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3,452,232

MULTIPLE-CATHODE X-RAY TRIODE TUBE

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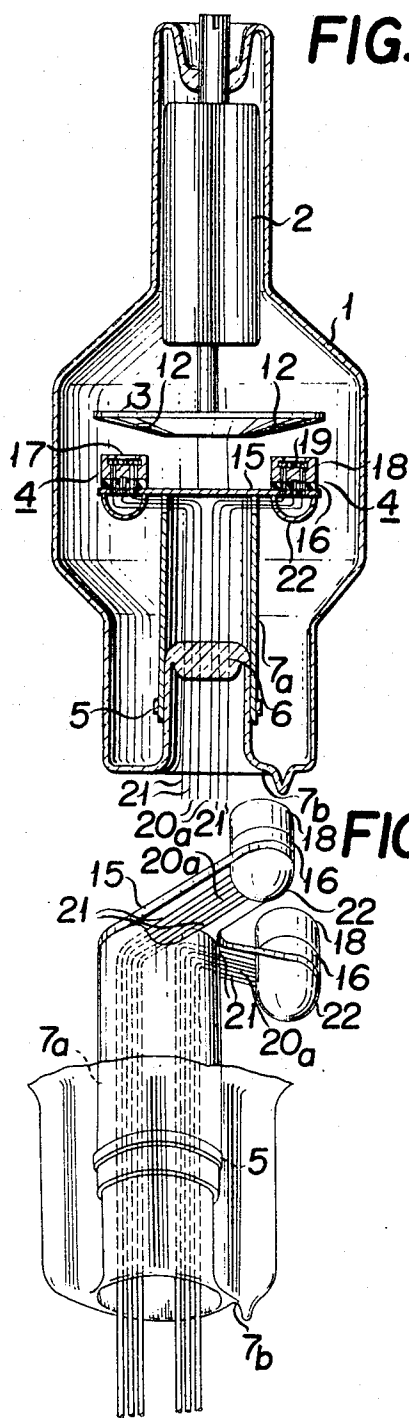


FIG. 1

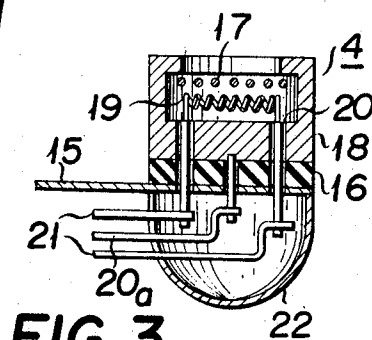


FIG. 3

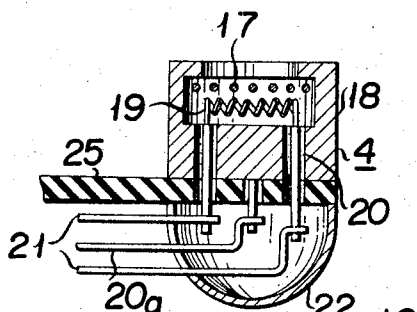


FIG. 5

FIG. 2

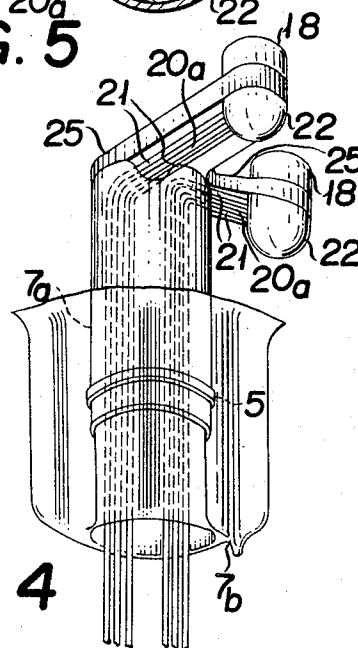


FIG. 4

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MULTIPLE-CATHODE X-RAY TRIODE TUBE
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4 Claims

ABSTRACT OF THE DISCLOSURE

Multiple-cathode X-ray triode tubes in which a plurality of cathodes each consisting of a cup-shaped control electrode and a thermionic emissive element are insulatedly mounted on tip of the cathode support arms which are in turn mounted on top of a single cylindrical cathode mount metallic stem mounted in one end of a tube envelope, each control electrode being independently applied with a control voltage.

This invention relates to X-ray triode tubes and more particularly to X-ray triode tubes in which a plurality of cathodes are enclosed within the same envelope to provide the same number of X-ray sources.

A prior art X-ray tube having a plurality of X-ray sources for use, for instance, in the three-dimensional observation of X-ray images of the objects to be examined has two separate cathodes hermetically sealed within the same envelope, so that electron beams shot from the individual cathode may strike different focal spots of the target to create two X-ray sources at these spots. Such an X-ray tube has a rotary target provided on one end of the envelope and two cathodes independently mounted within the glass envelope.

In this type of X-ray tube, the structure for mounting the cathodes in the glass envelope is too complex to mount more than two cathodes, the hermetic seal of individual cathodes within the envelope and the positioning of these cathodes relative to each other being the most difficult of the assembling processes. Moreover, the hermetic sealing part of the cathodes within the envelope is so complexly constructed that the glass envelope is apt to be broken by a mechanical distortion generated within the envelope.

According to the invention, these disadvantages are overcome by securing individual cathodes each having a control electrode and a thermionic emissive element on corresponding support arms which are in turn secured on one end of the cathode mount metallic stem. The cathode support arms are partly or entirely made of an insulating material so as to insulate the cathodes from the cathode mount metallic stem. The individual cathodes are held in position by the associated cathode support arms, with the envelope supporting only the cathode mount metallic stem.

With this construction, the sealing of the cathodes within the envelope becomes as simple as for the manufacture of single cathode tubes, while the mechanical strength and the easiness of the assembly are pronounced as compared to the afore-mentioned prior art multiple-cathode X-ray tubes.

Further, the fact that the cathode support arms carry the cathodes electrically independently of each other enables separately applying independent control voltages to the associated control electrodes so as to optionally change over the shooting of electron beams from individual cathodes, thereby achieving rapid alternation of the emission of X-rays from the corresponding X-ray sources,

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which is required, for instance, for the three-dimensional observation of the X-ray images.

Accordingly, an object of this invention is to provide a multiple-cathode X-ray tube which may be precision manufactured, is physically rugged and easy to manufacture.

Another object of the invention is to provide a multiple-cathode X-ray tube capable of rapid alternation of X-ray emission from individual X-ray sources.

In the accompanying drawing:

FIG. 1 is a partly schematic longitudinal sectional view of a preferred embodiment of the multiple-cathode X-ray tube according to the invention;

FIG. 2 is a perspective view of the portion pertinent to the invention of the X-ray tube shown in FIG. 1;

FIG. 3 is a schematic sectional view illustrating one cathode of the X-ray tube shown in FIG. 1;

FIG. 4 is a perspective view similar to FIG. 2 but illustrating a modification of the corresponding portion of the X-ray tube; and

FIG. 5 is a schematic sectional view illustrating the cathode shown in FIG. 4.

Referring now to FIGS. 1 to 3, an evacuated glass envelope 1 has a rotary anode 2 inserted at its one end. The anode 2 constitutes a rotor of a motor and is rotatable about the axis of the envelope 1 by means of an external rotating magnetic field generator (not shown). A disk-like target 3 extends concentrically with the tube axis from the inner end of the rotary anode 2.

For the three-dimensional observation of X-ray images it is necessary to irradiate the object to be examined with X-rays incident at the object at an angle with each other and originating at X-ray sources spaced apart from each other. The two X-ray sources are disposed within the same envelope in view of the adaptability to moving objects and desirability of the separation of the two X-ray sources to be equal to the distance between the pupils of the human eyes. The end of the tube envelope 1 opposing the target 3 has a reduced-diameter internal extension 7b closed at its top with a sealing portion 6, on which extension is mounted a cylindrical cathode mount metallic stem 7a which is held in position, for instance, by means of a suitable fastening ring 5. The stem 7a securely carries at its end facing the target 3 two radially extending cathode support branch arms 15 in the form of a metallic plate orientated in different directions. Each of the branch arms 15 carries at its free end and on the side facing the target 3 a circular insulating spacer 16 made of, for instance, a ceramic material. On the insulating spacer 16 is mounted a cathode generally designated at 4 and consisting of a cup-shaped control electrode 18 having a grid screen 17 provided over the open end of the electrode 18 and a thermionic emissive element 19 constituted by a filament of tungsten and the like and disposed immediately above the bottom of the cup of the control electrode 18. The ends of the filament 19 are insulated from and taken out through bores 20 formed in the bottom wall of the control electrode 18 to the side of the arm 15 opposite the cathode 4 and they are connected to filament leads 21. Another lead 20a is connected to a lead pin extending from the control electrode 18 past the arm 15. The leads 21 and 20a extend along the arm 15 enter the stem 7a and pass through the sealing portion 6 to be taken out of the envelope 1. The connection points of the thermionic emissive element 19 to the lead wires 21 and of the lead pin of the control electrode 18 to the lead wire 20a are shield by means of a metallic cover 22.

With the above-described construction the control electrode 18 of the cathode 4 is insulated from the cathode mount stem 7a by means of the spacer 16, it is possible

to apply voltages to individual cathodes independently of each other.

The electron beam shot from individual cathodes focus upon different spots, for instance a point 12 in FIG. 1 of the target 3 to produce spaced X-ray sources. The spacing of the two X-ray sources is preferably set to the distance between the pupils of the human eyes, which is about 6.5 cm. when the X-ray tube is used for the three-dimensional observation of the X-ray images.

FIGS. 4 and 5 illustrate a modification of the construction described hereinbefore and in the figures like parts to those of the previous embodiment are designated by like reference numerals. In this embodiment, cathode support branch arms 25 made of an insulating material such as a ceramic material replaces the combination of the metallic branch arm 15 and the insulating spacer 16 of the preceding embodiment, with the rest of the construction being the same as before.

With this construction where the cathodes 4 are insulated from the cathode mount stem 7b through the insulating branch arms 25 it is also possible to apply voltages to individual cathodes independently of each other.

In the operation of the afore-described X-ray tubes, the thermionic emissive elements 19 are heated by the current therethrough and a potential of, for instance, 60 to 150 kilovolts is applied between each of these elements 19 and the target 3. The potential of the control electrodes 18 is made alternately zero volts and -600 to -2500 volts with respect to the associated thermionic emissive elements 19, so as to provide a gate control such that thermionic electrons are shot from the cathodes 4 when their control electrode 18 is at zero potential with respect to the thermionic emissive element 19.

As has been described in the foregoing, according to the invention, a single cathode mount metallic stem is mounted in the envelope, said stem carrying a plurality of cathode support arms each made of at least partly insulating material and each carrying a cathode on the portion of the insulating material, so that it is possible to apply independent voltages to the individual control electrodes and as the thermionic beams may be shot from individual cathodes selectively at any optional instance, which is requisite for the taking of X-ray photographs, it is possible to emit X-rays from optional X-ray sources at optional instances. Further, the sealing of a single cathode mount stem within the envelope is very simple and never causes distortions of the envelope. Furthermore, the mutual spacing among the plurality of cathodes may be made very precise as it is determined by the machined mounting portion of the cathode mount stem.

While the invention has been described in connection

with some preferred embodiments thereof, the invention is not limited thereto and includes any modifications and alternations which fall within the true spirit and scope of the invention.

What is claimed is:

1. A multiple-cathode X-ray tube comprising an evacuated envelope, an anode disposed within said envelope and supported at one end of said envelope, a plurality of cathodes disposed within said envelope and each consisting of a cup-shaped control electrode and a thermionic emissive element disposed within said electrode, a cylindrical cathode mount metallic stem mounted on the end of the envelope remote from the anode, a plurality of cathode support branch arms secured on one end of said stem and radially extending in different directions, each of said branch arms being made at least partially of an insulating material and carrying one of said cathodes such that it faces said anode, said control electrodes being connected to independent leads, and said thermionic emissive elements being connected to independent terminal leads, whereby to apply individual control voltage to said control electrodes to achieve gate control of the electron beams from said thermionic emissive elements.

2. A multiple-cathode X-ray tube according to claim 1 wherein each of said cathode support branch arms is made of a metal plate which is provided with an insulating spacer on the position of mounting said control electrode, whereby insulating said control electrode from said cylindrical cathode mount metallic stem.

3. A multiple-cathode X-ray tube according to claim 1 wherein each of said cathode support branch arms is made of an insulating material.

4. A multiple-cathode X-ray tube according to claim 1 wherein there are two of said cathodes disposed such that the electron beams from said cathodes focus on different spots on said anode, the distance between said spots being substantially equal to the distance between the pupil of the human eyes.

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