The present invention comprises an improved X-ray device which is particularly suitable for the generation of X-rays of high penetrability.

This application constitutes a continuation-in-part of my prior application Serial No. 244,014, filed December 31, 1927.

When X-rays are generated by the impact of high speed electrons on a target, secondary electrons are emitted as well as X-rays. These secondary electrons are projected upon the back of the target, or anode, the anode and the surrounding glass parts. In devices of moderate current value, or operating voltage, these secondary electrons do not seriously interfere with normal operation of the device. At very high operating voltages, and particularly at substantial current values, the secondary electrons by charging the envelope near the anode to high negative potentials, set up such high electric strains as to cause puncture of the envelope.

In accordance with my invention, these difficulties are overcome by providing the target (commonly the target forms part of the anode) with a closely surrounding tubular extension, or chute, which extends toward the cathode and acts as a shield for intercepting secondary electrons. This shield should be long relative to its diameter so that the solid angle subtended by its mouth from the target face is relatively small.

Preferably the target shielding tube in my improved device has a length more than twice its diameter.

In the accompanying drawing Fig. 1 is a side elevation of a device embodying my invention with a diagram of electrical connections; Fig. 2 is an enlarged sectional view of the target end of the device shown in Fig. 1, and Fig. 3 is a sectional view of a modification.

The X-ray device shown in Fig. 1 comprises a sectional container constituted of two bulbous glass chambers 1, 2, joined at their necks 3, 4, by a metallic coupling member 5 which is fusion-sealed to the necks of the glass bulbs. A metal chute consisting of a section 6 of small diameter and a section 7 of greater diameter extends through the coupling 5 and through the chute 7 into the bulb 2. The enlarged diameter of the second chute 7 is required to accommodate the enlargement of the electron beam due to the distribution of the electric field. From the chute 7 the electron beam passes into a metal chute 9 having a diameter substantially equal to the diameter of the chute 7. In the chute 9 is located a target 10 (see Figs. 2 and 3). The open ends of the chutes are provided with enlarged edges to equalize the field, thereby avoiding cold cathode effect.

Before the structural details of the target and connected parts are described, attention is directed to the electrical connections whereby electric fields are established for giving the electrons successive accelerations. Between the cathode with its independent heating circuit 15 and the coupling 5 and from thence to chute 6 is connected the secondary of a transformer 12. Between the coupling 5 and chute 7 and the anode terminal 13 is connected the secondary of a transformer 14. The connection between the coupling 5 and the common terminal of the secondaries of the transformers 12, 14, is made preferably by grounds 15, 16, as indicated. The primary windings of the transformers 12, 14, are connected in parallel to the supply mains 17.

As shown in Fig. 2, a metal reservoir 20 for containing a cooling fluid is mounted on a metal tube 21 which is sealed by fusion to the neck 22 of the glass envelope 2. The chute 9 communicates with this reservoir which is mounted thereon by a ring 23 to which it is fastened by suitable screws 24, a suitable gasket being provided.

A wall 25 constituting the target and consisting of copper plate 26 faced with a plate 27 of tungsten, or other suitable refractory metal. In the form of device shown in Fig. 2, the target 10 is located short of the end of the chute 9 so that X-rays may be conveniently utilized when passing through a window 27 in the chute 9 as pictorially indicated. This window preferably is covered with a sheet 28 of thin metal, for example aluminum.

In the embodiment shown in Fig. 3, the target 10 closes the end of the chute 9, and the reservoir 20 is omitted. The sheet of tungsten 26 should be thin enough to permit of the effective passage of X-rays through it. In this form of device, the backing plate 25 of copper may be artificially cooled by circulation of a cooling fluid, as indicated by the inlet and outlet tubes 29, 30. In this modification the X-rays are taken out through the target and through the cooling chamber.

In an illustrative example of my invention, a sectional device as shown in Fig. 1 having a total length of about six feet and a bulb diameter of about one foot contained chutes 8, 6. In the bulb 1 of about two inches in diameter. In the second bulb 2, the chutes 7, 9, have a diameter of about three and one-half inches. The part
of chute or tube 9 extending from the target 10 toward its mouth is about fourteen inches in length. In the modification shown by Fig. 3, the chute 9 is somewhat longer. An inconsiderable part of the secondary electrons emitted at the target escape from the mouth of the chute 9. Such a device is operable at voltages as high as about five hundred thousand volts with currents of an amperage of the order of three milliamperes without deleterious effects due to secondary emission at the target.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An X-ray tube comprising an envelope constituted of conducting and non-conducting sections joined together, a cathode and a target in said envelope, means for preventing secondary electrons generated at the target from striking the envelope, said means including a metal shield carried by one of the conducting envelope sections, said shield closely surrounding the target and connected thereto and being interposed between the target and the non-conducting envelope section in the region of the target.

2. An X-ray tube comprising an envelope constituted of conducting and non-conducting sections joined together, a cathode and a target in said envelope, means for preventing secondary electrons generated at the target from striking the envelope, said means including a hollow metal shield carried by one of the conducting envelope sections and containing said target, said shield connected to said target and extending over a substantial portion of the non-conducting envelope section in the region of the target and being interposed between said non-conducting envelope section and the target.

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