A New Electroscope. By B. F. J. SCHONLAND, M.A., Ph.D., Gonville and Caius College.

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1. In the measurement of small ionisations it is usual and desirable to employ an ionisation-chamber whose central collecting electrode serves also as an electroscope, of the gold-leaf or the quartz-fibre type. As an instrument for the measurement of quantity of electricity even the most sensitive of these is inferior, by a factor of about 100, to the combination of an ionisation-chamber and a Compton electrometer. The new type of ionisation electroscope here described combines a high voltage-sensitivity with a small capacity and has a sensitivity for quantity of electricity of the same order as the combination mentioned.

2. The electroscope, as may be seen from the figure, consists of a small rectangular mirror of thin silvered mica, which is hung

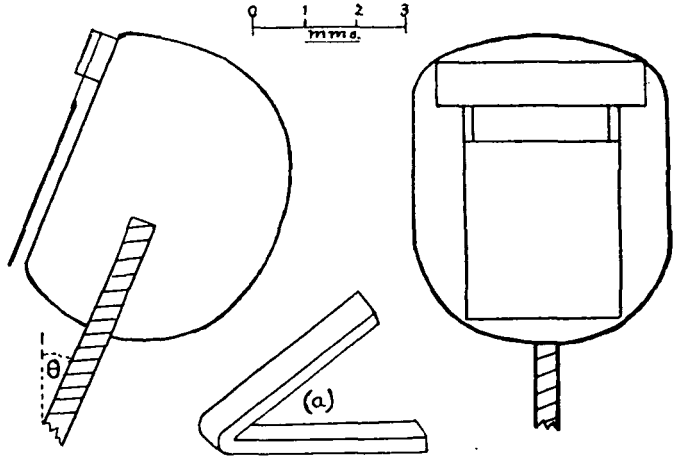


Fig. 1.

from a bridge on the plane face of the central electrode by two fine hinges of gold leaf. The mirror is itself the electroscope "leaf" and its weight is sufficient to prevent the hinges from taking an appreciable share in the mechanical control. The dimensions of the mirror, and hence the capacity of the instrument, may be made very small without impairing the voltage-sensitivity, since the angular movement is measured by means of a lamp and scale. Thus with a mirror 4 mm. long and with lamp and scale at a

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distance of 1·0 metre, the optical system has the same power as a microscope of magnification 500 focussed upon the lower end of the mirror.

It is convenient to arrange for the whole instrument to be tilted about a horizontal axis. Then if m is the mass of the mirror and θ the angle of tilt, the restoring force balancing the normal electrostatic repulsion is $mg \sin \theta$. It follows that both the sensitivity to charge, and the charging voltage required to cause the mirror to leave the electrode, increase with the angle of tilt. In practice a tilt of 30° is found to give about double the sensitivity obtained when θ is zero.

Sensitivities of from 30 to 60 divisions (mm.) per volt, at a tilt of 30°, have been obtained with the thinnest mirrors so far constructed. At the higher values the movement was somewhat heavily damped, however, and the time of response was of the order of one second. A practical working limit of 40 div./volt ensures a rapid and dead-beat movement. The charging voltage in this case is about 200 volts, and the time of response about $\frac{1}{10}$ second.

If such a mirror be combined with a central electrode of capacity 0·3 cm., a deflection of one scale division should be caused by a quantity of electricity equal to $5{\cdot}3 \times 10^4$ times the elementary charge. Thus the full ionisation from an α-particle emitted by Radium C′ should give a throw of 4·2 mm. Such throws have frequently been observed, the α-particles arising naturally from the walls of the vessel or from a weak source placed outside a thin mica window.

3. The method of construction will now be described.

The mirror. Mica, which can be split extremely thin by hand, is the most suitable material for the light mirrors required. It is possible to use thinly blown glass, but the optical properties of glass mirrors are very poor. For the lightest mirrors the mica should show bright Newton's colours. Small pieces, a sq. cm. or more in area, are mounted on a clean glass plate and held in place by a drop of collodion cement at one corner. They are silvered by cathodic sputtering, first on one side and then on the other.

The silvered material is cut with a sharp razor into rectangular slips of the same width as the final mirror is to be, and twice its length.

The material usually possesses cylindrical curvature and it is important to cut the length of the slips parallel to the axis of the cylinder. For subsequent manipulation a slip is attached at one end with a drop of cement to a needle-point provided with a handle.

The hinges. These are two small pieces of gold leaf, free of kinks and corrugations, about 5 mm. long and between 0·1 and 0·2 mm. wide.

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The bridge. To form the bridge a pair of lead jaws (Fig. 1 *a*), each measuring 4·0 mm. by 1·0 mm., is cut from a doubled sheet of lead of approximate thickness 0·03 mm., and the lower jaw is fastened by collodion cement to the central electrode. The jaws may be closed over a scrap of mica which serves to open the upper one, for the reception of the hinges, after the cement has set.

Construction and mounting. The mirror slip is given a very small drop of water-gum at one corner, applied by means of a fine camel-hair brush. It is then lowered over a gold-leaf hinge until the gum picks it up, no pressure being needed. The second hinge is fixed in the same way and the slip is cut with a sharp razor to the length of mirror required.

The electrode is now placed with its flat face horizontal and the top lead jaw bent upwards. The mirror is transferred to it with the help of a piece of clean paper and the hinges are "teased" into position with a fine copper wire. The actual effective length of the hinges need not exceed 0·5 mm. The top jaw is next pressed firmly down with a straight-edged piece of brass and the mounting is complete, though it is advisable to make good contact between electrode and bridge by means of Indian ink and a strip of gold leaf.

Optical properties. The thinnest mica mirrors have good cylindrical curvature and give an excellent horizontal focal line if mounted as described. With thicker material, plane mirrors of good quality may be obtained.

General dimensions. For instruments of small capacity it is desirable to make the dimensions of the mirror as small as possible. The limiting factor is the necessity for keeping the control gravitational. With mica showing Newton's colours and hinges about 0·15 mm. wide the mirror area should not be less than 9 sq. mm. A convenient size is 3 mm. wide and 3 to 4 mm. long.

Since the instrument is gravity controlled it must be mounted on a firm support, preferably a solid pillar or a wall. It can be moved about without injury provided that care is taken to keep the mirror always in contact with the electrode.

4. This electroscope was designed for measurements on the penetrating radiation but it may have applications in other directions where small ionisation currents have to be measured fairly quickly, and it can perhaps be utilised to effect a reduction in the size of ionisation vessels where this is needed.

With thicker mica and wider hinges the process of construction and mounting is very easy and such robust mirrors, with a sensitivity of 5 or 10 divisions per volt, may prove useful.

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It is hoped to describe certain other applications of these light mirrors at a later date.

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