LXXXVIII. *Extract of a Letter from* John Lining, *M. D. of* Charles Town, *in* South Carolina, *to* Charles Pinckney, *Esq; in* London: *With his Answers to several Queries sent to him concerning his Experiment of Electricity with a Kite.*

Charles Town, January 14, 1754.

Read May 4, 1754.

INcloſed I ſend you anſwers to the queries, which you ſent me concerning the experiment with the kite.

Since I made that experiment laſt May, I have not had an opportunity of making any more, having been confined all the ſummer and autumn with the gout, which perhaps prevented my meeting with the ſame unhappy fate with profeſſor Richman. In the London Daily Advertiſer, Thurſday 27 September laſt, there is a more particular account of that unhappy accident. From that account it appears, that the profeſſor had a wire, which came down from the iron rod, erected on his houſe, through the gallery-ceiling, to an iron bar, which ſtood in a glaſs veſſel, which was filled with water and filings of braſs; and that the profeſſor ſtood ſo near that iron rod, that his face was within a foot of it. Now if there was no wire, that went from that iron rod, or from any part of the wire above it, into the earth, it is no great wonder, that the profeſſor was killed. I ſhould be extremely glad to be informed, whether the iron rod upon his houſe, at the time the experiment was made,

made, had any communication, by means of metal, with the earth. For, if it had, there is then more danger attending theſe experiments than I imagined. It is likewiſe ſaid in that paper, that from the electrical needle, which he obſerved, there was no danger. I am at a loſs to know what that electrical needle was, and ſhould be glad to be informed. I know, that a magnetic needle placed on a ſharp point upon the prime conductor, as ſoon as the conductor is ſufficiently electrified, will move round with ſo great rapidity, that in the dark the electricity, thrown off from both poles of the needle, will appear like a circle of fire.

Anſwers of Dr. Lining *to the Queries ſent to him.*

Query 1. In what manner, and of what materials, was your kite, and the ſtring, by which you flew it, made? and to what height did it riſe above the earth?

Anſwer. The kite, which I uſed, was made in the common way; only, in place of paper, I covered it with a ſilk, called *alamode*. The line was a common ſmall hempen one of three ſtrands. A ſilk line, except it had been kept continually wet, would not conduct the electricity; and a wire, beſides other inconveniencies, would have been too heavy. I had not any inſtrument, whereby I could take the height of the kite; but, I believe, it was at leaſt 250 feet high. It was flown in the day-time.

Query 2. You ſay alſo, "*All* the electrical fluid, "or lightning, was drawn from the cloud, and diſ-"charged in the air; and a greater degree of ſere-"nity ſucceeded, and no more of the awful noiſe

" of thunder, before expected, was heard." Now I ſhould be glad you would inform us, whether the ſerenity in the air you mention, was ſuch, as generally follows, after the clouds in the ſummer thunder-ſtorms have diſcharged ſeveral loud thunder-claps; and whether any flaſhes of lightning appeared in the ſkies, after you had diſcharged the cloud of its lightning by the kite, as commonly do after a thunder-ſtorm is over in a ſummer's night? For if there were no appearance of ſuch flaſhes, then, I think, your aſſertion, that *all* the electric fluid, or lightning, was drawn from the cloud, ſtands fully proved; but if there were ſuch flaſhes after, I conceive there muſt have been ſome of the electrical matter left behind.

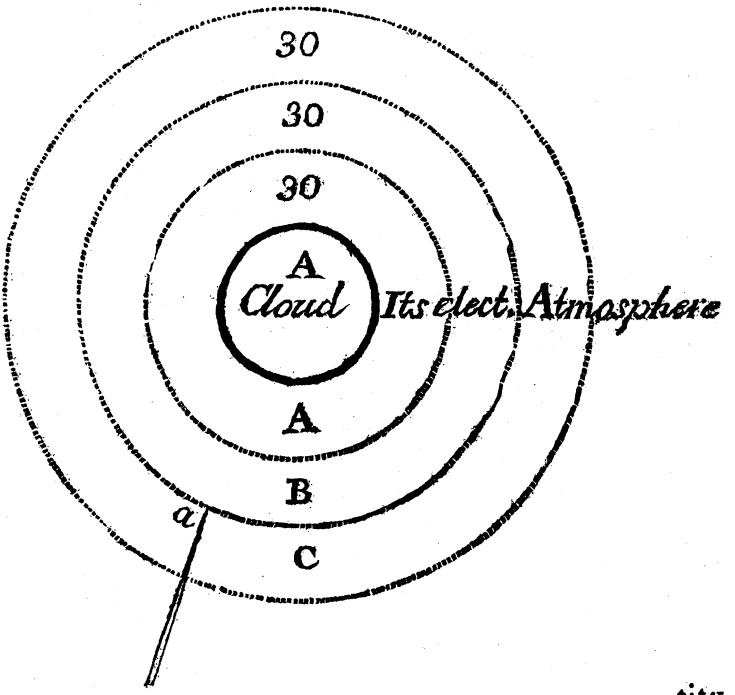
Anſwer. During the time of my drawing the lightning from the cloud, and for ſome little time afterwards, it rained; by which means, the body of the cloud being diminiſhed, a greater degree of ſerenity neceſſarily ſucceeded; and the quantity of lightning extracted from the cloud, or rather its atmoſphere, proved ſufficient to prevent any thunder in town that afternoon; though there was a great appearance of thunder before the kite was raiſed. But whether the ſame ſerenity ſucceeded, as frequently happens after a thunder-ſtorm, and whether there were any flaſhes of lightning ſeen in the evening, I cannot now recollect. If ſuch flaſhes had afterwards been ſeen in the ſkies, as is common in a ſummer's evening, eſpecially after a thunder-ſtorm, thoſe might proceed from other clouds, which had paſſed the town, at too great a diſtance to be acted upon by the kite.

If three electrified clouds (which we ſhall call) *A*, *B*, and *C*, paſs from weſt to eaſt, and are ſo ſituated to one another, and to this town, that the cloud *B* is not only in breadth and length equal to the area of the town, but vertical over it, having an electrical atmoſphere, which reaches low enough to be acted upon by ſharp points, either raiſed by kites, or erected upon the houſes; then the cloud *B* may be ſo far deprived of its electricity, before it has paſſed over the town, as to be incapable of giving any flaſhes of lightning, till it meets with other leſs electrified clouds, and approaches very near them. But the clouds *A* and *C*, being at too great a diſtance, in their paſſage by the town, to be acted upon by thoſe points, fly on in their electrical ſtate, till they meet with clouds, or other bodies, in a non-electric ſtate, or at leaſt with thoſe, which have a leſs degree of electricity. If the cloud (ſuppoſe) *A* meets, or rather approaches afterwards near enough, the cloud *B*, which was deprived of great part of its electricity, or any other non-electric cloud, it will diſcharge at once part of its electricity into *B*, or the non-electric cloud; and if into the latter, which we ſhall call *D*, in that exploſion, it will deliver ſo much of its electricity to *D*, as will make an equilibrium in electricity between them; *i. e.* if *A* had 100 degrees of electricity, and *D* only its natural quantity, after the exploſion, each will have 50. Then *D* is in a condition to flaſh into a non-electric cloud; but that exploſion will be much weaker than that was from *A*; becauſe *D*, in exploding into a non-electric cloud, will only part with one-half (if thoſe two clouds are of equal dimenſions); that is with 25 degrees

grees of its electricity. But if it exploded upon a houſe, tree, or the like, the loudneſs of that exploſion would be equal to the firſt; as in this caſe, it has an opportunity of parting, at once, with its whole charge of electricity, which, by ſuppoſition, was 50. Hence we ſee, that one electrified cloud *only* may be productive of many claps of thunder; and that thoſe proceeding originally from that cloud, will become weaker, as the whole quantity of electricity may at laſt be divided amongſt many clouds; and from hence ſeveral phænomena, which appear during a thunder-ſtorm, and which ſucceed it, may be accounted for. If therefore any flaſhes of lightning were ſeen that evening, after the experiment with the kite, you ſee how thoſe might be produced, whether the cloud was deprived of its electricity or not.

Electrified clouds have an electrical atmoſphere, as well as the prime-conductor, when it is electrified; and the diameter of that atmoſphere, *cæteris paribus*, will bear ſome proportion to the ſize of the cloud. My ſmalleſt prime-conductor is two inches and an half in diameter; and when it is fully charged, its atmoſphere extends to the diſtance of about three feet from the ſurface of the conductor. How great then muſt the extent be of the atmoſphere, which ſurrounds a large cloud fully electrified? It perhaps may extend to many hundreds of feet round the cloud, and may even reach ſo low as to touch the ſurface of the earth: And when that is the caſe, a man, or a rod of metal, placed on a cake of reſin on the ground, may be electrified, and yield ſparks of fire.

When a ſharp point is preſented to that atmoſphere, it cannot deprive the cloud of its whole quantity of electricity, except the ſharp point be ſo near, that the cloud may explode upon it; and, in that caſe, the cloud muſt have a communication with the ground, by means of ſome non-electric body. Suppoſe an electrified cloud to have an atmoſphere, which extends round it to the diſtance of 90 feet from its ſurface; and let that atmoſphere be divided into three parts *A*, *B*, and *C*, each 30 feet in diameter: Now if a ſharp metalline point (*a*) erected on a kite, or otherwiſe, is placed either vertically or horizontally in the moſt interior part of the atmoſphere *C*, that point will continue to act till a quan-



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tity of the lightning is drawn off, equal to the quantity which was contained in that atmoſphere, and no longer. For then the ſemi-diameter of the atmoſphere being reduced to 60 feet, every part of it is above, and not in contact with, the ſharp point *(a)*, and conſequently beyond its ſphere of action. But let the ſharp point be then advanced into the atmoſphere *B*, and it will act as before, *&c.*

The truth of this, however contradictory it may be, to the general opinion of the action of ſharp points, in drawing off the electricity or lightning *, may be illuſtrated by the following experiment on the prime-conductor. Electrify the prime-conductor in a dark room, and draw back the globe to a ſufficient diſtance from the prime-conductor, to prevent its being ſupplied with any more electricity from the globe, while you are taking off the electrical atmoſphere with a ſharp point. Bring then a ſharp point, either vertically or horizontally, or in any other direction, within two feet of the prime-conductor; and the point, for ſome time, will appear luminous. After that light diſappears, advance the point three or four inches nearer to the conductor, and you will obſerve the ſame phænomena as before; and by advancing the point gradually in this manner, as the light upon it diſappears, the point will be alternately luminous and dark, till you have taken off the whole atmoſphere in different laminæ. As the

* Mr. Franklin ſays, ſpeaking of ſharp points, "At whatever "diſtance you ſee the light, you may draw off the electrical "fire." page ii.

point appears more and more luminous, the nearer that it approaches the prime-conductor, the electrical atmoſphere may have different degrees of denſity, being perhaps denſer near the prime-conductor, and rarer at a greater diſtance from it. If a phial is charged on the prime-conductor, when this experiment is made, the light upon the ſharp point will be much greater, and continue longer.

Query 3. Did you make any trial, at what diſtance you could kill an animal with a diſcharge of the electrical fluid from the key or the bottle ſuſpended to it?

Anſwer. I have not hitherto had an opportunity of making any ſuch experiments with the kite. But as to the firſt, I apprehend, that no animal could be killed by the diſcharge of any quantity of electricity accumulated on the key; as the key in that experiment anſwers the ſame end as the prime-conductor, and, like it, is capable of receiving *only* a certain charge of electricity, except the lightning flows down the line too faſt, or the kite be ſo near the cloud that it may explode, when one ſtanding on the ground approaches the key to draw ſparks from it: but ſuch an exploſion would probably be fatal to the operator.

When a phial is ſuſpended to the key, after it has received its charge, if you let it continue hanging on the key, the ſurcharge will fly off from the hook of the phial, and the phial, when charged in that manner, will not give a greater ſhock than if it had been charged in the common way with the globe.

J. L.