun-barrel would ſnap, and ceaſe upon his replacing his foot. But of this hypotheſis more hereafter.

32. The accumulation of *electricity* may be meaſured to great exactneſs by the following method, diſcovered by Mr. Canton. When the phial is ſufficiently *electrified*, by applying the wire thereof to the glaſs globe, which is known by the appearance of a bruſh of flame at the end of the wire, hang a ſlender piece of wire to the ſuſpended gun-barrel, detached for this purpoſe from the globes. Upon your applying the wire of the *electrified* phial to that hanging to the gun-barrel, you perceive a ſmall ſnap; this you diſcharge by touching the gun-barrel with your finger, which likewiſe ſnaps: and thus alternately *electrifying* and diſcharging, you proceed until the whole *electricity* of the water is diſſipated, which is, ſometimes, not done under an hundred diſcharges. If you do not diſcharge the *electricity* every time, the ſnaps from the wire of the *electrified* phial to the gun-barrel, are ſcarcely perceptible. The acquired *electricity* of the water is eſtimated in proportion to the number of ſtrokes.

This accumulation of *electricity* may perhaps be thought to deſerve a farther explanation, and may be thus illuſtrated. As we take it for granted, that there is always a determinate quantity of atmoſphere ſurrounding the terraqueous globe, we conceive, when we ſee the mercury in the barometer very low, that there then is a leſs accumulated column of this atmoſphere impending over us, than when we ſee the mercury high. In like manner, when we obſerve that the *electrified* gun-barrel attracts or repels only very light ſubſtances, at a very ſmall diſtance, or that the ſnap and fire therefrom are ſcarce perceptible, we conceive then a much leſs quantity of *electrical* atmoſphere ſurrounding the gun-barrel. This power being more or leſs, is called the greater or leſs degree of the accumulation of *electricity*. And this is only attainable to a certain point, if you *electrify* ever ſo long; after which, unleſs otherwiſe directed, the diſſipation thereof is general. In the phial filled with water, in Muſchenbroek's experiment, or filled with any other *non-electric*, as filings of iron, if the wire be held to the globe in motion, when the accumulation is complete, the ſurcharge runs off from the point of the wire, as a bruſh of blue flame. That by ſtopping the current of *electricity*, *non-electrics* might be excited; and that by accumulating their power, they might be made to exert more force than *electrics per ſe* would at any point of time, is that capital diſcovery of the late Mr. Gray; which is to be regarded as the baſis upon which all the preſent improvements of our knowledge in *electricity* are founded.

33. By comparing the reſpective velocities of *electricity* and ſound, that of *electricity*, in any diſtance yet experienced, appears inſtantaneous.

For the detail of theſe curious experiments, and of ſeveral others, we muſt refer to Mr. Watſon's experiments and obſervations, tending to illuſtrate the nature and properties of *electricity*, Lond. 1745; and the ſequel to the experiments, *&c.* Lond. 1746; as alſo to his account of the experiments made by ſome gentlemen of the Royal Society, Lond. 1748.

34. Mr. Franklin of Philadelphia, in his experiments and obſervations on *electricity*, has obſerved, that granulated lead is better than water for filling the phial or glaſs jar to be *electrified*; and he has been able to excite the *electrical* force to ſuch a degree, as not only to fire gunpowder [a], and to kill a turkey of ten pound weight [b], but to produce a fuſion of metals [c].—[[a] Phil. Tranſ. Vol. XLVII. p. 291. [b] Ibid. p. 209. [c] Ibid. p. 290.]

This ingenious author's method of firing gunpowder by the *electric* flame has ſomething particular, as it does not require any inflammable vapour to be previouſly raiſed. The powder may be fired thus: a ſmall cartridge is filled with dry powder, hard rammed, ſo as to bruiſe ſome of the grains. Two pointed wires are then thruſt in, one at each end, the points approaching each other in the middle of the cartridge, till within the diſtance of half an inch: then the cartridge being placed in the circle, when four *electrified* glaſs jars are diſcharged, the *electric* flame leaping from the point of one wire to the point of the other, within the cartridge among the powder, fires it, and the exploſion of the powder is at the ſame inſtant with the crack of the *electrical* diſcharge.

35. As to metals, this gentleman obſerves, that he has been able by *electricity* frequently to give polarity to needles, and to reverſe it. A ſhock from four large glaſs jars ſent thro' a fine ſewing needle, gives it polarity; and it will traverſe, when laid on water. The polarity is given ſtrongeſt, when the needle is ſtruck lying north and ſouth; and weakeſt, when lying eaſt and weſt. In this caſe, the end entred by the *electric* blaſt points north: but when the needle lies north and ſouth, the end that lies towards the north will continue to point north, whether the fire entred at that end, or the contrary end.

36. In theſe experiments, the ends of the needles are ſometimes finely blued, like a watch-ſpring, by the *electric* flame. This colour, given by the flaſh from two glaſs jars only, will wipe off; but four will fix it, and frequently melt the needles. Sometimes the ſurface on the body of the needles is alſo run, and appears bliſtered, when examined by a magnifying glaſs. The jars Mr. Franklin made uſe of hold ſeven or eight gallons, and are coated and lined with tin-foil. Each of them takes a thouſand turns of a globe of nine inches diameter to charge it. Tin-foil has been melted between glaſs by the force of two jars only. Phil. Tranſ. loc. cit.

37. The effects of lightning and thoſe of *electricity* appear very ſimilar. Lightning has been known to ſtrike people blind, the *electrical* ſhock has had the ſame effect on animals. Animals have been killed by both. The mariners compaſs has ſometimes loſt its virtue by lightning; and by Mr. Franklin's experiments it appears, that polarity may be given and reverſed by *electricity*. The late Mr. Stephen Gray obſerved ſeveral years ago [d], that the *electric* fire ſeemed to be of the ſame nature with that of thunder and lightning. Others have ſince fallen into the ſame opinion. Indeed many experiments ſhew, that the flame of *electricity* has been juſtly called by Mr. Franklin a mimic lightning [e], ſince it blinds and kills animals, and melts metals, *&c.*

like natural lightning.—[d Phil. Tranſ. Vol. cit. p. 536. e Ibid. p. 290.]

38. This analogy is now farther confirmed by the diſcovery made in France, in conſequence of Mr. Franklin's hypotheſis, of being able, by a proper apparatus, to collect the *electricity* from the atmoſphere during a thunder ſtorm. For a pointed bar of iron, 40 feet high, having been placed upon an *electrical* body, and a ſtormy cloud having paſſed over the place where the bar ſtood, thoſe that were appointed to obſerve it drew near, and attracted from it ſparks of fire, perceiving the ſame kind of commotions as in the common *electrical* experiments. The like effect followed, when a bar of iron 99 feet high was placed upon a cake of reſin, two feet ſquare and two inches thick. For a ſtormy cloud having paſſed over the bar, where it remained half an hour, ſparks were drawn from the bar. Theſe were the firſt experiments made in France, and they have been ſufficiently varied and verified ſince; ſo that it ſeems now certain, 1°. that a bar of iron, pointed or not, is *electriſed* during a ſtorm. 2°. That a vertical or horizontal ſituation is equally fitting for theſe experiments. 3°. That even wood is *electriſed*. 4°. That by theſe means a man may be ſufficiently *electriſed* to ſet fire to ſpirit of wine with his finger, and repeat almoſt all the uſual experiments of artificial *electricity*; for ſuch may that which is excited by friction be denominated.

It is, however, to be remarked, that theſe phænomena are attended with irregularities, and do not always ſucceed perfectly. Sometimes ſimple clouds, without thunder or lightning, produce more *electricity*, than when there is loud thunder. Sometimes the *electricity* does not ſhew itſelf but where there is lightning: in other caſes, the *electricity* which ſeemed diſſipated during the rain, began again as ſoon as the rain ceaſed, altho' the thunder was very diſtant. See the Phil. Tranſ. Vol. XLVII. p. 534, ſeq.

39. Mr. Franklin has contrived a very ingenious and eaſy way of trying experiments of this kind by means of an *electrical* kite, made of a large thin ſilk handkerchief, extended and faſtened at the four corners to two ſlight ſtrips of cedar, of ſufficient length for this purpoſe. This kite being accommodated with a tail, loop, and ſtring, will riſe in the air like thoſe of paper. To the top of the upright ſtick of the croſs is to be fixed a very ſharp-pointed wire, riſing a foot or more above the wood. To the end of the twine, next the hand, is to be tied a ſilk ribband; and where the twine and ſilk join, a key may be faſtened. The kite is to be raiſed when a thunder guſt appears to be coming on, and as ſoon as the thunder-clouds come over the kite, the pointed wire will draw the *electric* fire from them, and the kite with all the twine will be *electrified*; and the looſe filaments of the twine will ſtand out every way, and be attracted by an approaching finger. When the rain has wet the kite and twine, ſo that it can conduct the *electric* fire freely, it will ſtream out plentifully from the key, on the approach of a man's knuckle. At this key the phial may be charged; and from *electric* fire thus obtained ſpirits may be kindled, and all the other *electrical* experiments be performed, which are uſually done by the help of a rubbed glaſs globe or tube, and the ſameneſs of the *electric* matter with that of lightning may thereby be completely demonſtrated. Phil. Tranſ. Vol. cit. p. 565, ſeq.

From this identity, ſome have conceived hopes of depriving the clouds of all their thunder, and thereby rendering thunder ſtorms harmleſs. See Philoſ. Tranſ. Vol. cit. p. 289, 535.

40. It has been pretended, that odours would pervade *electrified* globes and tubes of glaſs, and that the medicinal effects of drugs might likewiſe be tranſmitted this way; as alſo, that if perſons were to hold in their hands, or place under their naked feet, odoriferous, or purging ſubſtances, and were then to be *electriſed*, they would be ſenſible of the effects of theſe ſubſtances. But it ſeems now certain, that all theſe pretences have been impoſitions on the credulity of the world, and that when proper experiments have been tried, no ſuch effects have been perceived, nor have the moſt poiſonous ſubſtances manifeſted any influence in this way. See Dr. Bianchini's experiment, mentioned in the Philoſ. Tranſ. Vol. XLVII. p. 399, ſeq.

41. However, though theſe pretended wonders, tranſmitted to the reſt of Europe from Italy and Leipſic [f], have no foundation in fact, yet it does not follow, that medicinal advantages are not to be gained from *electricity* itſelf. So ſubtle and ſo elaſtic a fluid admitted in a large quantity into our bodies, as, from undoubted experience, it greatly heats the fleſh, and quickens the pulſe, may, more eſpecially when aſſiſted with the expectation of ſucceſs in the patient, in particular caſes be attended with very great advantages [g]. —[f Phil. Tranſ. Vol. cit. p. 231, ſeq. g Mr. Watſon in Phil. Tranſ. Vol. cit. p. 406.]

In effect, we meet with ſome cures performed in paralytic caſes by the force of *electricity*. See Hiſtoire generale et particuliere de l'*Electrité*, Paris, 1752, part. 3. p. 36, ſeq. And we meet with accounts of ſeveral other diſorders cured by the ſame means, in that treatiſe; but we fear not all equally well atteſted.

42. The *electrical* virtue having, in ſome caſes, accelerated and facilitated the motion of liquids through capillary tubes, the Abbé Nollet was led to ſuppoſe, that the *electrical* effluvia might alſo contribute to accelerate the growth of vegetables, and to increaſe the perſpiration of animals, and the experiments made by that gentleman ſeem to ſupport his opinion; though objections have ariſen, as to what he has advanced with reſpect to the acceleration of the motion of fluids through capillary tubes or ſyphons: for Mr. Ellicott ſeems to have proved, that this acceleration is not barely owing to the fluids being *electrified*, but that other circumſtances are neceſſary, in order to produce this effect. Mr. Ellicott obſerves, that if a veſſel of water is hung to the prime conductor, having a ſyphon in it of ſo ſmall a bore that the water will be diſcharged from it only in drops, on the water's becoming *electrical* by means of the machine, it will immediately run in a ſtream, and continue to do ſo, till the water is all diſcharged, provided the ſphere is continued in motion. And the true reaſon of the water's running in a ſtream in this caſe ſeems to be, that ſo long as the machine is in motion, there is a conſtant ſucceſſion of the *electric* effluvia excited, which viſibly run off from the end of the prime conductor in a ſtream; and as they are in like manner carried off from all bodies hung to it, thoſe effluvia which run off from the end of the ſyphon, being ſtrongly attracted by the water, carry ſo much of it along with them, as to make it run in a conſtant ſtream. See Mr. *Ellicott*'s Eſſays before mentioned, p. 11, 12, *&c.*

The ſame author obſerves farther, that if the veſſel of water, with the ſyphon in it, is ſuſpended by any *non-electric* body over another ſtrongly *electrified*, the water will immediately run from the ſyphon in a ſtream; but if ſupported by a piece of ſilk, or any other *electrical* body, the water will immediately ceaſe running, and only be diſcharged in drops. And he accounts for this phænomenon from the principles of attraction between *non-electrics* and *electrical* effluvia, and of non-attraction between the ſame effluvia and original *electrics*. See page 15 of the Eſſays before cited.

43. Mr. Watſon has given us a particular account of ſeveral curious phænomena of *electricity* in vacuo in the Philoſophical Tranſactions, Vol. XLVII. p. 362, ſeq. The *electrical* effluvia, in their paſſage through an exhauſted glaſs tube, of almoſt three inches in diameter, afford a moſt agreeable ſpectacle in a darkened room. We may obſerve, not as in the open air, bruſhes or pencils of rays an inch or two in length, but coruſcations extending the whole length of the tube, that is, in his experiment, thirty-two inches, and of a bright ſilver hue. Theſe did not immediately diverge, as in the open air, but frequently, from a baſe apparently flat, divided themſelves into leſs and leſs ramifications, and reſembled very much the moſt lively coruſcations of the aurora borealis. At other times, when the tube has been exhauſted in the moſt perfect manner, the *electricity* has been ſeen to paſs between two braſs plates, contrived ſo, that they might be placed at different diſtances from each other, in one continued ſtream, of the ſame dimenſions throughout its whole length.

If the exhauſted tube be made part of the circuit before mentioned in Muſchenbroek's experiment, at the inſtant of exploſion, a maſs of very bright embodied fire may be ſeen jumping from one of the braſs plates in the tube to the other. But this is obſerved not to take place, when one of the plates is farther diſtant from the other than ten inches. If the diſtance be greater, the fire begins to diverge, and loſe part of its force; and this force diminiſhes in proportion to its divergency, which is nearly as the diſtance of the two plates.

But though the vacuum here employed greatly exceeded that which is uſually made by common air-pumps, yet it was far from being perfect. Theſe experiments were therefore tried with a torricellian vacuum, very ingeniouſly contrived by Lord Charles Cavendiſh. The apparatus conſiſted of a cylindrical glaſs tube of about three-tenths of an inch in diameter, and of ſeven feet and an half in length, bent in ſuch a manner, that thirty inches of each of its extremities were nearly ſtraight, and parallel to each other, from which an arch ſprung, which was likewiſe of thirty inches. This tube was carefully filled with mercury; and each of its extremities being put into its baſon of mercury, ſo much of the mercury ran out, until, as in the common barometrical tubes, it was in equilibrio with the atmoſphere. Each of the baſons containing the mercury was of wood, and was ſupported by a cylindrical glaſs of about four inches in diameter, and ſix inches in length; and theſe glaſſes were faſtened to the bottom of a ſquare wooden frame, ſo contrived, as that to its top was ſuſpended, by ſilk lines, the tube filled with mercury before mentioned; ſo that the whole of this apparatus, without inconvenience, might be moved together. The torricellian vacuum then occupied a ſpace of about thirty inches. In making the experiment, when the room was darkened, a wire from the prime conductor of the common *electrical* machine, communicated with one of the baſons of mercury, and any *non-electric* touching the other baſon, while the machine was in motion,

the *electricity* pervaded the vacuum in a continued arch of lambent flame, and as far as the eye could follow it, without the leaſt divergency.

It is to be obſerved, that upon admitting a very ſmall quantity of air into the exhauſted tube, the phænomena diſappear; not ſo much from the ſmall quantity of air admitted, as from the vapours which inſinuated themſelves therewith. For theſe phænomena have been viſible, though in a leſs perfect degree, when a much larger quantity of air was left in the receiver, by omitting to exhauſt it as much as poſſible.

If the *electrifying* machine, and the man who turns the wheel thereof, are ſupported by *electrics per ſe*; and if a piece of wire be connected with the braſs cap covering the upper extremity of the exhauſted tube, or to the end of the long braſs rod, by the ſliding of which through a box of oiled leather, the upper braſs plate may be moved in the tube; and if the other end of the wire be faſtened to any part of the frame of the *electrifying* machine, when this is put in motion, the *electrical* coruſcations may be ſeen to paſs, as before, from one of the braſs plates contained in the tube to the other, and to continue, unleſs the air inſinuates itſelf, as long as the machine is in motion. If, under theſe circumſtances, the hand of a perſon ſtanding on the floor is brought near the ſides of the glaſs, the coruſcations will direct themſelves that way in a great variety of curious forms.

This experiment, in which the *electricity* is ſeen puſhing itſelf on through the vacuum by its own elaſticity, is conſidered by Mr. Watſon as an *experimentum crucis* of the truth of his doctrine hereafter mentioned.

It may be obſerved in all theſe experiments, that a vacuum does not conduct *electricity* ſo perfectly as metals or water. For, in the laſt experiment, a perſon ſtanding upon the floor, and applying his finger to the upper braſs cap of the tube, receives a ſmart ſtroke; and in the former, ſnaps of fire may be drawn from the prime conductor. Theſe are arguments of ſome degree of accumulation, while the *electricity* is paſſing through the vacuum; ſince nothing of this kind happens when metals, ſtanding upon the ground, touch the prime conductor.

Such are the principal phænomena of *electricity* hitherto diſcovered; but the chief queſtion remains: What are the general laws of theſe phænomena, and what are their cauſes?

Mr. Ellicott thinks that the following concluſions, or general laws, may be juſtly deduced from the phænomena.

1°. That theſe remarkable phænomena are produced by means of effluvia; which, in exciting the *electrical* body, are put into motion, and ſeparated from it.

2°. That the particles compoſing theſe effluvia ſtrongly repel each other.

3°. That there is a mutual attraction between theſe particles and all other bodies whatſoever.

That there are effluvia emitted from the tube when rubbed, and which ſurround it as an atmoſphere, is evident from that offenſive ſmell ariſing from them, from that ſenſation on the hands or face, when the tube is brought near either of them, and from thoſe ſparks of light, on a ſtill nearer approach of the finger to it.

That the particles of theſe effluvia repel each other, is proved by the cork balls, and the fibres of the feather repelling each other, when impregnated with them; and by the leaf-gold being repelled by the tube, and not returning to it again, until by coming near, or touching ſome *non-electric* body, the effluvia are drawn off from it. From this property it is, that theſe effluvia expand themſelves with ſo great a velocity whenever they are ſeparated from the *electric* body; and as they are likewiſe capable of being greatly condenſed, may we not from hence juſtly conclude they are *elaſtic*?

That there is a mutual attraction between theſe effluvia and moſt other bodies, appears from their collecting from the tube ſuch quantities thereof, as to endue them with the ſame properties with the tube itſelf, as is proved from ſeveral of the experiments above mentioned.

Theſe principles being admitted, it will follow, that the greater difference there is in the quantity of *electrical* effluvia in any two bodies, the ſtronger will be their attraction. For, if the effluvia in each are equal, inſtead of attracting, they will repel each other; and in proportion as the quantity of *electric* matter is drawn from one of the bodies, will the attraction between them increaſe, and conſequently be ſtrongeſt, when any one of them has all the *electrical* matter drawn from it.

The particles of theſe effluvia are ſo exceeding ſmall, as eaſily to pervade the pores of glaſs, as is evident, in that a feather, or any light bodies incloſed in a glaſs ball hermetically ſealed, will be put in motion on the excited tube being brought near the outſide of it: and it has been generally thought that they paſs thro' the pores of the denſeſt bodies, and ſeveral experiments render this ſuppoſition not improbable, tho' none of them are quite concluſive.

Mr. Ellicott then proceeds to ſhew, in a very ingenious manner, how, from theſe principles, the phænomena of ſome of the more remarkable experiments of *electricity* may be accounted for. But as what he ſays cannot, with juſtice to his reaſonings, be abridged, we muſt refer the curious to his eſſays before quoted; only adding, that we have ſeen a manuſcript of his, where he endeavours to account for the experiment of Muſchenbroek on theſe principles, in a manner that makes us wiſh to ſee the reſt of his experiments, obſervations, and reaſonings on this ſubject publiſhed.

Mr. Watſon has endeavoured to prove, that *electricity* is not furniſhed from the glaſſes employed in the experiments, nor from the circumambient air. He thinks that *electricity* is the effect of a very ſubtile and elaſtic fluid, occupying all bodies in contact with the terraqueous globe, and that every where in its natural ſtate it is of the ſame degree of denſity; and that glaſs, and other bodies, which are called *electrics per ſe*, have the power of taking this fluid from one body, and conveying it to another, in a quantity ſufficient to be obvious to all our ſenſes; and that under certain circumſtances, it is poſſible to render the *electricity* in ſome bodies more rare than it naturally is, and, by communicating this to other bodies, to give them an additional quantity, and make their *electricity* more denſe; and that theſe bodies will thus continue until their natural quantity is reſtored to each; that is, by thoſe which have loſt part of theirs, acquiring what they have loſt, and by thoſe, to which more has been communicated, parting with their additional quantity. Both one and the other of theſe is, from the elaſticity of the *electric* matter, attempted to be done from the neareſt *non-electric*; and when the air is moiſt, this is ſoon accompliſhed by the circumambient vapours, which here may be conſidered as preventing, in a very great degree, our attempts to inſulate *non-electric* bodies.

This ſhort ſketch of Mr. Watſon's ſyſtem is taken from his own words in the Philoſophical Tranſactions, Vol. XLVII. p. 371, 372. For the detail of his illuſtrations and proofs, his treatiſe before quoted, or the Phil. Tranſact. Vol. XLIV and XLV, muſt be conſulted, and particularly Vol. XLVII, p. 372, & ſeq. where, after giving the *experimentum crucis* before mentioned, he endeavours to ſhew that it amounts to a full proof of the truth of his doctrine, that *electricity* is furniſhed by thoſe bodies, hitherto called *non-electrics*, and not by the *electrics per ſe*; and that we are able to add to, or take from, that quantity of *electricity* naturally adherent to bodies.

Mr. Watſon's ſyſtem naturally leads him to aſk, by what denomination ſhall we call this extraordinary power? From its effects in theſe operations ſhall we call it *electricity*? From its being a principle neither generated nor deſtroyed; from its being every where and always preſent, and in readineſs to ſhew itſelf in its effects, tho' latent and unobſerved, till by ſome proceſs it is produced into action, and rendered viſible; from its penetrating the denſeſt and hardeſt bodies, and its uniting itſelf to them; and from its immenſe velocity; ſhall we, with Theophraſtus, Boerhaave, Niewentiit, 'sGraveſande, and other philoſophers, call it elementary fire? Or ſhall we, from its containing the ſubſtance of light and fire, and from the extreme ſmallneſs of its parts, as paſſing thro' moſt bodies we are acquainted with, denominate it, with Homberg and the chemiſts, the chemical ſulphureous principle, which, according to the doctrines of theſe gentlemen, is univerſally diſſeminated? Whatever we call it, it ſeems certain, that this power has many ſurpriſing properties, and cannot but be of great moment in the ſyſtem of the univerſe.

To conclude, we muſt obſerve that the ingenious Mr. Wilſon has, in a treatiſe expreſs, endeavoured to account for the phænomena of *electricity*, from Sir Iſaac Newton's æther.

As to other hypotheſes, we refer to the *Hiſtoire generale et particuliere de l'Electricité* before mentioned.

SOUND (*Suppl.*)—The ſpace through which *ſound* is propagated in a given time, has been very differently eſtimated by authors who have written concerning this ſubject. Roberval gives it at the rate of 560 feet in a ſecond; Gaſſendus, at 1473; Merſenne, at 1474; Du Hamel, in the Hiſtory of the Academy of Sciences at Paris, at 1172; the Academy del Cimento, at 1185; Boyle, at 1200; Roberts, at 1300; Walker, at 1338; Sir Iſaac Newton, at 968; Dr. Derham, in whoſe meaſure Mr. Flamſteed and Dr. Halley acquieſced, at 1142. But by the accounts ſince publiſhed by M. Caſſini de Thury, in the Memoirs of the Royal Academy of Sciences at Paris for the year 1738, where cannon were fired at various, as well as great diſtances, under great variety of weather, wind, and other circumſtances, and where the meaſures of the different places had been ſettled with the utmoſt exactneſs, *ſound* was propagated at a medium at the rate only of 1038 French feet in a ſecond. The French foot exceeds the Engliſh by nearly ſeven lines and a half, or is as 107 to 114: And conſequently, 1038 French feet are equal to 1106 Engliſh feet. The difference therefore

of

of the meaſures of Mr. Derham and M. Caſſini is 34 French, or 36 Engliſh feet in a ſecond. According to this laſt meaſure, the velocity of *ſound*, when the wind is ſtill, is ſettled at the rate of a mile, or 5280 Engliſh feet, in $4\frac{77}{100}''$.

UNDULATION, or BEAT, in muſic, is uſed for that rattling, or jarring of ſounds, which is obſerved, chiefly, when diſcordant notes are ſounded together.

The phænomenon is more fully deſcribed thus, by Dr. Smith[a]: In tuning muſical inſtruments, eſpecially organs, it is a known thing, that while a conſonance is imperfect, it is not ſmooth and uniform, as when perfect, but interrupted with very ſenſible *undulations* or *beats*; which, while the two ſounds continue at the ſame pitch, ſucceed one another in equal times, and in longer and longer times, while either of the ſounds approaches gradually to a perfect conſonance with the other, till at laſt the *undulations* vaniſh, and leave a ſmooth, uniform conſonance.—[a Harmonics, p. 107.]

This learned author obſerves farther, that quicker *undulations* are *beats*, and are remarkably diſagreeable in a concert of ſtrong, treble voices, when ſome of them are out of tune; or in a ring of bells ill tuned, the hearer being near the ſteeple; or in a full organ badly tuned. Nor can the beſt tuning wholly prevent that diſagreeable battering of the ears with a conſtant rattling noiſe of *beats*, quite different from all muſical ſounds, and deſtructive of them, and chiefly cauſed by the compound ſtops called the cornet and ſeſquialter, and by all other loud ſtops of a high pitch, when mixed with the reſt. But if we be content with compoſitions of uniſons and octaves to the diapaſon, whatever be the quality of their ſounds, the beſt manner of tuning will render the noiſe of their *beats* inoffenſive, if not imperceptible.

The Doctor has with great ingenuity deduced the theory of theſe *undulations* from his principles, and has applied his doctrine to the tuning of inſtruments; by which he has ſhewn, that a perſon of no ear at all for muſic may ſoon learn to tune an organ, according to any propoſed temperament of the ſcale, and to any deſired degree of exactneſs, far beyond what the fineſt ear, unaſſiſted by theory, can poſſibly attain to. This may be done by counting the number of *undulations* in a certain time, ſuch as 15 ſeconds. See the treatiſe before cited, Prop. xx. p. 215. and the table, p. 244. Plate 20.

From this ingenious theory the learned author has demonſtrated ſeveral errors in what Monſieur Sauveur has delivered concerning theſe *undulations* or *beats*. See Harmonics, Scholium 2. p. 115.

In the ſame treatiſe we find ſome curious obſervations relating to the analogy of audible and viſible *undulations*. See p. 128, 273.

FINIS.