LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the eighteenth of the preceding month, for the second issue, the third of the month. Because of the late closing dates for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Communications should not in general exceed 600 words in length.

Spark Discharge on Surfaces

It has been shown by a number of different workers,[1] by means of a rotating lens or film camera, that the initiation of a lightning flash consists of two principal stages. First, a so-called leader which usually, although not always, starts from the cloud and progresses toward the earth with a velocity between 10^7 and 5×10^9 cm/sec. This leader is relatively faint and normally on the first flash shows on the photographs as "stepped." Second, following the arrival of the leader at the earth, a very intense "return stroke" occurs which moves in the opposite direction to the leader but over the same path at a much higher velocity. The same type of phenomenon has been shown to occur in both long[2] and short sparks,[3] in air as well as in the discharge tube.[4] In the latter two cases the leader may or may not be stepped, depending upon the characteristics of the electrical circuit. The purpose of this note is to report observations with the rotating mirror of the same kind of phenomenon in the spark discharge on surfaces. In order to obtain sufficient luminosity in the leader stroke, the usual method for the production of surface discharges was modified. A wash tub $2\frac{1}{2}$ feet in diameter was half-filled with a dilute solution of $CuSO_4$ in water. A $\frac{1}{8}''$ brass rod about one foot long was then mounted horizontally just below (3–6 mm) the surface of the liquid along the diameter of the tub. One end of this rod was near the axis of the tub and the other was connected to the grounded terminal of the circuit. The discharge occurred along the surface of the water solution above this rod. The high voltage electrode was a small metal rod mounted with its axis vertical and its lower end about a millimeter above the water surface, and directly above the end of the horizontal rod which was nearest the axis of the tub. A third electrode, connected to the tub, was mounted vertically with its lower end just touching the water so that it could be moved along directly over the horizontal rod. When voltages of 10 kv were applied impulsively from a one-mf condenser, surface discharges 25 cm in length were obtained. If either the capacity or voltage was increased, the maximum length of the surface discharge was increased. If the distance between the two vertical rods was made greater than the maximum length of the spark, only the leader discharge occurred.

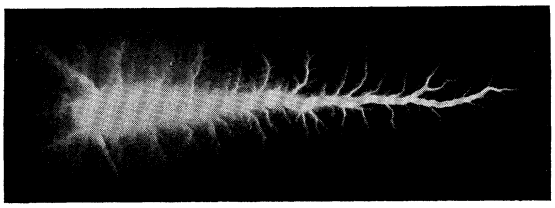

FIG. 1. Leader stroke with branches. Stationary camera.

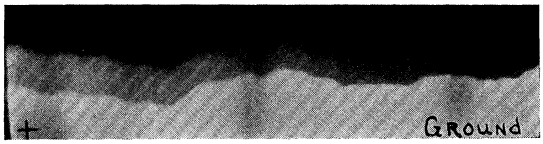

FIG. 2. Discharge along the water surface photographed with a revolving mirror.

Figure 1 shows a stationary photograph of these leaders when the high voltage electrode was positive. It will be observed that the main path of the leader follows the surface directly above the horizontal grounded wire. Clearly the reason for this is that the field is greatest at the tip of the leader along this direction because if the horizontal rod is removed, various leaders move in random directions along the surface. Also, branching takes place in the direction of propagation. A statistical study of this branching indicates that the number of branches is roughly proportional to the length of the leader.

Figure 2 shows a rotating mirror photograph of a non-oscillatory discharge along the surface when the high voltage electrode was positive. It will be observed that a leader starts at the high voltage electrode, moves along the surface of the water solution until it reaches the vertical grounded electrode. An intense return stroke then occurs. In Fig. 2 the leader travels at an average speed of 5×10^5 cm/sec., but it has been found that this speed can be markedly increased or decreased by increasing or decreasing the current supply to the leader. The same general phenomena are observed with the high voltage electrode either positive or negative, although they differ considerably in certain details which will be described in a later paper. If the horizontal rod was removed and a drop of oil placed on the liquid surface, the leader followed the outline of the water, oil interface.

L. B. SNODDY
J. W. BEAMS

Rouss Physical Laboratory,
University of Virginia,
Charlottesville, Virginia,
March 3, 1939.

[1] B. F. J. Schonland and H. Collens, Proc. Roy. Soc. **A143**, 654 (1934); **A152**, 595 (1935); **A164**, 132 (1938); McEachron, J. Frank. Inst. **227**, 149 (1939); Workman, Beams and Snoddy, Physics **7**, 375 (1936).
[2] T. E. Allibone and J. M. Meek Proc. Roy. Soc. **A166**, 97 (1938); **A169**, 246 (1938).
[3] L. B. Snoddy and C. D. Bradley, Phys. Rev. **45**, 432 (1934); **47**, 541 (1935); H. Raether, Zeits. f. Physik **107**, 91 (1937).
[4] J. W. Beams, Phys. Rev. **36**, 997 (1930); Snoddy, Beams and Deitrich, Phys. Rev. **50**, 469 (1936).

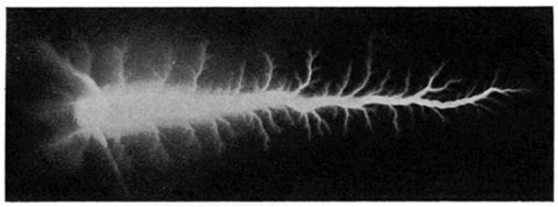

FIG. 1. Leader stroke with branches. Stationary camera.

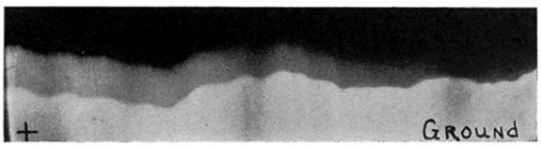

FIG. 2. Discharge along the water surface photographed with a revolving mirror.