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ROTATING ANODE CONSTRUCTION

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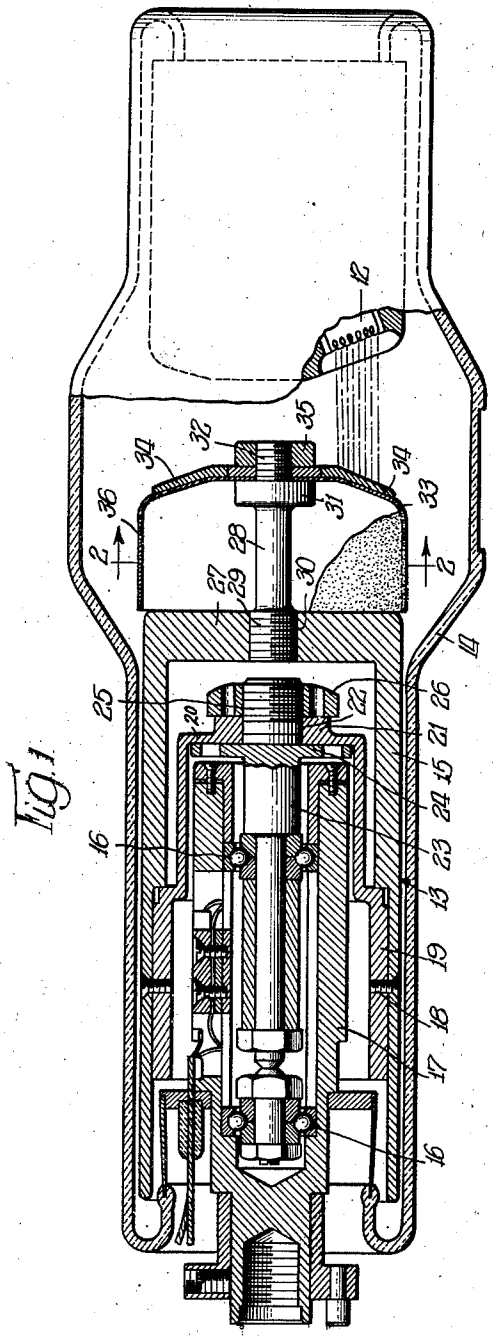

Fig. 1

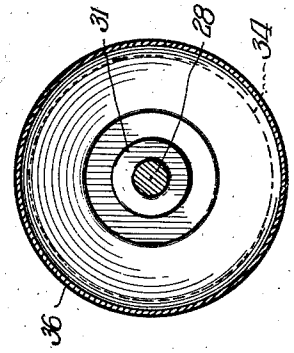

Fig. 2

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ROTATING ANODE CONSTRUCTION

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14 Claims. (Cl. 250—148)

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The present invention relates in general to electron tubes and more particularly to the construction of a rotating anode for X-ray tubes used in radiography involving exposures of a fraction of a second in duration. The voltages employed in tubes used for this purpose are of such an order as to make desirable the use of a rotating anode and to focus the flow of electrons upon a relatively small area of the anode, thereby avoiding to a considerable extent the overheating of the anode and the ill effects of such overheating.

The construction of the rotating anode is necessarily affected by considerations of radiation and the method of securing the target to the body of the anode. Such considerations induce the use of a solid tungsten target in the form generally of a disc. The employment of such a target, however, entails the disadvantage of a voltage or electrostatic field gradient set upon the inside of the envelope by the sharp edge of the disc and of such magnitude as possibly to cause a rupture of the envelope.

An important object of this invention is to provide in an X-ray tube used for fractional second radiography a rotating anode including means for overcoming this field gradient. Another object of this invention is to provide means for increasing the thermal emissivity factor of the anode and the radiation of heat from it.

The foregoing objects are accomplished in the present invention by mounting the tungsten disc on a molybdenum stem forwardly of the body of the anode and providing a generally cup-shaped molybdenum shield, preferably coated with zirconium, behind the disc with the skirt of the shield extending rearwardly and substantially closing the gap between the disc and the body of the anode. The shield in effect streamlines the tungsten disc, offsetting its sharp edge and largely preventing the creation of an electrostatic field gradient otherwise likely to be caused thereby during rotation of the target as the generator is operated, and provides increased radiation of heat from the disc. The thermal emissivity factor of the shield is enhanced by providing a zirconium coating on the surface of the molybdenum.

While the improvement is not as marked as when the shield is employed, good results have been experienced without the shield when a coating of zirconium has been applied to the back of the tungsten disc in tubes having a relatively large envelope where the field gradient is of a lower order.

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This invention further resides in the combination, construction and arrangement of parts illustrated in the accompanying drawings, and while there is shown therein preferred embodiments of the invention, it is to be understood that the same are susceptible of modification and change without departing from the spirit of the invention.

The accompanying drawings illustrate a selected embodiment of the invention, and the views therein are as follows:

Fig. 1 is a side elevation of an X-ray tube employing the invention with the anode portion of the tube shown in central, vertical section;

Fig. 2 is a sectional view along the line 2—2 of Fig. 1.

The particular embodiment of the invention illustrated in the drawings comprises an X-ray tube or generator 11 having a cathode 12 of any usual or preferred character, and a rotating anode 13 supported within a sealed evacuated envelope 14. The anode 13 comprises a generally tubular body 15 of suitable material preferably black coated copper, and is mounted for rotation on bearings 16 within a generally hollow spindle 17, which is supported by the envelope 14.

The bearings 16 may be of any suitable form, but for present purposes I prefer to employ bearings of the form and in an arrangement generally similar to that shown and described in Letters Patent of the United States No. 2,293,037 issued August 18, 1942, including provision for their lubrication with barium as there shown and described.

In the embodiment of the present invention, as shown in Fig. 1, the anode body 15 is secured by means of screws 18 upon an iron rotor 19 of generally cup shape. The closed end 20 of the rotor is provided with a hub portion 21 and an axially extending bore 22 and is secured upon a shaft 23 which is received within the bore 22.

The shaft 23 is provided adjacent one of its ends with an annular flange 24. The end of the shaft adjacent the flange is threaded as at 25 and the rotor is arranged upon the shaft intermediate the flange 24 and the threaded end 25 of the shaft. The rotor 19 is secured upon the shaft by means of a nut 26 threaded upon the shaft and turned tightly against the outer face of the hub 21 so as to hold the inner surface of the closed end 20 of the rotor in abutting relation with the adjacent surface of the flange 24. The shaft 23 is mounted for rotation within the spindle 17 on the bearings 16.

The anode body 15 has a generally closed end

27 which is provided with an axially extending stem 28. The stem 28 which is preferably of molybdenum, may be formed integrally with the anode body or, as shown in Fig. 1, may have a threaded end 29 and be threaded into a threaded bore 30 provided in the end 27.

The stem 28 is provided with a portion 31 of enlarged diameter adjacent its end remote from the anode body 15, which is threaded as at 32. A molybdenum shield 33, generally cup-shaped and preferably of zirconium coated molybdenum, and a disc 34 of solid tungsten, are mounted on the stem 28 adjacent its portion 31 of enlarged diameter, the shield being positioned intermediately of the disc and the portion 31. The shield and disc are tightly secured in abutting relation by means of a nut 35 threaded on the end 32 of the stem. The adjacent surfaces of the shield and disc conform with each other to form a close fit. The skirt 36 of the shield 33 is of such conformation as substantially to close the gap between the disc 34 and the end 27 of the anode body. The arrangement is such that the shield and disc will rotate together and the shield will operate generally to streamline the disc and thereby largely avoid the field gradient set up by the sharp edge of the tungsten disc, preventing the accumulation of excessive charges upon limited areas of the inner surface of the envelope and the consequent danger of rupturing the envelope. The shield also provides greatly increased radiation of heat and appreciably enhances the efficiency and life of the tube.

Other metal, such as chromium, vanadium or titanium, may be used instead of zirconium for coating the shield 33.

Changes may be made in the form, construction and arrangement of the parts without departing from the spirit of the invention, and the right is hereby reserved to make all such changes as fairly fall within the scope of the following claims.

The invention is hereby claimed as follows:

1. An X-ray generator comprising an envelope, an electron emitting cathode, and a cooperating anode, in the envelope, said anode comprising a metal disc turnably supported for rotation about its central axis, in the envelope, and means for reducing the electrostatic voltage gradient on the walls of the envelope comprising a metal skirt member on and extending from the marginal edge of said disc, said skirt member providing a sleeve portion disposed outwardly of the marginal edge of said disc, and an inwardly extending curved shoulder portion at said edge whereby to streamline the said edge and thereby suppress the gradient producing effect thereof.

2. An X-ray generator as set forth in claim 1 wherein the skirt member carries a coating of metal having high thermal emissivity to improve the thermal emissivity of said skirt member.

3. An X-ray generator as set forth in claim 1 wherein said skirt member comprises molybdenum and carries a coating of metal having high thermal emissivity to improve the thermal emissivity of said skirt member.

4. An X-ray generator comprising an evacuated envelope, and an anode rotatably mounted in said envelope, said anode comprising a copper body, a molybdenum stem mounted on said body and extending axially therefrom, a disc shaped target mounted on said stem in spaced relation with said body, and a molybdenum shield mounted on said stem intermediately of the disc and the body and having a surface abutting and conforming with an adjacent surface of said disc, said shield being of such conformation and so arranged as substantially to envelop the space between the disc and the body.

5. An X-ray generator comprising an evacuated envelope, and an anode rotatably mounted in said envelope, said anode comprising a copper body, a metallic stem mounted on said body and extending axially therefrom, a disc shaped target mounted on said stem in spaced relation with said body, and a metallic shield mounted on said stem intermediately of the disc and the body and having a surface abutting and conforming with an adjacent surface of said disc, said shield having a metallic coating thereon and being of such conformation and so arranged as substantially to envelop the space between the disc and the body.

6. An X-ray generator as set forth in claim 5 wherein said metallic coating comprises zirconium.

7. An X-ray generator as set forth in claim 5 wherein the metallic coating comprises chromium.

8. An X-ray generator as set forth in claim 5 wherein the metallic coating comprises vanadium.

9. An X-ray generator comprising an evacuated envelope, and an anode rotatably mounted in said envelope, said anode comprising a copper body, a metal stem mounted on said body and extending axially therefrom, a disc shaped target mounted on said stem in spaced relation with said body, and a metal shield mounted on said stem intermediately of the disc and the body and having a surface abutting and conforming with an adjacent surface of said disc, said target and said shield being arranged in axial alignment with said body, and said shield being of such conformation and so arranged as substantially to envelop the space between the disc and the said body, whereby largely to prevent the accumulation of excessive potential upon the surface of the envelope while the generator is being operated.

10. An X-ray generator comprising an evacuated envelope, and an anode rotatably mounted in said envelope, said anode comprising a copper body, a metal stem mounted on said body, a disc shaped target mounted on said stem in spaced relation with said body, a metal shield mounted on said stem intermediately of the disc and the body and having a surface abutting and conforming with an adjacent surface of said disc, said shield having a zirconium coating thereon and being of such conformation and so arranged as substantially to envelop the space between the disc and the body, said stem, said target and said shield being arranged in axial alignment with said body, and means on said stem for securing said disc and said shield on said stem.

11. An X-ray generator comprising an evacuated envelope, and an anode rotatably mounted in said envelope, said anode comprising a copper body, a metal stem mounted on said body and extending axially therefrom, and a disc shaped target mounted on said stem in spaced relation with said body, the surface of said target facing said body being coated with a metal of high thermal emissivity whereby largely to prevent the accumulation of excessive potential upon the surface of the envelope opposite the edges of said disc while the generator is being operated.

12. An X-ray generator as set forth in claim 11 wherein the metal of high thermal emissivity comprises zirconium.

13. An X-ray generator as set forth in claim 11 wherein the metal of high thermal emissivity comprises chromium.

14. An X-ray generator as set forth in claim 11 wherein the metal of high thermal emissivity comprises vanadium.

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