The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo

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XX. *The Effect of Radium in Facilitating the Visible Electric Discharge in Vacuo.* By A. A. CAMPBELL SWINTON*.

As has been shown by Edison, Fleming, and others, the passage of the electric discharge in vacuo is much facilitated by heating the cathode.

More recently, as has been shown by Owen (Phil. Mag. viii. 1904) and by Wehnelt (Phil. Mag. x. 1905), the passage of the discharge is still further facilitated by coating the heated cathode with oxides of the alkaline metals; the effect in this case being so great that large and highly luminous discharges amounting to several amperes can, under favourable conditions, be passed through the vacuum tube, using pressures of only 30 to 300 volts.

It is generally held that the efficacy of the hot oxides in this direction is due to their giving off negatively charged ions or corpuscles.

It therefore occurred to the writer to ascertain whether similar effects could not be obtained by painting the cathode with radium, and as radium gives off corpuscles when cold, it was anticipated that it might not be necessary to heat the cathode.

In the first experiment, however, this was found not to be the case, as with a cold cathode, and using continuous current up to 400 volts pressure, the radium did not seem to have any appreciable effect in producing a visible discharge. When, however, the radium-coated cathode was heated to redness, the radium was found to have a very marked action in facilitating the production of a luminous discharge.

In the experiments a strip of platinum foil was used for the cathode, which, before mounting in the tube, was dipped into a solution of radium bromide and dried. The amount of radium on the foil must have been extremely small, but with a suitable vacuum, and with the cathode heated to a bright red colour, the discharge passed, and the gas in the tube lighted up brightly with electrical pressures as low as about 80 volts.

In order to determine whether it was necessary that the

* Read June 22, 1906.

radium should be on the cathode itself or whether the mere presence of radium in the tube would be sufficient to produce the effect, a tube was constructed, as shown in the illustration, with two similar platinum-foil electrodes, either of which could be used as a cathode, and both being arranged so that they could be heated to redness by passing a current through them, the anode being mounted midway between the two cathodes. One of the cathodes was dipped before mounting in a solution of radium bromide, while the other was not so treated.

Under these circumstances, it was found that with pressures up to 400 volts a visible discharge passed only when the platinum strip that had been treated with radium was used as cathode and was heated to redness, and that when both platinum strips were heated to redness there was no visible discharge when the untreated strip was used as a cathode. Furthermore, it was found that the tube would only allow visible discharges to pass in the direction that made the

treated platinum strip cathode, the tube acting as a uni-directional valve in the same way as do tubes with cathodes coated with oxides.

It was not found possible to obtain as large currents through these radium tubes as through oxide tubes under similar conditions as regards voltage, degree of exhaustion, and temperature of cathode ; but, having regard to the very small quantity of radium employed in comparison with the quantities of oxide, this is not surprising.

Experiments were next made without any heating of the cathode, but using alternating currents of higher voltages than were available in continuous current.

Employing the tube with one central electrode and two symmetrically placed loop electrodes, one of the latter being treated with radium and the other being plain, the following results were obtained, the voltages being measured by means of a Duddell thermo-galvanometer.

It was found that, using the untreated electrode, it required from 800 to 900 volts to get a visible discharge to pass ; whereas, using the radium treated electrode, a visible discharge could be got to pass with from 700 to 800 volts. The exact voltages required in each case to cause a visible discharge were somewhat variable ; but it was always found that a visible discharge could be got to pass, using the radium treated electrode, with about 100 volts less than when the untreated electrode was employed. It was further very noticeable that, using the treated electrode and gradually reducing the voltage, a much fainter luminosity of discharge could be obtained without actual extinction of the discharge than was the case when the untreated electrode was employed, in which case the transition from a visible discharge to no luminosity was much more abrupt. This fact goes to show that the differences in the minimum voltage required to produce a visible discharge in the two cases was actually due to the presence of radium, and not to any slight difference in the distances between the electrodes or other want of symmetry in the tube.

A d'Arsonval mirror galvanometer was next inserted in the circuit. With a plain alternating current this galvanometer would, of course, give no deflexion. It was, however,

found that whether the radium treated or the untreated electrode was used, there was always a slight deflexion of the galvanometer, due no doubt to some unidirectional valve action on the part of the vacuum-tube. It was found, however, that using the treated electrode, the galvanometer deflexion was between two to three times as great as when the untreated electrode was used, this being evidence that the presence of radium increased the valve action to a considerable extent.

The thermo-galvanometer was next substituted for the d'Arsonval mirror galvanometer, and it was then found that, using the radium treated electrode, the amount of current that passed through the tube was from one and a half times to twice as large as when the untreated electrode was employed, this showing that the presence of radium on the cathode materially increases the amount of current that passes through the tube with any given voltage.

The writer is indebted to Mr. J. C. M. Stanton and Mr. R. C. Pierce for their assistance in making the above investigations.

XXI. *The Effect of Electrical Oscillations on Iron in a Magnetic Field.* By W. H. ECCLES, D.Sc., A.R.C.S.*

THE following investigation of the action of high-frequency oscillations upon iron held magnetized in a magnetic field was carried through in July and August of last year, and was undertaken to supplement in a quantitative manner the rather vague information available. Since Marconi† announced in 1902 that feeble electrical oscillations were capable of altering the flux of induction in a piece of magnetized soft iron, a great deal of work has been done in the endeavour to determine what it is that really happens in this process. A glance through the chronicles of these labours reveals a surprising lack of precise data, and shows, in fact, that most of our knowledge of this subject is merely qualitative. This is due, no doubt, to the complicated possibilities

* Read June 22, 1906.

† Roy. Soc. Proc. lxx. p. 341, July 1902.