



EXPERIMENTS AND OBSERVATIONS ON ELECTRICITY

BENJAMIN FRANKLIN

JVA EDITORA

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Experiments and Observations on Electricity

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EXPERIMENTS
AND
OBSERVATIONS
ON
ELECTRICITY,
MADE AT
Philadelphia in America,
BY
Mr. BENJAMIN FRANKLIN,
AND

Communicated in several Letters to Mr. P. COLLINSON,
of London, F. R. S.

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The P R E F A C E .

It may be necessary to acquaint the reader, that the following observations and experiments were not drawn up with a view to their being made publick, but were communicated at different times, and most of them in letters wrote on various topicks, as matters only of private amusement.

But some persons to whom they were read, and who had themselves been conversant in electrical disquisitions, were of opinion, they contain'd so many curious and interesting particulars relative to this affair, that it would be doing a kind of injustice to the publick, to confine them solely to the limits of a private acquaintance.

The Editor was therefore prevailed upon to commit such extracts of letters, and other detach'd pieces as were in his hands to the press, without waiting for the ingenious author's permission so to do; and this was done with the less hesitation, as it was apprehended the author's engagements in other affairs, would scarce afford him leisure to give the publick his reflections and experiments on the subject, finish'd with that care and precision, of which the treatise before us shews he is alike studious and capable. He was only apprized of the step that had been thus taken, while the first sheets were in the press, and time enough for him to transmit some farther remarks, together with a few corrections and additions, which are placed at the end, and may be consulted in the perusal.

The experiments which our author relates are most of them peculiar to himself; they are conducted with judgment, and the inferences from

them plain and conclusive; though sometimes proposed under the terms of suppositions and conjectures.

And indeed the scene he opens, strikes us with a pleasing astonishment, whilst he conducts us by a train of facts and judicious reflections, to a probable cause of those phænomena, which are at once the most awful, and, hitherto, accounted for with the least verisimilitude.

He exhibits to our consideration, an invisible, subtile matter, disseminated through all nature in various proportions, equally unobserved, and, whilst all those bodies to which it peculiarly adheres are alike charged with it, inoffensive.

He shews, however, that if an unequal distribution is by any means brought about; if there is a coacervation in one part of space, a less proportion, vacuity, or want, in another; by the near approach of a body capable of conducting the coacervated part to the emptier space, it becomes perhaps the most formidable and irresistible agent in the universe. Animals are in an Instant struck breathless, bodies almost impervious by any force yet known, are perforated, and metals fused by it, in a moment.

From the similar effects of lightening and electricity our author has been led to make some propable conjectures on the cause of the former; and at the same time, to propose some rational experiments in order to secure ourselves, and those things on which its force is often directed, from its pernicious effects; a circumstance of no small importance to the publick, and therefore worthy of the utmost attention.

It has, indeed, been of late the fashion to ascribe every grand or unusual operation of nature, such as lightening and earthquakes, to

electricity; not, as one would imagine, from the manner of reasoning on these occasions, that the authors of these schemes have, discovered any connection betwixt the cause and effect, or saw in what manner they were related; but, as it would seem, merely because they were unacquainted with any other agent, of which it could not positively be said the connection was impossible.

But of these, and many other interesting circumstances, the reader will be more satisfactorily informed in the following letters, to which he is therefore referred by

The EDITOR.



LETTER I.

FROM

Mr BENJ. FRANKLIN, in *Philadelphia*.

TO

Mr PETER COLLINSON, F.R.S. *London.*

July 28, 1747.

SIR,



THE necessary trouble of copying long letters, which perhaps when they come to your hands may contain nothing new, or worth your reading (so quick is the progress made with you in Electricity) half discourages me from writing any more on that subject. Yet I cannot forbear adding a few observations on M. *Muschenbroek's* wonderful bottle.

1. The non-electric contain'd in the bottle differs when electrified from a non-electric electrified out of the bottle, in this: that the electrical fire of the latter is accumulated *on its surface*, and forms an electrical atmosphere round it of considerable extent: but the electrical fire is crowded *into the substance* of the former, the glass confining it.

2. At the same time that the wire and top of the bottle, &c. is electrified *positively* or *plus*, the bottom of the bottle is electrified *negatively* or *minus*, in exact proportion: *i. e.* whatever quantity of electrical fire is thrown in at top, an equal quantity goes out of the bottom. To understand this, suppose the common quantity of Electricity in each part of the bottle, before the operation begins, is equal to 20; and at every stroke of the tube, suppose a quantity equal to 1 is thrown in; then, after the first stroke, the quantity contain'd in the wire and upper part of the bottle will be 21, in the bottom 19. After the second, the upper part will have 22, the lower 18, and so on 'till after 20 strokes, the upper part will have a

quantity of electrical fire equal to 40, the lower part none: and then the operation ends: for no more can be thrown into the upper part, when no more can be driven out of the lower part. If you attempt to throw more in, it is spued back thro' the wire, or flies out in loud cracks thro' the sides of the bottle.

3. The equilibrium cannot be restored in the bottle by *inward* communication or contact of the parts; but it must be done by a communication formed *without* the bottle, between the top⁽³⁾ and bottom, by some non-electric, touching both at the same time; in which case it is restored with a violence and quickness inexpressible: or, touching each alternately, in which case the equilibrium is restored by degrees.

4. As no more electrical fire can be thrown into the top of the bottle, when all is driven out of the bottom, so in a bottle not yet electrised, none can be thrown into the top, when none *can* get out at the bottom; which happens either when the bottom is too thick, or when the bottle is placed on an electric *per se*. Again, when the bottle is electrised, but little of the electrical fire can be *drawn out* from the top, by touching the wire, unless an equal quantity can at the same time *get in* at the bottom. Thus, place an electrised bottle on clean glass or dry wax, and you will not, by touching the wire, get out the fire from the top. Place it on a non-electric, and touch the wire, you will get it out in a short time; but soonest when you form a direct communication as above.

So wonderfully are these two states of Electricity, the *plus* and *minus*, combined and balanced in this miraculous bottle! situated and related to each other in a manner that I can by no means comprehend! If it were possible that a bottle should in one part contain a quantity of air strongly compressed, and in another part a

perfect vacuum, we know the equilibrium would be instantly restored *within*. But here we have a bottle containing at the same time a *plenum* of electrical fire, and a *vacuum* of the same fire; and yet the equilibrium cannot be restored between them but ~~by~~ by a communication *without*! though the *plenum* presses violently to expand, and the hungry vacuum seems to attract as violently in order to be filled.

5. The shock to the nerves (or convulsion rather) is occasion'd by the sudden passing of the fire through the body in its way from the top to the bottom of the bottle. The fire takes the shortest course, as Mr Watson justly observes: But it does not appear, from experiment, that, in order for a person to be shocked, a communication with the floor is necessary; for he that holds the bottle with one hand, and touches the wire with the other, will be shock'd as much, though his shoes be dry, or even standing on wax, as otherwise. And on the touch of the wire (or of the gun-barrel, which is the same thing) the fire does not proceed from the touching finger to the wire, as is supposed, but from the wire to the finger, and passes through the body to the other hand, and so into the bottom of the bottle.

EXPERIMENTS *confirming the above.*

EXPERIMENT I.

Place an electrised phial on wax; a small cork-ball suspended by a dry silk-thread held in your hand, and brought near to the wire, will first be attracted, and then repelled: when in this state of repellency, sink your hand, that the ball may be brought towards

the bottom of the bottle; it will there be instantly and strongly attracted, 'till it has parted with its fire.

If the bottle had an electrical atmosphere, as well as the wire, an electrified cork would be repelled from one as well as from the other.

EXPERIMENT II.

FIG. 1. From a bent wire (*a*) sticking in the table, let a small linen thread (*b*) hang down within half an inch of the electrised phial (*c*). Touch the wire of the phial repeatedly with your finger, and at every touch you will see the thread instantly attracted by the bottle. (This is best done by a vinegar cruet, or some such belly'd bottle). As soon as you draw any fire out from the upper part by touching the wire, the lower part of the bottle draws an equal quantity in by the thread.

EXPERIMENT III.

FIG. 2. Fix a wire in the lead, with which the bottom of the bottle is armed, (*d*) so as that bending upwards, its ring-end may be level with the top or ring-end of the wire in the cork (*e*), and at three or four inches distance. Then electricise the bottle, and place it on wax. If a cork suspended by a silk thread (*f*) hang between these two wires, it will play incessantly from one to the other, 'till the bottle is no longer electrised; that is, it fetches and carries fire from the top to the bottom of the bottle, 'till the equilibrium is restored.

EXPERIMENT IV.

{6}