

GROUND MARKINGS BY LIGHTNING

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On June 23, 1928, during an electric storm, and while several men were taking shelter in a shed, a green on the course of the Toronto Golf Club was struck by lightning. The grass being exceedingly short, the markings left afforded a unique opportunity for study and measurement. The distance from the shed to the green is 100 yards. The flash was described as blinding and the thunder as deafening. Immediately after the flash, smoke and

of some less definite lines the side grass was uninjured. It is evident that the markings shown in Figures 1 and 2 were caused by the same flash but the grass between *A* and *B* was untouched. Possibly the flash divided when near the ground. At *A* was a deep, round hole and for a short distance lines diverging from it were wide and deep, while at *B* the earth was showing but the scoring was not deep and a hole immediately at this point was not visible. There were small holes, however, north and south of this point 3 inches apart, slanting northward and southward, respectively.

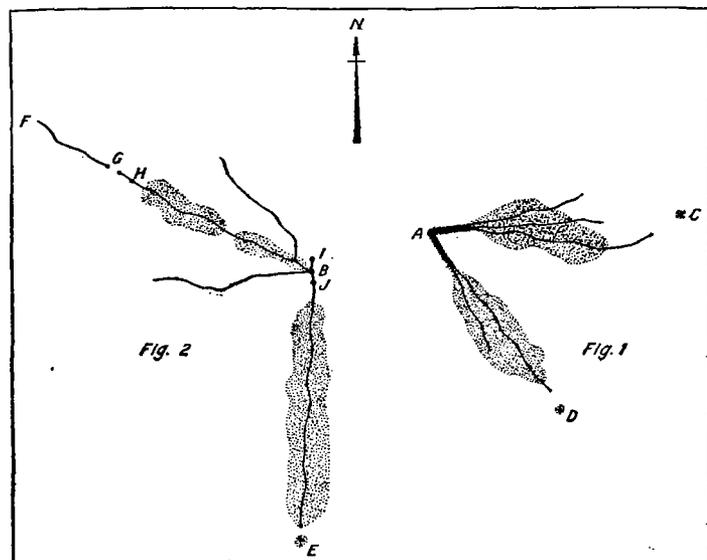
The main legs or lines were more or less scored, showing earth as though a small bullet had ricocheted along these lines, while other lines showed only withered grass.

The most remarkable discovery was that of short round tunnels at the end of the lines at *C*, *D*, and *E*, also a short distance up the line, *B* to *F* at *G*. The course of the current was evidently outward as the entrance holes of these tunnels were slightly cut, while the escaping holes were covered with dead grass and were only discovered by passing a pliable stick through the tunnels. The grass above all these tunnels remained green. At *H* (Fig. 2) there was a deep, narrow hole sloping slightly toward the northwest.

After careful examination the impression left was that upon striking the ground at *A* and *B* the fluid had splashed and bounded outward down the lines shown in the diagram.

The following measurements are appended:

- Upper short groove at *A*, 6½ inches long, ⅞ inch wide.
- Lower short groove at *A*, 7 inches long, ⅞ inch wide.
- Width of tunnels at entrance, ¼ inch.
- Length of tunnels at *C*, 12½ inches; at *D*, 4 inches; at *E*, 3½ inches; at *G*, 3 inches.
- Extreme depth of tunnels, 1 inch.
- Length of lines, *A* to *C*, 44 inches; *A* to *D*, 39 inches; *B* to *F*, 61 inches; *B* to *E*, 40½ inches.
- Distance of small hole at *H* from apex at *B*, 38 inches.
- Hole at *A*, ¾ inch in diameter and 5 inches in depth.
- Depth of hole at *H*, 4 inches; diameter, ¼ inch.
- Depth of hole at *I*, 4 inches; diameter, ¼ inch.
- Depth of hole at *J*, 3 inches; diameter, ¼ inch.
- Distance from *A* to *B*, 43 inches.
- Distance from *A* to bamboo flagpole, 15 feet.
- Distance from *A* to nearest tree, 150 feet.



steam were seen rising from the green, and upon examination it was found littered with a small quantity of earth and grass roots. These came from some deep holes and grooves, and the grass at the edge of these was slightly burned. Elsewhere the wet grass was only withered by heated moisture. Definite lines forming angles soon appeared, these lines being indicated by continuous withered grass. Upon each side of the main lines or legs of the angles there were also wide patches of withered grass along the greater part of their length. In the case

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FRANKLIN'S KITE EXPERIMENT AND THE ENERGY OF LIGHTNING

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SYNOPSIS

Franklin's kite experiment as described by him in the well-known letter to Collinson, dated October 19, 1752, naturally challenged the attention of the scientific world and established the electrical nature of lightning. Efforts to get accurate dates and details have proved unavailing thus far, although it would seem that in contemporaneous journals and correspondence some corroborative evidence must exist.

The common belief that the kite experiment paved the way for the introduction of the lightning rod is disproved by Franklin's own use of the rod and his clearly expressed views as to the identity of lightning and electricity, at earlier dates.

Perhaps the most promising method of obtaining knowledge of the nature of lightning is the duplication by artificial means of high voltage discharges having considerable current and very steep wave fronts. Such work is now carried on by the General Electric Co. in its high tension laboratory at Pittsfield, Mass., under the direction of Mr. F. W. Peek, jr. These discharges may well be called *near-lightning*, and illustrate well the peculiar character-

istics of the natural discharges whether we regard them as oscillatory or unidirectional.

There has been a tendency in scientific circles to depreciate the importance of this line of attack and to give preference to values obtained on theoretical grounds and measurements which seem open to criticism. Attention is called to an error in a published statement critical of our estimate of the energy of an average flash; and it is shown that confusion has arisen from the use of units with similar initials but quite different values.

Some approximate measurements of the energy in kilowatt-hours are given, based upon fusion of kite wire at Blue Hill Observatory, and the voltage is shown to be of the order of 13,000,000 as compared with 10,000,000,000 given by so eminent an authority as C. T. R. Wilson. Kite experiences at a number of Weather Bureau stations are summarized as confirmatory of the lower values.

The importance of a study of the side discharges or split-off flashes is urged as contributing to a knowledge of the process of breakdown of the dielectric, the origin of the path, the concentration of electrons producing ionization, and the nature of the explosive effect.