SOME EXPERIMENTAL STUDIES ON ITOH'S STRIATED ELECTRICAL DISCHARGE FIGURES. PART II

By

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CONTENTS.

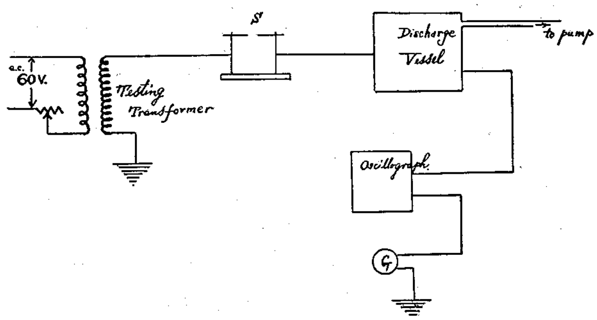
INTRODUCTION.

In the course of the experiment with somewhat modified apparatus as described in the preceding report, we have some electric discharge figures similar to Itoh's. The electrodes used in that experiment consist of a needle and a disc, while the electrodes used at present consist of a needle and a cylinder or of a needle and ring, as we can set more closely the measuring apparatus such as photographic camera or spectrograph. There are some conveniences of observation compared with the former apparatus. For example, we can easily obtain the rough distribution of the electric potential of these striated figures on the glass plate by means of the dust powder. The amount of the current which flows through the circuit and is sufficient to produce these striated figures is precisely shown in paragraph II.

I. THE CASE WHERE A NEEDLE AND A CIRCULAR METALLIC CYLINDER ARE USED AS THE ELECTRODES.

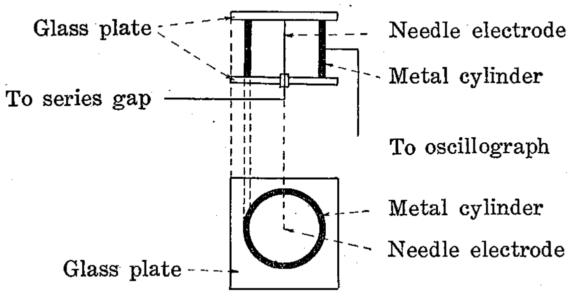
1. Apparatus used in this experiment.

First, the discharge vessel is prepared by rubbing the thick pieces of plane glass so as to make airtight both ends of the hollow metal cylinder in which the needle electrode coincides with the cylinder's vertical axis. The air pressure in the vessel is reduced by a Cenco vacuum pump. The needle electrode is connected through the series gap to one terminal of the high tension side of the testing transformer. The electric connection is illustrated in Fig. 1.



Electrical connection

Fig. 1. *a*.



Discharge vessel

Fig. 1. *b*.

2. Experimental results.

Keeping the primary voltage of the testing transformer constant, we obtain the relation between the pressure of the air and the rectified current through this electric discharge circuit. The data thus obtained are shown in Fig. 2, as P-I curves for the various lengths of the series gap. These curves are shown in the following three different curves.

(a) for the gap length smaller than 0.5 mm.
(b) for the gap length within the range of 1 to 2 mm.
(c) for the gap length within the range of 2 to 3 mm.

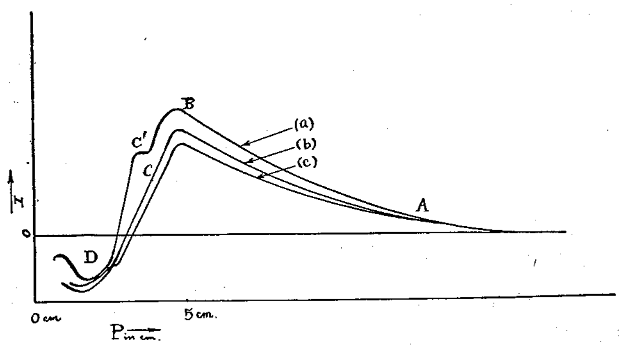


Fig. 2. *a*.

Enlarged curves of B-A part in Fig. 2, *a*.

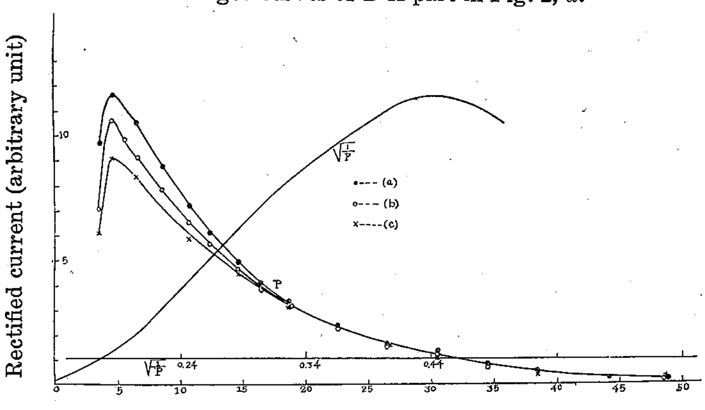


Fig. 2. *b*.

Enlarged curves of B-C-D part in Fig. 2, *a*.

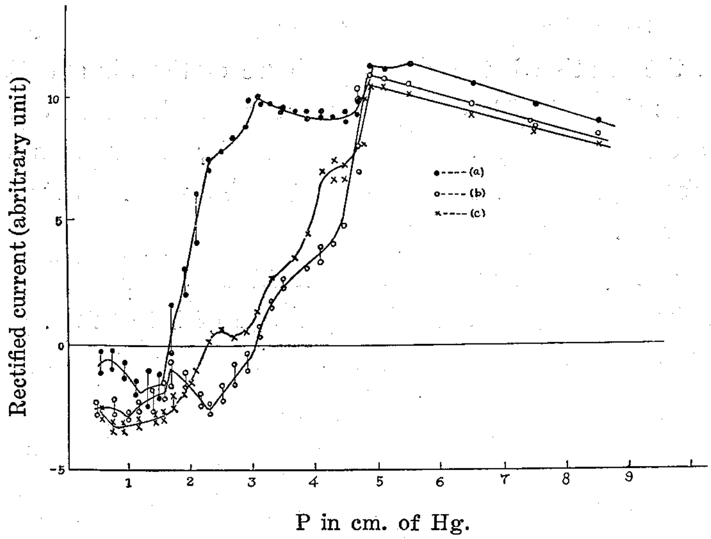
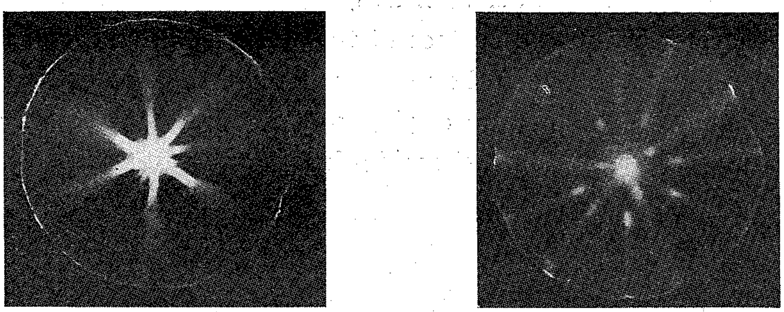


Fig. 2. *c*.

If the pressure of the air is higher, P-I curves for the various S nearly coincide in the range A. Near the range AB, the discharge figure takes the brush form radially from the needle point (see Fig. 3, a) The wave form of this discharge current in this case is indicated in Fig. 4. a. The most stable and finest figure occurs when the maximum positively rectification is attained. These figures correspond to the radial figures treated by Dr. Itoh.

Reducing the air pressure in the vessel to 4.5 cm. of Hg., the deflection (C part) of the galvanometer decreases abruptly with the appearance of the arc-like streamer. This means that the arc-like streamer has the character of a negative charged particle. Therefore its current is shown in Fig. 2. a. The steep part of the graph of the current is shown in the enlarged curve of Fig. 2. c. In case the gap length is smaller than 0.5 mm., a pink coloured discharge figure occurs. An example of these figures with the air pressure within the range of 5 to 15 mm. of Hg., is shown in Fig. 3. b; their current is shown in the oscillogram of Fig. 4. b. This figure may be considered as the elongation of the central figure at low pressure of

$\times\frac{2}{9}$ $\times\frac{2}{9}$



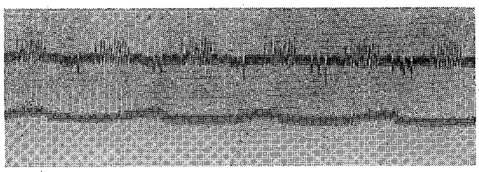
$\begin{cases} S = 0.2 \text{ to } 0.3 \text{ mm.} \\ P = 6 \text{ cm.} \end{cases}$

a

$\begin{cases} S = 0.2 \text{ to } 0.3 \text{ mm.} \\ P = 1.5 \text{ cm.} \end{cases}$

b

Fig. 3.



b I = 0.04 ma.

a I = 0.45 ma.

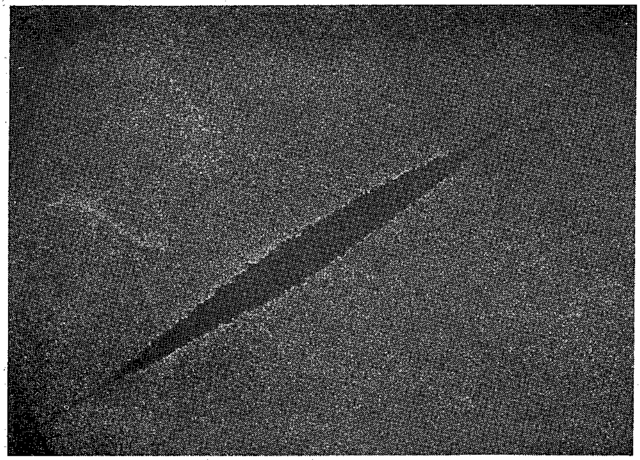
⟵ time

Fig. 4.

the air. Then, if we rub the outward surface of the glass plate with our finger lightly in any direction, we see that our finger attracts the luminous striae of the figure appearing on the inward surface of the plate. If we place a conducting or insulating material on the outward surface of the glass plate, the electrostatic field on the inward surface of the plate is distorted and therefore the distribution of the striae changes. At several mm. of Hg. these discharge figures (part D) become reddish. At this stage, the disturbance of the striae due to such introduction that affects the internal electric field becomes most remarkable. If the pressure of the air is further reduced to a few mm. of Hg., these figures gradually disappear in that vessel.

3. Potential distribution of the figure.

Fine insulating powder such as lycopodium powder is uniformly strewn over the outward surface of the plate and a thin earthed wire is put on the plate across the needle point electrode. Next, making the striated discharge figure display on the inward surface of glass plate, we get a dust figure shown in Fig. 5 on the outward surface of



Potential distribution of the figure.

Fig. 5.

plate. We suppose that the powder is repelled from the wire according to the potential difference between each corresponding point of the striated figure and thin earthed wire. Thus the present dust figure indicates roughly the potential distribution along the stria of the discharge figure.

II. THE CASE WHERE A NEEDLE AND A RING-FORMED CONDUCTOR ARE USED AS THE ELECTRODES.

Next, we have also electric discharge figures on the glass plate inserted between a needle and a ring-formed electrode as shown in Fig. 6. Its electrical connection is the same as Fig. 1. This glass disc consists of several circular sheets of ordinary window glass.

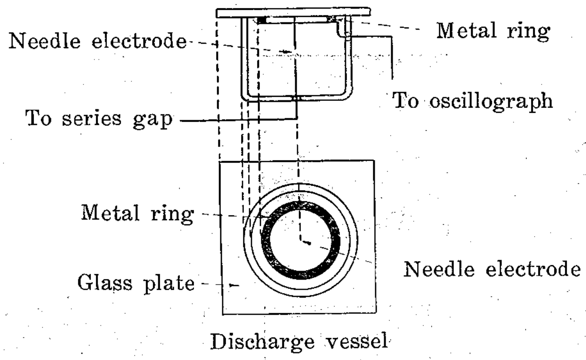


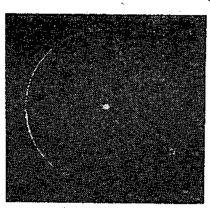
Fig. 6.

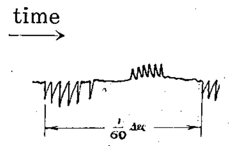
Applying a high tension voltage of 60 cycles between the electrodes, we have similar figures to Itoh's on the glass disc. The oscillographical study shows in this case that the current flowing through the circuit is quite similar to Itoh's.

In the next place, taking the glass disc out the discharge vessel, we take the discharge between the needle and ring-formed conductors on the inner surface of the glass plate as shown in Fig. 6. The relation between the air pressure and the amount of rectified current through the galvanometer is entirely similar to the relation obtained in the paragraph I of this paper, within the range of the gap length from 0.5 to 3 mm. With increased gap length some different figures are obtained. The series of photographs of these figures (Fig. 7. a, b, c. d, e, f, g) shoud be compared with the wave forms of the currents.

$\times\frac{1}{10}$

$a\begin{cases} S = 0.0\,\text{mm.} \\ P = 3.7\,\text{cm.} \\ I = 1\sim1.5\,\text{cm.} \end{cases}$



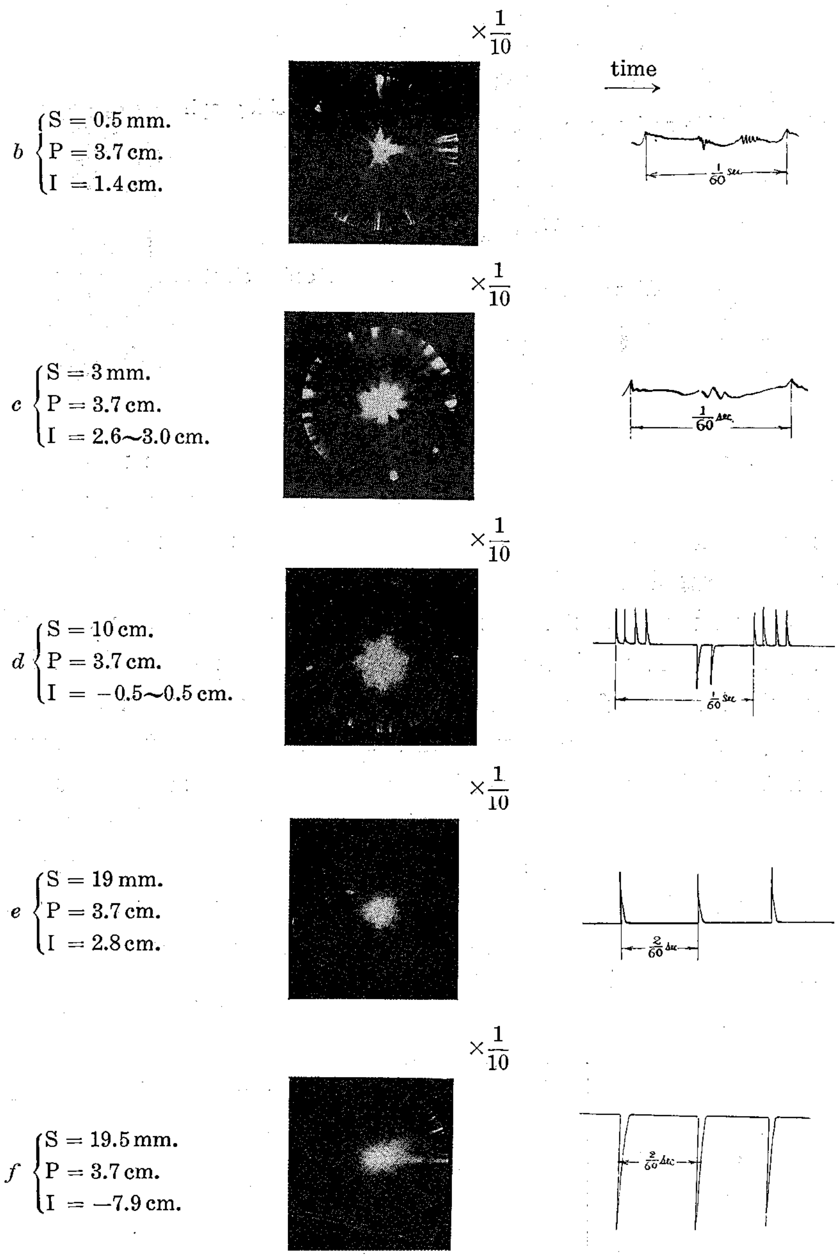


1 cm. deflection of galvanometer corresponds to 0.055 ma.

A series of electric discharge figures.

Wave form of electric discharge current corresponding to each figure on the left-hand side.

Fig. 7.



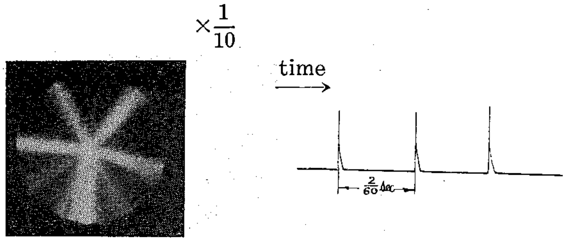
1 cm. deflection of galvanometer corresponds to 0.055 ma.

A series of electric discharge figures.

Wave form of electric discharge current corresponding to each figure on the left-hand side.

Fig. 7.

$g \begin{cases} S = 19\,\text{mm.} \\ P = 1.3\,\text{cm.} \\ I = 1.6\,\text{cm.} \end{cases}$



1 cm. deflection of galvanometer corresponds to 0.055 ma.

A series of electric dischaege figures.

Wave form of electric discharge current corresponding to each figure on the left-hands side.

Fig. 7.

SUMMARY.

1. Using the needle and metal cylindrical electrodes or the needle and the metal ring instead of the needle and the metal disc, electric discharge figures similar to the radial one already studied by Dr. Itoh are obtained by the writer.

2. The characteristic P-I curves of these figures are precisely obtained by means of the galvanometer.

3. The various electric figures for the various gap lengths are compared with the oscillograms of the current producing them.

4. The rough electric field distributions of these figures on the glass plate are easily obtained by means of a specially generated dust figure.

In conclusion, the writer wishes to express his hearty thanks to Prof. Y. Ikeda for the continual guidance given to carry out this work and also to Dr. Itoh for valuable suggestions.