

Nov. 24, 1964

L. B. J. JANSSEN ET AL
METHOD OF MANUFACTURING DISC-SHAPED ANODES
FOR ROTARY-ANODE X-RAY TUBES
Filed Jan. 15, 1960

3,158,513

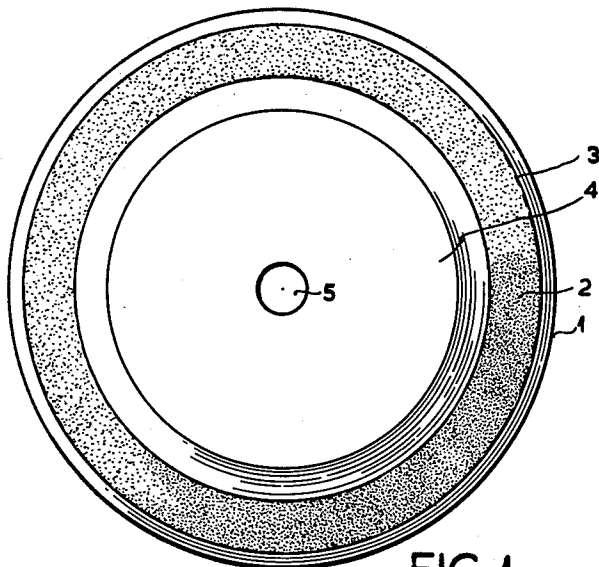


FIG. 1

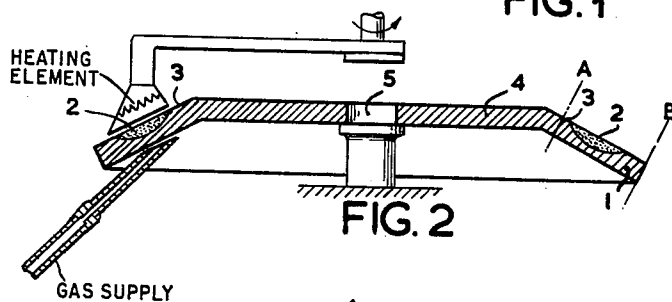


FIG. 2

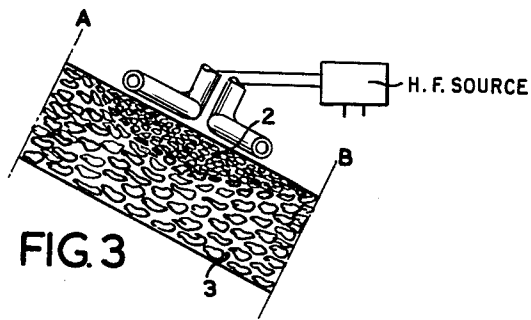


FIG. 3

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METHOD OF MANUFACTURING DISC-SHAPED ANODES FOR ROTARY-ANODE X-RAY TUBES

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Filed Jan. 15, 1960, Ser. No. 2,690

5 Claims. (Cl. 148—13)

This invention relates to a method of manufacturing anode discs for use in X-ray tubes, in which they are rigidly mounted on a rotary shaft. Such discs are made of tungsten, because this metal is capable of withstanding a higher load per unit area than other metals and the X-ray emission is satisfactory owing to the high atomic number.

It is known that the manner of loading a rotary anode in an X-ray tube has irregularly occurring deleterious after-effects. Owing to the electron bombardment, the point of impact of the electrons on the anode material is intensely heated. The local great heat generation gives rise to high mechanical stresses in the anode material. Since the heat generation is concentrated in a small spot which, when the anode performs the predetermined rotary movement, occupies any one position on the anode surface for a short time only, and because the temperature gradient in the anode disc is high, great stresses are produced. Sooner or later, but frequently after too short an operational life, the anode material is damaged by these stresses, so that the intensity of the X-rays produced is reduced or the X-ray tube becomes useless. The nature of the damage depends upon the structure of the material subsequent to the manufacturing of the anode.

Initially the anode discs, which were made of tungsten sheet, were used in the X-ray tubes without the use of treatments which change the structure of the material. The sheet material obtained by rolling has a structure of substantially elongated fibres, so that it is mechanically strong. The long-fibred structure proved to be incapable of withstanding the intense heat generation in the point of impact of the electrons. The insufficient suitability shows itself by the occurrence of fissures between the fibres and the curling and scaling of the latter.

Endeavours have been made to avoid this disadvantage by imparting a fine-grained structure to the anode. To this end, tungsten discs of fibrous structure are subjected to a heat treatment which is continued or repeated until the structure has been converted into a fine-grained one. It is known to apply this treatment to stationary and rotary anodes mounted in the X-ray tube by exposing them to ever-increasing loads. If the anode is damaged during this treatment, the X-ray tube also is useless.

Completely recrystallized discs have also been used, but these must be handled very carefully. It is known that the mechanical strength of the material is highly reduced owing to the recrystallization. Hence, slight balancing inaccuracies may result in that the centrifugal forces produced in the rotation of the anode already excessively stress the material. The stresses in the material due to the rotation and the high temperature gradient may cause deformation and cleavage of the anode disc.

Practice has shown that an isotropic structure of the tungsten, which structure is obtained by recrystallization, is most highly desirable for maintaining greatest soundness of the surface at the points on which the electron stream impinges. Although the occurrence of fissures at the crystal bounds is not completely avoided, curling and scaling are substantially prevented. Consequently, to obtain the most reliable design of an anode disc, the base

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material must have the properties determined by the rolled structure whilst the portion of the disc on which the electron beam impinges in operation of the tube, must have a recrystallized isotropic structure.

The method in accordance with the present invention consists in heating a narrow annular anode strip, which eventually comprises the path of the focal spot, to so high a temperature as to produce recrystallization before the anode is mounted in the X-ray tube. Preferably the heat treatment is carried out so that in a comparatively thin layer of material below the surface the fibre structure is completely converted into an isotropic structure by recrystallization. Undesirable extension of the region within which recrystallization occurs is avoidable by using suitable artificial cooling.

It should be noted that the known method, in which progressively increasing loads, which alternate with cooling periods, are imposed on the anode, takes very much time. In rotary anode X-ray tubes a considerable number of loadings is required to ensure the desired recrystallization. Although initially the load is small, the electron bombardment may damage the anode surface so that the X-ray tube becomes useless. In these cases, the losses exceed the cost of the anode many times. In the method in accordance with the invention, the anode surface cannot be damaged in this manner during recrystallization so that, when the X-ray tube is put into operation, the strip of the anode surface which receives the point of impact of the electrons, still is completely sound.

The heat supplied to the anode can be concentrated in a circular or elongated spot the radial dimension of which is equal to the width of the strip on the surface. By moving this heat spot over the surface along a circle about the centre of the disc, the spot describes an annular path. Alternatively, a number of sources of heat can be arranged along the circumference of the disc. The most effective method of heating consists in supplying high-frequency energy.

The drawing shows by way of example, an embodiment of an anode disc manufactured in accordance with the invention.

FIG. 1 is a plan view of an anode disc, of which

FIG. 2 is a cross-sectional view.

FIG. 3 shows the part A-B of the cross-section of FIG. 2 on an enlarged scale.

On an anode disc 1 there is indicated a strip 2 which is intended to serve as the area of impact of the electrons. This strip is disposed on a bevelled edge 3 of the anode which forms part of a conical surface. The centre part 4 of the disc is flat and has a central aperture 5 for securing the rotary shaft by which the disc is supported.

In FIG. 3, the part A-B of the cross-section of the edge portion 3 of the disc is shown to an enlarged scale. Photographs of the structure of the material in this part show the picture sketched, in which a channel of material of isotropic structure is enclosed by metal which has substantially retained the fibre structure produced by the mechanical working.

In order to counteract the spreading of heat in the disc due to the heating of the strip-shaped zone, during the heat treatment a stream of cooling gas may be applied to the back of the disc, use being preferably made of a non-oxidizing gas.

In some cases, two adjacent focal spots are used on the anode surface, one being spaced from the disc centre by a larger distance than the other. In these cases, the strip to be heated can be made so wide as to comprise both focal spot paths. If the two paths are widely spaced, each strip is preferably heated separately.

What is claimed is:

1. In the method of manufacturing anode discs for use in rotary anode X-ray tubes, in which method the anode

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material is subjected to a heat treatment after the mechanical shaping, the step of heating a narrow annular strip intended to serve as the path of the focal spot to a temperature at which a comparatively thin layer of material below the surface is converted from a fiber structure to an isotropic structure by recrystallization before the anode is mounted in the X-ray tube.

2. A method as claimed in claim 1, in which the heating is concentrated in an oval spot which is moved along a circle about the disc centre.

3. A method as claimed in claim 2, in which the anode disc is rotated about an axis passing through the disc centre, the heating area being shifted radially with respect to the centre.

4. A method as claimed in claim 1, in which heating is effected by supplying high-frequency energy.

5. A method as claimed in claim 1, in which the side

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of the anode more remote from the heating area is cooled by means of a stream of gas counteracting oxidation of the metal.

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