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CATHODE ASSEMBLY FOR AN ELECTRON TUBE

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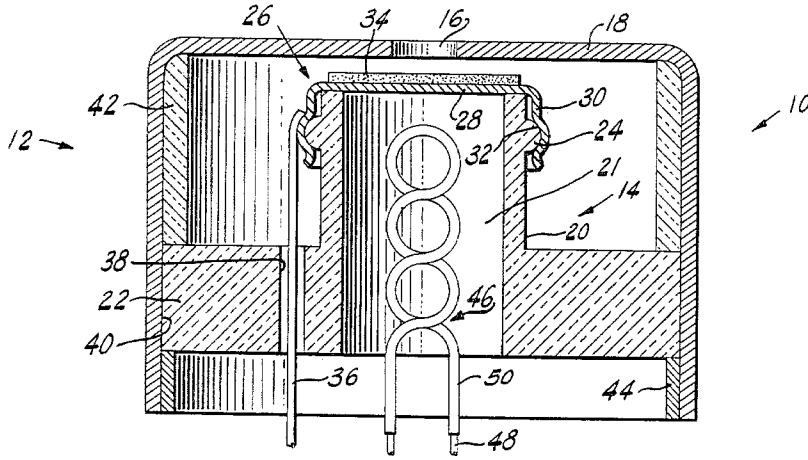


Fig. 1

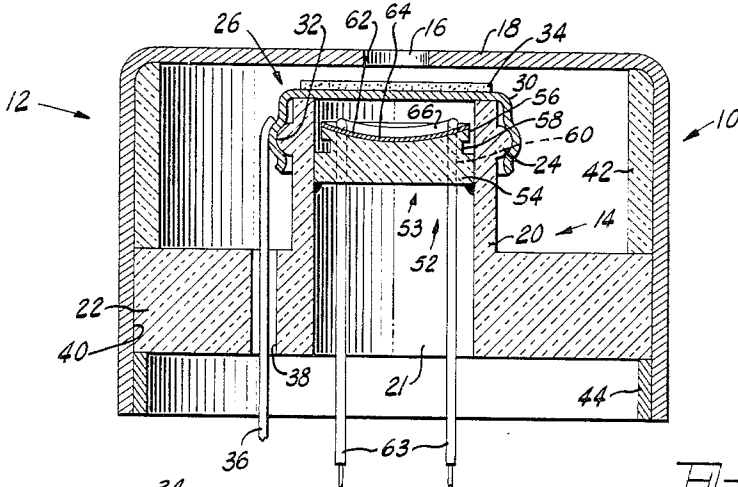


Fig. 2

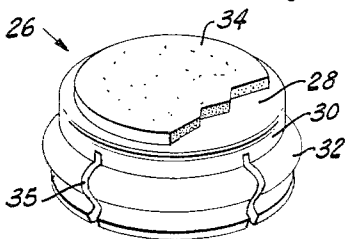


Fig. 3

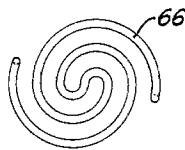


Fig. 4

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CATHODE ASSEMBLY FOR AN ELECTRON TUBE
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This invention relates generally to electron tubes and more particularly to cathode assemblies for use in devices such as cathode ray tubes.

In conventional cathode ray tubes, such as those used in television receivers and instrumental display applications, there is provided an electron gun mounted within the evacuated tube envelope which comprises a heated cathode assembly for emitting a beam of electrons and a plurality of grid electrodes axially aligned therewith formed to provide the control, modulation, focussing, and acceleration of the beam necessary for proper tube operation. In this type of tube the heater-cathode assembly is usually mounted within the control grid which has a substantially cup-shaped configuration. The active cathode portion faces the closed end of the above mentioned grid which is provided with an aperture to permit the passage of a beam of electrons.

The heater-cathode assembly may comprise an electrically insulating mounting wafer provided with a centrally located opening, a hollow electrically conductive cathode support body fabricated from a relatively passive nickel material fixedly mounted in the wafer opening and a cap of relatively more active nickel closing one end of the body and electrically connected thereto. An electron emissive coating is provided on the end of the cap, and an electrically insulated tungsten heater filament is positioned within the body. During tube operation the heater maintains the cathode at a sufficiently high temperature to insure emission of copious quantities of electrons from the coating.

It will be seen from the above description that, while all of the tube components are necessary for the proper operation of the tube, certainly the cathode and its associated heater can be considered of primary importance when considering the life of the tube. Since it is currently possible to provide a cathode with relatively long lasting satisfactory emissive characteristics under appropriate conditions, it is the heater that, for all practical purposes, can presently be considered to be one of the most predominant factors in determining the useful life expectancy of the tube. This is borne out by the fact that heater failure and excessive heater cathode leakage are recognized as two of the most common life problems in cathode ray tube performance. Accordingly, any increase in the useful life of the heater will cause a corresponding increase in the useful life of the tube in a predictable number of instances.

While premature heater failures may result from contributions of a number of factors, such as faulty construction or an overloaded heater circuit when the tube is in operation, of primary concern here is the failure and less effective performance caused by the change in heater material compositions and characteristics and of the level of heater-cathode leakage current, all of which occur to a greater or lesser degree in all cathode ray tubes. Very often these problems are most pronounced when the heater is operated at a positive potential with respect to the cathode. Since the electrical connection to the cathode is made through the nickel support body, the heater has a positive potential relative to the support body surrounding it.

As stated above, the prior art has utilized a relatively passive nickel alloy for the cathode support body. A passive material is one which enters into a reaction at a

lower rate as compared to an active material such as that used in the cathode cap.

However, although the support body is passive, experience has shown that it will emit some electrons and ions when the tube is operated because of the potential field gradients and the high temperatures involved. For a conventional tungsten heater filament having an aluminum oxide insulating coating thereon, this operating temperature may be approximately 1450° K. or higher and the potential gradient may exceed a hundred volts. Accordingly, the electrons and ions flowing from the support body will eventually deposit upon the heater coating and migrate through the porous coating to the heater wire. These migrating ions and electrons combine with the aluminum oxide and tungsten wire to form complex alloys and oxides which cause the wire to change its resistivity and to embrittle and eventually fail. This migration electrically represents heater cathode leakage which is also deleterious to the proper operation of the tube in the circuit. Of course, these undesirable results normally increase as the heater is positioned closer to the support or sleeve. Also, the probability of shorting and arcing between the heater wire and cathode sleeve increases with a decrease in spacing and an increase in the above described phenomena.

It has been suggested that both of these problems can be reduced to some extent by coating the inside of the nickel support body with alumina. However, to minimize leakage currents, the alumina must be extremely pure as even small amounts of impurities therein can be detrimental to the tube operation. This requires very critical processing controls and is expensive and time consuming to accomplish. Further, it is very difficult to uniformly coat the internal surface of the small sleeve or support.

It is, therefore, an object of this invention to reduce premature heater failures and heater cathode shorts in cathode ray tubes and to ruggedize the assembly.

It is another object of this invention to reduce the amount of heater-cathode leakage in an indirectly heated cathode assembly.

A further object is to enhance the life operating characteristics of a thermionic electron tube.

In accordance with these objects, the cathode assembly, according to one aspect of the invention, is provided with an electrically insulating cathode support body having a longitudinal bore and peripheral engaging means formed thereon spaced from one end. Means are provided at the other end of the body and integral therewith for mounting and aligning the assembly in a cup-shaped grid. A metallic cap having an active cathode base portion and a rim is provided to telescope over the one end of the support body and cooperate with the engaging means. The exterior surface of the cap has an electron emissive coating formed thereon and the rim of the cap has an electrically conductive cathode tab attached to it and extending therefrom. An insulated heater element is disposed within the bore and spaced from the cap.

The provision of the improved cathode support substantially reduces heater-cathode leakage, arcing and shorting problems and deleterious heater embrittlement. In addition, the fabrication of the support and mounting means as an integral unit enhances ruggedization and avoids many of the prior necessary assembly steps and coating operations.

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawings in which:

FIG. 1 is a sectional elevational view of an electrode assembly illustrating one embodiment of the invention;

FIG. 2 is a sectional elevational view of an electrode assembly illustrating an additional embodiment of the invention;

FIG. 3 is a perspective view of one type of cap which may be utilized with this invention; and

FIG. 4 is a plan view of the heater illustrated in FIG. 2.

Referring now to the drawings, in FIG. 1 is shown an electrode structure 10 comprising a substantially cup-shaped member 12 and a cathode assembly 14. Member 12 is formed from an electrically conductive material, such as a nickel alloy, and has a centrally located aperture 16 in the closed end 18 thereof. This electrode may serve as the first grid in a cathode ray tube. Cathode assembly 14 comprises an electrically insulating cathode support body 20 provided with a longitudinal bore 21. Mounting and aligning wafer 22 is formed on one end of support body 20 and is integral therewith, and an external annular bead 24 is formed on the opposite end. A metallic cap 26 having a relatively active nickel base portion 28 and an upstanding rim 30 provided with a groove 32 is telescoped over the end of support body 20 opposite wafer 22, in such a manner that the groove 32 engages bead 24. The external surface of base 28 is provided with an electron emissive material 34. To provide ease of assembly rim 30 may be provided with slots 35, as shown in FIG. 3.

An electrically conductive cathode tab 36 is fastened, as by welding, to the rim 30 and projects toward the rear of assembly 14. An opening 38 is provided in wafer 22 to permit tab 36 to extend beyond assembly 14.

Cathode assembly 14 is positioned within member 12 by means of wafer 22 which may have a diameter such that it will provide frictional engagement with the internal wall 40 of member 12. The thickness of wafer 22, when measured along the longitudinal axis of assembly 14, should be sufficient to maintain the axial alignment of the assembly relative to aperture 16 in member 12. The spacing between emissive material 34 and the closed end 18 of member 12 may be provided by conventional means, as by ceramic spacer 42.

The position of assembly 14 may be fixed in member 12 by a metallic ring 44 which can be welded to the internal wall 40. A conventional heater element 46 comprising a tungsten filament 48 having an insulating coating 50 of alumina thereon is positioned within bore 21.

The embodiment of the invention shown in FIG. 1 substantially reduces the amount of heater-cathode leakage, shorting, and heater embrittlement in cathode ray tubes due in substantial part to the reduction in migration of electrons and ions to the heater. Likewise, the incorporation of the mounting wafer as an integral part of the assembly reduces fabrication problems and ruggedizes the tube.

The assembly 10 illustrated in FIG. 2 utilizes a heater element nest assembly designated generally as 52. This assembly comprises an electrically insulating, cylindrical heater support 53 having a lower portion 54 and an upper portion 56 which has a diameter less than that of the lower portion. A circumferential groove 58 may be provided between the upper and lower portions to lengthen any possible sublimation paths. A pair of opposed heater lead receiving apertures 60 is provided in support 53 in the direction of the longitudinal axis thereof. The upper surface of support 53 is formed to provide a substantially concave recess 62 which may have a heat deflecting, metallic coating 64 thereon. A pancake wound, electrically insulated heater 66, of a type shown in plan view in FIG. 4, is positioned in recess 62 with its leads 63 projecting through apertures 60 so that electrical connection may be made thereto.

Nest assembly 52 is positioned in bore 21 so that it is a given distance from cap 26, and may be maintained in this position by any known method, for example, as by

cementing. With this form of heater assembly, the concave recess will direct most of the heat from the heater upwardly toward the cathode, thereby resulting in faster warm-up time.

There has thus been provided by this invention a structure which minimizes the occurrence of heater-cathode problems in a thermionic tube, thereby improving the useful life characteristics of the tube.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modification may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. A cathode assembly for an electron tube employing a heater element and a cathode adapted to operate with a potential difference therebetween, said assembly comprising an electrically insulating cathode support body provided with a longitudinal bore and having an annular bead formed thereon, a metallic cap having an active cathode base portion and a rim formed to telescope over one end of said body and embracingly engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and an upper and lower surface, said upper surface being formed to provide a substantially concave recess having a metallic, heat reflecting coating thereon, and a pancake wound electrically insulated heater having a pair of leads positioned in said concave recess with said leads extending through said receiving apertures.

2. A cathode assembly for an electron tube employing a heater element and a cathode adapted to operate with a potential difference therebetween, said assembly comprising:

an electrically insulating cathode support body provided with a longitudinal bore and having an external annular bead formed thereon, a metallic cap having an active cathode base portion and a rim formed to telescope over one end of said body and embracingly engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and an upper and lower surface, said upper surface being formed to provide a substantially concave recess having a metallic, heat reflecting coating thereon and having a diameter less than that of said lower surface and a pancake wound, electrically insulated heater having a pair of leads positioned in said concave recess with said leads extending through said receiving apertures.

3. A cathode assembly for an electron tube employing a heater element and a cathode adapted to operate with a potential difference therebetween, said assembly comprising:

an electrically insulating cathode support body provided with a longitudinal bore and having an external annular bead formed thereon, a metallic cap having an active cathode base portion and a rim formed to telescope over one end of said body and embracingly engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and an upper and lower surface, said upper surface being formed to provide a substantially

concave recess having a metallic, heat reflecting coating thereon and having a diameter less than that of said lower surface and a groove positioned intermediate said upper and lower surfaces, said groove having a diameter less than said upper surface and a

4. An electrode structure for use in an electron discharge device comprising:

a substantially cup-shaped electrically conductive member having an aperture in the closed end thereof and a cathode assembly employing a heater element and a cathode adapted to operate with a potential difference therebetween mounted interiorly of said member with said cathode spaced from and axially aligned with said aperture, said assembly comprising an electrically insulating cathode support body provided with a longitudinal bore and having an external annular bead formed on said body and spaced from one end thereof, means formed on the other end of said body and integral therewith to provide said mounting and said axial alignment within said cup-shaped member, a metallic cap having an active cathode base portion and a rim formed to telescope over said one end of said body and embracingly engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and an upper and lower surface, said upper surface being formed to provide a substantially concave recess having a metallic, heat reflecting coating thereon, and a pancake wound electrically insulated heater having a pair of leads positioned in said concave recess with said leads extending through said receiving apertures.

5. An electrode structure for use in an electron discharge device comprising:

a substantially cup-shaped electrically conductive member having an aperture in the closed end thereof and a cathode assembly employing a heater element and a cathode adapted to operate with a potential difference therebetween mounted interiorly of said member with said cathode spaced from and axially aligned with said aperture, said assembly comprising an electrically insulating cathode support body provided with a longitudinal bore and having an external annular bead formed on said body and spaced from one end thereof, means formed on the other end of said body and integral therewith to provide said mounting and said axial alignment within said cup-shaped member, a metallic cap having an active cathode base portion and a rim formed to telescope over said one end of said body and embracingly

engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and in upper and lower surface, said upper surface being formed to provide a substantially concave recess having a metallic, heat reflecting coating thereon, and having a diameter less than that of said lower surface, and a pancake wound electrically insulated heater having a pair of leads positioned in said concave recess with said leads extending through said receiving apertures.

6. An electrode structure for use in an electron discharge device comprising:

a substantially cup-shaped electrically conductive member having an aperture in the closed end thereof and a cathode assembly employing a heater element and a cathode adapted to operate with a potential difference therebetween mounted interiorly of said member with said cathode spaced from and axially aligned with said aperture, said assembly comprising an electrically insulating cathode support body provided with a longitudinal bore and having an external annular bead formed on said body and spaced from one end thereof, means formed on the other end of said body and integral therewith to provide said mounting and said axial alignment within said cup-shaped member, a metallic cap having an active cathode base portion and a rim formed to telescope over said one end of said body and embracingly engage said bead, said cathode base portion having an electron emissive material on the exterior surface thereof, and a heater element nest assembly disposed within said bore and spaced from said cap comprising an electrically insulating, substantially cylindrical heater support having heater lead receiving apertures therein and an upper and lower surface, said upper surface being formed to provide a substantially concave recess having a metallic, heat reflecting coating thereon, and having a diameter less than that of said lower surface and a groove positioned intermediate said upper and lower surfaces, said groove having a diameter less than said upper surface and a pancake wound electrically insulated heater having a pair of leads positioned in said concave recess with said leads extending through said receiving apertures.

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