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LVIII. *On Figures Produced by Electric Action on Photographic Dry Plates.* By J. BROWN*.

[Plates VI. & VII.]

WHILE photographing the electric discharge from an induction-coil it occurred to me to try what effect would be produced on the plate by the discharge when taking place directly on the *sensitive film* itself.

A rather rapid photographic dry plate was laid film upwards on a piece of sheet metal connected to one terminal of the secondary, whose ordinary discharging points were set about 3 centim. apart to act as a by-pass to the spark and prevent it striking over the edge of the plate. The end of a wire from the other terminal rested on the centre of the film. A single discharge from the coil was caused by moving its mercury-break by hand, and the plate was then placed in the developer.

When the terminal wire at the centre of the plate was negative, and particularly if no discharge passed over the edge of the plate, the result was like that represented at A (Plate VI.), which shows the typical negative form consisting of beautiful sharply defined symmetrical palm-like fronds on irregular stems branching out from the centre where the wire rested, together with a mass of less distinct irregular straggling lines also branching outwards, but not reaching so far as the fronds.

When the wire terminal was made positive and a discharge caused under otherwise precisely similar conditions, the figure was quite different, as in B, and consisted on the plate of dark irregular branchings sharply defined except near the centre, where apparently the luminosity of the spark has caused a nebulous edge to the branch. These branchings are accompanied by light irregular straggling radiations, similar to those on the negative plate, but having a rather more distinctly centrifugal direction and extending beyond the well-defined branches, from which they seem to be to some extent off-shoots. The experiments were repeated several times and gave similar characteristic results. If, however, the metal sheet were omitted, and wires from both positive and negative terminals brought down on a plate insulated on a paraffin block, neither the palm-fronds on the negative, nor the dark markings on the positive appeared, but only the lighter irregular branchings, and these were in much greater quantity round the positive

* Communicated by the Author.

A.

B.

terminal than at the negative ; but with the poles not too far apart they stretched across from one to the other in the form of confused and irregular lines of flow.

When the plate was laid as before on a metal sheet and wires from both positive and negative terminals brought down on the film, a discharge produced the characteristic figures under their respective wires. These were best defined only when no spark discharge crossed between the wires on the plate ; and there was in this case no branching out of the positive and negative markings towards each other, the inductive circuit sensibly completing itself through the metal sheet under the plate.

When the difference of potential was made sufficient to produce spark-discharge between the terminals on the plate, the resulting marking depended in several respects on the presence or absence of a metal sheet under the plate.

With no metal sheet, and the plate insulated on a block of paraffin, the discharge took a fairly direct course between the terminals C (Plate VII.), with only slight crookedness, but sometimes in a double line. On this plate the characteristic palm-fronds of the negative and dark branchings of the positive pole are wanting, and the lighter tracery forms a rough indication of confused lines of flow between the poles.

With a sheet of foil pasted on the back of the plate (leaving a margin of about 2 centim. round the edge) and spark-discharge between the terminals, there is exceedingly little, if any, distinct tendency of the positive and negative markings towards each other. The track of the main spark is very crooked, meandering over the plate in a quite irregular way, and making sometimes sharp distinct angles in its course. From about half of its length from each end, but principally from the terminals, branch off here and there the characteristic positive or negative markings. D, E, and F (Plate VII.) are examples, the latter being the result of half a dozen sparks passed over a plate in succession from a pair of terminals resting on it.

When a strip only of foil was fixed on the back of the plate so that its length crossed the line joining the poles at an angle of about 45° , as at G (Plate VII.), where the rectangle shows the position of the foil, and about twenty sparks were passed, they all took a similar S-shaped course, having been apparently attracted out of the direct line to follow that of the foil underneath the glass.

The meandering form and general appearance of these sparks, when acted on inductively by the foil under the plates, remind one very much of certain kinds of lightning-flashes,

Mantern Bros. lith.

and suggest at least a possibility of some similarity in the causes producing each.

The question now arose as to whether the result was due to a photographic effect of the luminosity of the spark, or to some more direct action of the discharge on the film—to what might be called an “electrographic” action.

As evidence for the latter view came the apparent insufficiency of the light, actually visible when the discharge took place, to produce the effect. The lighter branchings were not to me visible at all in either positive or negative, and only an indication of the frond formations in the negative.

There are also in the positive plate B (Plate VI.) several intervals as if the spark had not been in immediate contact with the film, but had passed over it, leaving only a foggy mark instead of a sharply defined black line. The break or interval would scarcely have been so marked if the whole effect were photographic only.

However, to further investigate this question the discharge was taken with the two terminals on the back or uncoated side of the plate. The figures which now appeared on the film were quite different from those described above. In each case there was impressed on the *back* of the film (next the glass) the cloudy photographic effect of the branching discharge on the back of the plate.

On the front or outer side of the film under the positive terminal the figure reminded one of a photograph of a maiden-hair fern out of focus. That under the negative is a collection of peculiar tadpole-like markings, whose general arrangements correspond in size and shape to the fronds formed by the discharge on the back of the plate. These figures would appear to be due to electricity induced in the film.

To try further the effect of induction on the film, I cut my initials in tin-foil after the manner of a stencil plate, placed the foil on the film, a piece of gutta-percha tissue on the foil, and pressed all together in an ordinary photographic printing frame. A second piece of foil was placed on the back of the plate, leaving a margin all round, and the foils were joined to opposite poles of the coil with its terminals giving a by-pass of about 1 centim., so as not to have any spark discharge over the plate. The result with the poles connected in either sense, and the coil working for about a minute was, with the stencil foil either positive or negative, an irregular blackening all round the edge of the foil, including the edges of the cut-out parts as if a discharge had passed out from the edges. In some places the characteristic markings of positive or negative, as the case might be, were visible. There was, however,

a slight visible discharge from the edge of the foil on the back of the plate, and probably therefore the same from that on the film to which the edge-marking may be due. There was also on the plate much blotchy marking, apparently corresponding to the wrinkling of the foil in contact with the film.

With a piece of gutta-percha tissue between the stencil-plate foil and the film, the result was similar, only the line round the edges was narrower and the blotching less marked, hence the initials came out more distinctly. When four thicknesses of gutta-percha were interposed, there appeared only blotchy markings on the part under the foil.

These results would go to show that actual disruptive discharge over or in the film is not needed to produce an effect visible on development, but that the figures are produced partly at least by direct electric action on the sensitive film without the intervention of a visibly luminous action, or what would be usually understood as a purely photo-chemical cause. Possibly further investigation may show that we have here a new kind of experimental evidence on the relation of electricity to light.

I may add that it is necessary, especially in the experiments with the terminals on the back of the plate, to use rather sensitive plates; "60 times" plates do very well, while slow plates give imperfect figures in all cases and show almost nothing with the terminals on the back.

LIX. *The Invisible Solar and Lunar Spectrum.*

By S. P. LANGLEY.*

THE following investigation has been made from studies at the Allegheny Observatory; but it is proper to state that the provision of the very special apparatus used is due to the liberality of a citizen of Pittsburgh, who has desired that his name should not be mentioned.

This paper is an abstract of a forthcoming memoir, which will eventually appear in the fourth volume of the publications of the United States National Academy of Sciences, to which the reader is referred for fuller details.

* Communicated by the Author, to whom we are likewise indebted for the clichés.

As the writer has already presented to the National Academy a memoir (read October 17, 1884, *Memoirs Nat. Acad. of Sci.*, vol. iii.) on the heat of the moon, in which he spoke of investigations still in progress on it, it should be said that these are not yet published, and that they are only given here so far as is necessary in explanation of certain anomalies in the infra-red solar-heat spectrum, which forms the principal subject of the present paper.