# On the Figures produced on Photographic Plates by Electric Discharges

By

**Shinsuke Tanaka**

(Received July 4, 1921)

---

One of the poles of an influence machine is connected through a short spark gap to a metallic electrode placed on the sensitive film of a photographic plate, and the other pole is connected to a smooth metallic plate placed under the photographic plate. When a momentary brush discharge occurs in this case at the metallic electrode, an impression of a beautiful negative or positive discharge figure, according to the sign of the electrode, will be produced on the plate after development.

S. Mikola[1] observed that, if a small portion of the sensitive film of the photographic plate around the electrode was covered by water, a curious discharge figure was impressed on the plate. Two different brush discharges of opposite polarities started at the boundary of the water and extended in opposite directions, the brush which extended outward being of the same polarity as the electrode on the photographic plate.

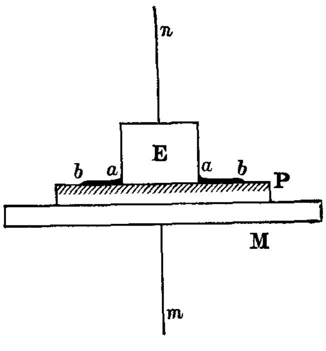


Fig. 1.

Mikola's experimental arrangement is illustrated, diagramatically in Fig. 1. Here E denotes the metallic electrode, M

---

1 S. Mikola, Phys. Z. S., **18**, 158, (1917).

the smooth metallic plate, P the photographic plate and ab a thin layer of water. When E was positive the positive brush started at the boundary b of the water and extended outward, and the negative brush which started at the same boundary b extended in the opposite direction. Next when E was made negative the polarities of these two brushes became opposite respectively. Fig. 2 in the annexed photographs obtained by the writer is reproduced to show such a behavior of the brush discharges.

The writer has examined this behavior of the brush discharge using liquids having different electric conductivities, and gave a rough explanation of the formation of the figures. When a liquid of comparatively large electric conductivity, such as a dilute aqueous salt solution or a dilute aqueous acid solution, was taken to wet the photographic plate, no impression of the brush discharge was produced in the wet part of the photographic plate. The liquid behaved in this case as if it were a part of the electrode on the plate, and only the brush of the same sign as that of the electrode started at and extended outward from the boundary of the liquid. Next when a comparatively thick layer of the order of 2 mms. or more of the distilled water or of the water from the water pipes was employed to cover the plate, the appearance of the brush discharge was essentially the same as above as shown in Fig. 3. Actually the writer could ascertain by visual observation that, in these cases, the visible discharge took place only at the region outside the boundary of the liquid, and that no visible discharge occurred at the portion covered by the liquid. This was naturally expected, and the liquid behaved in this case, on account of their comparatively small electric resistance, as a part of the electrode on the photographic plate.

When a liquid of bad conductivity such as oils of various kinds or absolute alcohol was used instead of water, the brush discharge of the same polarity as the electrode started directly at the electrode and extended along the surface of the liquid and thence to the surface of the sensitive film of the photographic plate. Only the portion of the brush-impression just under the liquid, appearing somewhat weak and diffuse ; whilst the main feature of the figure was entirely the same as the ordinary discharge figure on the photographic plate as shown in Fig. 4. The correctness of the above statement was verified directly by visual observations. The total electric resistance of the liquid with which the photographic plate is covered, could also be increased by reducing its thickness. Thus the effect of greatly reducing the thickness of the water layer was essentially the same as using a bad conductor such as oils of various kinds. In such a case the brush of the same polarity as the electrode also started at and extended outward directly from the electrode.

Judging from the experiments above stated, it seems now evident that a liquid of proper elεctric resistance was suitable in order to cause the curious discharge figure observed by Mikola.

Thus when the water from the water pipes was employed to cover the portion of the photographic plate around the electrode, a thickness of from one tenth of a millimeter to one millimeter was found to be suitable to get the curious discharge figure in question. The photograph reproduced in Fig. 2 was obtained under such a condition.

In the case of a very bad conducting liquid the electric discharge from the electrode takes place only in the form of a visible brush discharge along the surface of the liquid. On the contrary in the case of a good conducting liquid, the electric discharge from the electrode passes only through the liquid without causing any luminosity. Thus with a liquid layer of proper thickness and of intermediate conductivity, such as water, it may happen that the electric discharge takes the form of a luminous brush along a portion of the surface of the liquid, together with a non-visible discharge through the liquid itself.

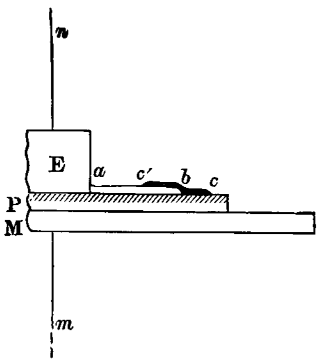


Fig. 5.

In Fig. 5, let E be the anode, M the metallic plate connected to the negative pole of an influence machine, P the photographic plate, and ab the layer of the water of proper thickness. On account of the comparatively smallness of the resistance of the liquid layer, when the potential difference between E and M is sufficiently incrsased, the positive charge on the anode E will be conducted through the water, not causing at all the brush discharge along the surface of the water. The luminous positive brush discharge will now start at the boundary of the water b and will extend outward to c along the surface of the sensitive film of the plate. In this state of the discharge, the branches of the positive brush bc will behave as if it were a conductor. The positive ions will be repelled toward the terminals c of the branches of the brush, and a large number of negative ions will accumulate on the sharp starting points b of the branches. Consequently, in spite of the presence of a semiconducting liquid layer, the electric field along its surface will become so intense at the end b that the brush of the negative polarity now starts at the boundary of the liquid and extends back toward the electrode along the surface of the liquid. When the electrode E on the photographic plate is made cathode, we have simply to reverse the signs of all the charges and brushes respectively. The photographic impression of the brush which starts at the boundary b of the liquid and extends back toward the electrode seems to be due to the brush along the surface of the liquid. Thus considered, the fact that the impression of the brush under consideration becomes more diffused with a thicker liquid layer seems to be explained at once.

In conclusion, the writer wishes to express his sincere thanks to Assist. Prof. U. Yoshida for his kind guidance during the work.

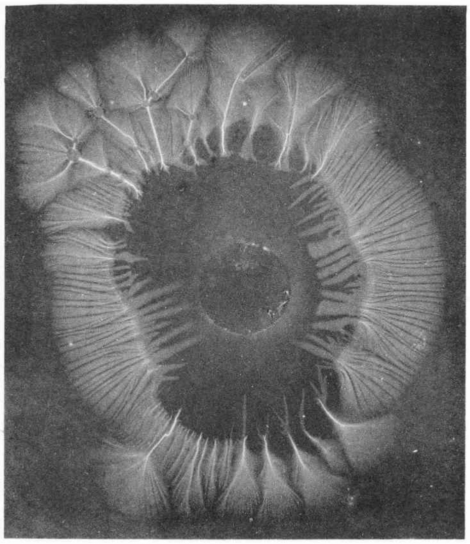
Fig. 2.

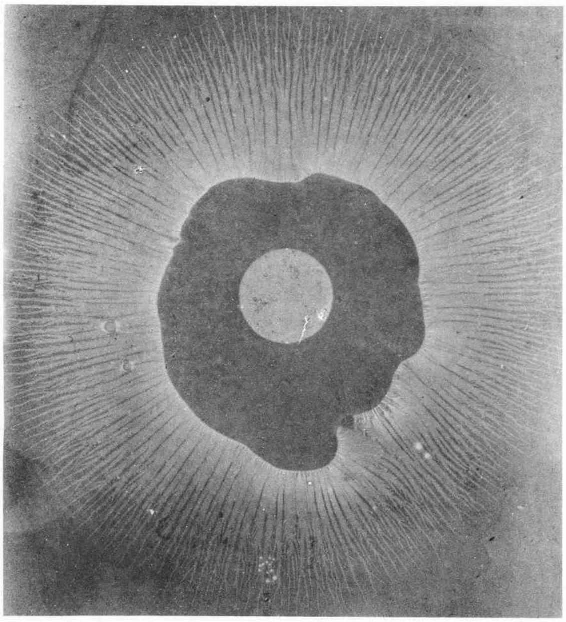
Fig. 3.

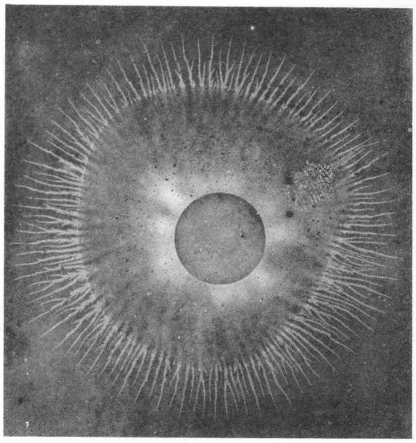
Fig. 4.