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[54] **X-RAY TUBE WITH ROTARY ANODE**

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[51] **Int. Cl.** **H01j 35/04**

[58] **Field of Search** 313/60, 330, 58

[56] **References Cited**

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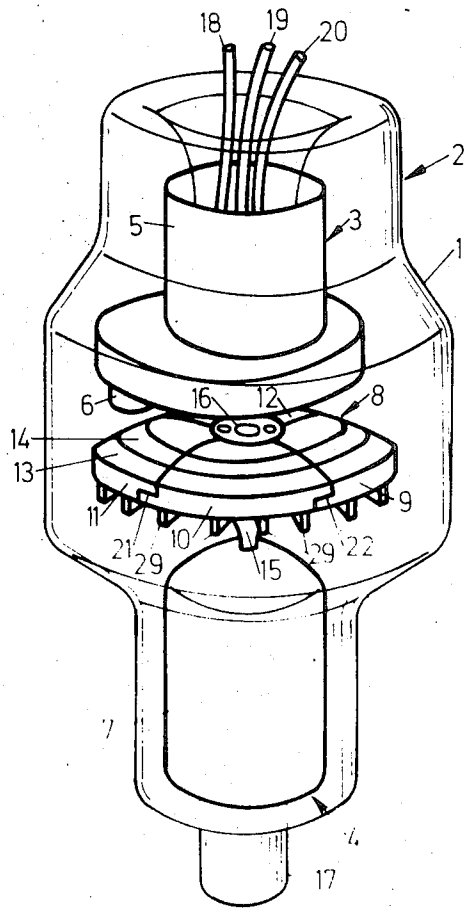
[57] **ABSTRACT**

An X-ray tube with a rotary anode the path of the focal spot of which is subdivided by separating adjoining surfaces. The invention is particularly characterized in that the separating adjoining surfaces extend not only through the path of the focal spot but also through the anode body.

5 Claims, 2 Drawing Figures



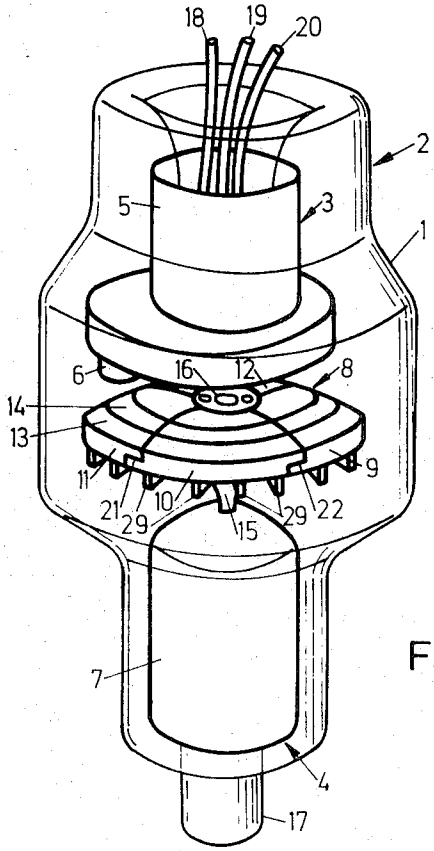


Fig. 1

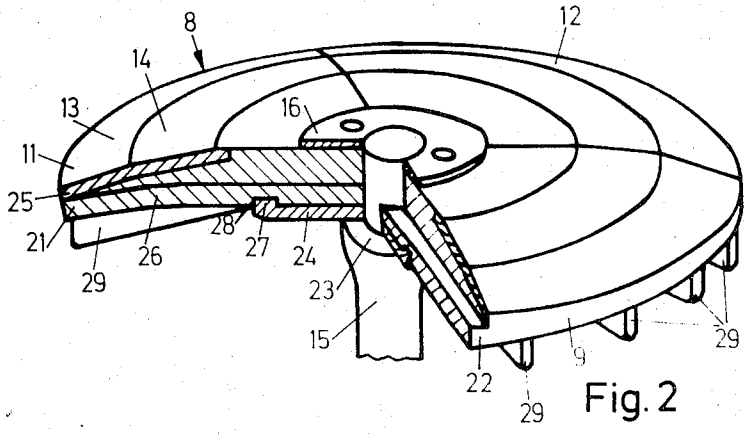


Fig. 2

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X-RAY TUBE WITH ROTARY ANODE

DESCRIPTION OF THE INVENTION

This invention relates to an X-ray tube with a rotary anode the path of the focal spot of which is subdivided by separating joints. The entire anode consists of a material which does not melt easily and has the shape of a plate, a pot, a ring or the like, from which heat created during the production of rays is radiated.

In X-ray tubes with rotary anodes the anode is heated by electrons which are braked in the path of the focal spot. This results in mechanical tensions between the colder parts of the anode and the focal spot path which can cause tears. Due to the action of the centrifugal force this can cause the breaking up of the anode and thus the destruction of the X-ray tube. Tensions are caused by the fact that in most cases the loading takes place so quickly that the speed of passage of heat to the other parts of the anode does not always suffice to maintain the tensions below dangerous stresses. The danger of tearing is particularly great in anodes made of tungsten and molybdenum since in these substances zones which are colder than 200°C have a substantially greater brittleness than those which are warmer. Consequently, at the present time, when using the generally available plates the load must be so adjusted that the heating extends over a time period sufficient for the outflow of heat, thereby avoiding dangerous tensions. However, the resulting extension of the time of illumination is undesirable since it makes impossible instantaneous photographing. For the usual diameter of 1.cm. the required time period is about 20–40 sec.

In known X-ray tubes with rotary anodes, wherein the focal point path has separating joints, these joints are constituted by bordering parts of wound bands, or tubes placed one over the other, or pieces of wire inserted brushlike into the focal spot path. However, in those cases as well the actual anode consists of a plate extending from its center to the periphery. Thus even this known interruption of the focal spot path used to prevent granulations does not avoid the possibility of cracks resulting in the breaking of the anode plate.

It was hoped that a remedy would be found by the use of rotary anodes which are also known and wherein the focal spot path lies upon the outer surface of a ring. It was expected that the loading capacity would be increased due to the short path of heat flow. On the other hand tensions produced relatively to the axis of rotation would be padded by spoke-like elastically form changing holders. However, a ring has only a small outer surface as compared to known anode plates and also has only small contacting surfaces with the holding means which extend to the axis. Thus it has also smaller heat conductivity and particularly smaller heat transmission than anodes having the usual plate shape, so that tensions occur in the ring shape as well.

An object of the present invention is to avoid these drawbacks of prior art constructions.

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

In the accomplishment of the objectives of the present invention it was found desirable to provide separating adjoining surfaces which in addition to the focal spot path also extend through the body of the anode. According to this construction the ring-shaped part of the anode which is heated during ray formation and expands to a considerable extent, is broken up into

smaller parts which can be shifted relatively to each other. Then an expansion relatively to the remaining colder material cannot produce detrimental tensions any more. The best subdivision of plates having, for example, a diameter of 100mm. and a thickness of 4 to 6 mm., consisting of tungsten or some other substance which melts with diffuculty, is to be considered as consisting of three or four parts, since then there are only a few separating adjoining surfaces and nevertheless there are no great expansions and relative shiftings.

Parts which in the usual anode plates or anode rings have the shape of sectors and consist of difficultly-melting substances of high order, such as tungsten, molybdenum, alloys of tungsten and rhenium etc., can be held together by clamps, or a ring consisting of similar or the same material as the parts of the anode. Then during heating the clamping has properties similar to the subdivided anode and thus the holding together of the parts is assured. By way of example, the clamping ring can be inserted or soldered at the lower side of the anode in a ring-shaped groove extending concentrically to the central axle. Besides the above-mentioned metals a compound material consisting of layers can be also used for the anode. This material may consist of a difficultly melting carrier, for example, graphite, and a difficultly melting metal, such as tungsten and its alloys, which is sprayed or soldered etc. as a layer.

The side edges of the parts of the anode which engage each other in the separating adjoining surfaces are preferably cut relatively to each other, so that, for example, they overlap each other, so that no slits are formed which extend through the thickness of the anode plate and which would permit passage for the electrons of the cathode. It is of importance that the separating adjoining surfaces should extend at least partly in a direction different from that of the electrons coming from the cathode. The separating adjoining surfaces can also deviate from a straight line in the radial direction. They can have, for example, the shape of teeth, etc. Parts of anode, particularly at their lower sides, can be provided for additional stabilization with radially extending strengthening members, such as ribs, etc.

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 perspective view of an X-ray tube constructed in accordance with the principles of the present invention.

FIG. 2 is a perspective view of an anode plate on an enlarged scale, one of the sectors having been removed.

FIG. 1 shows the glass bulb 1 of the X-ray tube 2. The glass bulb 1 is cylindrical and at its two ends are located opposite each other in a manner known per se the cathode combination 3 and the anode combination 4. The cathode combination 3 includes the holder 5 with the screen 6 in which is located the glow cathode. The glow cathode is covered and therefore not shown in the drawing. The anode combination 4 consists of a rotor 7 and an anode plate 8 having in the illustrated example a diameter of 100 mm. and a thickness of 6 mm. The anode plate 8 is composed of sectors, 9, 10, 11 and 12. Focal spot paths 13 and 14 are located upon the sectors

in a manner known per se in connection with anode plates. The plate **8** is fixed upon an axle **15** by a screw **16.**

To produce the rays the necessary operational and heating voltages are supplied to the X-ray tube through the anode joint **17** as well as the conduits **18, 19** and **20.** The sectors **9** to **12** of the anode plate **8** can shift relatively to each other due to the heating which is then produced and which causes their expansion relatively to each other, thereby avoiding tears. Step-like overlaps **21** and **22** are located, as shown, at the edges of the plate **8;** they prevent the electrons proceeding from the cathode from passing through the separating adjoining surfaces of the anode plate **8.** The connection of the sectors **9** to **12** takes place from the bottom by means of a plate **24** consisting of the difficultly meltable metal molybdenum and mounted upon a flange **23** of the axle **15.**

Furthermore, the sides surfaces of the sectors **9** and **11** shown in FIG. **2** indicate that the focal spot paths **13** and **14** of the anode **8** are located upon a layer **25** of a rhenium-tungsten alloy which is 1.5 mm. thick and which is carried by a plate **26** consisting of molybdenum. A firm connection takes place by an annular shoulder **27** located upon the edge of the plate **24** and engaging an annular groove **28** provided upon the under surfaces of the sectors **9** to **12.** To provide this firm connection the sectors **9** to **12** are pressed by the screw **16** against the plate **24** which lies upon the flange **23** of the axle **15.** Due to this arrangement the annular shoulder **27** firmly engages the groove **28** and together with the plate **24** constitutes a hook connecting the sectors **9** to **12** with the axle **15.**

Ribs **29** are located upon the underside of sectors **9** to **12** at uniform distances from each other. At their outer edges the ribs are axially 5 mm. high and their height diminishes gradually to zero at the edge of the plate **24.** Each of the sectors **9** to **12** has four ribs **29** which serve to strengthen the structure. The ribs have a base which is 2.5 mm. wide and they have a narrow end surface with rounded edges.

I claim:

1. An X-ray tube having a rotary anode and a focal spot path upon said anode having an outer surface consisting of the same material throughout the focal spot path, said anode and said focal spot path consisting of sectors separated by adjoining surfaces extending through the anode from the center of the anode to its outer edges.

2. An X-ray tube in accordance with claim **1,** having a plate-like or ring-shaped anode plate, wherein said separating adjoining surfaces extend radially to divide the anode plate into a plurality of sectors, said sectors having an annular groove upon their bottom surface, and a ring engaging said groove for holding said sectors together.

3. An X-ray tube in accordance with claim **1,** having a cathode and wherein said separating adjoining surfaces extend at least partly in a direction different from that of electrons emanating from the cathode.

4. An X-ray tube in accordance with claim **3,** wherein said separating adjoining surfaces have step-like overlaps.

5. An X-ray tube in accordance with claim **2,** wherein said sectors have strengthening members.

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