A Peculiar Reversal of the Discharge-Figures on Photographic Plates

By

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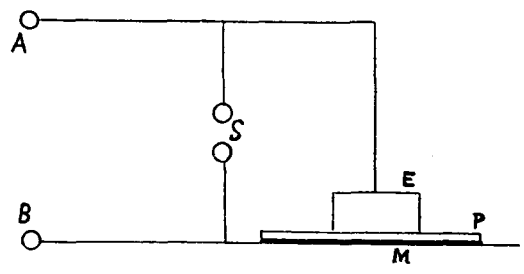
Abstract

A peculiar reversal of the discharge-figures on photographic plates, which is caused by fogging the plate with a spark-light simultaneously with the impression of the discharge-figures, is examined by the present experiment. It is found that the wave-length of the fogging light which is effective in this respect is shorter than about 420 $\mu\mu$. It is also observed that this peculiar reversal is not due to a simultaneous illumination of the photographic plates with two lights of short duration.

About ten years ago, one of the writers[1] observed a peculiar reversal of the electric discharge-figures on a photographic plate, when the plate was illuminated by an electric spark simultaneously with the impression of the discharge-figures. Recently the same phenomenon was again examined; and though its final solution has not yet been attained it seems to have become a little clearer than before by the present experiment.

Fig. 1



The experimental arrangement is illustrated schematically by Fig. 1. An electrode E is placed on the sensitive film of a photographic plate P, which is covered beneath with a metallic plate M. These

1 U. Yoshida; These Memoirs, **2**, 315 (1917).

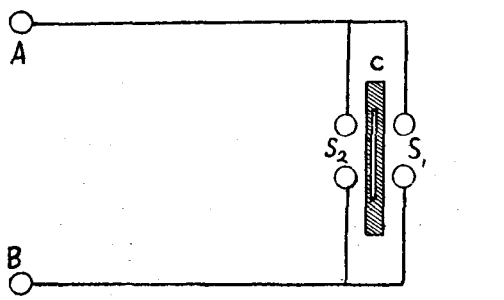
two electrodes E and M are connected to the two terminals A and B respectively, and a spark gap S is inserted in the manner represented by the figure. When the terminals A and B are connected momentaneously to both terminals of an influence machine respectively, a discharge-figure will be impressed on the photographic plate, and at the same time a spark will pass across the spark gaps, when its length is adjusted properly. Under these circumstances, the discharge-figure displays a peculiar reversal in the region illuminated by the spark, in addition to the effect of fogging by the light of the spark. When the discharge-figure is of the positive sign, every one of its irregular branches is enveloped by a somewhat diffuse margin of much stronger intensity as shown in Fig. 1, Plate I; and when the discharge-figure is of the negative sign, the general and regular outer boundary of its regular branches is enveloped by a somewhat diffuse margin of stronger intensity as shown in Fig. 2, Plate I.

It was stated in the former paper that the essential cause of this peculiar reversal was the simultaneity of the illumination of the spark and the impression of the discharge-figure; and consequently that, this being not an ordinary photographic reversal, nor the Clayden-effect, the presence of an intense electric field on the photographic plate at the momenent of formation of the discharge-figure may have an important bearing on this phenomenon. As to the effect of the illuminating spark, it was simply assumed in the former paper that this was due to the light emitted by the spark. This point was examined more closely in the present experiment by inserting various substances between the spark-gap and the photographic plate so as to screen the effect of the illuminating spark. The presence of a glass plate or a quartz plate as the screen does not essentially obstruct the occurrence of the peculiar reversal before mentioned, if we disregard the difference in the degree of the peculiar reversal, which is a little more weakened with a glass plate than with a quartz plate. This excludes the possibility of some corpuscular radiation being the agent from the illuminating spark to cause the peculiar reversal, as it will be entirely stopped by the glass plate or by the quartz plate. Next, it was observed, with the screen of a wire-gauze connected to earth, this screen did not offer any obstruction against the effect of the illuminating spark in any other region on the photographic plate than that of the shadow cast by the metal-wire of the gauze. This indicates that the effect of the illuminating spark in causing the peculiar reversal is not due to some electro-magnetic disturbance of comparatively long wave-length. These results seem to indicate

convincingly that the agent of the illuminating spark which is effective in causing the peculiar reversal of the discharge figure is the visible or ultra-violet light emitted by the spark. This consideration is further tested by screening off the light emitted by the spark with a sheet of black paper, and it was ascertained that a sheet of black paper is enough to stop the agent of the spark which is effective in producing the peculiar reversal. The next problem was to know the wave-length of the light which is emitted by the spark, and is effective in causing the peculiar reversal under consideration. This was examined by illuminating the photographic plate with the spark-light filtered by means of various colour-filters; and it was ascertained that the wave-length of the spark-light which was effective in causing the peculiar reversal was shorter than about 420 $\mu\mu$. This indicates that the light of the spark which is very effective in giving the photographic impression, is also very effective in causing the peculiar reversal under consideration. The effect of the polarization of the spark-light was also examined by letting the illuminating spark-light pass through a Nicol-prism at various orientations, and no detectable effect of the orientation of the plane of polarization of the illuminating spark-light upon the peculiar reversal was observed.

As to the part played by the discharge-figure on the photographic plate in giving rise to the peculiar reversal, a suggestion was given by one of the writers in the former paper that the strong electric field applied to the sensitive film at the moment of the impression of the discharge-figure has a complex rôle in some direct or indirect manner in causing the peculiar reversal. Another peculiarity of the discharge-figure on being impressed on the photographic plate was the momentariness of its light, by means of which its impression seems to be made on the photographic plate. If the peculiar reversal under consideration is due to the momentariness of the light of the discharge-figure, a simultaneous illumination of a photographic plate with two momentaneous lights will give rise to somewhat similar phenomenon as the peculiar reversal. This point was tested by an experiment illustrated by Fig. 2, and the result was negative. In Fig. 2, P is a photographic plate, S_1 and S_2 are two spark-gaps which are connected in parallel to the two terminals A and B. When these terminals are connected instantaneously to both terminals of an influence machine respectively, two sparks will pass across the spark gaps S_1 and S_2, and the photographic plate P will be illuminated simultaneously by the light emitted by these two sparks. By inserting in the position represented by Fig. 2 a screen C,

Fig. 2



which is provided with a narrow and long slit in a direction parallel to that of the spark gap S_2, the light emitted by the spark at S_2 is so constricted that only a narrow and long portion of the photographic plate is illuminated by it. On the other hand the light emitted by the spark at S_1 is made to illuminate a large portion of the photographic plate, so that a fogged image of the spark at S_2 is impressed on the photographic plate by simultaneous illumination. On about twenty photographs taken under such circumstances no trace of some similar phenomenon as the peculiar reversal under consideration was detected, so far as the present experiment is concerned. This indicates that the peculiar reversal is not due to a simultaneous illumination of the photographic plate with two instantaneous lights, and is in favour of the view that the presence of a strong electric field on the photographic plate at the moment of the impression of the discharge-figure is a primary cause in bringing about the peculiar reversal. The fact, mentioned before, that the fogging light of shorter wave-length is much more effective in causing the peculiar reversal seems to suggest that the peculiar reversal is due to the photo-electric effect of the fogging light upon the photographic plate which is subjected to a strong electric field.

Plate I

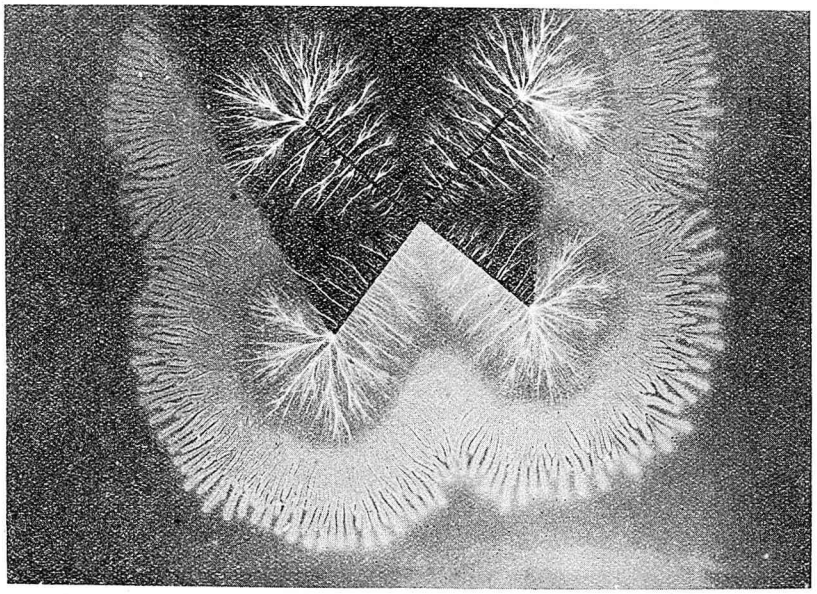


Fig. 1

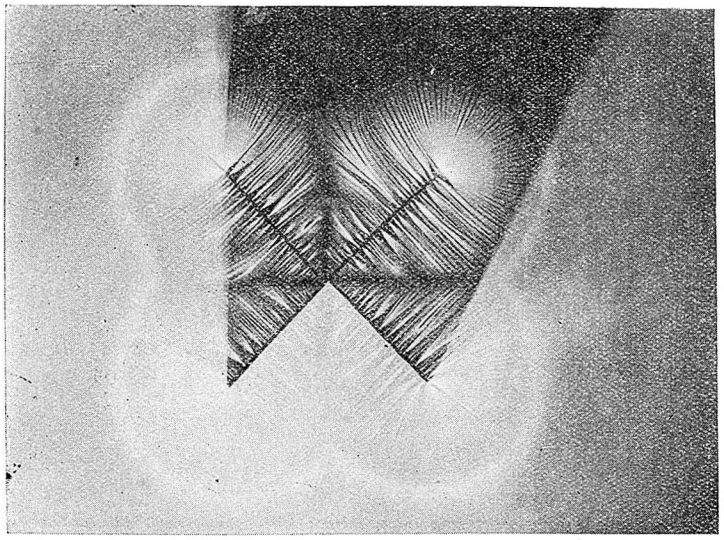


Fig. 2