

[54] **FILAMENTARY CATHODE MOUNT AND MOUNTING METHOD**

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313/338, 269, 351

[56] **References Cited**

UNITED STATES PATENTS

2,844,752	7/1958	Hoover	313/338 X
3,202,853	8/1965	Weimer	313/66 X

3,573,535	4/1971	Hughes	313/278
3,558,967	6/1971	Miriam	313/338

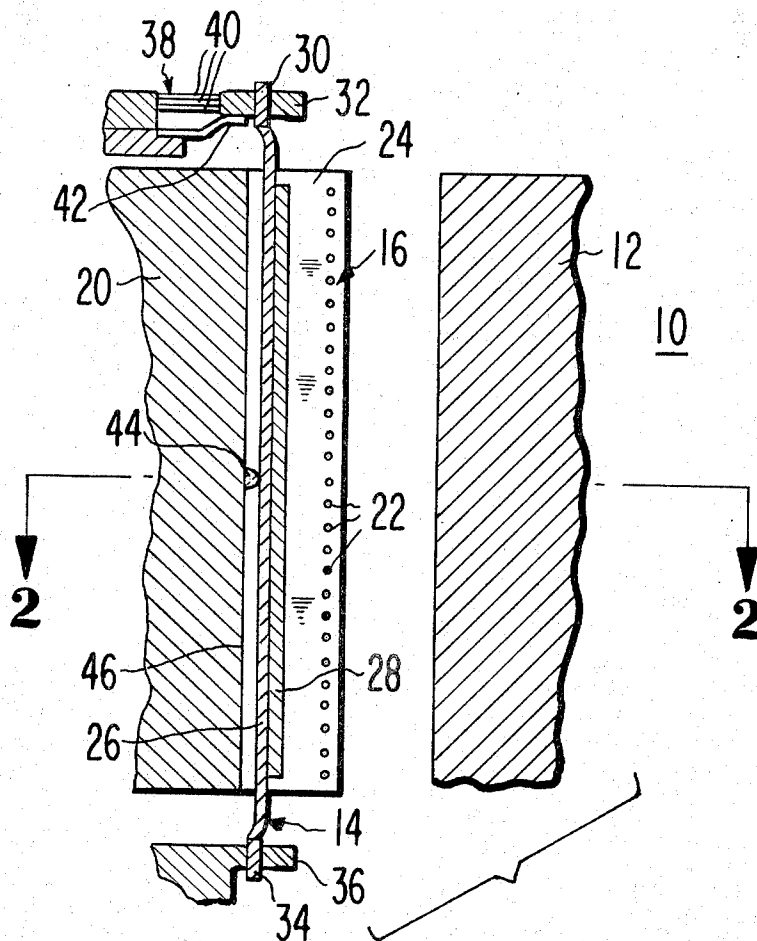
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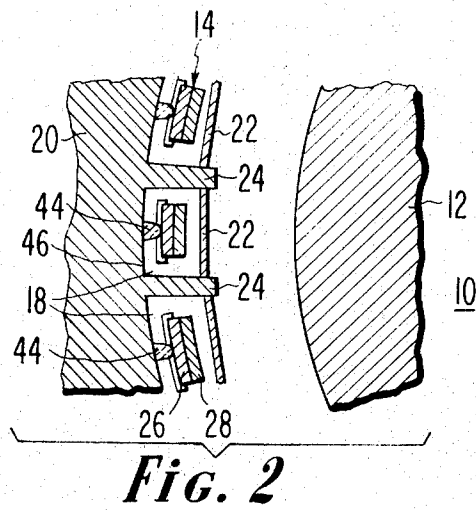
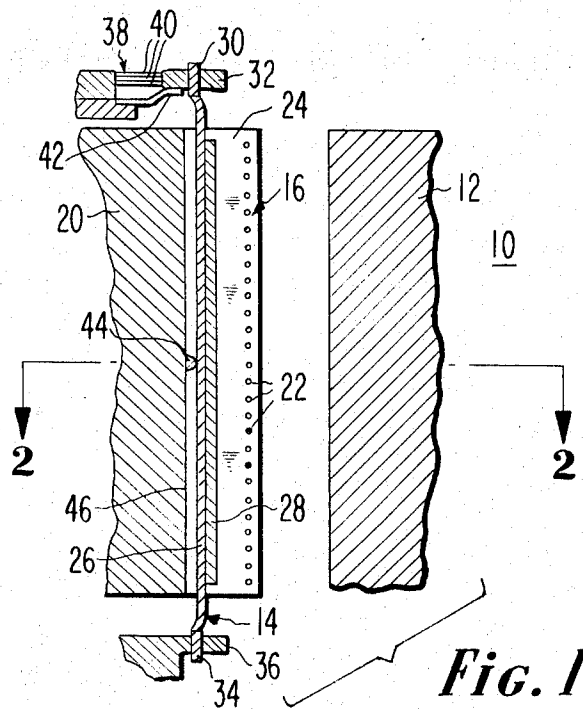
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ABSTRACT

A mount comprising a filamentary cathode held in longitudinal tension between two suspension members movable one with respect to the other; a fixed electrically-insulating support in contact with a surface of the cathode intermediate the ends thereof; and means for displacing the longitudinal pulling plane relative to the center-of-gravity of the cathode, whereby the cathode surface is forced against the support. Also included is a method of mounting a filamentary cathode in the mount.

10 Claims, 2 Drawing Figures





FILAMENTARY CATHODE MOUNT AND MOUNTING METHOD

BACKGROUND OF THE INVENTION

This invention relates to a novel filamentary cathode mount having improved vibration characteristics and to a method of mounting a filamentary cathode in the novel mount.

Filamentary cathodes are widely used in electron-beam devices such as super-power beam tubes. A super-power beam tube is a multi-electrode tube in which directed electron beams are used to increase substantially the power-handling capability of the tube. A typical super-power beam tube comprises an array of cathodes surrounding a centrally-located anode. The cathodes are directly-heated, individually-suspended, ribbon-type filaments made of thoriated tungsten or a nickel-based alloy coated with an oxide matrix. Disposed between each filamentary cathode and the anode are one or more grid electrodes. See, for example, U.S. Pat. No. 3,601,647, issued on Aug. 24, 1971, to F. G. Hammersand.

The usual mounting for filamentary cathodes in a super-power beam tube is described by M. V. Hoover in "Advances in the Techniques and Applications of Very-High-Power Grid-Controlled Tubes," *Proceedings of the Institution of Electrical Engineers*, Vol. 105, Part B, Supplement No. 10, pp. 550-558 (1958). Each filamentary cathode has an enlarged head at either end thereof which is hooked into a V-groove in a metal support member. A so-called "pantographic" device permits longitudinal movement of one of the V-groove mountings to compensate for thermal expansion of the cathode. The pantographic device comprises a stack of thin metal strips bonded together at their ends to define a precise length, whereby the middle of the device is capable of being flexed to provide pantographic parallelism between the upper and lower surfaces thereof. A separate leaf spring acts against the movable mounting to hold the filament in tension.

Despite the general success of the above-described mounting, problems of vibration have been encountered with super-power beam tubes having severe performance objectives. Two such problems, amplitude-modulated noise in the output electrical signal and internal electrical arcing, are related directly to the filamentary cathode mounts. Each filament, while held in tension by the pantographic device-leaf spring combination, is subjected to mechanical vibration during tube operation. This vibration translates into electrical noise, and produces, in some situations, cathode-to-grid shorting.

SUMMARY OF THE INVENTION

The novel filamentary cathode mount comprises a filamentary cathode held in longitudinal tension between two suspension members movable one with respect to the other, as in the prior art, the improvement comprising a fixed electrically-insulating support in contact with a surface of the cathode intermediate the ends thereof, and means for displacing the longitudinal pulling plane relative to the center-of-gravity of the cathode. Preferably, the fixed support is a sapphire pin disposed at the rear surface of the filament midway along the length thereof, and the means for displacing the longitudinal pulling plane relative to the center-of-gravity of the cathode comprises offset heads at the

ends of the filament. By displacing the longitudinal pulling plane relative to the center-of-gravity of the filamentary cathode, the surface of the cathode in contact with the fixed support is also forced thereagainst. Thus, in mechanical vibration, the cathode acts like two structural beams, the sum of the lengths of which is equal to the length of the cathode itself. The mechanical resonance frequency of the cathode is thereby increased, and the relative cathode-to-grid displacement is thereby decreased, with respect to the corresponding characteristics of filamentary cathodes in prior-art mounts. If the fixed support is a sapphire pin disposed at the rear surface of the filament, midway along the length thereof, then non-electrically-conducting contact is made to the cathode; the heat-transfer and electron-emission characteristics of the cathode are undisturbed; and the cathode acts like two structural beams, each having a length equal to one-half that of the cathode itself. Also, if the means for displacing the longitudinal pulling plane relative to the center-of-gravity of the filamentary cathode comprises offset heads at the ends of the filament, then the method of mounting the filamentary cathode in the novel mount is easily adapted from the method for prior-art filamentary cathode mounts.

The method of mounting a filamentary cathode in the novel mount comprises the step of holding the cathode in longitudinal tension between two suspension members movable one with respect to the other, as in the prior art, the improvement comprising the steps of providing a fixed support to contact a surface of the cathode, and displacing the longitudinal pulling plane relative to the center-of-gravity of the cathode. Preferably, the fixed support is a sapphire pin, as described above, which is provided by embedding the pin in an adjacent surface of a portion of a usual grid-support block. Also preferably, the longitudinal pulling plane is displaced relative to the center-of-gravity of the filamentary cathode by offsetting the heads at the ends of the filament. Filamentary cathode mounts employing this method have the improved vibration characteristics discussed above, whereby the related problems of electrical noise and cathode-to-grid shorting are greatly mitigated.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal sectional view of a super-power beam tube comprising an example of the novel filamentary cathode mount; and

FIG. 2 is a sectional view, along the line 2-2, of the tube of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An example of the novel filamentary cathode mount is shown in FIGS. 1 and 2, which depict a super-power beam triode 10. The triode 10 comprises a centrally-located cylindrical anode 12 surrounded by a concentric circular array of directly-heated filamentary cathodes 14. Disposed between each cathode 14 and the anode 12 is a grid electrode 16. The anode 12 is typically a hollow copper pipe the inner surface of which (not shown) is fluted to increase the heat transfer therefrom to a coolant (also not shown) normally circulating through the pipe. Each cathode 14 is located within a vertically-disposed U-shaped channel portion 18 of a grid-support block 20, the block also made typically of copper. The grid electrodes 16 each comprise

a plurality of fine wires 22 made of a refractory metal such as tungsten. The wires 22 extend horizontally across the openings of the channels 18, between the open arms 24 thereof.

Each cathode 14 comprises a ribbon-type strand or filament 26 made of a suitable material such as Hastelloy Alloy B (registered trademark of Haynes Stellite Company), a high-temperature nickel-base alloy. Disposed on the front surface of the filament 26, i.e., the surface thereof facing the anode 12, is a layer 28 of electron-emissive material. The emissive layer 28 is typically a standard matrix-oxide coating. The filament 26 is usually about 5 inches long and has an enlarged vertically-offset head at each end. At the upper end 30 of the filament 26, the head of the filament is hooked into a V-groove in a first metal suspension member 32; at the lower end 34, the head of the filament is hooked into a V-groove in a second metal suspension member 36. The cathode 14 is thus suspended between the first and second suspension members 32 and 36, respectively.

To compensate for thermal expansion of the filament 26 during normal operation of the cathode 14, the first suspension member 32 is in longitudinally movable relation to the second suspension member 36. The relative longitudinal movement is provided by a "pantographic" device 38 attached to the first suspension member 32 at the end thereof opposite the V-groove. The pantographic device 38 comprises a stack of thin metal strips 40 bonded together at their ends to define a precise length, whereby the middle of the device is capable of being flexed to provide pantographic parallelism between the upper and lower surfaces thereof. To hold the filament 26 in longitudinal tension, a separate leaf spring 42 acts against the lower surface of the first suspension member 32. Because of the vertical offset of the heads at the ends 30 and 34 of the filament 26, the longitudinal pulling plane is displaced relative to the center-of-gravity of the cathode 14. Thus, the filament 26 is forced to bow away from the grid electrode 16.

In contact with the rear surface of the filament 26, i.e., the surface thereof opposite that facing the anode 12, is a sapphire pin 44. The pin 44 is embedded in the base 46 of the channel 18 and disposed midway along the length of the filament 26. Thus, the pin 44 serves as a fixed support against which the filament 26 is forced. And, in mechanical vibration, the cathode 14 acts like two structural beams, each about two and one-half inches long. The resulting mechanical resonance frequency of the cathode 14 is increased about twofold over that of the filamentary cathode unsupported along its length. Also, the danger of electrical shorting between the cathode 14 and the grid electrode 16 is greatly reduced.

The following is an example of the method of mounting a filamentary cathode in the novel mount. Referencing FIGS. 1 and 2, a copper grid-support block 20 is constructed with a cylindrical inner surface comprising a plurality of vertically-disposed U-shaped channel portions 18. Each channel 18 has a base 46 and open arms 24. A sapphire pin 44 is embedded in the base 46, about midway along the length thereof. A plurality of fine tungsten wires 22 are then extended horizontally across the channel opening, between the arms 24, to form a grid electrode 16.

A cathode suspension system is also constructed, wherein a first metal suspension member 32 is provided adjacent to the upper end of the channel 18 and a second metal suspension member 36 is provided adjacent to the lower end of the channel 18. Each of the suspension members 32 and 36 is made with a V-groove therein, in longitudinal alignment with the channel 18. Longitudinal movement of the first suspension member 32, relative to the second suspension member 36, is provided by attaching a pantographic device 38 to the former. As described above, the pantographic device 38 comprises a stack of thin metal strips 40 bonded together at their ends. A separate leaf spring 42 is also provided, to act against the lower surface of the first suspension member 32.

A plurality of filamentary cathodes are each made by producing an electron-emissive layer 28 of standard matrix-oxide coating on a first (front) surface of a suitable ribbon-type filament 26. The filament 26 has enlarged vertically-offset heads at both ends, which are hooked into the V-grooves in the first and second suspension members 32 and 36, respectively, of the cathode suspension system. Each cathode 14 is thereby suspended and held in tension between the suspension members 32 and 36. The cathode 14 is oriented within the suspension system such that the front (coated) surface of the filament 26 faces the grid electrode 16 and the rear surface of the filament 26 is forced against the pin 44.

A super-power beam triode 10 is produced by assembling a concentric cylindrical anode 12 within the inner surface of the grid-support block 20. Appropriate electrical connections (not shown) are then made to the cathodes 14, grid electrodes 16, and anode 12; and suitable anode cooling means (also not shown) are provided. Finally, the tube is evacuated and sealed for normal operation.

GENERAL CONSIDERATIONS

It should be understood that the invention is not limited to the examples described above and shown in FIGS. 1 and 2. For example, the triode may be inverted such that the filamentary cathodes are surrounded by the anode. As shown in the Hoover article cited above, additional electrodes may be provided to produce super-power beam tetrodes. Also, the novel filamentary cathode mount may be employed in devices other than super-power beam tubes.

The filamentary cathode may be made of thoriated tungsten rather than a matrix-oxide-coated nickel-based alloy. In addition, the filament may have a size and shape other than those described above. The cathode suspension system may employ suspension means other than V-grooved members and tension means other than the pantographic device-leaf spring combination. Also, means other than offset heads for displacing the longitudinal pulling plane relative to the center-of-gravity of the cathode may be employed.

The fixed support against which the cathode is forced may be an insulating rod or insulator-coated metal member as well as a sapphire pin. It may be disposed other than midway along the length of the cathode and give rise to more than one mechanical resonance frequency. Also, more than one fixed support may be employed; however, such an embodiment may give rise to filament heat-transfer as well as resonance problems.

What is claimed is:

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1. In a filamentary cathode mount comprising a filamentary cathode held in longitudinal tension between two suspension members movable one with respect to the other, the improvement comprising:

- a. a fixed electrically-insulating support in contact with a surface of said cathode intermediate the ends thereof; and
- b. means for displacing the longitudinal pulling plane relative to the center-of-gravity of said cathode, whereby said surface is forced against said support.

2. The filamentary cathode mount of claim 1, wherein said support is disposed midway along the length of said cathode.

3. The filamentary cathode mount of claim 1, wherein said support is a pin made of electrically-insulating material.

4. The filamentary cathode mount of claim 1, wherein said means comprises offset heads at said ends of said cathode.

5. In a filamentary cathode mount comprising a filamentary cathode located within a longitudinal channel and held in longitudinal tension between two suspension members movable one with respect to the other, the improvement comprising:

- a. an electrically-insulating support affixed to said channel, said support being in contact with a surface of said cathode midway along the length thereof; and
- b. means for displacing the longitudinal pulling plane relative to the center-of-gravity of said cathode, whereby said surface is forced against said support.

6. The filamentary cathode mount of claim 5,

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wherein said support is a sapphire pin.

7. The filamentary cathode mount of claim 5, wherein said surface of said cathode faces the base of said channel.

8. The filamentary cathode mount of claim 7, wherein said surface of said cathode is a non-electron-emissive portion thereof.

9. In a filamentary cathode mount comprising a plurality of filamentary cathodes, each cathode being located within a longitudinal channel and held in longitudinal tension between two suspension members movable one with respect to the other, the improvement comprising:

- a. each channel having affixed thereto an electrically-insulating pin in contact with one of said cathodes, intermediate the ends thereof; and
- b. means for displacing the longitudinal pulling plane relative to the center-of-gravity of each cathode, whereby each cathode is forced against one of said pins.

10. In a method of mounting a filamentary cathode comprising the step of placing said cathode in longitudinal tension between two suspension members movable one with respect to the other, the improvement comprising the steps of:

- a. providing a fixed electrically-insulating support to contact a surface of said cathode intermediate the ends thereof; and
- b. displacing the longitudinal pulling plane relative to the center-of-gravity of said cathode, thereby forcing said surface against said support.

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