Franklin and Electrostatics-
Ben Franklin as my Lab Partner

A Workshop on Franklin's Experiments in Electrostatics

Developed at the Wright Center for Innovative Science Teaching
Tufts University
Medford MA 02155

by Robert A. Morse, Ph.D.

©2004
Sept. 2004

Part VIII. Franklin's kite experiment

Franklin's description of the kite experiment, Priestley's account of the kite experiment, and descriptions of the many experiments later carried out by others using kites to collect atmospheric electricity.

Copyright and reproduction

Copyright 2004 by Robert A. Morse, Wright Center for Science Education, Tufts University, Medford, MA. Quotes from Franklin and others are in the public domain, as are images labeled public domain. These materials may be reproduced freely for educational and individual use and extracts may be used with acknowledgement and a copy of this notice.These materials may not be reproduced for commercial use or otherwise sold without permission from the copyright holder. The materials are available on the Wright Center website at www.tufts.edu/as/wright_center/

Letter Concerning the Kite Experiment

Bigelow Vol. II p. 378 XCII

To PETER COLLINSON

READ AT THE ROYAL SOCIETY, DECEMBER 21, 1752

PHILADELPHIA, 19 October, 1752.

Sir:—As frequent mention is made in publick papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, &c., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows.

Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, so you have the body of a kite; which, being properly accommodated with a tail, loop, and string, will rise in the air, like those made of paper; but this being silk is fitter to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder-clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. And when the rain has wetted the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from electric fire thus obtained spirits may be kindled, and all the other electric experiments be performed which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.

B. FRANKLIN.

There are many opinions concerning whether Franklin actually did the experiment with the kite. A recent book by Tom Tucker (*Bolt of Fate: Benjamin Franklin and his Electric Kite Hoax*, Parsecs, 2003) argues that he did not do the experiment, as he would have been killed. In fact the experiment was repeated safely many times in the years after Franklin described it. (See review by M. Schiffer, <http://hnn.us/articles/1770.html>)
Priestley recounts the story in the following excerpt.

"As every circumstance relating to so capital a discovery as this (the greatest, perhaps, that has been made in the whole compass of philosophy, since the time of Sir Isaac Newton) cannot but give pleasure to all my readers, I shall endeavour to gratify them with the communication of a few particulars which I have from the best authority."

"The Doctor, after having published his method of verifying his hypothesis concerning the sameness of electricity with the matter of lightning, was waiting for the erection of a spire in Philadelphia to carry his views into execution; not imagining that a pointed rod, of a moderate height, could answer the purpose; when it occurred to him, that, by means of a common kite, he could have a readier and better access to the regions of thunder than by any spire whatever. Preparing, therefore, a large silk handkerchief, and two cross sticks, of a proper length, on which to extend it, he took the opportunity of the first approaching thunder storm to take a walk into a field, in which there was a shed convenient for his purpose. But dreading the ridicule which too commonly attends unsuccessful attempts in science, he communicated his intended experiment to no body but his son, who assisted him in raising the kite."

"The kite being raised, a considerable time elapsed before there was any appearance of its being electrified. One very promising cloud had passed over it without any effect; when, at length, just as he was beginning to despair of his contrivance, he observed some loose threads of the hempen string to stand erect, and to avoid one another, just as if they had been suspended on a common conductor. Struck with this promising appearance, he immediately presented his knucle to the key, and (let the reader judge of the exquisite pleasure he must have felt at that moment) the discovery was complete. He perceived a very evident electric spark. Others succeeded, even before the string was wet, so as to put the matter past all dispute, and when the rain had wetted the string, he collected electric fire very copiously. This happened in June 1752, a month after the electricians in France had verified the same theory, but before he had heard of any thing that they had done."

"Besides this kite, Dr. Franklin had afterwards an insulated iron rod to draw the lightning into his house, in order to make experiments whenever there should be a considerable quantity of it in the atmosphere; and that he might not lose any opportunity of that nature, he connected two bells with this apparatus, which gave him notice, by their ringing, whenever his rod was electrified."

The History and Present State of Electricity, with original experiments, by Joseph Priestley, 1775 Vol. I pp 216-217

Joseph Priestley
Image SIL14-P006-02a
The Smithsonian Libraries
The Dibner Library of the History of Science and Technology
Washington, DC

I. Bernard Cohen, in *Benjamin Franklin's Science*, pp 100-109 discusses the work of Jacques de Romas, who carried out extensive kite experiments with atmospheric electricity, as well as Franklin's friend Ebenezer Kinnersley, and John Lining. Abbé Beccaria used a kite to discover that there are electrical effects even in fair weather. Pieter van Musschenbroek of Leyden jar fame also flew kites to investigate atmospheric electrification.

Schiffer,*Draw the Lightning Down*, (2003, University of California Press) pp. 166-171, describes kite investigations by Bertholon, Cuthbertson and Cavallo. The latter reported hundreds of experiments, and noted that the worst experience was a shock to his arms.

Excerpts from Tiberius Cavallo, *A Complete Treatise on Electricity*, 3rd Ed. Vol II., 1786.

"The first electrical kite that I constructed, was seven feet high; and it was made of paper, with a stick or straighter, and a cane-bow, like the kites commonly used by school boys. On the upper part of the straiter I fixed an iron spike, projecting about a foot above the kite, which I then thought absolutely necessary to collect the Electricity..." Vol II, p. 4.

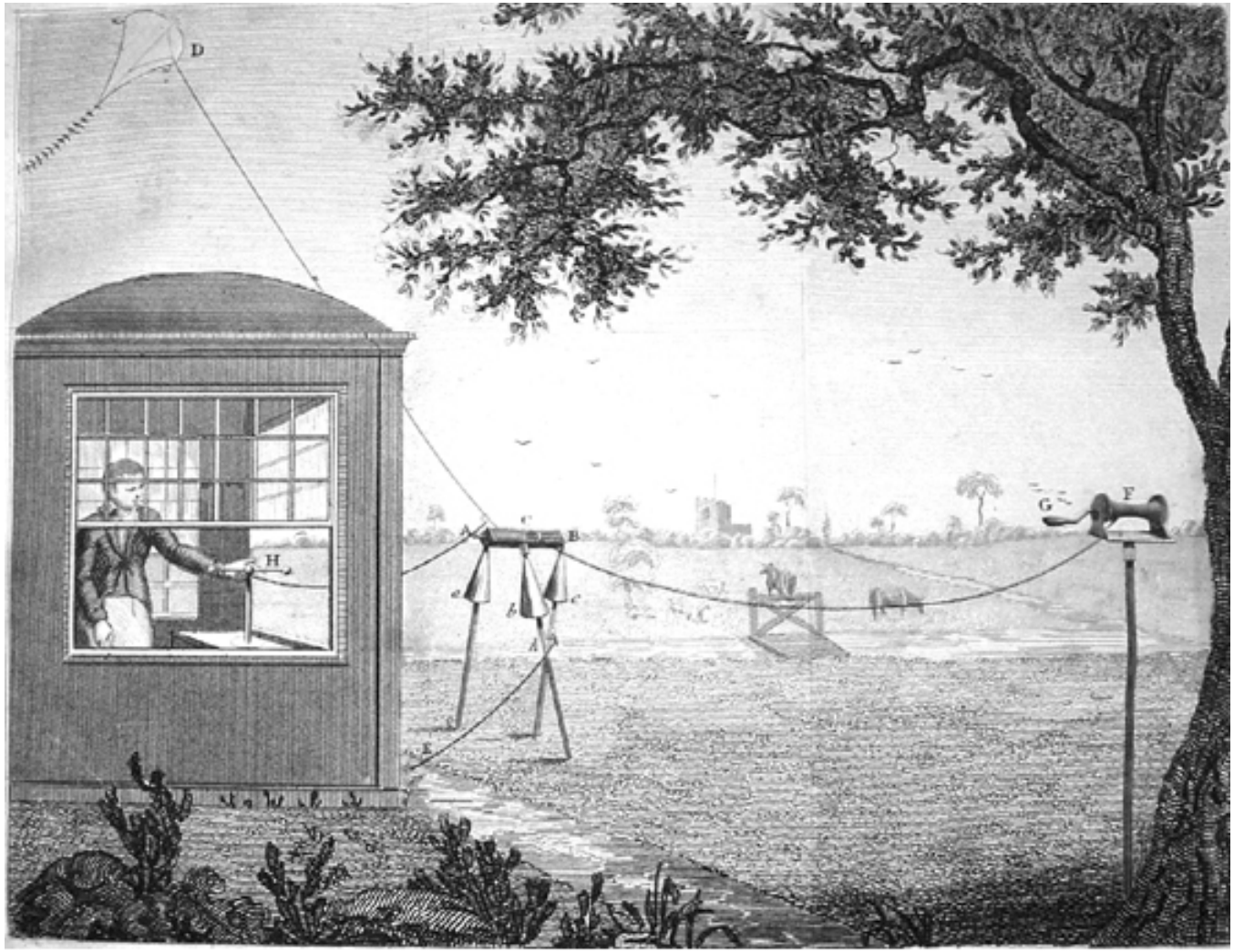
"I gradually lessened their size, and varied their form, till I observed, upon trial, that a common school-boy's kite was as good an electrical kite as mine.....I also furnish the upper extremity of the straiter with a slender wire pointed...the kites that I generally have used are about four feet high,...the best string was one, which I made by twisting a copper thread with two very thin threads of twine." Vol II, pp. 5-6.

Cavallo details about 40 observations made with his kites between September 1775 and January 1777, selected from the many that he made. (pp 15-36). Two examples:

"September the 2nd, 1775. The weather being very cloudy, and actually raining, the kite was raised at eight o'clock P.M. with two hundred yards of string, which had a brass wire through its whole length. The wind was from the south and very strong. The Electricity at the string was negative, and just sufficient to charge a half-pint phial so as to give a shock sensible to the elbows."

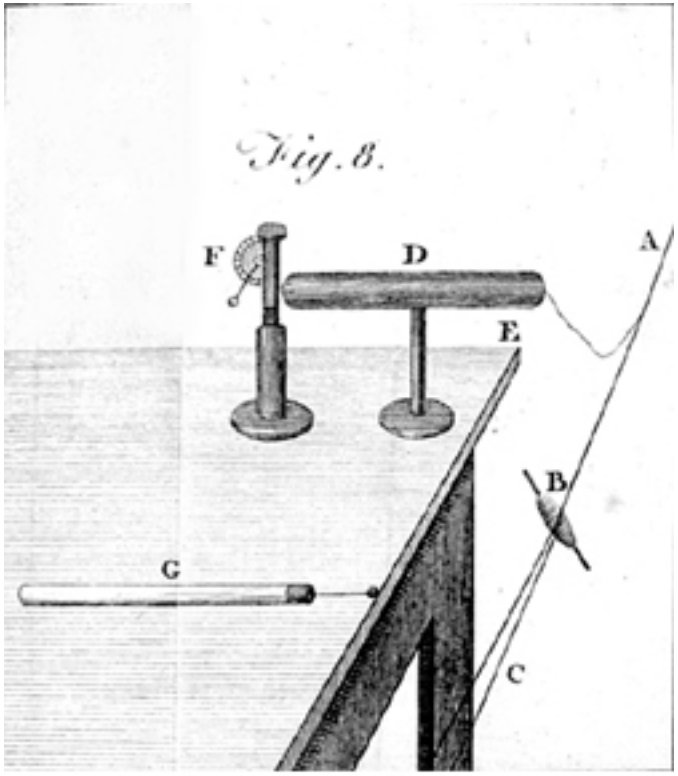
"June the 20th. The weather being cloudy, and the wind east, and just sufficient, the kite was raised at three quarters past three P. M. with one hundred and seventy yards of string. The Electricity was positive, and the index of the electrometer stood about 8^{o}. At five o'clock the weather began to clear up, and the Electricity to increase; so that in half and hour's time, the index of the electrometer arrived to 17^{o}; and at six o'clock stood at 25^{o}. But the wind suddenly failing about this time, the kite fell."

An apparatus for carrying out kite experiments from John Cuthbertson, *Practical Electricity and Galvinism,* 1821. The book also served as a catalog for his instrument making business. Note the insulators and protection for the experimenter.



Equipment for Kite experiments
Frontispiece, John Cuthbertson, *Practical Electricity and Galvanism,*
Second Edition, London, 1821
The Burndy Library, Dibner Institute for the History of Science & Technology, Cambridge, MA

Cavallo would get his kite flying and then lead the string, A, in through an upper window of the house, where he tied it off to the leg C, of a table. The wire from the string was lead to the prime conductor, D, which was connected to an electrometer, F. The insulated rod, G, could be used to draw sparks or transfer small amounts of electrical charge to other apparatus.



Apparatus at end of kite string
Tiberius Cavallo 1786, *Complete Treatise on Electricity*
Third edition, Vol. I Plate I

The Burndy Library, Dibner Institute for the History of Science & Technology, Cambridge, MA

Another experimenter was the Abbé Beccaria, in Italy, who conducted a long series of experiments. Priestley's description:

"All that was done by the French and English electricians, with respect to lightning and electricity, fell far short of what was done by Signior BECCARIA at Turin." p. 395

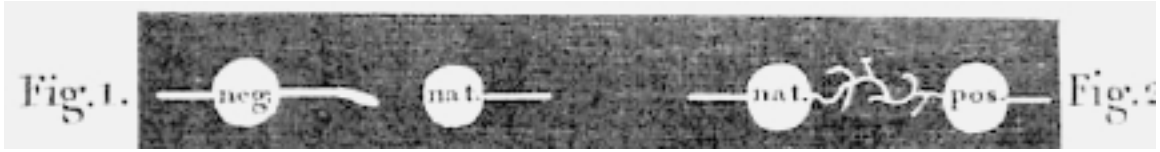
"He made use of both kites and pointed rods, and of a great variety of both at the same time, and in different places. Some of the strings of his kites had wires in them, and others had none. Some of them flew to a prodigious height, and others but low; and he had a great number of assistants, to note the nature, time, and degree of appearances, according as his views required.

"To keep his kites constantly insulated, and at the same time to give them more or less string, and for many other purposes, he had the string rolled upon a reel, which was supported by pillars of glass; and his conductor had a communication with the axis of the reel."

"To distinguish the positive and negative state of the clouds, when the electricity was vigorous, with more certainty, and with more safety than it could be done by presenting an excited stick of glass, or sealing-wax to threads diverging from his conductor; he inclosed a pointed wire and a flat piece of lead opposite to it within a cylindrical glass vessel, wrapped in pasteboard, so that the inside could have no communication with the external light. Into this cover, and opposite to the point of the wire, he inserted a very long tube of pasteboard; through which he could look from a considerable distance, and see the form of the electric light at the end of the wire; which is the surest indication of its quality." pp. 396-397.

The History and Present State of Electricity by Joseph Priestley, 1775 Vol I

The figure below illustrates what Beccaria was looking for. In watching many discharges, in dim light, experimenters had noticed a difference in the shape of the corona discharge and sparks from negative and positive terminals. The discharge from a highly charged positive terminal to a neutral or "natural state" (shown on the right) was more branched than that from a highly charged negative terminal to one in the neutral or "natural" state (shown on the left).



George Adams & William Jones, *An Essay on Electricity*, London, 1799,5th Ed.
Plate I, Fig 1 and Fig 2

The Burndy Library, Dibner Institute for the History of Science & Technology
Cambridge, Massachusetts

The experiments were not without danger. Priestley recounts several occasions on which experimenters received severe shocks, and in one instance, in St. Petersburg, Professor Richmann was killed while performing a lightning rod experiment. Richmann was using a lightning rod similar to Franklin's lightning bells, but apparently without the grounded lower portion and was bending over to collect a charge when he brought his head near the rod just as a lightning stroke occured. (Schiffer, *Draw the Lightning Down,* pp. 165-166) In a letter to James Bowdoin, Franklin notes "I have yet received no particulars of the unhappy gentleman's death at Petersburg, (whose fate I lament). One of the papers says that all the letters from thence confirm the account, and mentions his name (Professor Richmann), but nothing farther. No doubt we shall have a minute account of the accident with all its circumstances, in some of the magazines or the *Transactions of the Royal Society."* (Bigelow Vol. III, p. 5; Morse, page 127)

It is worth noting that even in dry, clear weather, there is an electric field in the atmosphere, so that a kite with a collector and conducting string will become electrified. Franklin could have shown that atmospheric electricity existed even when no thunderstorms were present.

Given the total number of experiments that were successfully carried out, following essentially the same procedure as that of Franklin's description of the kite experiment, I concur with I. Bernard Cohen (*Benjamin Franklin's Science)* that there is no reason to doubt Franklin's account.