Allow the rays to act for 15 or 20 seconds. This time will depend greatly upon the strength of the rays and will have to be tested by a preliminary trial for the particular bulb used. Develop the plate in the ordinary way and observe the impression produced.

On a thin board about 3 or 4 mm. thick fasten various objects, such as discs of metal or coins of different kinds and different thicknesses and objects of various shapes. Place this set of objects in the path of the rays and take a photograph of it. Note carefully the difference in the absorption by the different objects as shown by the difference in the intensity of the shadows cast.

46. Conductivity of Gases Produced by Röntgen Rays.—Probably the most striking property of Röntgen rays is their power to cause gases to become conductors of electricity. As before mentioned, gases under normal conditions of temperature and pressure and under ordinary voltage are almost complete non-conductors of electricity. If a well insulated body such as the leaves of a gold leaf electroscope be charged up in thoroughly dry air the charge will be retained for many hours. There may be an extremely slow diminution of the charge on the gold leaves due in part to the want of perfect insulation and partly due to a very small leakage through the air. If however a beam of Röntgen rays be allowed to pass through the gas surrounding the leaves they will immediately lose their charge and collapse, showing that the charge must have leaked away through the air.

Set up an electroscope, of the form described in § 22, Fig. 14, at a distance of 25 or 30 cm. in front of the window of the lead box containing the Röntgen ray bulb. Charge up the leaves by storage cells to a fairly high positive potential, and if the insulation is good the leakage of the charge should be extremely small. Start the X ray bulb and allow the rays to fall upon the air in the electroscope. Observe the sudden collapse of the leaves.

Now by means of a lead screen without any opening in it placed over the window cut down the intensity of the rays to a small fraction of their original intensity and also adjust the position of the electroscope so that a well defined beam of rays passes through only the lower portion of the electroscope as far away from the leaves as possible. Recharge the leaves and start the rays again, and if the intensity has been cut down sufficiently the leaves should collapse at a very much slower rate than before. Charge up the leaves with a negative charge and repeat the experiment. Observe that the discharge takes place just as before and at just the same rate as in the case of the positive charge.

These experiments show that the air has become conducting under the influence of the rays and discharges electricity of either sign with equal facility, and the conductivity depends to some extent at least on the intensity of the rays. By interposing screens of different thicknesses the dependence of the conductivity on the intensity of the rays may be noted by observing that the less the intensity of the rays the slower the rate of leak shown by the leaves.

47. Transportation and Persistence of Conductivity.—Arrange a scheme of apparatus as shown in Fig. 28. *AB* is a

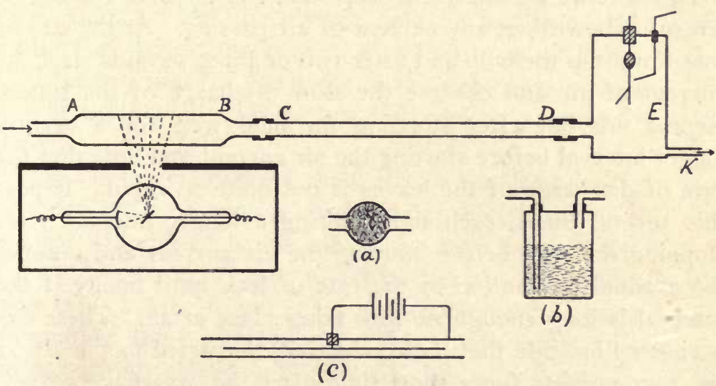

FIG. 28.

thin brass tube about 12 cm. long and 4 or 5 cm. in diameter placed as shown in front of the window of the Röntgen ray enclosure. It is joined by a temporary joint of large rubber tubing or other convenient means to a brass tube *CD* about 30 or 40 cm. long and 3 cm. diameter. This is joined at *D* by a similar temporary joint to the tube leading into the electroscope *E*. Connect the metal parts all to earth. A current of air may be slowly drawn through the whole system entering at *A* and leaving at *K* by an aspirator attached to the outlet *K*.

Charge the leaves of the electroscope. Start a slow current of air through the system and note that the leaves still retain their charge. Now start the X ray bulb with the current of air still flowing and observe that the leaves immediately begin to lose their charge. This indicates that the conductivity imparted to the air in *AB* may be conveyed by the current of air to the electroscope at a considerable distance away and that it lasts long enough at least to be carried that far. Stop the rays and the current of air and recharge the electroscope. Start the X ray bulb again without any current of air flowing through the system and observe that there is now no leakage of the charge from the leaves. This shows that it requires an air current or some such means to transport the conductivity from where it is produced in *AB* to the electroscope.

Again recharge the electroscope and run the bulb for five or ten seconds without any current of air passing. At the end of that time stop the bulb and after two or three seconds start the current of air and observe the slow discharge of the leaves. Repeat this but after stopping the bulb wait for a slightly longer interval before starting the air current and note that the rate of discharge of the leaves is not quite so rapid. Repeat this several times, each time waiting a longer interval after stopping the rays before starting the air current and observe the gradual diminution of the rate of leak until finally if the interval is long enough no leak takes place at all. These experiments indicate that the conductivity imparted to the air by the rays persists for a short time after the rays have ceased. It does not last indefinitely but gradually disappears.

48. Removal of Conductivity.—Between *B* and *C* at the joint *BC* insert a glass bulb *a* filled with cotton wool, not too closely packed. Start the current of air and also the Röntgen rays and observe the effect on the electroscope. It should show no leakage of the charge from the leaves, showing that the air in passing through the cotton wool loses its conductivity.

Remove the bulb *a* and substitute for it a wash bottle *b* partially filled wtih water and repeat the last experiment. Again there should be no discharge of the electroscope, indicating as before that the air loses its conductivity by bubbling through water.

Remove the wash bottle *b* and also the tube *CD* and in its place substitute the brass tube *c*, which has about the same dimensions as *CD*. Along the central axis of this tube there is a stiff wire supported and insulated by an ebonite plug. When this tube is in place it should be insulated from both *AB* and the electroscope. Connect the central wire to one pole of a battery of small accumulators and the tube to the other pole, so that there is a field of about 150 volts between the wire and the tube. Now start the Röntgen rays and also the current of air and observe whether there is any leakage from the gold leaves. They should show no leakage. Disconnect the battery from the wire and the tube and connect them to earth while the Röntgen rays and the air current are still running and observe that the leaves immediately begin to lose their charge. Put the electric field on to the tube and wire once more but in the reverse direction to what it was before and observe that the discharge in the electroscope ceases. The conductivity of the air is thus removed by passing through a strong electric field.

49. These experiments show that when Röntgen rays pass through air it becomes a conductor of electricity and this conductivity imparted to the air by the rays persists for a short time after the rays cease to act on the air, but gradually disappears. While it lasts it may be transported from one point to another along with the air. This conductivity must be due to something mixed with the air, for it is removed by the passage through the cotton wool and the water, and its removal by the electric field also indicates that whatever is mixed with the air to produce this conductivity must be charged. In the following chapter we shall discuss the full significance of these phenomena.