

XXXII. *Experiments and Observations on a new Apparatus, called, A Machine for exhibiting perpetual Electricity. In a Letter to the Rev. Dr. Horley, Sec. R. S. from Mr. William Henly, F. R. S.*

REVEREND SIR,

March 4, 1776.

R, May 16, 1776. MY ingenious friend Mr. GEORGE ADAMS, philosophical instrument-maker to his majesty, lately put into my hands a little apparatus, which he called a machine for exhibiting perpetual electricity, and informed me, that it was the invention of some foreign gentleman^(a). This machine consisted of a circular plate of glass, about eight inches in diameter, covered on one side with a coating of bees-wax and rosin, about the sixteenth part of an inch thick. This coat of wax, &c. being strongly excited with a dry warm flannel, he placed upon it a circular board, of the same dimensions, coated with tin-foil, and furnished with a glass handle screwed to, and standing upright upon it. These bodies having remained in contact some seconds, the board was raised up by the glass handle; when, applying the knuckle to the tin-foil coating, a snap was heard, a spark seen, and a small sensation felt. On replacing the board, and permitting it to remain some seconds, as before, having touched the tin-foil with a finger, on removing it again, and applying the knuckle, as at first, the same

(a) I have since learned from Mr. NARNE, that M. VOLTA, of Como, near Milan, was the inventor of it.

phenomena

phenomena were produced; and might, Mr. ADAMS observed, be repeated for a long time, without any renewal of the excitation of the wax, any farther than the replacing the board might be said to excite it. It immediately occurred to me, that, as this plate of wax, &c. was made by excitation, a strong negative electric, the phenomena produced by it could only be the reverse of those I had formerly made with an excited plate of glass, and published in the Phil. Transf. vol. LXIV. part II. p. 407.; *viz.* where mine were positive, these were negative; and where mine were negative, these were positive. But, to determine this matter, I made the following experiments. First, I insulated Mr. CANTON's electrometer, and having electrified the balls positively, I presented toward them the excited wax, as soon as it had been separated from the coated board; and perceived, as I expected, that the balls were attracted by the wax; but, if the balls were electrified negatively, they were as plainly repelled by it. The board produced just the contrary effect. Secondly, I held my Leyden *vacuum*, or analysis of the Leyden bottle, described Phil. Transf. vol. LXIV. part II. p. 400. by the coated bulb, and touched the brass ball on the neck of it with the coated board, the moment it had been separated from the excited wax, &c. and instantly perceived a variety of beautiful streams dart from the point of the wire in the bottle, and spread themselves in different directions through the bulb. On repeating the experiment, and presenting the coated part of the bottle toward the board, a small spark of light appeared upon the point of the inclosed wire; a plain indication

indication that the point had received electricity, and, as before observed, that the coated board, being separated from the wax, &c. was strongly electrified *plus*; and consequently, the coating of wax, &c. on the plate of glass, *minus*. These phenomena, being so often produced, without a fresh excitation of the wax, though they are astonishing to strangers, will not be so surprizing to electricians, who have considered Mr. GREY's experiment with a cone of sulphur, contained in a glass vessel, which, as often as they were separated, shewed signs of electricity in all states of the weather. See Dr. PRIESTLEY's History of Electricity, 2d edit. p. 39. I have shewn at large, in a former paper, that merely hearing either glass or amber will not make them electrical; but the friction of glass against glass, or sealing-wax against sealing-wax, previously warmed, I find, will excite either of these substances; and my ingenious and learned friend THOMAS RONAYNE, Esq. informs me, that he had long since made the same remark on sealing-wax. But, pressing a finger in the gentlest manner on the amber, after heating, will excite it. Indeed, a fine piece, which I frequently carry in my pocket, I always perceive to be electrical, without any other friction than what it receives from the pocket. Sealing-wax, Mr. RONAYNE tells me, he always found to be affected in the same manner; and negative electrics, *per se*, being once thoroughly excited, are observed to retain their electrical quality very long, as they do not so soon attract the moisture in the atmosphere as glass. Glass, however, will retain its electricity many hours, as I have had frequent occasion to remark. My late friend

Mr. CANTON informed me, that, having excited a rod of glass very strongly, he set it at some distance from the fire in his parlour, and found that it was electrical, after standing in that situation, in dry air, twenty-four hours. How much longer it would have retained its electricity, had he let it remain there, he knew not. How long a large and neatly-prepared Leyden bottle will retain its charge, so as to be sensibly electrical, I have never experienced; but DR. PRIESTLEY observes, *History of Electricity*, p. 516, that he has more than once received such shocks as he should not like to receive again from the *residuum* of his battery, even two days after the discharge, and when papers, books, his hat, and many other things, had lain upon the wires the greatest part of the time. Even the *residuum* of a *residuum*, he says, he has known to remain in his battery many days^(a). One thing, however, is very remarkable in Mr. ADAMS's apparatus, *viz.* supposing the negative electric to have parted with its electricity to the rubber; why, when the coated board or plate of metal is set upon it, and that plate is touched by a finger, the equilibrium is not thus presently restored? But, perhaps, when the electric matter, naturally inherent in bodies, is once thoroughly excited and put in

(a) My friend the reverend Mr. HEMMING, hath been so obliging as, at my request, to make a variety of experiments, with a view to determine this matter, and shewed me a small bottle, which attracted a thread of trial at one-sixteenth of an inch distance, May 23, though the bottle had been charged and stood in a cupboard in his study from March 14, *viz.* 70 days. The cylinder to his electrical machine will also separate the balls of Mr. CANTON's electrometer a fortnight after using, though a variety of methods have been repeatedly used to destroy that power in the interval.

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action, it is not so soon as might be suspected reduced again to a quiescent state, especially in bodies so peculiarly adapted to affect each other as these appear to be. Mr. LANE has favoured me with a very curious experiment, which he made as long since as the month of June 1764, and then shewed to many of his friends, which seems fully to confirm this opinion. I have, therefore, requested his leave to insert it, as follows. Having procured two large pieces of thick plate glass A and B, with plain surfaces, and fitted them so as to coincide with each other, he coated a part (about eighteen square inches) of A, on one side, with tin-foil, and an equal part of B he coated in the same manner, so as to answer exactly to A, leaving a margin of glass, an inch and a half broad, in the narrowest part; but, at one of the ends of each plate (which end was reduced in breadth), not less than five inches of the glass were reserved uncoated, for the purpose of handling them. The uncoated sides of these glasses being laid together, they were charged by the machine as one plate; when the plate A, which touched the prime conductor, was found, on separating them, to be positive on both sides; and B, which was touched by a finger during the operation, was negative on both sides. Then, laying them in contact, as at first, and making the discharge as with the Leyden bottle, the plates were still found to cohere, and after separation were observed to remain strongly electrical; but with an electricity directly contrary to that they shewed before the discharge, A being now negative, and B positive on both sides. But, what is particularly to my purpose, if the

coating on A and B (after laying them again together as at first) were touched, at the same time, by a thumb and finger of the hand, or any conductor communicating with the earth, the plates would then, on being separated (the experiment being made in a dark room) emit a strong flash of light; and this phenomenon Mr. LANE has frequently produced twelve or fourteen times successively, touching the coating of the plates each time before the separation, without renewing the charge in the glass by the machine; but if he omitted to touch the coatings as above mentioned, no light was visible on the separation of the plates.^(b) Should those gentlemen, if any such remain, who are of opinion, that in electrical experiments two fluids, the vitreous and the resinous, are concerned, proceed to make experiments of this kind, they may, perhaps, from some phenomena, be induced to draw conclusions which they may think not unfavourable to their own hypothesis.

My experiments with the excited plate of glass, published in the Philosophical Transactions, as before mentioned, may serve, however, as a key to explain both Mr.

(b) Crown-glass, that is, the glass commonly used for sash-windows, though so much thinner, succeeds in this experiment as well as the plate-glass; but what is very remarkable, the Dutch plates, when treated in the same manner, have each a positive and a negative surface, and the electricity of both surfaces, of both plates, is exchanged for the contrary electricity in the discharge. If a clean, dry, uncoated plate of looking-glass be placed between the coated looking-glass plates, or between the plates of crown-glass, it appears, after charging, to be negatively electrified on both sides; but if it be placed between the Dutch plates, it acquires, like them, a positive electricity on one surface, and a negative electricity on the other. Further particulars, with a description of some new electrical apparatus, constructed on account of these phenomena, will be given at another opportunity.

GREY's experiments, and those made with Mr. ADAMS's little apparatus now under consideration. Having procured a plate of glass, ten inches long and eight inches broad, coated in the manner of Mr. ADAMS's, I was inclined to pursue these inquiries somewhat farther. Accordingly, I placed, upon a strong supporter of glass, a circular board, with a smooth and flat surface; and upon this board I laid a circular brass plate, of nearly the same size; and lastly, I placed upon the brass plate Mr. CANTON's electrometer. Then, having excited the plate of wax with dry, warm flannel, experiment 3, I set it upon the insulated apparatus. The balls presently opened, and, on examination, appeared to be electrified negatively; but, on removing the wax, they closed, and opened again much wider, and were then found to be electrified positively. In this experiment, the quantity of electricity, naturally inherent in the balls, strings, &c. had been drawn up into the apparatus by the attractive power of the excited plate of wax, and they were thus left in a negative state; but, on removing the plate of wax, the balls closed again, in consequence of the return of the electricity, which would be increased if the plate of brass had been touched by a finger, &c. and the balls then became very powerfully electrified *plus*. By applying, in the same manner, the excited uncoated plate of glass, or the excited uncoated side of the same plate, the reverse of these phenomena took place, as I have before described them and referred to in the beginning of this paper.

Experiment 4. I insulated two of Mr. CANTON's electrometers, A and B, and having raised them in such a manner

manner as to let the balls hang about the eighth part of an inch higher than the plate of brass on which the excited plate of wax was laid, I electrified the balls of A positively, and the balls of B negatively, so as to diverge about an inch; I then brought the insulated apparatus as near as I could to the balls, without affecting either, (the brass plate might then be at nearly an inch and a half distance from the nearest ball, both of A and B); then, suddenly removing the excited wax, the balls of B instantly flew to the brass plate, and those of A were, at the same instant, repelled to as great a distance from it. The apparatus having remained in this situation some seconds, on withdrawing the stand with the brass plate, &c. the balls of B closed, having received by this process the quantity of electricity they had before been deprived of; but the balls of A still remained separate, as wide as ever.

Experiment 5. Having replaced the excited wax, &c. upon the brass plate, I again electrified the balls of A and B, as in the former experiment, *viz.* those of A positively, and those of B negatively. I then took a small phial, properly prepared for the Leyden experiment, containing only about three square inches of coated surface; then, presenting the knob, on the wire of the phial, to the plate of brass, I removed the wax, &c. and instantly saw a strong spark between the brass plate and the knob of the phial: when, presenting that knob towards the balls of A, they were considerably repelled; but on presenting it toward those of B, they were as much attracted. I have made several other experiments with this apparatus; but, as they all agree with those above

above mentioned, I think it unnecessary to recite them. I have likewise omitted to give a drawing; as to electricians, I apprehend, this paper will be intelligible without one; and to those who have not considered the subject, I imagine, it would be of very little, if indeed of any use whatever. The same difficulty which occurred to Dr. FRANKLIN, in his analysis of the Leyden bottle, may be said to occur also in this apparatus, *viz.* it is hard to say how, or where this electricity is deposited, there is so much of it; and it is so easily put in action, that I am still further confirmed in an opinion that I have long entertained, *viz.* that the slightest friction between bodies of every kind, in every situation, may disturb the electric matter contained in them, though this effect be imperceptible to us, having no electrometer nice enough to discover it. I am, &c.

In the month of March last, I repeated Mr. GREY's experiment with the cone of sulphur and the glass; and find that, on separating these bodies, the sulphur hath hitherto ^(c) always acted as a strong negative electric. Mr. WILCKE, in repeating this experiment, observed, that if the glass vessel, into which the sulphur was poured, was covered with a coating of metal, the electrical property of the two bodies would be increased, the sulphur having acquired a stronger negative, and the glass a strong positive electricity ^(d).

(c) Sept. 23, 1776.

(d) The stem of the glass should be varnished, or covered with cement, and the cone of sulphur (as M. EPINAS hath directed) be provided with a glass handle, that the respective bodies may be separated at pleasure, without touching them.

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I have lately seen a very neat apparatus, much smaller than that I have mentioned in this paper, made by Mr. NAIRNE, the coated plate of glass measuring only three inches in diameter. With this apparatus I made the following experiments. I insulated two of Mr. CANTON's electrometers, A and B, and having excited the coating on the glass plate, I set upon it the plate of metal, and having permitted it to remain in that situation about half a minute, I raised it up by the glass handle, having first pressed it closely into contact, and placed it upon the electrometer A. The excited electric I placed in like manner upon B. The balls of both the electrometers diverged considerably; those of A positively, and those of B negatively. Then, removing the excited plate of wax, &c. from B, the balls closed, and opened again positively, upon the principle already explained in the preceding paper. If, instead of the brass plate, the plate of glass was excited (that is, the uncoated side of it), and placed upon the electrometer A, the balls were affected in the very same manner (differing only in the degree of power) as those I have before mentioned in my experiments with the excited uncoated plate of glass; Phil. Transf. vol. LXIV. part II. p. 407.

A variety of new experiments and observations, relative to several articles mentioned in this paper, and other new facts in electricity, particularly the electricity of chocolate, and the restoration of that property of it, when lost, by melting it, with the addition of a small quantity of olive oil, will be presented to the Royal Society, as soon as the materials are properly digested and transcribed.