

History Of Experiments On Atmospheric Electricity

Being A Report Presented By A Committee* Of The "Franklin Kite Club," At The Request Of The Club
(From the Journal of the Franklin Institute.)

**John C. Cresson, Esq., Chairman.*

The Committee appointed to enquire into the history of experiments, upon the electricity of the atmosphere, having given such attention to the subject as their other engagements would allow, beg leave to submit the following report:-

The fact that amber and some gems, when excited by friction, possessed the curious property of attracting light bodies, was known to philosophers several centuries before the Christian era. Nothing further, however, than this simple fact, seems to have been ascertained for the space of two thousand years.

The first modern experiments upon record were those of Dr. Gilbert of Colchester, an account of which he published about the year 1600, in a Treatise de Magnete. Although several philosophers repeated the experiments of Gilbert, and somewhat augmented the list of electric substances, no discovery of importance was effected until about the year 1670, at which period Otto Guericke, celebrated as the inventor of the air-pump, constructed the first electrical machine of which we have any account, and acquired an additional title to renown, by discovering the light and sound by which the electric fluid is accompanied.

The existence of electric light was observed shortly afterwards in England, by Dr. Wall, to whom also is due the honour of first suggesting the idea of a resemblance between electricity and lightning.

This resemblance was afterwards noticed by Mr. Stephen Gray, who flourished about the year 1730; and still later by the Abbé Nollet; but neither of them appears to have attempted any investigation of the subject. The complete solution of this interesting problem in electrical science was reserved for our venerated countryman, Franklin; who, at an early period in his investigations, became strongly impressed with the idea that lightning and electricity were identical. He accordingly drew up a statement of the principal points of resemblance between them, and suggested a plan for proving the truth of his theory, by elevating pointed conductors upon a lofty tower or spire. This paper, together with several others upon the same subject, he transmitted to his friend Mr. Collinson, of London, by whom they were communicated to the Royal Society.

The reception which these essays met with in that learned body was by no means flattering, as will be perceived from the following extract from Franklin's Memoirs: - "Obliged, as we were to Mr. Collinson, for the present of the tube, &c., I thought it right he should be informed of our success in using it, and wrote him several letters containing accounts of our experiments. He got them read in the Royal Society,

where they were not at first thought worthy of so much notice as to be printed among their transactions. One paper which I wrote for Mr. Kinnersly, on the sameness of lightning and electricity, was read, but was laughed at by the connoisseurs." The papers being afterwards shown to Dr. Fothergill, he thought them of too much importance to be stifled, and advised the printing of them. They were accordingly published in a pamphlet form by Cave, a bookseller in London, with a preface by Dr. Fothergill. A copy of this pamphlet happening to fall in the hands of Buffon the naturalist, this eminent philosopher was so well satisfied of the justness of Franklin's views, that he determined on making the attempt to draw down lightning from the clouds. Accordingly, he raised an insulated rod of iron upon the tower of Montbar, and prevailed upon M. D'Alibard to prepare an apparatus for the same purpose at Marly La Ville, about six miles from Paris. This apparatus consisted of a pointed rod, about forty feet long and an inch in diameter, the lower extremity of which was brought into a sentry box, and insulated upon a table with glass feet. M. D'Alibard entrusted the charge of his apparatus to a man called Coiffier, who, having served fourteen years in the dragoons, was supposed to have sufficient courage for such an undertaking.

We have been thus particular in our description of this machine, because it was the first to receive a visit from the ethereal fire; and shall now proceed to give a narrative of that important event, extracted from a paper laid before the Royal Academy of Science, at Paris, three days after the occurrence. " On Wednesday, the 10th day of May 1752, between two and three o'clock in the afternoon, M. Coiffier, an old dragoon, whom I had entrusted to make observations in my absence, hearing a pretty loud clap of thunder, immediately flies to the machine, taking with him a vial in which was fixed a brass wire; on presenting the point of the wire to the rod, he sees a small brilliant spark issue from it, and hears a crackling noise; he takes a second spark stronger than the first, and with a louder noise! He calls his neighbours, and sends for M. Roulet, the Prior of Marly. The Prior runs with all his might, and the parishioners seeing his haste, imagine that poor Coiffier had been killed by the thunder; the alarm spread throughout the village, and the hail which succeeded did not prevent them from following their pastor.

"The honest ecclesiastic arrived at the machine, and seeing there was no danger tries the experiment himself, and takes some strong sparks. The hail storm was not more than a quarter of an hour in passing the zenith of our machine, and there was no more thunder after the first clap." As soon as the cloud had passed, and they could get no more sparks from the rod, the Prior despatched M. Coiffier with the following hasty letter: -

"I announce to you, sir, the fulfilment of your expectations; the experiment is complete. This day at twenty minutes after two in the afternoon, it thundered directly over Marly, the clap was pretty

History Of Experiments On Atmospheric Electricity

loud. The desire to please you, and curiosity, induced me at once to quit my arm chair, in which I was engaged reading. I was hastening to M. Coiffier, and met on the road a child whom he had despatched to call me, I redoubled my speed through a torrent of hail. Arriving at the spot where the rod was placed, I took a brass wire, and advancing it towards the rod, when within about an inch and a half, a small column of blueish flame with a smell like sulphur, sprung with wonderful quickness to the point of the wire, and occasioned a noise as if the rod had been struck with a key. I repeated the experiment at least six times in about five minutes, each experiment requiring about the time of a Pater and an Ave. I wished to continue them, but the action of the fire gradually abated, and at length ceased altogether. The stroke of thunder which had occasioned this event was not followed by any other, and the whole was terminated by a copious shower of hail.

"I was so engaged during the experiment that receiving a blow upon my arm above the elbow, I could not tell whether it proceeded from the brass wire or the rod. I did not complain at the moment, but the pain continuing on returning home, I uncovered my arm in the presence of Coiffier, and we perceived a contusion around it, such as would be caused by a blow from the wire upon the bare skin. When returning with Coiffier, I met the curate, M. de Milley, and the schoolmaster, to whom I reported what had happened. They all three perceived a smell of sulphur, which increased as they approached me: this odour was also perceived by the servants before I said any thing to them about it.

"You have here, sir, a hasty recital, but it is correct and true, and I assure you that I am ready to testify to these facts on all occasions. Coiffier was the first to make the experiment, and he repeated it several times before he sent for me. If any other testimony besides his and mine is necessary, you can obtain it. Coiffier is in haste to depart. I am yours with respectful consideration,

"RAULET, Prior of Marly.

"May 10, 1753."

Immediately upon the announcement of M. D'Alibard's success, M. Delor, demonstrator of physic, at Paris, erected a bar of iron upon his dwelling for the purpose of repeating the experiment, and succeeded in procuring several sparks during a thunderstorm on the 18th of May. On the 19th of the same month, Buffon obtained a similar result at Montbar.

Thus was Franklin's hypothesis verified in Europe, while its illustrious author was waiting for the erection of a spire at Philadelphia, by which he should be enabled to reach what he supposed to be the proper region for experiment. At length he devised the simple expedient of using a common kite for the attainment of his object, and in June, 1752, about a month after the French discoveries but before any report of them had reached America, he performed his celebrated experiment.

Although it may seem unnecessary to repeat in this place a narrative with which every school-boy is familiar, we shall, nevertheless, annex an account of this famous experiment, believing the omission would leave our report defective in a very essential point. The kite used by Franklin on this occasion, was made by extending a silk handkerchief upon two crossed sticks. To the upright stick was affixed an iron point.

The string was of hemp, except for a small portion of the lower end, which was of silk: where the hempen string terminated a key was fastened. With this apparatus, on the approach of a thunder-storm, he repaired to an open field, accompanied by his son, to whom alone he had communicated his intentions.

Having raised his kite, he placed himself under a shed, to avoid the rain and preserve the insulation of his silk cord. A thunder cloud passed over the kite, and no signs of electricity appeared. When, almost despairing of success, he observed the loose fibres of the string become erect, as if they were repelled. He now presented his knuckle to the key and received a strong spark; others succeeded even before the string was wet; but when the string was thoroughly wetted by the rain, he collected the electric fire in great abundance.

Franklin afterwards erected an insulated rod upon his house, by means of which he continued to investigate the subject for several years, in conjunction with his friend Mr. Kinnerly. The new field of discovery thus opened to the votaries of science, was speedily entered by a host of experimenters. Of these, it will be necessary to name only a few of the more prominent, whose experiments and discoveries embrace all that is interesting to know.

In England, the first attempts to repeat these experiments, were made by Mr. Canton and Dr. Bevis; but owing to the unfavourable nature of the climate, or some defect in their apparatus, it was not until after numerous disappointments that they succeeded in obtaining some feeble indications of electricity. The most splendid experiments that have come under the notice of the Committee, were those made in France by M. De Romas, assessor of the presidial of Nerac.¹ This gentleman made use of a kite which was seven feet five inches in height, and three feet in its greatest width, having above eighteen square feet of surface. The string was wrapped with copper wire somewhat after the manner of the base string of a violin.

On the 7th of June, 1753, at one o'clock, it thundered in the west; at half-past two M. De Romas had raised his kite with a cord 780 feet long, inclined at an angle of 45°; so that the elevation of the kite was about 550 feet. To the lower end of the cord he tied a ribbon of silk about three and a half feet long; this was brought under the cover of a pent-house, and was there fastened to a heavy stone. Near the junction of the cord and ribbon was suspended a tube of tin one foot long and an inch in diameter, from which the sparks were to be drawn.

History Of Experiments On Atmospheric Electricity

He had prepared a discharging-rod with a glass handle twelve inches long, and provided with a brass chain of sufficient length to touch the ground when sparks were drawn from the tube. By means of the discharging-rod he at first obtained sparks as large as those produced by a good globe, and several of his assistants drew sparks with keys and with the naked finger. This performance continued about twenty-two minutes, when the electricity disappeared; the little black clouds from which it was procured having passed from the zenith of the kite. In about seven minutes the electricity reappeared, but was at first very feeble; it gradually increased, and the sparks were drawn by the fingers, canes, and swords, of the spectators. M. De Romas now touched the tube with his knuckle, and received a terrible shock, such as he had never experienced from the Leyden vial charged by the best globes. Seven or eight of the bystanders having joined hands, received sparks which struck the feet of the fifth person. The storm now approached and increased in violence, not a drop of rain had fallen; but in the zenith of the kite, and about 600 around it, there were black clouds, which indicated a great increase of electricity.

M. De Romas, therefore, thought proper to receive sparks only by the discharge, and in this manner drew several sparks more than two inches long and of proportionate thickness. After this the electricity became so strong, that instead of sparks sheets of fire three inches long and three lines in diameter, flashed to the distance of more than a foot from the tube. At this time, when about three feet from the cord, he felt a sensation as if a spider's web was upon his face. He advised his assistants to keep at a greater distance, and himself retired about two feet; and when five feet from the cord, he again perceived the same sensation, and retired still further. M. De Romas now paused to observe what took place in the clouds above the kite; there was no lightning, almost no thunder, and not any rain, the wind was west, and so strong that the kite rose about 100 feet higher than at first. Having cast his eyes upon the tin tube which was about three feet from the ground; he observed three straws about a foot long, and others four and five inches in length, standing erect upon the ground and dancing in a ring beneath the tube-like puppets. This little spectacle lasted about fifteen minutes, after which some drops of rain fell, and he again felt the spider web sensation, and hearing a rustling sound of a small forge bellows. This was considered a warning of a new increase of electricity, and he cautioned his assistants to retire to a greater distance. Now came the last act of this magnificent drama, which M. De Romas says made him tremble. The longest straw was attracted by the tube, and then followed an explosion which some compared to the noise of a petard, and others to the sound of a large earthen jar dashed upon a pavement. The fire, which accompanied this explosion, had the form of a spindle eight inches long, and four or five lines in diameter. The straw which had caused the explosion, followed the string of the kite, and was seen at the distance of forty or fifty toises going with great

rapidity, alternately attracted and repelled, every attraction being accompanied by sheets of fire and continual explosions. During this part of the exhibition there was a strong smell of sulphur, and around the string there appeared a cylinder of permanent light three or four inches in diameter; which, it was supposed, would have appeared to be four or five feet in diameter if the experiment had been made at night. Shortly after this, the wind shifted to the east and the rain fell abundantly, followed by some hail, so that they were unable to keep the kite up any longer; as it fell, the string came in contact with a roof, the kite was made to rise again, and as soon as it was released from the roof, the person who held the string received such a violent blow in his hands that he was compelled to relinquish it. The string now became slack, and falling upon the feet of one of the assistants, he felt a concussion almost insupportable. On the 16th of August, 1757, M. De Romas, having again raised his kite with accord more than 1000 feet in length, obtained results even more astonishing than those just narrated.

In a letter to the Abbé Nollet, giving an account of this experiment, he says, "Imagine to yourself sheets of fire nine or ten inches in length, and one inch in diameter, with the noise like the report of a pistol: in less than an hour I had certainly thirty flashes of these dimensions without counting a thousand others of seven feet and under."

The dangerous nature of these experiments was fearfully illustrated about this time, by an accident which created a deep sensation throughout the scientific world. Professor Richman, of St Petersburg, being engaged in a treatise upon electricity, had erected upon his house an apparatus for observing the electrical conditions of the atmosphere, during thunderstorms. On the 6th of August, 1753, while attending the usual meeting of the Imperial Academy of Sciences, a little before noon he heard the sound of distant thunder, he hastened home, accompanied by Mr. Sokolow, engraver to the academy. Upon examining the electrometer which was attached to his apparatus, Richman remarked that the thread pointed to four degrees on the quadrant; and described to Mr. Sokolow, the dangerous consequences that might ensue if the electricity should increase to 45 or more. At this moment, while Mr. Richman was in a stooping posture, with his head about a foot distant from the rod, a globe of white and blue fire, about the size of a man's fist, appeared between the machine and Mr. Richman's head.

At the same time, a sort of steam or vapour arose which stupefied the engraver, and made him sink down, so that he could not remember to have heard the thunder, which was very loud.

As soon as Mrs. Richman heard the loud clap of thunder, she hastened to her husband's chamber, fearful of some bad consequences, and found him entirely lifeless, sitting upon a chest which happened to be placed behind him, and leaning against the wall.

History Of Experiments On Atmospheric Electricity

After this unfortunate occurrence, electricians became more circumspect in experimenting upon an agent so dangerous and intractable. The phenomenon of thunderstorms having been investigated to a considerable extent, philosophers next directed their attention to observations upon the ordinary electrical condition of the atmosphere, and the changes to which it is subject. Experiments were prosecuted in America, by Mr. Kinnersly, the friend and associate of Franklin; in France, by M. Le Monnier, and the Abbé Mazcas; in Switzerland, by M. De Saussure; and in England, by Mr. Cavallo, Mr. Read, and several others. But the labours of these philosophers, although of great value and interest, fall far short of those achieved by Signor Beccaria, of Turin, who continued a series of experiments through a period of twenty years.

The observations of this eminent philosopher were made in all kinds of weather, and every season of the year. He made use of a great variety of instruments, and employed numerous assistants, sometimes causing simultaneous observations to be made at several distant places. As the limits of this report will not allow a detailed account of the phenomena observed by all these philosophers, it is deemed advisable to furnish a condensed statement of the general results, upon which most of the observers agree in a very satisfactory manner.

In calm, clear, dry weather, the electricity was always perceptible and invariably positive. It was more abundant in winter than in summer. During a rain it was generally negative, but it sometimes became positive while the rain was falling; and on some occasions these changes occurred several times in the course of a single storm.

In cloudy, damp, or windy weather, it was mostly positive but feeble. The quantity always increased with the length and elevation of the conductor; insulated strings extended horizontally, sometimes gave strong indications of electricity; a cord, 1,500 Paris feet in length, extended across the river Po, was found to be as strongly electrified during a shower unattended by thunder, as a rod of metal had been during a thunderstorm.

The latest of these experiments were made about the year 1791; since which period, the interesting phenomena brought to light by the discovery of galvanism, have so much engrossed the attention of philosophers, that the other branches of electrical science have been comparatively neglected.

As far as the committee have been able to extend their researches, it appears that the observers of atmospheric electricity, have confined their experiments to a region of comparatively very small elevation, none of them having attained a greater distance from the surface of the earth, than one thousand feet; and even the few who reached this height, made use of such imperfect conductors, as were not calculated to furnish accurate results. It

therefore seems probable, that a course of experiments made with good conductors elevated to the height of ten or fifteen thousand feet, would furnish such an addition to our knowledge of this interesting subject, as would fully compensate the labour and expense necessary for their prosecution.

Notes by Paul Chapman: above text has been copied unchanged from *Mechanics Magazine No 697, Saturday December 17th 1836*. It should be noted that there are differences in the text describing De Romas's experiment with his August 1757 letter to the Abbé Nollet published in *The Gentleman's Magazine, March 1764*. For details of De Romas's work in his own words see his *Moyens De Se Garantir De La Foudre Dans les Maisons, 1776*; the collected work of De Romas edited by J Bergonie in 1911 as *Oeuvres Inédites de J. De Romas sur L'Electricite* the detailed technical description of his *Cerf-Volant Electrique Chariott Electrique* M J Brisson's 1781 *Dictionnaire Raisonne De Physique*. of Cavallo's electrical kite apparatus and his experiments conducted principally at Islington are described in his 1782 edition of *A Complete Treatise on Electricity*.

It goes without saying that these experiments to demonstrate atmospheric electricity were extremely dangerous and could result in significant injury, or death, if repeated.

Paul Chapman Aeronautical Archive, January 2008

¹A small account of these experiments may be found in the *Memoirs de Savans Etrangers*, published by the French Academy



An illustration from Abbé Jacquet de Malzet's book of 1775. It depicts something very close to Franklin's experiment complete with a pre-Eddy kite. The flier is depicted with his kite line angled correctly for reaching as high as possible. Note that if a roof covered this as Franklin specified—to keep the silk dry but also never to touch the twine—the roof height adequate to the task would rival a contemporary airplane banger. This illustrator sacrifices Franklin's directions to good sense and simply does away with the shed.