

VI. *An Account of some new Electrical Experiments.* By  
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*F. R. S.*

DESCRIPTION AND USE OF THE ATMOSPHERICAL  
 ELECTROMETER.

Read Dec. 19,  
 1776. **F**IG. I. represents a very simple instrument, which I have contrived for making observations on the electricity of the atmosphere, and which on several accounts seems to be the most useful instrument hitherto invented for that purpose. AB is a common jointed fishing-rod, without the last or smallest joint. From the extremity of this rod proceeds a slender glass tube c, covered with sealing-wax, and having a cork d at its end, from which a pith-ball electrometer is suspended. HGI is a piece of twine fastened to the other extremity of the rod, and supported at G by a small string FG. At the end I of the twine a pin is fastened, which, when pushed into the cork d, renders the electrometer E uninfused.

When

When I intend to observe the electricity of the atmosphere with this instrument, I thrust the pin *i* into the cork *D*, and holding the rod by its lower end *A*, project it out of a window in the upper part of the house, into the air, raising the end of the rod with the electrometer so as to make an angle of about  $50^{\circ}$  or  $60^{\circ}$  with the horizon. In this situation I keep the instrument for a few seconds, and then pulling the twine at *H*, I disengage the pin from the cork *D*, which operation causes the string to drop in the dotted situation *LK*, and leaves the electrometer insulated, and electrified with an electricity contrary to that of the atmosphere. This done, I withdraw the instrument, and examine the quality of the electricity without any obstruction either from wind or darkness.

With this instrument I have made observations on the electricity of the atmosphere several times in a day, and have kept a journal of those experiments from the 27th of September last to this day.

The following is the most remarkable part of the above-mentioned journal, in which I have noted the electricity of the electrometer, that is the contrary of that in the atmosphere.

The stroke ——— signifies *as above*.

Time of Observation.	Clouds.	Fog.	Wind.	Opening of the Electrometer in inches.	Electricity.
Oct. 19th, 10½ o'clock.	Cloudy.	{ Very little at a distance.	{ Very strong.	$\frac{1}{10}$	Negative.
11	—	—	—	—	—
2	Heavy clouds.	—	Violent.	$\frac{3}{4}$	Positive.
2½	Less cloudy.	—	Little.	1	—
3	Few at a distance.	—	—	$\frac{1}{2}$	Negative.
8	o	o	—	—	—
Oct. 31st, 11 post mer.	—	—	o	$\frac{1}{2}$	—
Nov. 6th, 11 post mer.	—	Very thick.	—	1	—

From the above-mentioned journal I have deduced the following general observations.

1st, That there is in the atmosphere at all times a quantity of electricity; for whenever I use the above described atmospherical electrometer it always acquires some electricity.

2dly, That the electricity of the atmosphere or fogs is always of the same kind, namely positive; for the electrometer is always negative, except when it is evidently influenced by heavy clouds near the zenith.

3dly, That the strongest electricity is observable in thick fogs, and the weakest when the weather is cloudy and there is a strong appearance of rain; but it does not seem to be less at night than in the day-time.

DESCRIPTION OF THE ELECTROMETER FOR  
THE RAIN.

THE rain-electrometer is, in its principle, nothing more than an insulated instrument to catch the rain, and by a pith-ball electrometer to show the quantity and quality of its electricity.

Fig. 2. represents an instrument of this kind, which I have frequently used, and after several observations have found to answer very well. ABCI is a strong glass tube about two feet and a half long, having a tin funnel DE cemented to its extremity, which funnel defends part of the tube from the rain. The outside surface of the tube from A to B is covered with sealing-wax, as also that part of it which is covered by the funnel. FD is a piece of cane, round which several brass wires are twined in different directions, so as to catch the rain easily, and at the same time to make no resistance to the wind. This piece of cane is fixed into the tube, and a slender wire proceeding from the former goes through the bore of the tube, and communicates with the strong wire AG, which is thrust into a piece of cork fastened to the end A of the tube. The end G of the wire AG is formed into a ring, from

H 2

which

which I suspend a more or less sensible pith-ball electrometer as occasion requires.

This instrument is fastened to the side of the window-frame, where it is supported by strong brass hooks at *cb*. The part *H* stands out of the window, with the end *F* a little elevated above the horizon. The remaining part of the instrument passes, through a hole in a glass of the sash, into the room, and no more of it touches the side of the window than the part *bc*.

When it rains, especially in flying showers, this instrument, standing in the situation above described, is frequently electrified; and by the diverging of the electrometer the quantity and quality of the electricity of the rain may be observed, without any danger of mistake. With this instrument I have observed that the rain is generally electrified negatively, and sometimes so strongly, that I have been able to charge a small coated phial at the wire *AG*.

This rain-electrometer should be fixed in such a manner that it may be easily taken from and replaced at the window as occasion may require; for it will be necessary to clean it very often, particularly when a shower of rain is approaching.

EXPERIMENTS MADE WITH A GLASS TUBE HERMETICALLY SEALED, AND HAVING SOME QUICKSILVER INCLOSED IN ITS CAVITY.

IN making some experiments rather foreign to electricity, it occurred to me, that when I agitated some quicksilver in a glass tube hermetically sealed, and in which the air was very much rarefied, it contracted a very sensible quantity of electricity; which however was not constant, nor, as I first thought, in proportion to the agitation of the quicksilver. Being desirous of ascertaining the properties of this tube, I constructed several of them, and, as accurately as I could, observed their properties; but as they all agreed with regard to the chief points, I shall only describe one, which is the best I have yet made.

This tube is two feet and seven inches long, and about four tenths of an inch in diameter: the quicksilver in it may be about three quarters of an ounce, and to exhaust it of air, I closed it whilst the quicksilver was boiling in its opposite end.

Before I use this instrument I warm it a little and clean it; then holding it nearly horizontally, I let the quicksilver in it run from one end of the tube to the other,

other, by gently and alternately elevating and depressing its extremities. This operation immediately renders the outside of the tube electrical, but with the following remarkable property, *viz.* that part or end of the tube where the quicksilver actually stands is positive, and the remaining part negative. If, by elevating this positive end of the tube a little, I let the quicksilver run to the opposite end which was negative, then the former instantly becomes negative and the latter positive. The positive end is always more strongly electrical than the negative. If when one end of the tube (which we call A) is positive, that is, if, when the quicksilver is in it, I do not take off the electricity; then on elevating it so as to let the quicksilver run to the opposite end B, the end A becomes negatively electrified in a very small degree: if I make it positive a second time, and do not take off that positive electricity; then, on elevating it again, it appears to be positive in a small degree: but if whilst it is positive I take off that positive electricity, then on being elevated it appears strongly negative.

These appearances I would explain in the following manner: the quicksilver agitated within the cavity of the tube acts like a rubber, that is, excites the inside surface of the tube positively, and becomes itself negative. Now when the quicksilver, negatively electrified, is on one

end of the tube, the outside of the glass, by the known property of charged electrics, must be positive. The remaining part of the tube being positive on its inner surface, must be negative on the outside. But as there is a *vacuum* within the tube, it may be asked, why is not the equilibrium between the negative electricity of the quicksilver and the positive electricity of the glass instantly balanced?

When about two inches of each extremity of this tube are coated with tin-foil, that coating assists to make the electricities more conspicuous.

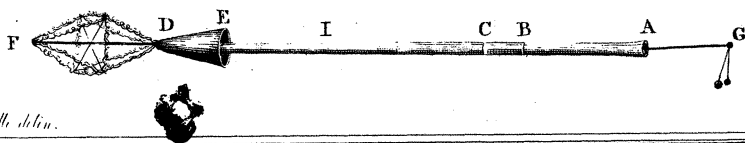
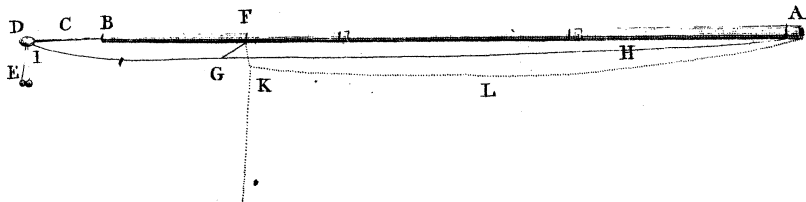
With regard to the construction of such tubes (which I have made of several lengths from nine inches to two feet seven inches) I find that some will act very well, while others will hardly acquire any electricity at all, even when they are made very hot. I am not as yet thoroughly satisfied with respect to the cause of this difference, but suspect that the thickness of the glass is more concerned in it than any thing else; for I find that a tube whose glass is about one twentieth of an inch thick, answers better than either a thicker or a thinner one.

November 13, 1776.





Fig. 1.



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Fig. 1.

Fig. 5.

Fig. 2.

Fig. 6.

Fig. 3.

Fig. 7.

Fig. 4.