The Construction of a Rutherford's Electroscope.

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Introduction.

At the suggestion of Dr. R. A. Millikan the author recently undertook the problem of constructing an electroscope for general laboratory work in radio-active measurements. The general outlines and plans suggested by Dr. Rutherford in his original papers published in the Philosophical Magazine and in his work entitled Radio-active Transformations have been followed. Suggestions have also been taken from the following works: Studies in Radio-activity, by Bragg; Conduction of Electricity Through Gases and Radio-activity, by McClung; and Practical Measurements in Radio-activity, by Makower and Geiger.

The purposes have been, first, to show, in greater details than the original papers give, the methods of constructing a successful electroscope; and, second, to embody in one instrument as wide a range of experimental work as possible.

construction.

A diagram of the electroscope is shown in Fig. 1. The dimensions of the gold leaf chamber (E) are $10 \times 10 \times 10$ cm. This chamber is constructed from sheet brass 1.7 mm. in thickness. The four plates for the sides, top and bottom are first carefully jointed by means of a file and then soldered together as shown in Fig. 2 (A). To facilitate the process of soldering two right angle pieces of metal are joined together forming a right angle frame as shown in Fig. 2 (B). When two pieces of the box are to be joined together they are carefully adjusted upon the frame, a few small pieces of solder and soldering fluid are placed along the joint and a pointed flame is directed along the joint in the inside angle until the solder is thoroughly fused. In this way the parts of the electroscope box can be joined together square and straight.

The front side of the electroscope box is a hinged door. This door has a window in it 6.5 cm. square covered with mica. Through this window the gold leaf may be observed by means of a reading microscope. A dia-

gram on the back side of the door is shown in Fig. 3 (A). The mica is held in place by means of four pices of brass, 1.7 mm. thick and 1.5 cm. wide. These pieces are screwed onto the door in such a way that they not

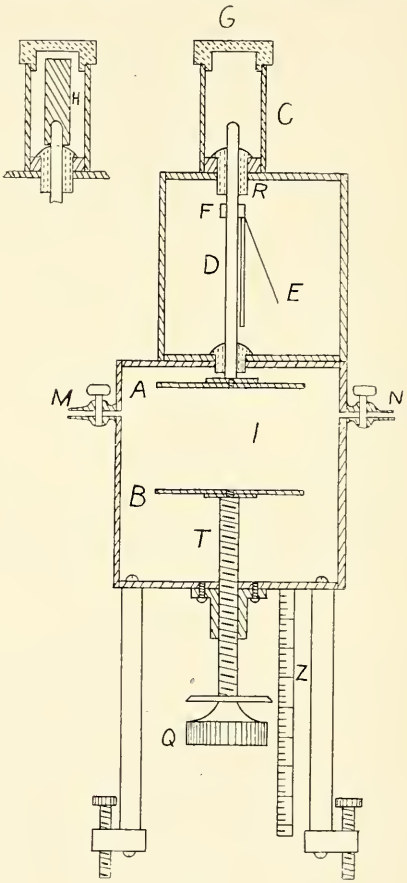

Fig. 1.

only hold the mica in place over the window but they also form a close fitting rabbeted joint of the door to the box.

The back side of the electroscope is constructed like the front side, with a mica window of the same dimensions for illumination. This side may be either hinged to the box or it may be held in place by means of two little hooks.

Using the same methods as described abov-e, the ionisation chamber (I) is constructed. No mica windows are needed in the front door or the back side of (this ionisation) chamber. The dimensions of (I) are 12 x 12 x 12 cm., and the thickness of the walls is 1.7 mm. With the exception of the

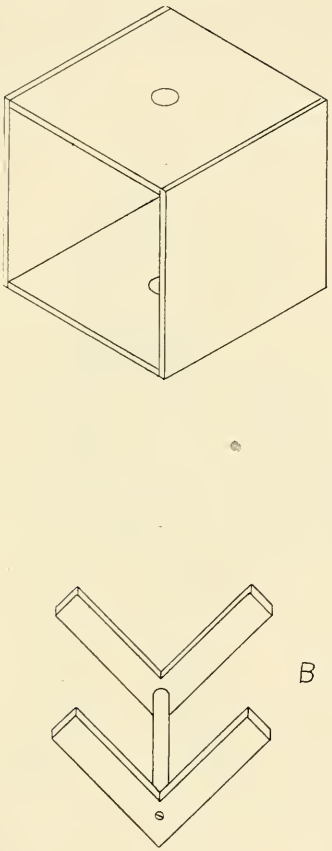

Fig. 2.

mica window the door to the ionisation chamber is constructed like that of the door to the gold leaf box. The front door should be hinged to the box and the back side can either be permanently soldered to the box or it can be fastened by means of hinges.

The two boxes (E) and (I) are fastened together by screws, the right hand sides being flush with each other as shown in Fig. 1. This arrange-

ment places the condenser in the center of the ionisation box and the gold leaf support is on one side of the box thus giving more free space to the gold leaf.

Through openings in the top and bottom of the electroscope box (E), and the top of (I) a brass rod (D), about 4 mm. in diameter is adjusted being insulated from the boxes by means of two amber plugs (R) and

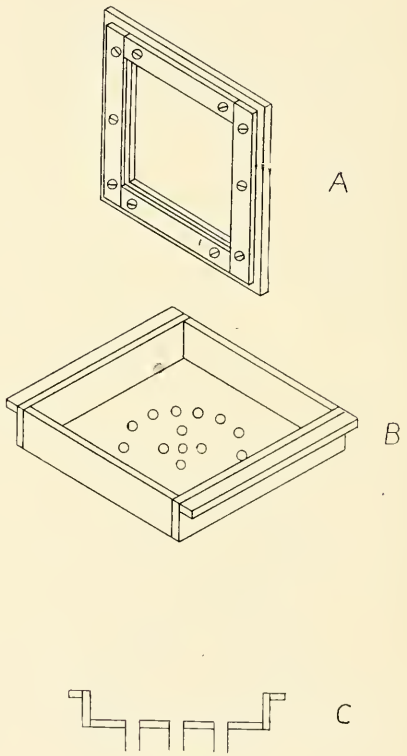

Fig. 3.

(S). The upper end of the rod (D) is covered by a metal cap (C). The upper opening of the cap is closed by means of an ebonite plug (G). The cap can be removed for charging purposes. The rod (D) may be extended and enlarged by fitting to the upper end a brass cylinder (H). This cylinder acting with the metal cap (C) forms a condenser which increases the capacity of the electroscope. Upon the side of (D) a brass

strip (S), which is about 6 mm. in width, is fastened by means of a small screw at (F). To this strip the gold leaf is fastened by means of wax or shellac. The rod (D) is terminated at its lower end by means of a

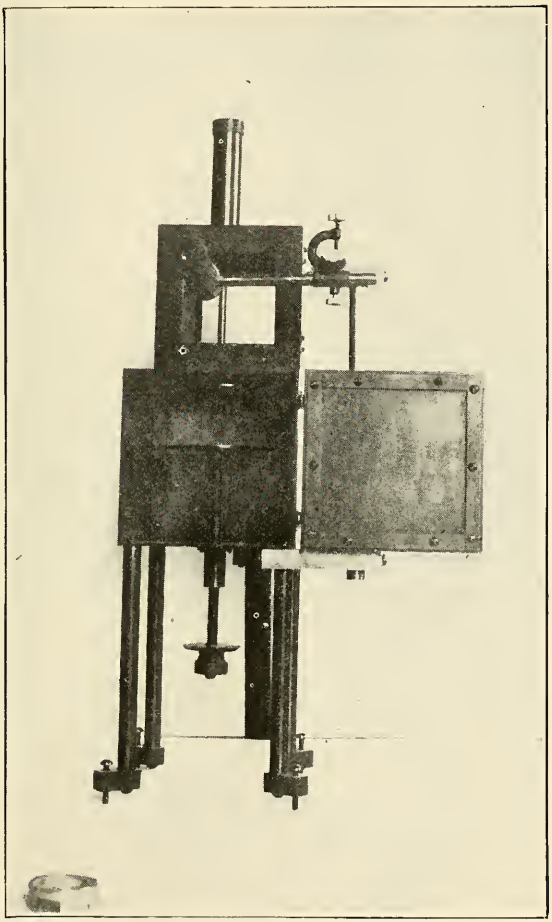

Fig. 4.

disk (A), which is 8 cm. in diameter. This disk is screwed onto the end of (D), and larger or smaller disks may be used, thereby varying the capacity of the electroscope. Supported upon a screw (T) which passes through the bottom of the ionisation chamber is a disk (B) the same

size as that of (A). By turning the screw (T) the position of (B) can be made to change through a range of about 8.5 cm. Its distance in cm. or mm. from (A) can be determined by reading the position of the disk (Q) with reference to the scale (Z).

To the bottom of the ionisation chamber four brass rods 1.2 cm. in diameter and 15 cm. in length are securely fastened by means of screws for legs. Leveling screws are adjusted to the lower ends of these legs.

The electroscope can be converted into an emanation electroscope by placing stopcocks (M) and (N) in the sides of the ionisation chamber. The active gas can be admitted to the electroscope by exhaustion through one stopcock and attaching the source of gas to the other stopcock. Or the active gas can be forced into the ionisation chamber by means of a pressure bulb. In testing active gases it is usually necessary to reduce the capacity to the lowest amount possible. This can be done by removing the cylinder (H) and the condenser plate (A). A small rod should be screwed onto the end of (D) in place of the disk (A). Figure four shows the instrument mounted ready for use.

The instrument can be changed into one for measuring the "Variations of the ionisation produced by an alpha particle along its path," by enclosing the condenser plate (A) in a metal box which has a number of short, small, brass tubes passing through the bottom. (See Makower and Geiger's Practical Measurements in Radio-activity, article 32, page 46.) A drawing of the box is shown in Fig. 3 (B) and a cross section in Fig. 3 (C).

After a thorough test it has been shown that this one instrument with its attachments can be used for a wide range of radio-active measurements, and that it is well adopted to general laboratory work.

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