

LXXI. *A Letter from John Canton, M. A. and F. R. S. to Benjamin Franklin, L.L. D. and F. R. S. containing some Remarks on Mr. Delaval's Electrical Experiments.*

Dear Sir,

Read Feb. 4,
1762, **M**R. Delaval, in his curious electrical experiments, found that Portland stone, common tobacco-pipe, &c. would readily conduct the electrical fluid, when very hot, or when quite cold; but were non-conductors in an intermediate state. As no one, that I know of, has yet attempted to account for this, I shall submit the following solution to your judgment.

The stone, tobacco-pipe, wood, &c. I apprehend, conduct when cold, by the moisture they contain in that state; when their moisture is evaporated by heat, they become non-conductors; and when they are made very hot, the hot air at, or near their surfaces, will conduct, and the bodies appear to be conductors again.

To prove that hot air will conduct the electrical fluid, let the end of a poker, when red-hot, be brought, but for a moment, within three or four inches of a small electrified body, and its electrical power will be almost, if not entirely destroyed.

And if excited amber, &c. be held within an inch of the flame of a candle, it will lose its electricity

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tricity before it has acquired a sensible degree of heat (1).

That glass is a conductor in damp weather, on account of the moisture on its surface, is well known; as also, that warming it a little will render it a non-conductor; and that a great degree of heat will make it seem to be a conductor again. Now tobacco-pipe, wood, &c. will not only attract the moisture of the air to their surfaces, but will also absorb it; whence they are conductors in dry weather; and require more heat than glass, as well as a longer continuance in it, to render them non-conductors. It is remarkable, that tobacco-pipe, after it begins to cool, will become a conductor again, sooner than most other substances, and much sooner than wood. The cause of this appears to me, to be the tobacco-pipe's absorbing the moisture of the air faster than most other

(1) I have observed also, that the Tourmalin, Brazil Topaz, and Brazil Emerald, will give much stronger signs of electricity while cooling, after they have been held about a minute within two inches of an almost surrounding fire, where the air is a conductor, than they ever will after heating them in boiling water. And if both sides of either of those stones be equally heated, but in a less degree than will make the surrounding air a conductor, the electricity of each side, whether *plus* or *minus*, will continue so, all the time the stone is both heating and cooling; but will increase while it is heating, and decrease while it is cooling. Whereas, if the heat be sufficient to make the surrounding air conduct the electric fluid from the positive side of the stone to the negative side of it, while heating; the electricity of each side will increase, while the stone is cooling, and be contrary to what it was, while the stone was heating. See the Philosophical Transactions, Vol. LI. p. 403 and 404.

substances,

substances, and much faster than wood: for the surfaces of tobacco-pipe and wood being wetted, the surface of the wood will continue wet much longer than the surface of the tobacco-pipe.

That tobacco-pipe does not become a non-conductor by a particular degree of heat, without evaporating its moisture, is evident, from the following experiments. If three or four inches of one end of a tobacco-pipe, of more than a foot in length, be made red-hot, without sensibly heating the other end; this pipe will prove a ready conductor, through the hot air surrounding one part of it, and the moisture contained in the other; although some part of it must have the degree of heat of a non-conductor. But if the whole pipe be made red-hot, and suffered to cool, till it has only superficial moisture enough to make it a good conductor; and then three or four inches of one end be again made red-hot, it will become a non-conductor. And if a nail be placed at, or near each end of a longish solid piece of any of the absorbent bodies above-mentioned, so that the point of each nail may be about half the thickness of the body, within its surface; this body, by heat, may be made a non-conductor externally, or superficially, while it remains a good conductor internally: for the electric fluid will pass readily from one nail to the other, through the middle of the body, when it will not pass on its surface; and even when the internal parts of the body are in an equal degree of heat with the external; as they must soon be, after it begins to cool. But if the same body be exposed, for a short time, to a greater degree of heat than before; or if it be kept

kept longer in the same heat, it will become a non-conductor entirely.

In making the above experiments, I used the little electrometer, which I have described in the forty-eighth volume of the Philosophical Transactions, p. 783, and supported it by sealing-wax, or warm glass.

I well remember your acquainting me, that Mr. Delaval did not approve of the above manner of accounting for his experiment on tobacco-pipe, soon after you related it to him, which was some time last summer: but as it still appears satisfactory to me, notwithstanding what that gentleman has lately offered against it (2), your laying it before the Royal Society will oblige,

Dear Sir,

Your most obedient

and most humble servant,

Spital-Square,
January 21, 1762.

John Canton.

(2) See a Letter from Mr. Delaval to Mr. Wilson, in the first part of the fifty-second volume of the Philosophical Transactions.

P. S. Having formerly observed, that the friction between Mercury and Glass *in vacuo*, would not only produce the light of electricity, as in the luminous barometer, or within an evacuated glass ball, but would also electrify the glass on the outside; I immersed a piece of dry Glass in a basin of Mercury, and found, that by taking it out, the Mercury was electrified *minus*, and the Glass electrified *plus*, to a considerable degree. I found also, that Amber, Sealing-wax, and Island Crystal, when taken out of Mercury, were all electrified *positively* (3). How does it then appear, that the electricity, which was observed upon rubbing the last mentioned substance, after it was taken out of Mercury surrounded by Ice, was owing to *cold*, and not to the *friction* between it and the Mercury, in taking it out? Island Crystal, when *warm*, is a non-conductor; and all non-conductors may be excited with proper rubbers.

(3) A small quantity of an *amalgama*, or mixture, of Mercury and Tin, with a very little Chalk or Whiting, being rubbed on the cushion of a globe, or on the oiled silk-rubber of a tube, will excite the globe or tube to a great degree, with very little friction; especially if the rubbers be made more damp, or dry, as occasion may require.