"The Reversal-Like Phenomena" of the Secondary and the Tertiary Discharge-Figures impressed on Photographic Plates

By

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ABSTRACT

1. The reversal-like phenomena occur also in the secondary and the tertiary discharge-figures similarly as in the primary ones.

2. The phenomena in the secondary figures corresponding respectively to the primary negative and the primary positive figures are similar to those of the primary positive and the primary negative figures respectively; and the phenomena in the tertiary figures corresponding respectively to the primary negative and the primary positive figures are similar to those of the primary negative and the primary positive figures respectively. Therefore, the tertiary figure corresponding to the primary negative, and the secondary figure corresponding to the primary positive are of a negative nature.

INTRODUCTION

In the arrangement shown in Fig. 1, P_1 and P_2 are two photographic plates, which are in contact with each other on their plain glass sides; and P_3 is another photographic plate. The shaded portions of these photographic plates represent the film-covered sides of the plates. M, which is just beneath the photographic plate P_3, is an earthed metal-plate; and s is an air-space.

Now, one of the electrodes of a charged condenser is connected to the terminal E which is laid on the sensitive film of the photographic plate P_1, and the other electrode to the earth, and if a momentaneous brush discharge takes place on the sensitive film of the photographic plate P_1, we shall see the beautiful discharge-figures impressed on the photographic plates after development. The discharge-figures impressed on the photographic plates P_1, P_2 and P_3 are called respectively the primary, the secondary and the tertiary figure by Mikola,[1] Pedersen,[2] and Yoshida and Tanaka.[3] According to these investigators when the positive terminal of the charged condenser is connected with the terminal *E* on the photographic plate P_1, the figure impressed on it is called "the primary positive figure," that on the plate P_2 "the secondary negative figure" and that on the plate P_3 "the tertiary positive figure." When the negative terminal of the charged condenser is connected with the terminal *E*, the discharge-figures are named "the primary negative figure," "the secondary positive figure" and "the tertiary negative figure" respectively.

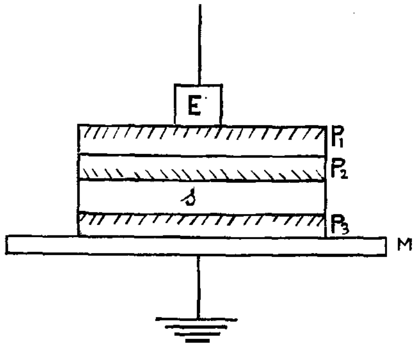

Fig. 1

The secondary positive figure consists of two parts: one the concentric lines running in the direction perpendicular to the branches of the primary negative figures, and the other the short brushes radiating outward or inward from the concentric lines. The secondary negative figure consists of an assemblage of many diffuse lines running in a direction nearly perpendicular to the branches of the primary positive figure.

As shown in Fig. 2, if a spark gap *G* is inserted between the electrode *E* and the earthed metal-plate M, then when a brush discharge from the electrode *E* takes place on the sensitive film of the photographic plate P simultaneously with a direct spark at the spark gap *G*, an interesting phenomenon occurs in each of the primary negative and positive figures. This interesting phenomenon was first ob-

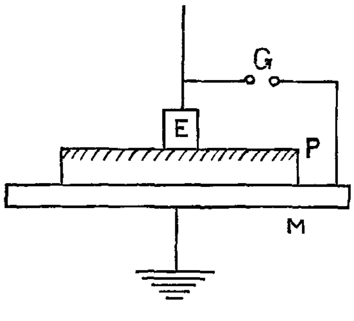

Fig. 2

1 Mikola, Phys. Z.S. **18**, 158, (1917).
2 Pedersen, K. Danske. Vidensk. Selsk. **1**. No. II, (1919).
3 U. Yoshida and S. Tanaka, Mem. Coll. Sci. Kyoto, **5**, 145, (1921).

served by Prof. Yoshida.[1] In the negative figure, an enveloping margin comes out at the ends of the negative branches as shown in Fig. 1a, Plate I; and in the positive figure, each branch is enveloped separately with a diffused margin of stronger intensity as shown in Fig. 1b, Plate I. According to Prof. Yoshida, these phenomena are not explained by a mere photographic reversal, so the writer will hereafter call this interesting phenomenon " The reversal-like phenomenon " for convenience' sake.

Now, it is interesting to see whether or not this reversal-like phenomenon will occur with the secondary and the tertiary figures as with the primary one, since it may enable us to learn the real nature of this phenomenon. The experimental arrangements and the results are described below.

EXPERIMENTAL ARRANGEMENTS AND RESULTS

The electrical circuit used is shown in Fig. 3. This circuit is similar to those used by Max Toepler,[2] Przibram,[3] Pedersen,[4] Peters[5] and Paul Heymans.[6]

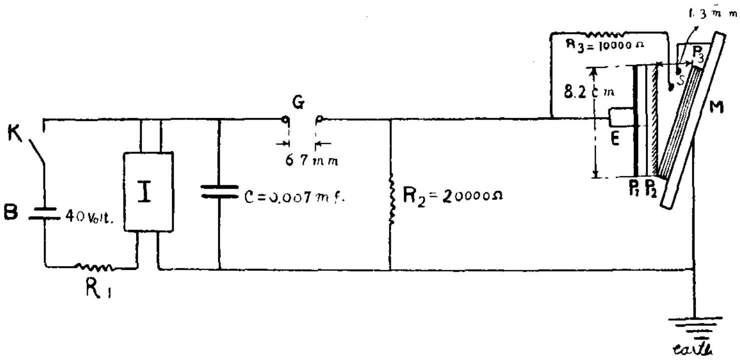

Fig. 3

In Fig. 3, *K* is a key, *B* a 40-volts battery, *I* an induction coil of which the maximum needle-plate-spark-gap is 40 cms. with the primary electric source of 40 volts, R_1 an electric resistance as the regulator of the primary current, *C* a condenser whose electric capacity is 0·007

1 U. Yoshida. Mem. Coll. Sci. Kyoto, **2**, 315, (1917).
2 Toepler. Phys. Z. S., **8**, 743, (1907).
3 Przibram. Phys. Z. S., **21**, 480, (1920).
4 Pedersen. Ann. d. Phys. **69**, 205, (1922), Ann. d. Phys. **71**, 315, (1923).
5 Peters. Elec. Wld. **83**, 769, April 19, (1924).
6 Heymans and Frank. Phys. Rev. **25**, 865, (1925).

microfarad, G a spark gap, E the cylindrical terminal whose diameter is 1·27 cm., R_2 a water resistance of about 20,000 Ω, R_3 another water resistance of about 10,000 Ω, and S is a short spark gap. This illuminating spark gap S is laid on an insulating plate P_3. The plate P_1 is a black glass plate obtained by developing a photographic plate of 1·2 mm. in thickness, which had previously been exposed to the sunlight for some seconds. By means of this black glass, the writer prevented the light, which is emitted by the primary discharge at the terminal E, from coming toward the photographic plate P_2. The secondary figures, Fig. 2a, Fig. 2b in plate I, and Fig. 3a, Fig. 3b, Fig. 4a in plate II are obtained by the use of this black glass P_1 and the insulating glass plate P_3, which is 1·2 m.m. in thickness. The tertiary figures, Fig. 2c in Plate I and Fig. 3c and Fig. 4b in Plate II are obtained on a photographic plate in the position of P_3 in Fig. 3, the glass side of which had been brought into contact with the earthed metal-plate M.

In the first place, the electric resistance R_1 and the lengths of the spark gaps G and S are so adjusted that the electric sparks take place simultaneously at these two spark gaps, when the key is broken. In that case, when the electric impulse resulting from a spark at the gap G reaches the electrode E and the gap S, the secondary and the tertiary figures are impressed respectively on the plates P_2 and P_3, at the same time as the formation of a spark at S; and the light emitted by this spark illuminates the plates P_2 and P_3.

The brushes of the secondary figure corresponding to the primary negative one grow from the system of concentric rings outwards or inwards according to the thickness of the insulating plate P_3 in Fig. 1, as was pointed out by Yoshida and Tanaka.[1] Fig. 2a in Plate I, was obtained when the thickness of insulating plate P_3 was 1·2 mm., Fig. 2b in the same plate was secured when its thickness was 0·2 mm. In these cases, the brushes of the former grow inwards, and those of the latter outwards. With the arrangement in Fig. 3, if the illuminating spark appears at the same time as the impression of the discharge-figures, each of the brushes causes the reversal-like phenomenon as shown in Figs. 3a and 3b in Plate II, and it may be easily seen in these figures that the reversal-like phenomenon is of the nature characteristic of the positive one.

Fig. 2c in Plate I is the tertiary figure corresponding to the primary negative one, and it will easily be seen that this figure consists of regular

1 U. Yoshida and S. Tanaka, Mem. Coll. Sci. Kyoto. **5**, 145, (1921).

negative and irregular positive-like brushes. Fig. 3c in Plate II, is the tertiary negative figure obtained with the arrangement in Fig. 3, by illuminating the plate with the spark at *S*. In this figure, we can see clearly the enveloping margin which is characteristic of the negative figure. Again, the same phenomenon was obtained with a celluloid film instead of a photographic plate.

As to the secondary figure corresponding to the primary positive one, Yoshida and Tanaka[1] say "......it was observed by the writers that these diffuse lines in the secondary figure, on some of photographs taken with a sufficiently thick air space, had fine structures characteristic of the regular primary negative figure. Judging from this, the secondary figure corresponding to a primary positive one seems to be of a negative nature, and it may be called ' the secondary negative figure, after Mikola and Pedersen."

The writer undertook to observe the reversal-like phenomena of this secondary figure by using an insulating glass plate P_3 as shown in Fig. 3, which was 1·2 mm. in thickness; but the result was negative, probably owing to the weakness of the impression of the secondary figure. Next, he used a thin celluloid film 0·2 mm. in thickness as an insulator instead of the glass plate P_3 in Fig. 3; and the expected phenomenon appeared on the photographic plate P_2 in Fig. 3 as reproduced in Fig. 4a, Plate II. The enveloping margin in this photograph was clearly of a negative nature as was seen in the primary negative one.

The reversal-like phenomena of the tertiary figure corresponding to the primary positive one was observed by the writer on a photographic plate placed in the position of the insulating plate P_3 in Fig. 3, by putting the film-side of the photographic plate against the spark gap *S* in this figure. In some dozens of photographs taken, the reversal-like phenomena characteristic of the primary positive figure always happened as shown in Fig. 4b, Plate II. The same phenomenon was also obtained with a celluloid film instead of a photographic plate.

In conclusion, the author wishes to express his hearty thanks to Professor U. Yoshida of the Kyoto Imperial University for the deep interest he has taken in this research.

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1 U. Yoshida and S. Tanaka, loc. cit.

Plate I

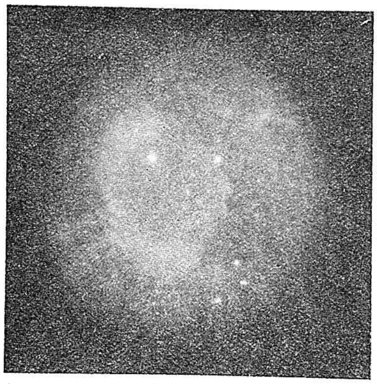

Fig. 2a

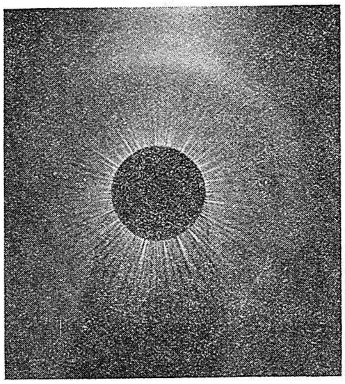

Fig. 1a

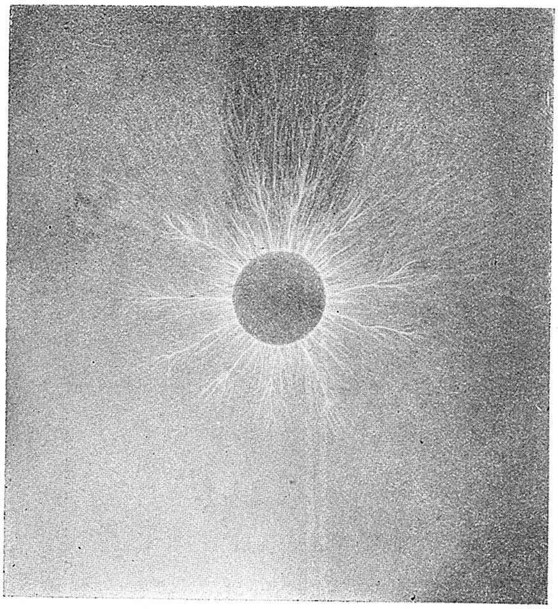

Fig. 1b

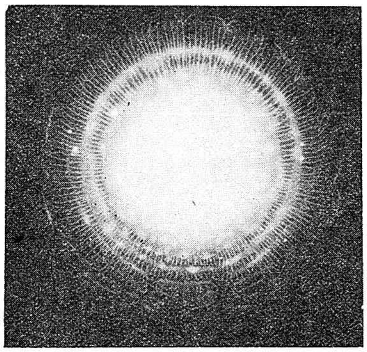

Fig. 2b

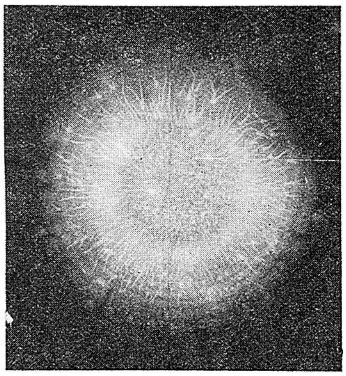

Fig. 2c

Plate II

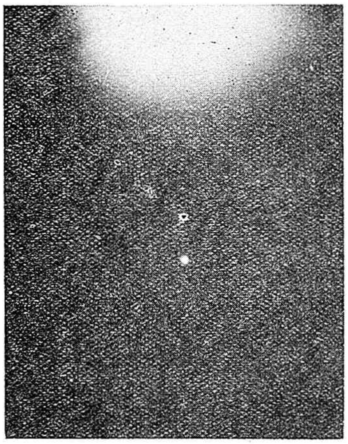

Fig. 3a

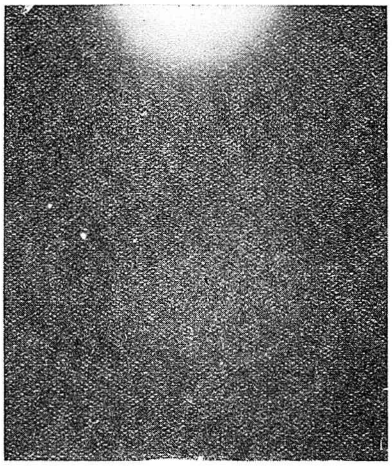

Fig. 3b

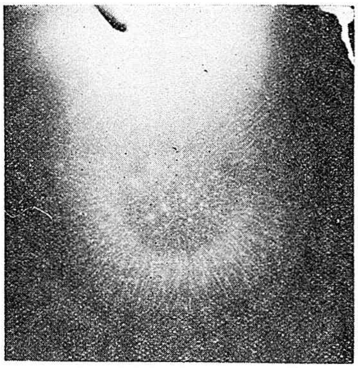

Fig. 3c

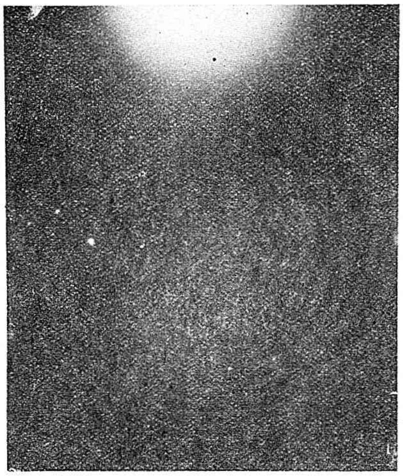

Fig. 4a

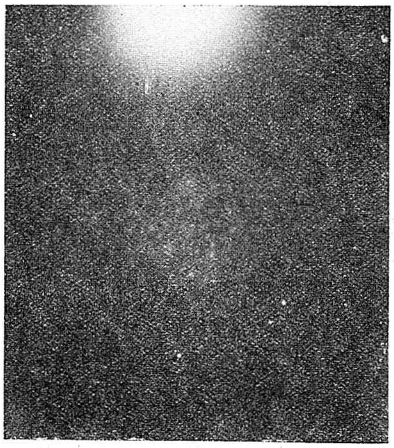

Fig. 4b