An evaluation of the mean rate of propagation of the discharge, using the formula $v = d/t_f$ (d is the distance between the electrodes, t_f is the formation time of the discharge) gives a value of $v = 10^6$ cm/sec. This value of the rate is considerably less than the rate of propagation of an electron avalanche or a streamer under experimental conditions [9, 10]. It is approximately equal to the rate of propagation of positive ions in the air pores of a substance.

The experimental data and the evaluation of the rate of propagation of the discharge provide a basis for the assumption that the breakdown of a porous dielectric with open porosity starts with the appearance of an electron at the cathode and ends when the positive ions, formed in the air pores at the anode with shock ionization, reach the cathode and effect the formation of a plasma filament.

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VERIFICATION OF THE CASE OF THE ORIGIN OF BALL LIGHTNING

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In [1] there is a description of a case of the origin of a luminescing sphere in an S-shaped bend of a lightning rod. Under these circumstances, it is assumed that this sphere was ball lightning.

The present author has made a model verification of this observation, in a three-cascade pulse voltage generator, with a working voltage of 150 kV in an air atmosphere at a pressure of 730–750 mm Hg. Under these circumstances, the S-shaped bend was effected by installing dielectric bodies made of vinyl plastic and celluloid in a discharge gap of the "rod—rod" type; the bodies are bent according to the law $x = e^{-\alpha y^2}$. The electrodes of the discharge gap were arranged at the axis. For control of the initial breakdown, in the plane of the electrodes, along the surface of the body and its apex, there was led a graphite line with a thickness of 0.001 m, falling short of the electrodes by 0.01–0.015 m on each side.

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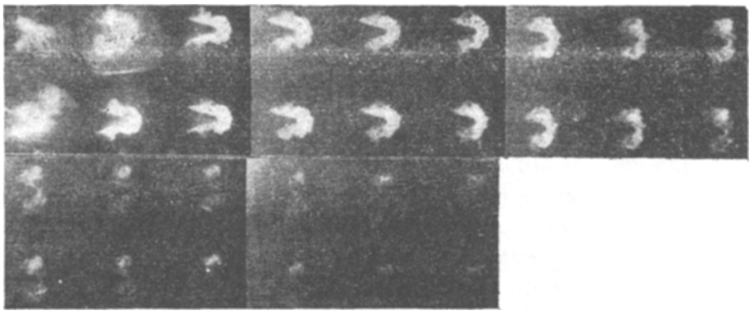

Fig. 1

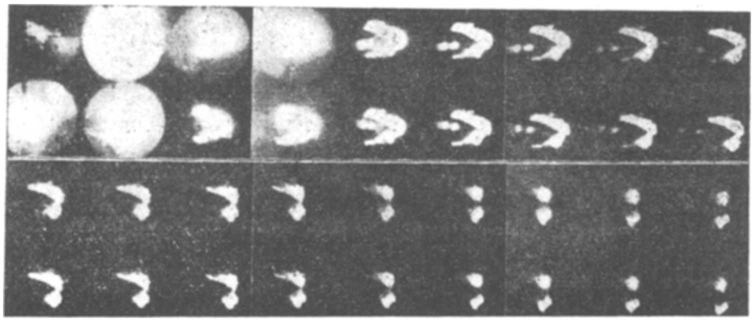

Fig. 2

The pulse-voltage generator was actuated from a source of ultraviolet radiation, triggered from the panel of an SFR-2M moving-picture streak camera. The parameters of the electrical discharge, which were not varied during the course of the experiments, with the aim of avoiding returning the pulse voltage generator, were the following: maximal amplitude of current 7 kA; period of vibrations of damped discharge $6.5 \cdot 10^{-6}$ sec; duration of discharge $70 \cdot 10^{-6}$ sec; energy stored in pulse voltage generator ~ 2.2 kJ. The maximal evolution of energy takes place in the course of the first $\sim 20 \cdot 10^{-6}$ sec. The electrodes of the discharge gap were made of red copper. The diameter of the hemispherical tips was equal to 0.024 m. The length of the discharge channel along the surface of the body was 0.15 m.

During the course of a great number of experiments, the origin of luminescing clusters with a diameter of 0.025-0.04 m was observed. Their number in one discharge could be varied from one to three by varying the arrangement of the electrodes with respect to the nose of the body and shifting them with respect to the plane in which they are arranged.

Figure 1 gives a moving-picture photo of the origin of one long-time luminescing cluster, moving away from the body with a velocity up to 240 m/sec. Its luminescence is observed over the course of $\sim 3 \cdot 10^{-3}$ sec.

Figure 2 gives a moving-picture photo of the origin of two clusters, which, approximately up to 500 μsec, are connected by a thin luminescing filament ahead of the nose of the body. The form of the nose of the body was different on the moving-picture photos shown.

As has been shown by an analysis of the results of a great number of experiments, the appearance of plasma clusters is connected with the development of turbulent flows of low-temperature plasma (from the erosion products of the body and the electrodes) along the surface of the body, predominantly toward its nose. The motion of the plasma is brought about in the first place by a pulse of electrodynamic forces applied to the plasma in the channel of the discharge with the passage of a current, and, in the second place, by flows of atmospheric air tangent to the surface of the body, in the direction of the nose of the body, both from the side of the electrodes and from the side of the nose of the body. These flows are formed behind a shock wave departing from the body, formed by an electrical discharge. In the third place, there is an outflow of the heated products of the erosion of the material of the body to the atmosphere. As a result of the imposition of the flows there is observed the formation of plasma clusters, similar in form to cylindrical vortices.

More long-lived are clusters forming near the electrode which serves as the anode at the moment of breakdown. The duration of the existence of the plasma clusters and their volume rise with a rise in the energy introduced into the discharge, and in the duration of the discharge current.

An investigation of the magnetic fields in the plasma clusters was made using a miniature magnetic probe with an inductance of $1 \cdot 10^{-7}$ G and a Hall pickup. With a sensitivity of the measurements not worse than 10 A/m, no residual magnetic field was observed. The vibrations of the electrical charge in the clusters were recorded using a flat probe with a diameter of 0.01 m, arranged at a distance of 0.15 m from the nose of the body, and connected with the grounded electrode through the plates of an ÉNO-1 oscillograph. The sensitivity of the probe was a quantity not worse than the 10^{-4} class. Within the limits of the accuracy of the experiment, no uncompensated electric charge was observed in the clusters.

Spectral measurements, made using a KSA-55 spectrograph, give results usual for a recombining air plasma with impurities of carbon and the lines of copper.

Starting from the results obtained, the conclusion can be drawn that the fall of a luminescing plasma cluster observed in [1] was similar in structure to a cylindrical vortex and did not have the complex of properties formulated in [2-4] as characteristic of ball lightning.

In conclusion, the author wishes to express his thanks to V. F. Chuchko and V. A. Vyrodov for help in carrying out the experiments in the pulse-voltage generator, and to S. N. Kulish for help with work in the IAB-451 shadow unit.

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