

- I. *Two Letters from Mr. Stephen Gray, F. R. S. to C. Mortimer, M. D. Secr. R. S. containing farther Accounts of his Experiments concerning Electricity.*

L E T T E R I.

S I R,

ACCORDING to my Promise, I herein give an Account of what farther I have discover'd relating to Electrical Attraction, which I should have done sooner, but was willing to see what farther Improvement I could make to those Experiments, at my Return to *London*, which were begun in the Country.

About the latter End of *August*, being at Mr. *Wheler's*, after having repeated the Experiment of making Sulphur attract Leaf-Brafs *in vacuo*, Mr. *Wheler* having a very good Air-Pump of the larger Sort, made by Mr. *Hauksbee*, we suspended from the Top of a Receiver, which was first exhausted of Air, a white Thread that hung down to about the Middle of the same: Then the Receiver being well rubbed, the Thread was attracted by it vigorously. When it was at rest, and hung perpendicular, the Tube was rubbed, and being held near the Receiver, the Thread was attracted towards that Side of it; if the Tube was removed slowly, the Thread returned to the Centre of the Receiver, but when moved swiftly, the Thread

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was attracted by the opposite Side of the Receiver : If the Hand was held near the Receiver, and moved hastily from it, the Thread was attracted by the opposite Side, as before. This seemed at first difficult to account for ; but upon farther Consideration, we concluded it proceeded from the Motion of the Air made by the Tube, and in the other Case by that of the Hand, which took off the Attraction from that Side, and not on the other Side ; so that, as Mr. *Wheler* very well expressed it, by this Means the Balance of the Attraction was taken off.

We made another Experiment by suspending a Thread on the Top of a small Receiver, and wheeling a large one over it ; then by first rubbing this, and holding the rubb'd Tube near it, the Thread in the middle Receiver was attracted to that Side of it where the Tube was held.

An Experiment, shewing that Attraction is communicated through opacous as well as transparent Bodies, not in vacuo.

There was taken a large Hand-Bell, the Clapper being first taken out, and a Cork suspended by a Thread from the Top of the Bell, the Cork being smeared over with Honey : Then the Bell was set on a Piece of Coach-Glass, which had been well rubbed, on which the Leaf-Brass was laid ; then the Tube being rubbed, and held near the Handle of the Bell, and afterwards near the Top and Side of the same, the Bell being taken off, there were several Pieces of the Leaf-Brass sticking to the honey'd Cork that had been attracted by it : It appeared also that some others
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of them had been attracted by the Bell, being removed from the Places they were left in when covered by it.

Some time after Mr. *Wheler* told me of an Experiment he had made *in vacuo*, when I was gone from him. He took a small Receiver, and in it suspended a Thread, and over this four other Receivers, all exhausted, and the Thread was attracted through all the five Receivers, and he thought the Attraction was rather stronger than before, when a single Receiver only was made use of; but instead of wet Leather, he made use of a Cement I had recommended to him, *viz.* Bees-Wax and Turpentine, which was what Mr. *Boyle* made use of in his Experiments with the Air-Pump, and that, as I had told him, it was my Opinion the Attractions would be much stronger, the Steams of the wet Leather taking off some of the attracting Force.

I shall now proceed to give some Account of the Experiments made at Mr. *Godfrey's*; the first of which was giving an Attraction by the Tubeto a Boy suspended on Hair-Lines, and that by the Intervention of a Line of Communication, the attractive Virtue passes to another Boy that stands at several Feet distant from him. But before I go any farther, it may not be improper to give an Account of that Experiment of the attractive Power that is communicated to the Boy standing on Rosin; which though the Society have seen the Experiment, I have not given you any Account of it in Writing.

June the 16th, 1731, in the Morning, I made the following Experiment on the Boy mentioned, causing him to become Attractive by suspending

him on Hair-Lines. There was taken two Pieces of white Rosin made into round flat Cakes of somewhat more than eight Inches Diameter, and two Inches thick. These were laid down on the Floor of my Chamber, so near together, that the Boy might stand with one Foot upon one, and the other upon the other Cake of Rosin: Then the Leaf-Brafs being laid under his Hands, the Tube rubb'd and held near his Legs, caus'd both his Hands to attract and repel the Leaf-Brafs to the Height of several Inches: Or if there was laid Leaf-Brafs under one Hand, and the Tube held near the other Hand, there was an Attraction communicated to the farther one; and when the Tube was applied either to his Hands or Feet, there was an Attraction given to his Cloaths; so that a Piece of white Thread being held by one End, the other End would be attracted at near the Distance of a Foot; so that the Attraction is altogether as strong, if not stronger, than when the Boy was suspended on Hair-Lines.

I come now to the above-mentioned Experiment: One of the Boys being suspended on the Hair-Lines, and the other standing upon the two Cakes of Rosin, the Boys holding Hands with each other, under the Boy's Hand that stood on the Rosin was laid the Leaf-Brafs; then the Tube being rubb'd, and held near the Boy's Feet that hung on the Hair-Lines, the Hand of the Boy that stood on the Rosin attracted strongly. Then there was taken a four Foot Rule, and given to the Boys to hold by each End, and there was the same Vertue of Attraction given to the other Boy as before. After this a Line of Packthread was given them to take hold of by the Ends, and there was an Attraction

traction communicated from one End to the other, with as much Vigour as by any of the other Methods before mentioned. This Experiment was made *September 13, 1732.*

September 14 I first made the following Experiment. There was taken a Rod which was composed partly of Wood and partly Cane: It was twenty-four Feet in Length, and in Form not unlike two Fishing Rods suppos'd joined together at their bigger Ends. This Rod was suspended Horizontal by two Threads of Silk: Over this, at about two Feet from the End, was suspended a small hazel Wand, about five Feet long, at right Angles to it, but not touching the Rod: Then going to the other End of the Rod, the Tube being excited and held near it, repeating the same three or four times as usual, and going to the hazel Wand with a small white Thread, I found that it was attracted to it when held near to any Part thereof. The next Day Mr. *Wheler* came to Mr. *Godfrey's*, and now, by their Assistance, I repeated the Experiment, and we found that by suspending the Wand at several Heights, we could perceive there was an Attraction, when it was at the Height of more than twelve Inches. I shall now give some Account of my repeating, and what farther Improvements I have made to some of these Experiments since my Return to *London.*

September 29th I repeated the Experiment on two Boys, first setting one of them on Cakes of Rosin, and the other being suspended on the Hair-Lines, and the Effect was the same as hath been above related. I then caused both the Boys to stand on Cakes of Rosin, giving them to hold a Part of a *Spanish* Cane-Fishing-

Fishing-Rod that was eight Foot long, one Boy holding one, and the other Boy the other End of the Rod; then the Leaf-Brafs being laid on the Stand, and one of the Boys holding his Hand over it; I went to the other Boy, and the excited Tube being held near the Palm of his Hand, the first Boy's Hand attracted and repelled the Leaf-Brafs strongly. Then there was a Piece of Packthread given them to hold by each End, about the same Length with the Rod, *viz.* eight Feet long. Under each of their Hands was laid Leaf-Brafs; then going to the middle of the Line, holding the Tube near it, the farther Hand of both the Boys attracted the Leaf-Brafs with so much Vigour, that it is not to be doubted that had the Line been much longer, they would have attracted at a far greater Distance. I then caused the Boys to stand on the Cakes of Rosin, so as to let the Flaps of their Coats touch, and then by holding the Tube to one of their Hands, the other Hand attracted, but not with more Force than when they were distant the Length of the Line. Then they stood so much farther as not to let their Coats touch by about an Inch, and then exciting one of them to attract, the other received not the least Degree of Attraction. I then bid one Boy put his Finger upon the other Boy's Wrist, and then he immediately became Electrical.

October the 4th I made the following Experiment: A Fishing-Rod of about ten Feet eight Inches long, being horizontal, and over it, towards the lesser End, a small Rod, being the Top End of another Fishing Rod, at the lesser End, which was Whale-Bone, there was put on a Ball of Cork two Inches Diameter, the

the small Rod touching the great one ; then the Tube being excited, and held near the great End of the great Rod, applying it as usual ; then going to the Cork with a pendulous Thread, I found it attracted it at the Distance of at least two Inches. Then the Rod was moved higher, so as not to touch the End of the long Rod, by Estimation about an Inch, and after several Trials, there was a visible Attraction, when the little Rod that carried the Ball was above the great one thirty-four Inches.

October the 5th, I took a Line of Packthread seventeen Feet four Inches long, with silk Lines tied to the Ends of the Packthread, one of them about four the other two Feet long, near two of the opposite Corners of my Chamber, where in each of them was drove a Hook at about three Foot and a half high, to which the Ends of the Silk were fastened, drawn so tight as to bear the Packthread nearly Horizontal : Then the small Part of the Fishing-Rod was suspended over the Packthread at about four Feet from the End ; then the Tube being applied to the other End of the Packthread, the Cork Ball at the End of the little Rod was attractive, and at several Removes, to the Height of forty-seven Inches, there was a visible Attraction of the pendulous Thread.

October the 6th, instead of the small Rod, I took a Packthread about four Feet long, and having tied silk Threads to each End, by which the Thread was suspended over the longer Line Horizontal, and at right Angles nearly to the said Line, which was by tying the Ends to perpendicular Lines of Packthread that were fastened to Hooks at each End, and had sliding Knots on them, so that the cross Line might be moved

moved higher or lower as there was Occasion for it; upon one End of this Line I put a Ball of Cork, and found, that when the first Line had been excited the Vertue was carried up to the second Line, and caused the Cork Ball to attract. I then took off the Cork Ball, and put one of Ivory in its Place, and this attracted after the same manner; and afterwards I hung two Ivory Balls, one at one End, and the other at the other End of the Line, and found there was a sensible Attraction when the Line that supported them was raised thirty-eight Inches above the Line of Communication.

October the 30th I repeated this Experiment, and now when the Line that supports the Ivory Balls was elevated about an Inch above the communicating Line, either Ball attracted the Thread at the Distance of more than a Semi-diameter of the Ball, and at the Height of ten Inches, at least half the same Distance.

By these Experiments we find, that the Electric Vertue may not only be carried from the Tube by a Rod or Line to distant Bodies, but that the same Rod or Line will communicate that Vertue to another Rod or Line that is at a Distance from it, and by that other Rod or Line the Attractive Force may be carried to other distant Bodies. I am,

S I R,

Yours, and the Royal Society's,

Most Obedient Humble Servant,

*Charter-House,
Oct. 15, 1732.*

Stephen Gray.

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L E T T E R II.

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THE Subject of Electrical Attraction at a Distance, without any Contact of the Line of Communication either by the Tube, or the said Line not touching the Attracting Body, being so very surprizing, I presume the following Account of the Experiments I have since my last made on that Subject, may not be unacceptable to the Society.

A small Hoop of about twenty Inches Diameter, and an Inch and a half in Breadth, being suspended by two Threads of Silk, so as that it hung perpendicular, and in a Plane at right Angles to the horizontal Line of Communication, which pass'd through, or at least very near to the Center of the Hoop, I went to the End of the said Line, and applying the excited Tube near it, there was an attractive Influence communicated to the Hoop in all Parts of it. Then by a Skrew-Hole made in the Side of the Hoop for that Purpose, I skrewed it upon the Top of a Pedestal that was about two Feet and a half in Height, setting it upon a Cake of Rosin, so as that the before mentioned Line might pass through the Center of the Hoop, and found that whether the Hoop was placed so as its Plane was at right Angles, or in any other Angle with the Line of Communication, the Hoop attracted after the same manner as it had done when suspended on the silk Lines.

Some time after I made the following Experiment. Into the Nose of a Glass Funnel I put the larger

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End of the Top of a small Fishing-Rod, and upon the lesser End a Ball of Cork ; then the Funnel was set on the Floor of the Room so as that the Rod was at some Inches distance from the Line of Communication ; then the Tube being excited, and applied near the End of the Line, the Electric Vertue was conveyed by it to the Cork Ball, and it attracted strongly when the Ball was, by Estimation, not less than two Feet Distance from the aforesaid Line.

December 11, there being a hard Frost, and a fair Day, I repeated the Experiment, making use of a large Hoop that was about forty Inches Diameter, and setting it perpendicular upon a hollow Cylinder of Glass, which was six Inches long, and five Inches and a half Diameter, so placing the Hoop that the Line of Communication might pass through, or at least very near to the Center of the Hoop ; then applying the Tube to the End of the Line, there was an Attraction communicated to all Parts of the Hoop, attracting a pendulous white Thread at the Distance, by Estimation, of about half an Inch. I then set the Hoop so as the inward Surface of the Hoop might touch the Line, and then communicating an Attraction by the excited Tube to the Packthread, the attractive Vertue was carried by it to the Hoop, and caused it to attract with that Force, as with the remotest Part of the Hoop to attract the Thread at a Distance, by Estimation, of about four Inches.

Some time after the foregoing, I made the following Experiment. The large Hoop being set upon the Glass Cylinder, and the Packthread passing through, or near its Center, the Tube being applied near

near the Hoop gave it a strong Attraction, so that it would attract a Thread at the Distance of seven or eight Inches; and at the same time there was an Attraction communicated to the Packthread. Then I suspended an Ivory Ball, of two Inches Diameter, at the other End of the Packthread, and applying the Tube to the Hoop, there was an Attractive Vertue carried to the Ball, and it would attract the pendulous Thread at the Distance of near an Inch. I then placed the Ball in or near the Center of the Hoop, and now it was so far from being attracted, that it was repelled by the Ball, but was attracted by the Packthread passing to it in the Arch of a Circle, whose Center seem'd to be that of the Ball.

This is all that I have at present to communicate, who am,

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The Society's, and your

Most humble Servant,

Stephen Gray.