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X-RAY GENERATOR TUBE WITH GRAPHITE ROTATING ANODE

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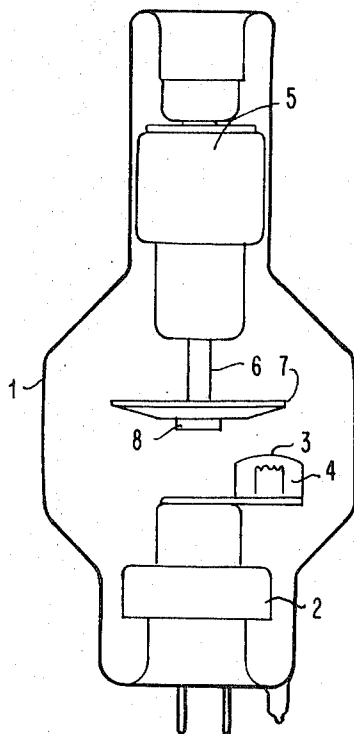


FIG. 1

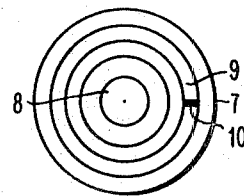


FIG. 2

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4 Claims

ABSTRACT OF THE DISCLOSURE

The anode is formed of high density graphite, with a focal track thereon, only, covered by an emissive band of a metal, or alloy, which is refractory and has a high atomic number, such as rhenium or tungsten, or alloys thereof, so that the entire anode is lighter than a metal anode and has a heat dissipation approaching black body radiation.

The present invention relates to X-ray tubes, and particularly to X-ray tubes with rotating targets having a high heat dissipation rate.

U.S. 2,863,083, assigned to the assignee of the present invention, discloses and claims an X-ray tube having a rotating anode structure and using rhenium, at least for part of the anode. U.S. Patent 2,863,083 also contains a complete discussion of the characteristics of rotating anodes, and particularly the desirable features these anodes must have for highest heat dissipation.

The principal problem in X-ray tubes, and particularly in rotating anode type X-ray tubes is heat dissipation. Almost the entire electrical energy of the electron beam is transformed into heat. Thus, cooling of the anode is particularly important if successive numbers of X-ray exposures are to be made. This cooling from the anode is primarily obtained by heat radiation therefrom.

It is an object of the present invention to provide an X-ray tube of high, repetitive output capability.

Subject matter of the present invention: Briefly, in accordance with the present invention, the anode is formed of a refractory material, and comprises a very fine dense graphite, to which an emissive band, or track is applied formed of a metal, or an alloy of such metals having high atomic number and refractory characteristics.

In accordance with features of the invention, the coefficient of expansion of the material of the graphite disk is chosen to be similar to the coefficient of expansion of the material for the emissive band of refractory metal and the width of the emissive band or track is chosen to be the same as the focal length of the X-ray tube. The emissive, refractory material may be tungsten, rhenium, or alloys of these substances.

The structure, organization, and operation of the invention will now be described more specifically with reference to the accompanying drawings, wherein:

FIG. 1 is a diagrammatic elevational view of an X-ray tube having a rotatable anode; and

FIG. 2 is a plan view of the anode assembly of the tube of FIG. 1.

The tube of FIG. 1 includes an envelope 1, a cathode assembly 2, having a filament 3 within a beam forming or concentrating member 4 thereon. An electron beam is emitted from the assembly 2, 3, 4 and directed to a rotating anode 7. The anode 7 is held by a central stem 6, secured thereto for example by a screw 8, and rotatable within the X-ray tube by means of a motor 5, as well known. The beam from the cathode assembly is concentrated on a track 9 (FIG. 2) to form a spot 10 thereon,

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from which X-rays are emitted. The energy of the beam is transformed almost entirely into heat which is dissipated from spot 10 along band or track 9 as well as to the total anode 7 itself.

The tube structure described is of a well-known type. The present invention relates, essentially, to the structure of the anode 7.

In accordance with the present invention, the anode 7 is formed of graphite having a high degree of density, fine grain, and thus great mechanical strength. The graphite itself is compressed and heated to a high degree to almost sintering in such a manner that the individual grains of graphite will merge, or even weld together so that the final product will be pseudo vitrified. The result will be a graphite of very low exposed porosity, of high resistance to flexing and breakage, for example in the order of 650 kg./cm.². Additionally, the expansion coefficient of the graphite, in the order of $4.2 \cdot 10^{-6}$ is very close to that of the band of emissive material, which is applied only along the focal track. This band of emissive material may be applied electrolytically, pyrolytically, and may consist of tungsten, rhenium, or alloys of one or both of these metals. Further disclosure of materials suitable for such anode is found in Pat. 2,863,083, to which reference is hereby made. The width of the emissive band or track is preferably chosen to be equal to the focal length of the tube or of the beam impinging on the track 9 of anode 7.

The rotating anode in accordance with the present invention provides for good heating radiation, since the radiation of the graphite is close to that of an ideal black body. Thus the heat capacity of the anode structure is increased and the X-ray output of the tube is improved, that is the rapidity of successive exposures which can be made with the tube is increased.

The graphite has the additional advantage that it is of lesser weight than that of metal, and in the order of a specific gravity of about 1.85 g./cm.³. This lower weight permits a higher speed of rotation of the anode.

Use of rhenium, or alloys thereof, as well as tungsten, or its alloys permits the application of an emissive track close to the theoretical density of the emissive material, thus decreasing out-of-focus dispersion of X-rays and maximum emission of X-rays in beam form. The lower weight, and the use of the graphite further provides a tube less sensitive to thermal shock than tubes having anodes wholly of metal.

Substrata of graphite, in general, and interchangeable with molybdenum or other bases for X-ray emissive material have been proposed before; the present invention is specifically directed to a special graphite—as disclosed—having the properties of heat radiation approaching that of a black body, while, at the same time, having a coefficient of expansion close to that of the emissive material, of specific gravity of about 1.85 g./cm.³, and being very pure and at the same time having a high degree of density, such as is obtained by an anode structure in which the grains of the graphite themselves are practically merged into one whole. This special material will then have the properties of supporting the X-ray emissive band, while at the same time providing the necessary structural strength with the heat radiation capability desired.

I claim:

1. X-ray tube having a rotating anode comprising a refractory base structure and an X-ray emissive band of refractory metal of high atomic number formed thereon, said refractory base structure being made of a high density, high purity, fine-grain, compressed and high temperature treated graphite material presenting low exposed porosity, a pseudo-vitrified structure, and having a coefficient of expansion close to that of said refractory metal,

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to provide correct adherence of said X-ray emissive band to said graphite base structure during the operation of said tube, said graphite material further having a high resistance to flexing and breakage.

2. Tube in accordance with claim 1, wherein the width of the band of emissive material is equal to the focal length of the tube. 5

3. Tube in accordance with claim 1, wherein the emissive band is formed of tungsten, rhenium, or alloys of tungsten and/or rhenium.

4. Tube in accordance with claim 1, wherein the anode is a disk of sintered graphite having the graphite grains merged together to provide a graphite structure of high density and low porosity of specific gravity in the order of 1.85 g./cm.³.

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U.S. Cl. X.R.

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