



III. Some notes on brush discharges in gases

W. H. Harvey & F. Hird B.A.

To cite this article: W. H. Harvey & F. Hird B.A. (1893) III. Some notes on brush discharges in gases , Philosophical Magazine Series 5, 36:218, 45-48, DOI: [10.1080/14786449308620448](https://doi.org/10.1080/14786449308620448)

To link to this article: <http://dx.doi.org/10.1080/14786449308620448>



Published online: 08 May 2009.



Submit your article to this journal [↗](#)



Article views: 2



View related articles [↗](#)



Citing articles: 3 View citing articles [↗](#)

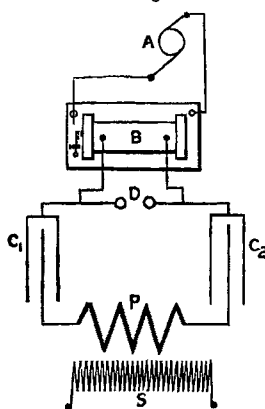
III. *Some Notes on Brush Discharges in Gases.*

By W. H. HARVEY and F. HIRD, B.A.*

WHILE experimenting on high-frequency discharges we came across a remarkable difference in the behaviour of positive and negative electricity, which forms the subject of these notes.

The apparatus was arranged in the now well-known manner for obtaining oscillatory discharges of high potential and high frequency, from the discharge of a condenser. The accompanying diagram and description will make clear the exact arrangement.

Fig. 1.



A is a small magneto-machine giving a continuous current at about 8 volts.

B is an ordinary induction-coil capable of giving about an inch spark.

C_1 and C_2 are equal condensers, consisting of shellacked glass plates coated with tin-foil. The capacity of each was approximately $\cdot 0038$ microfarad.

D is an adjustable spark-gap.

P and S are the primary and secondary of a transformer without iron core, the elements of which are as follows:—

P: mean diameter 5·65 centim.; axial length 20·3 centim.; wound with 9 turns of copper-strip 20 millim. \times $\cdot 064$ millim.; approximately $L=1123$ centim.

S: mean diameter 9·4 centim.; axial length 11 centim.; wound with 78 turns of $\cdot 38$ millim. wire silk-covered,

* Communicated by the Authors.

and each convolution separated from the next by a strand of silk equal in diameter to the wire.

The secondary was suspended by silk cords, so as not to be in contact with any part of the primary, and the whole was immersed in oil, in order to prevent the passage of brush-discharges.

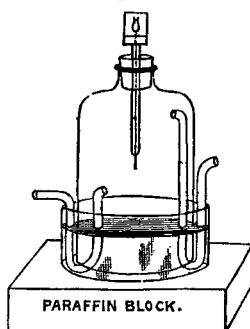
With this apparatus vivid brush-discharges are obtained.

It was observed that the brushes were most brilliant when allowed to take place between a point and a plate, especially if the latter had a fair capacity; also that the plate was always charged positively, although the discharge was of course oscillatory.

In order to put this fully to the test the experiment was varied in many ways. The current in the primary of the induction-coil was reversed, both mechanical and automatic breaks were used, and the two ends of the secondary of the transformer were in turn connected to the point (the unused end remaining immersed in oil), but the result was always the same, the plate being strongly charged positively. We may add that the charge was steady and, as near as we could tell, equal in amount with any of the above combinations.

We now added to our apparatus in order to test these brush-discharges in various gases. For this purpose a bell-jar (fig. 2) was fitted with a rubber bung, through which passed a

Fig. 2.



glass tube with a platinum point sealed in the lower end; from this point a wire leads into an upper tube and terminates in a small clip for making contact with either end of S.

Both tubes were entirely filled with oil, this being the only means we found of preventing brushes onto the glass of the bell-jar, which produced local charges and obscured the result.

The jar stood in a deep glass dish containing mercury, the level of which could be adjusted by means of a syphon (not

shown); two bent glass tubes afford an inlet and outlet for the gas to be experimented on.

During the experiments a continuous steady flow of gas was maintained through the bell-jar, the clip was connected alternately to the two ends of the secondary, and the current in the primary of the induction-coil was reversed in each case. The unused end of the secondary was insulated and entirely immersed in oil. The mercury in the glass dish was electrically connected to the plate of a gold-leaf electroscope, the sign of the charge on which was determined in the usual manner.

In the first case the jar was filled with dry air, of which a steady stream was kept up. The results confirmed those previously mentioned, the charge of the gold leaves being always strong and steady positive.

Next we passed into the jar a stream of dry hydrogen, and kept this steadily flowing during the experiments, which were of course commenced only after the air was all expelled.

In this case the leaves were always strong and steady negative.

This result was confirmed in a remarkable manner by using the ordinary induction-coil only, connected onto the bell-jar. Although there was no visible discharge, yet the electroscope was charged as follows :—

1. A. Strong steady negative.
2. A. Leaves go in and out but are always negative.
2. B. Strong steady negative.
1. B. Leaves go in and out but are always negative.

In the above table A and B represent the secondary terminals of the induction-coil, whilst 1 and 2 represent the direction of the current in the primary. When this was 1 the end A was made negative by the break and positive by the make.

Thus it appears that in the case of our induction-coil the weak E.M.F. due to the make could produce a greater silent discharge than could the strong E.M.F. due to the break, apparently because a negative discharge passes more easily in hydrogen than does a positive.

Reverting to the previous arrangement of condensers, &c., the jar was next filled with oxygen and the experiments repeated. In this case the electroscope was always charged strongly positive.

When the induction-coil alone was used, the charge on the leaves changed with the sign of the E.M.F. due to break, as would naturally be expected, but the positive charges were stronger than the negative.

We have also experimented with other gases, but owing to difficulties in obtaining them in a state of purity, on account of limited space and want of general conveniences, we have not obtained reliable results.

The results given above, however, may be depended upon, as they were all repeated some hundreds of times under varying conditions, and have always been satisfactory and consistent.

We may therefore sum up the results which we have established as follows:—

In a brush-discharge in air positive electricity passes more readily than negative from a point onto any neighbouring conductor.

In oxygen the same is the case.

In hydrogen the reverse holds, negative electricity passing more readily.

To a certain extent these results are anticipated by previous experiments. It has long been known that positive brushes were somewhat stronger than negative. Again, Guthrie has shown that a red-hot conductor in air will retain a negative but not a positive charge (*Phil. Mag.* vol. xlv. p. 257, 1873). This experiment, as having a bearing on our subject, we have repeated and confirmed.

In conclusion we may mention a few precautions which must be taken in conducting these experiments.

(1) The arrangement of two condensers in series was suggested by Prof. J. J. Thomson in his paper on “Discharges in Gases without Electrodes.” We have found it a very necessary precaution: if the discharge of only one condenser is used the unsymmetrical arrangement of the apparatus leads to very confusing results.

(2) The greatest care must be taken with the insulation of the transformer, both in insulating the primary from the secondary and also in insulating the turns of the secondary itself.

(3) It is advisable to prevent all brush-discharges except at the point where they are to be observed. This, as far as we know, can only be done by immersion of every part of the conductor in oil.

(4) It is necessary to use the gases in large bulk or to keep up a continuous flow, as otherwise they acquire a charge which confuses the results.

(5) The distance between the point and the conductor which is to be charged must be so adjusted that no spark passes. If a spark does pass, the conductor is entirely discharged.