

[54] X-RAY TUBE WITH ROTARY ANODES

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[51] Int. Cl. H01J 35/10

[58] Field of Search 313/60, 330

[56] References Cited

FOREIGN PATENTS OR APPLICATIONS

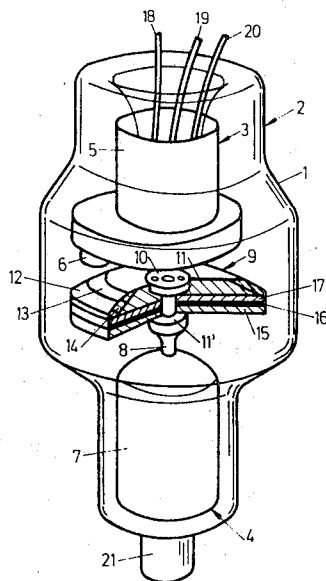
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[57] ABSTRACT

An X-ray tube has a rotary anode which is a compound body of heavy metal and graphite parts, the focal spot path lying upon the heavy metal. The invention is particularly characterized by the provision of a layer of metal selected from the group consisting of tantalum and/or tungsten and located between the heavy metal part and the graphite part. The heavy metal part consists at least primarily of molybdenum, is shaped as a plate and is soldered to the graphite part outside of the focal spot path.

8 Claims, 2 Drawing Figures



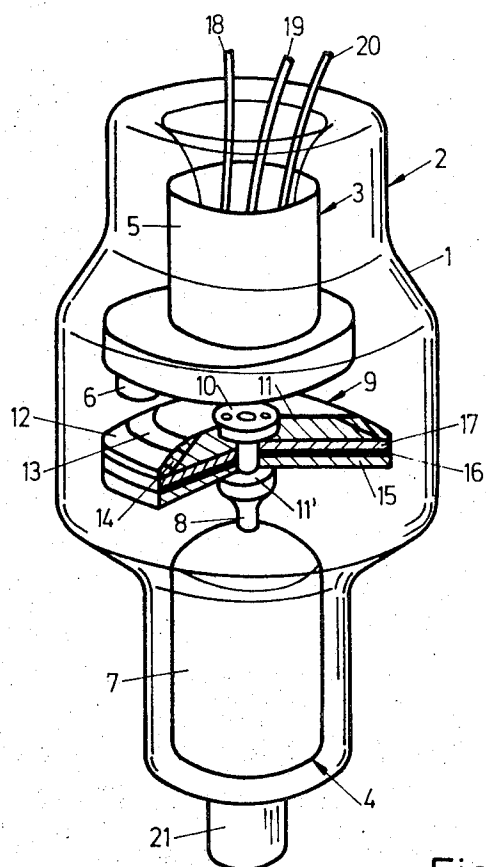


Fig. 1

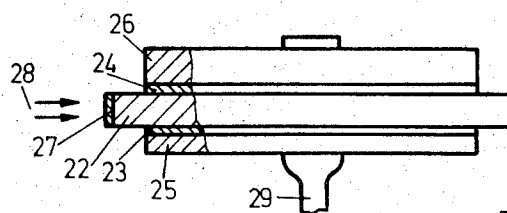


Fig. 2

X-RAY TUBE WITH ROTARY ANODES

This invention relates to an X-ray tube having a rotary anode which is a compound body of heavy metal and graphite parts, the focal spot path lying upon the heavy metal.

X-ray tubes with such anodes are used due to their high specific heat and good ray emission capacity of graphite, to produce higher load capacity.

Known rotary anodes of this type consist, for example, of a graphite part which is coated at least upon the focal spot path with a layer of heavy metal. By way of example, these layers are steamed on, sprayed on or produced by a pyrolytic decomposition of compounds. The layers must be thin to provide effective operation and to remain in technological paths useable from a manufacturing point of view. However, then there is the drawback that they are destroyed when tungsten is used through the formation of a carbide. Furthermore, carbide layers are brittle and conduct heat badly. Therefore, known anodes are not adapted to high heat exchange requirements of modern high output X-ray tubes. On the other hand, graphite particles can be torn off in a high electrical field producing arc-like discharges causing disturbances in cathode emission and possibly destruction of the tube. Furthermore, mechanical stresses are very high due to the used rotational speeds up to 1,000 per min. and accelerations of 200 to 300 rotations per sec². Therefore, when selecting graphite attention must be essentially given to its good strength. This means, however, that it is necessary to accept worse thermic properties and worse elasticity when strength is adequate.

An object of the present invention is to eliminate drawbacks of existing constructions.

Other objects will become apparent in the course of the following specification.

In the accomplishment of the objectives of the present invention it was found possible to eliminate the above-described drawbacks in a construction having a compound body consisting of a plate-shaped heavy metal part wherein the graphite parts are soldered outside of the focal point path, by making the heavy metal part at least primarily of molybdenum and by providing between the metal part and the graphite part a layer of tantalum and/or tungsten. Then an anode is produced the supporting structure of which consists of a disk of heavy metal upon which graphite parts are located which store and emit heat derived from the plate out of the focal spot path. Then the anode is highly loaded for a short time, since a quicker heat movement from the focal point path takes place in the metal part due to high heat conductivity. On the other hand there is also a good continuous load capacity since heat can be removed for good in the graphite particles due to high heat capacity and ray transmission capacity. The intermediate layer of tantalum and/or tungsten prevents the melting and loosening of the soldered locations in case of a thermic excessive load due to formation of a deeply melting eutectic with the molybdenum of the heavy metal part.

The X-ray tube of the present invention as compared to prior art X-ray tubes has the following additional advantages:

1. The short time loading capacity corresponds at least to that of the usual heavy metal plates.

2. The long time loading capacity is improved due to the additional heat capacity and ray emission of graphite. Heat emission can reach those of plates consisting solely of graphite due to the different structural possibilities of the graphite parts and of the heat conductivity through the metal.

3. The support of the plate consists of heavy metal so that during the selection of graphite properties it is not necessary to take strength into consideration and it is possible to use plate fixings provided in prior art plates.

4. The graphite parts can be applied to the side of the anode plate directed away from the cathode, so that these parts are located outside of the direct high voltage field which lies between the anode and the cathode.

According to an embodiment of the present invention which is preferred due to its high effectiveness, the anode is a heavy metal plate shaped in the usual manner and consisting of molybdenum to which 5 percent tungsten have been alloyed, while the plate has on its focal spot path a covering layer of tungsten and 10 percent rhenium. Upon the bottom side the plate has a layer of tantalum having a thickness of 0.1 to 1 mm. and used to prevent the formation of a deeply melting eutectic of molybdenum and soldering. A layer of tungsten having a thickness of 0.1 to 1 mm. can be used for the same purpose. The indicated limitations are not critical, since the only purpose is to cover the molybdenum surface sufficiently thickly so as to prevent securely the action of the soldering. The layer is preferably slaged. An additional operational step is saved, if the intermediate layer, as in the case of known connecting layers of focal spot paths, is made at the time of the actual manufacture. However, they can be also sprayed like plasma very uniformly and thus in thin layers of, for example, 0.2 mm.

As solder can be used different high melting metals or mixtures of these metals, preferably zirconium and hafnium, or their alloys. The graphite part which is to be soldered can be a plate having a thickness of 1 to 25 mm. which covers the entire surface of the anode plate.

In case of tubes wherein the surface directed toward the cathode receives only small amounts of stray electrodes and which are not operated with very high voltages, the upper parts of the anode can be additionally provided with graphite parts to further increase heat emission. This will also lower the disturbing extrafocal ray emission.

The invention will appear more clearly from the following detailed description when taken in connection with the accompanying drawing showing by way of example only, a preferred embodiment of the inventive idea.

In the drawing:

FIG. 1 is a side view of an X-ray tube of the present invention, partly in section.

FIG. 2 is a side view, partly in section, of a rotary anode of an X-ray tube, the focal spot path being shown as located upon the periphery of the anode.

FIG. 1 shows the glass container 1 of an X-ray tube 2 with rotary anodes. The cathode 3 is located within the container 1 adjacent one end thereof, while the anode 4 is located at the opposite end. The cathode consists of a cover 5 containing in a shoulder 6 the actual glow cathode which is not visible and is of the type well known in prior art. The anode 4 includes, as is also

known, the rotor 7 the axle 8 of which carries the actual compound anode 9. The anode 9 is pressed by the screw 10 against the counter support 11' and is held thereon. The anode 9 consists of a metal part 11 composed of an alloy containing molybdenum and 5 percent tungsten. The two focal spot paths 12 and 13 have different downwardly extending inclinations relatively to the vertical on the axle 8, and lie upon a coating 14 of an alloy of tungsten and 10 percent rhenium which has a thickness of 1 mm.

To the underside of the metal part which is 10 mm. thick is soldered a plate 15 of graphite having a thickness of 5 mm. The actual soldering is indicated in the drawing by a thick line 16 extending between the plate 15 and the intermediate layer 17. The intermediate layer 17 has a thickness of 1 mm., consists of tantalum and is applied during the manufacture of the part 11 according to the powder-metallurgical slag process.

The X-rays are produced in known manner by supplying high voltage between one of the conduits 18, 19 and 20 and the anode 21 and heating voltage between one of the conduits 18 and 19 and the conduit 20 for the glow cathodes located in the shoulder 6. Electrons emerging from the glow cathode strike one or both focal spot paths 12 and 13 and release X-rays. As is known, additionally a great deal of heat is produced. The heat is transmitted through the metal part 11, supplied to the graphite part 15 and then eliminated by radiation.

The rotary anode shown partly in section in FIG. 2 consists of a molybdenum plate having a thickness of 10 mm. and a diameter of 150 mm. and constituting the metal plate 22 the large surfaces of which are coated with tungsten layers 23 and 24, each 1 mm. thick. A 5 mm. thick graphite plate 25 is soldered to the layer 23 by hafnium and a 15 mm. graphite plate 26 is soldered by hafnium to the layer 24. The layers 23 and 24 as well as the plates 25 and 26 have a diameter of 110 mm. so that the plate 22 has a free edge which is 5 mm. wide. Due to this arrangement the soldering located between the layers 23 and 25 and between the layers 24 and 26 is spaced from the focal spot path located upon the periphery of the plate 22 and thus is thermically less exposed.

During the making of X-rays the arrangement corresponding to the cathode 3 is located to the side, so that the focal spot path located upon the layer 27 which

is 1 mm. thick and which consists of a tungsten alloy with 10 percent rhenium, is struck by electrons in the direction of arrows 28. Rotation takes place in the usual manner by a part corresponding to the rotor 7 and located upon the lower part of the axle 29 (not shown). Since the plate 25 is less thick than the plate 26, less heat is transmitted to the rotor and the distance does not have to be increased by making the axle 29 longer by extending the lever arm engaging the supports. This protects the supports thermically as well as mechanically.

I claim:

1. An X-ray tube comprising a rotary anode having a heavy metal part and at least one graphite part, said heavy metal part having the shape of a plate and consisting at least primarily of molybdenum, said heavy metal part having a focal point path and being soldered to said graphite part outside of said focal point path, and at least one layer between said heavy metal part and said graphite part, said layer consisting of at least one metal selected from the group consisting of tantalum and tungsten.

2. An X-ray tube in accordance with claim 1, wherein the graphite part is located upon the bottom surface of the metal part.

3. An X-ray tube in accordance with claim 2, wherein the entire bottom surface of the metal part is flat and wherein the graphite part consists of a plate covering said bottom surface.

4. An X-ray tube in accordance with claim 2, comprising additional graphite parts located upon the upper side of said metal part.

5. An X-ray tube in accordance with claim 1, comprising two layers located on opposite sides of the metal part and two graphite parts consisting of plates soldered to said layers, the focal point path being located upon the periphery of said metal part.

6. An X-ray tube in accordance with claim 5, comprising a rotor connected with the anode, the graphite part directed toward the rotor being thinner than the other graphite part.

7. An X-ray tube in accordance with claim 5, wherein the soldering of said graphite parts consists of a high melting soldering layer.

8. An X-ray tube in accordance with claim 7, wherein the soldering layer consists of a metal selected from the group consisting of hafnium and zirconium.

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