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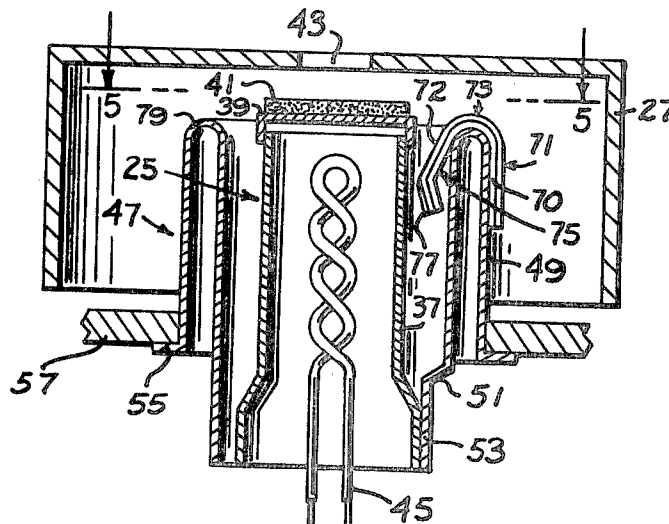
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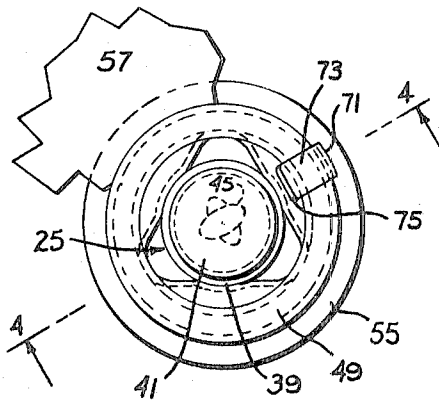
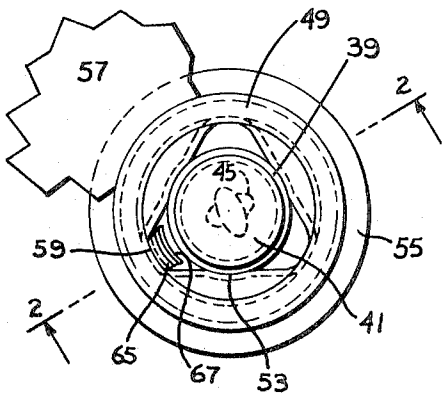
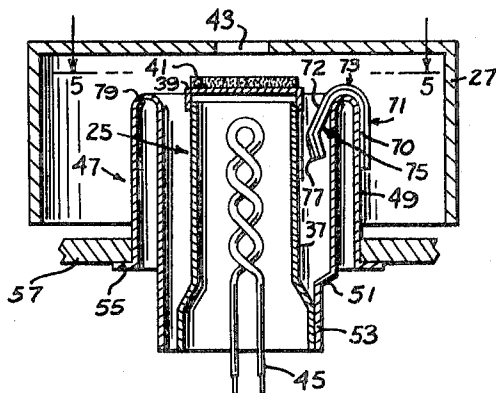
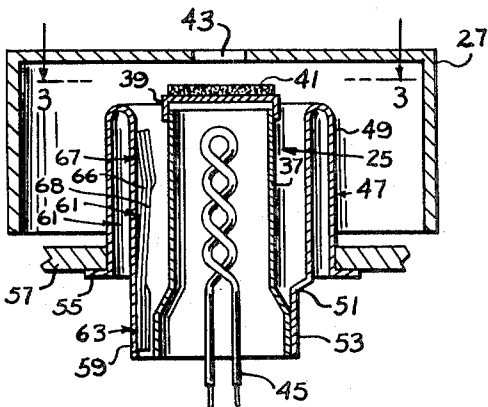
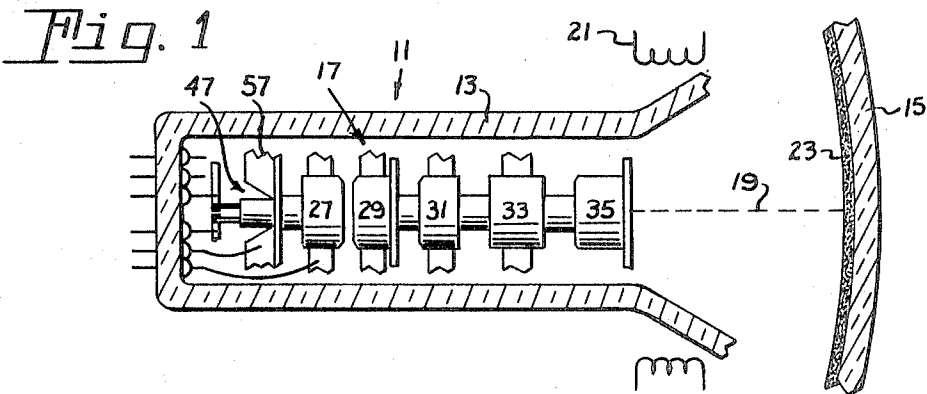
[54] **THERMAL SHUNT FOR A CATHODE STRUCTURE**
10 Claims, 10 Drawing Figs.

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 313/13, 313/82
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 H01j 1/02
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 46, 82, 82 BF, 38, 42, 355; 315/72, 73

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ABSTRACT: Means for regulating the operating temperature of an indirectly heated cathode in an electron discharge device wherein at least one selected bimetallic member is positioned adjacent the cathode in a manner to allow movement of a portion of the member to make thermal conductive contact with the cathode when influenced by increased temperature resultant from high-voltage cathode heater operation to provide a thermal shunt for reducing cathode-operating temperature to a desired level.





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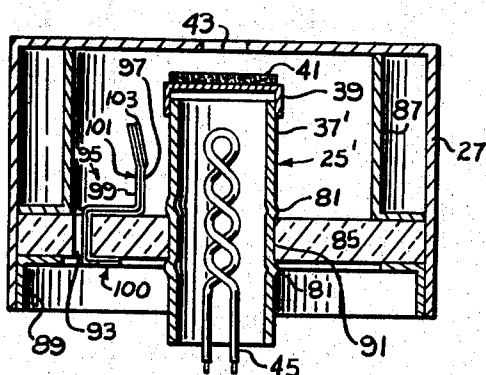


Fig. 6

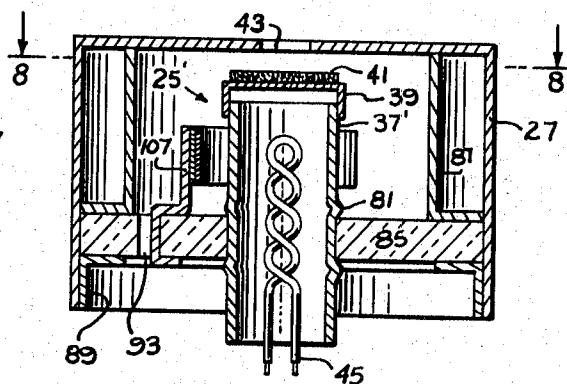


Fig. 7

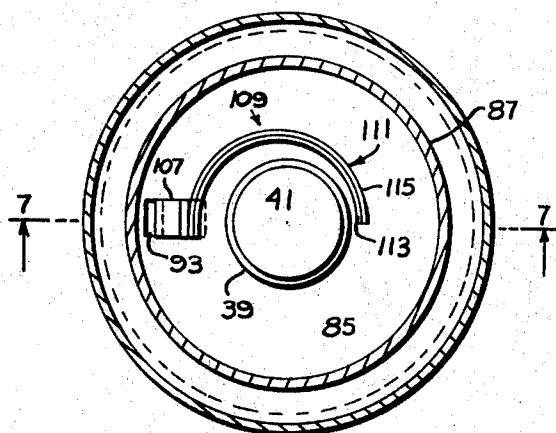


Fig. 8

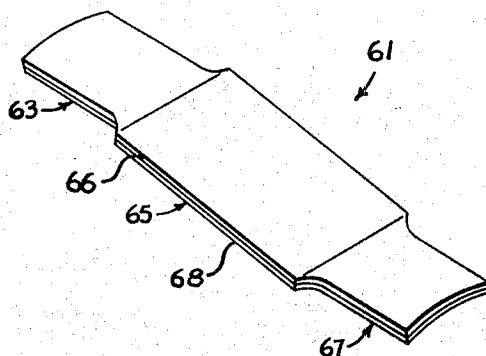


Fig. 9

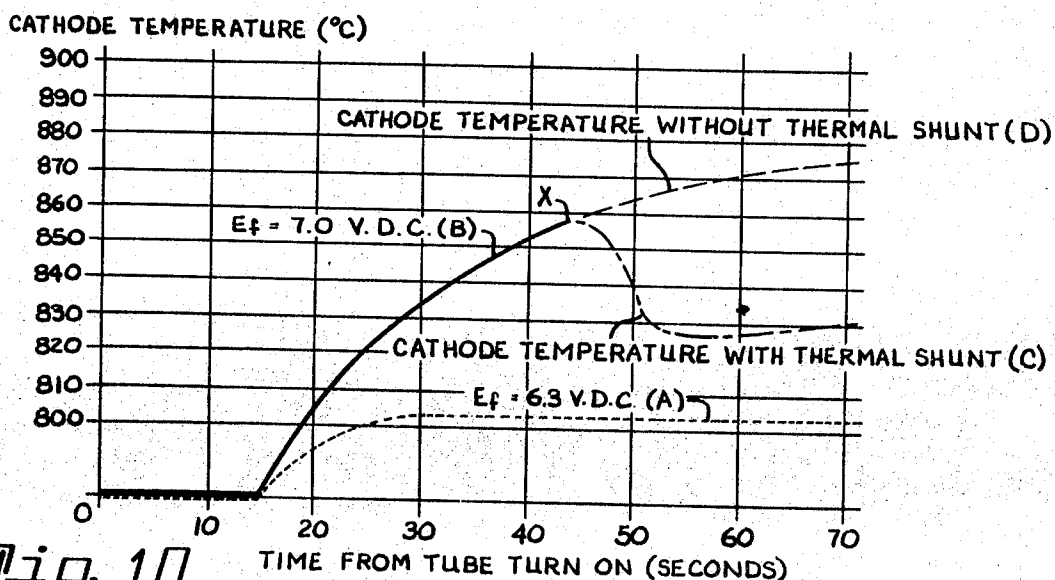


Fig. 10

THERMAL SHUNT FOR A CATHODE STRUCTURE

BACKGROUND OF THE INVENTION

This invention relates to electron discharge devices and more particularly to means for regulating the operating temperature of an indirectly heated cathode in an electron discharge device.

Many electronic devices, for example television sets and similar image display equipment, employ electron discharge devices such as cathode ray tubes which utilize indirectly heated cathodes as sources of electron emission. Certain types of such equipment conventionally obtain primary operational power from nominal 120 v. electrical distribution systems and therefrom provide specific voltages as may be required for the functioning of the several elements comprising the equipment. Many cathode ray tubes utilize cathode heaters rated for 6.3 v. operation which will provide an operating temperature for the electron emissive portion that is within the desired range of 780° to 820° C. When the cathode heaters are operated at or near the designed voltage and temperature conditions, the electron emission from the cathode is of desired life duration. There are occasions when some electrical distribution systems supply higher than nominal line voltage, for instance, in the vicinity of 130 v. which applies about 7.0 v. to the cathode heater. This higher heater voltage in turn raises the cathode temperature to a level that is detrimental to the electron emissive surface under sustained operation, as the higher-than-normal temperature greatly accelerates barium depletion from the emissive material. Thus, acceptable tube life under sustained high line operation is markedly curtailed. This relates to lower quality performance, an increase in the rate of failures, and need for frequent maintenance.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and to provide a cathode ray tube that has improved operational stability and life at both regular and high line voltage conditions. Another object is to provide a tube that has internal temperature regulating means to reduce the operating temperature of the cathode to a desired value when the heater has sustained operation at a voltage higher than rating.

The foregoing objects are achieved in one aspect of the invention by utilizing temperature-regulating means in the form of at least one bimetallic member that is affixed to the cathode support means in a position spaced from the cathode and formed in a manner to allow movement of a portion of the member to make contact with the exterior of the cathode sleeve when influenced by increased temperature resultant from high-voltage cathode heater operation to provide a conductive thermal shunt for reducing the cathode operating temperature to a desired level.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial plan view showing the neck section and screen portion of a cathode ray tube embodying the present invention;

FIGS. 2, 4, 6 and 7 are enlarged sectional views illustrating three embodiments of the invention;

FIGS. 3 and 5 are plan views illustrating two embodiments taken along the lines 3—3 and 5—5 of FIGS. 2 and 4 respectively;

FIG. 8 is a plan view of another embodiment taken along the line 8—8 of FIG. 7;

FIG. 9 is a perspective view of the embodiment utilized in FIG. 2; and

FIG. 10 is a graph illustrating cathode temperature characteristics of cathode ray tubes employing the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

For a better understanding of the present invention, together with other and further objects, advantages and capa-

bilities thereof, reference is made to the following specification and appended claims in connection with the aforesaid drawings.

With reference to FIGS. 1, 2, 3, and 9, there are shown pertinent portions of a cathode ray tube 11 as utilized in producing visual displays such as in conventional television. The tube comprises an envelope of which the neck portion 13 is suitably joined to an oppositely disposed faceplate portion 15 by an intermediate funnel portion which is not shown. Within the neck portion 13 there is positioned an electron gun assembly 17. While only one gun is shown for purposes of clarity, it is not to be considered as limiting as the invention is applicable to an integrated plurality of guns as well. The illustrative electron gun provides the source, acceleration, control and focusing of the electron beam 19 which is deflected by coils 21 to impinge the cathodoluminescent screen 23 lining the interior surface of the faceplate, thereby providing the image display raster according to the signalling supplied to the equipment.

The electron gun structure is a plurality of axially aligned electron-influencing electrodes which are positionally affixed to insulating support rods not shown. Structurally, one type of gun comprises, for example, an electron source or cathode 25 oriented within an apertured control electrode 27, a screen electrode 29, a first anode electrode 31, a focusing electrode 33, and an accelerating electrode 35.

With particular reference to FIG. 2, the cathode 25 comprises a sleeve 37 having a cap 39 terminally affixed thereto. The cap is conventionally made of electron emission promoting material such as nickel or nickel alloy. An electron emissive barium containing material 41 is disposed on the top surface of the cap and positioned in spaced relationship from the aperture 43 in the cup-shaped control electrode 27. An insulated heater 45 is oriented within the cathode sleeve 25 to provide the heat necessary to facilitate electron emission therefrom. The cathode sleeve is supported by being affixed to a compatibly dimensioned portion of a cathode shield or eyelet 47 which is a duodimensioned metallic structure having an overall length shorter than that of the cathode sleeve.

While a dual-wall eyelet is shown, the invention applies to single-wall, cup-shaped eyelets as well. Such shielding structures serve to conserve cathode heat, minimize conductive and radiated heat losses therefrom, and aid in controlling the dissipation of cathode sublimation. Structurally, the cathode shield 47, as shown, has an upper cylindrical upstanding portion 49 having an internal diametric dimension sufficient to provide encompassment of the cathode 27 in a manner to provide a substantially uniform spacing therebetween. Integrally formed in the wall of the lower portion 51 of the shield are three equispaced support lands 53 inwardly embossed to provide limited contact bonding of the cathode thereat to further minimize cathode conductive heat losses and effect rigidity to the cathode shield assembly. The shield eyelet has a seating portion 55 which is affixed to cathode assembly support means 57. With particular reference to FIG. 2 and 3, in shaping the lower portion 51 of the shield in a substantially triangular manner to form the above-mentioned support lands 53, there are three spaced-apart regions formed one in each apex 59 of the triangular shaping, whereat the cathode sleeve is spaced from the lower portion of the eyelet.

One embodiment of a temperature-regulating means illustrated in FIG. 2, 3 and 9, is in the form of at least one substantially longitudinal bimetallic member 61 of laminated high and low expansion materials having a basal end 63, an intermediate portion 65 and a terminal end 67. The member is fabricated of laminated strip material whereof the low expansion side 68 is oriented proximal to the cathode with the high expansion side 66 distal thereto. The basal end is substantially formed to mate with the apex shaping 59 in the lower portion of the shield whereat it is firmly affixed as by welding. By such orientation, the temperature-regulating member 61 is spaced from the cathode but is in a position to allow flexural movement of substantially the intermediate portion 65 to effect contact of the member terminal end 67 with the exterior sur-

face of the cathode sleeve when influenced by the increased temperature resultant from high-voltage heater operation. The terminal end 67 is shaped to substantially conform to the arcuate form of the cathode thereby providing area contact to effect a conductive thermal shunt for reducing the operating temperature of the cathode to a desired level. Because of the shapings of the basal and terminal ends, little flexural movement is evidenced in these portions. With this embodiment, from one to three temperature-regulating members can be accommodated in the formed apices of the lower portion of the shield.

Another embodiment of the invention is shown in FIG. 4 and 5 wherein the bimetallic temperature-regulating means is in the form of a substantially U-shaped member 69 of laminated high and low expansion materials having a basal leg 71, an intermediate section 73, and a terminal leg 75 with a formed terminal end 77 thereon. The U-shaped member is oriented in an inverted position on the top rim 79 of the shield with the basal leg 71 affixed to the outer surface of the upper portion of the shield 49. The terminal leg 75 is positioned in a manner spaced from the cathode sleeve but having freedom of movement to effect contact of the formed terminal end with the exterior surface of the cathode sleeve when influenced by the increased temperature resultant from high-voltage heater operation. The formed terminal end 77 is shaped to substantially conform to the cathode to provide area contact and effect a conductive thermal shunt. This temperature-regulating means is likewise formed of laminated high and low expansion materials whereof the low expansion side 72 forms the outer surface of the U and the high expansion side 70 forms the inner surface thereof. The low expansion side is proximal to the cathode. The U-shaped member may be positioned on any portion of the rim of the shield. The number to be utilized is determined by the thermal-shunting effect desired and the space available for placement of the individual members.

Still another embodiment is illustrated in FIG. 6 wherein the cathode 25' comprises a capped cathode sleeve 37' which is positioned, as by crimping 81, in suitable cathode support means as, for example, an insulative support member 85. Such support member is oriented within the control electrode 27 by spacing and retaining members 87 and 89 respectively. The insulative support member 85 has, in addition to the cathode aperture 91, at least one other aperture 93 suitably formed to accommodate a formed bimetallic temperature-regulating member 95. This bimetallic member is formed of laminated high and low expansion materials whereof the low expansion side 97 is proximal to the cathode 25' with the high expansion side 99 being distal thereto. The member 95 is attached to the insulative support member, as by crimping, with the low expansion side being formed in a contiguous manner against the top and bottom surfaces of the support member to effect tightening thereagainst by thermally induced flexure of the crimped portion 100. Flexure of substantially the intermediate portion 101 effects movement of the formed end portion 103 to make contact with the exterior surface of the cathode when influenced by the increased temperature resultant from high-voltage heater operation.

Another embodiment is shown in FIG. 7 and 8 wherein the cathode 25' is supported within the control electrode 27 in a manner similar to that described for the embodiment illustrated in FIG. 6. The insulative support member 85 has at least one aperture 93 wherein there is affixed a vertical support 107 such as a metallic member suitably crimped to effect firm attachment. To this vertical member there is bonded a temperature regulating member 109 in the form of a strip of bimetallic material which is substantially arcuately formed to have an extremal portion 111 partially encircling the cathode sleeve in a spaced manner. This bimetallic member is likewise formed of laminated high and low expansion materials whereof the low expansion side 113 is proximal to the cathode 27' and the high expansion side 115 distal thereto. When thermally influenced, this arcuately formed bimetallic member 109 moves toward the cathode in a manner that the extremal portion

111 makes contact with the exterior of the sleeve in a wrapping manner to effect a thermal-shunting thereby reducing the temperature of the cathode to a desired value.

Bimetal material suitable for use in the temperature regulating means may, for example, be a lamination of a nickel-iron low expansion alloy joined with a nickel-chromium-steel high expansion alloy. Materials having desired conductivity are chosen to provide a proper combination of temperature and deflection characteristics. The low expansion to high expansion material thickness ratios are substantially in the range of 1:1 to 3:1. An example of a suitable bimetal for functioning in substantially the 825°-875° C. range is No. 3,600 thermostatic bimetal as manufactured by The W. M. Chace Company, Detroit, Michigan.

Two or more of the several described embodiments of the temperature regulating members may be employed in combination relative to a single cathode. A plurality of the several embodiments can be fabricated of different bimetallic materials to introduce thermal-shunting at more than one temperature step.

There may be occasions in certain types of equipment, utilizing noise-sensitive circuitry, wherein the contact of the bimetallic member with the sleeve might introduce a noise voltage in the video or audio circuits. To meet the needs of such circuitry, a coating of an insulative material having high thermal conductivity, such as beryllium oxide, is applied to the cathode-contacting surface of the member or to the area of contact on the sleeve to effect heat loss without noise voltage being generated.

The effects of the aforedescribed thermal conductive shunts are graphically illustrated in FIG. 10 wherein cathode temperature versus Ef and tube operating time is presented. Curve "A", portrayed by a dotted line, shows typical cathode temperature evolution at a conventional heater voltage of 6.3 V. In approximately 30 seconds from tube turn on, the temperature of the cathode has reached a level of approximately 805° C. Sustained tube operation at this desired approximate temperature level will yield satisfactory tube performance both from length of service and quality of output. When the heater voltage is raised to substantially Ef 7.0 v. as, for example, by a higher than normal supply line voltage, the temperature of the cathode rises in a manner shown by the solid line of curve "B". After about 45 seconds of operation, the cathode temperature has increased to approximately 855° C. The heat radiating from the sleeve is sufficient to effect flexure of the bimetallic member bringing it into contact with the cathode. This is indicated at point "X" where the thermal shunt effect between the sleeve and the lower temperature shield is introduced causing a heat sink reaction which results in lowering the operating temperature of the cathode as illustrated by the dot-dash line of curve "C". Without the benefit of the temperature reducing member, the cathode temperature at a heater voltage of Ef 7.0 v. would continue rising beyond point "X" as shown by the continuation dash line of curve "D". Sustained cathode operation in the vicinity of 880° C. has a highly deleterious effect on cathode electron emission by greatly accelerating the loss of active barium emitter through rapid evaporation, thereby markedly reducing the operational lifespan of the tube.

Thus, there is provided an inexpensive, automatic thermally activated cathode temperature regulating means which, at overvoltage heater operation, effectively reduces the cathode temperature and thereby markedly increases the emission lifespan for cathodes of electron discharge devices including cathode ray tubes in particular.

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

1. An indirectly heated cathode structure in an electron gun of a cathode ray tube oriented relative to an associated control grid electrode and having means for regulating the tempera-

ture of the cathode electron emissive material when subjected to high-voltage heater operation comprising:

a cathode sleeve with a heater insulatively positioned therein and electron emissive material disposed on a discrete portion of the exterior thereof relative to said associated electrode;

cathode support means formed to insulatively and spacedly position said cathode sleeve relative to said associated control grid electrode; and

temperature-regulating means in the form of at least one bimetallic member of high and low expansion materials affixed to said support means and spaced adjacent to said cathode sleeve with the low expansion material proximal thereto, said bimetallic member being formed in a manner to allow movement of a portion of said member to make contact with the exterior surface of said sleeve when influenced by the increased temperature resultant from high-voltage cathode heater operation, said bimetallic member having a free terminal portion shaped to substantially conform to the arcuate form of the cathode sleeve to provide area contact therewith to effect a conductive thermal shunt for reducing the operating temperature of said cathode to a desired level whereupon said bimetallic member responds to break said area contact with said sleeve.

2. An indirectly heated cathode structure according to claim 1 wherein said support means is an insulative member having at least one aperture therein for accommodating said cathode sleeve, and wherein said supporting member contains means to effect affixation of said bimetallic temperature-regulating member thereto.

3. An indirectly heated cathode structure according to claim 2 wherein said bimetallic temperature regulating member is bonded to a substantially upstanding support affixed to said insulative member, said bimetallic temperature-regulating member being substantially arcuately formed with the low expansion material thereof being proximal to but spaced from said sleeve in a manner to allow movement of said regulating member to make substantially wrapping contact with a portion of the exterior surface of said sleeve when thermally influenced.

4. An indirectly heated cathode structure according to claim 1 wherein a coating of an insulative material having high thermal conductivity is applied to the contact surface of said bimetallic member at the area of contact with said sleeve to prevent the generation of noise voltage thereat.

5. An indirectly heated cathode structure according to claim 1 wherein a coating of an insulative material having high thermal conductivity is applied to the contact surface on said sleeve at the area of contact with said bimetallic member to prevent the generation of noise voltage thereat.

6. An indirectly heated cathode structure according to claim 2 wherein said shaped terminal portion of said bimetallic member makes predetermined contact with said cathode sleeve at an area substantially proximal to the emissive portion thereof.

7. An indirectly heated cathode ray tube cathode structure oriented relative to the apertured control grid electrode of an electron gun and having means for regulating the temperature

of the cathode electron emissive material when subjected to high-voltage heater operation comprising:

a cathode sleeve with a heater insulatively positioned therein and electron emissive material disposed on a discrete portion of the exterior surface thereof relative to the aperture of said first grid;

a cathode shield formed to spacedly encompass and support said cathode sleeve, said shield having a plurality of spaced cathode sleeve affixation provisions formed in the lower portion thereof to facilitate limited contact between the lower end of said sleeve and said shield to provide a cathode assembly;

cathode assembly support means formed to insulatively and spacedly position said shield and attached cathode sleeve relative to said control grid electrode; and

temperature-regulating means in the form of at least one laminated bimetallic member of high and low differentially expansive materials having a basal end affixed to said cathode shield in a manner spaced from said cathode but in a position to allow movement of an intermediate portion of said bimetallic member to effect contact of the member terminal portion with a portion of the exterior surface of said sleeve when influenced by the increased temperature resultant from high-voltage heater operation, said member terminal portion being shaped to substantially conform to the arcuate form of the cathode sleeve to provide substantial area contact therewith to effect a conductive thermal shunt for reducing the operating temperature of said cathode to a desired level whereupon said bimetallic member responds to break area contact with said sleeve.

8. An indirectly heated cathode ray tube cathode structure according to claim 7 wherein said bimetallic temperature regulating means in a formed substantially longitudinal member, the basal end of which is affixed to the lower portion of said shield in spaced relationship to the sleeve, said bimetallic member being of laminated strip material whereof the low expansion side faces the cathode sleeve.

9. An indirectly heated cathode ray tube structure according to claim 7 wherein said bimetallic temperature-regulating means is a formed substantially U-shaped member having a basal leg, an intermediate section and a terminal leg with a formed terminal end, said U-shaped member being oriented in an inverted position over the top rim of said shield with said basal leg of the U affixed to the outer surface of the upper portion of the shield, said terminal leg of the U being free to move within the space between said shield and said sleeve to effect contact of the formed terminal end with the exterior of said sleeve when influenced by the increased temperature resultant from high-voltage heater operation, said U-shaped bimetallic member being of laminated strip material having high and low expansion portions whereof the low expansion side forms the outer portion of the U.

10. An indirectly heated cathode ray tube cathode structure according to claim 7 wherein said shaped bimetallic member terminal portion makes predetermined contact with said cathode sleeve at an area substantially proximal to the emissive portion thereof.

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