

[54] MEANS FOR POSITIONING A HEATING ELEMENT WITH A THERMIONIC CATHODE STRUCTURE

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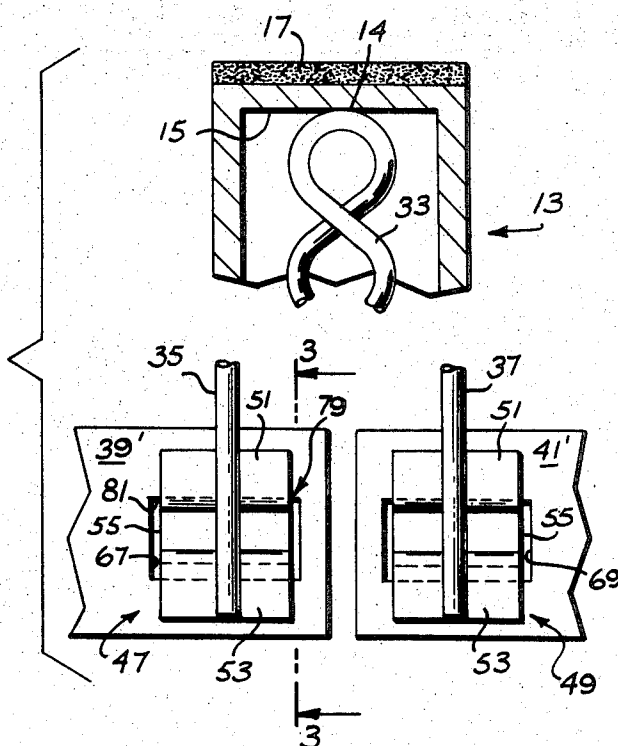
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ABSTRACT

This relates to means for effecting positive and sustained positioning of a heating element within an end-emissive cathode structure for utilization in a cathode ray tube electron gun. The orientation means is in the form of at least one heater positioning device located between a fixed heater support means and a connective extremity of the cathode heating element. The heater positioning device is formed of a bilaminate metallic material of predetermined flexure performance shaped to have an upper attachment portion at one end and a lower attachment portion at the opposite end thereof with an acutely curved bend of bilaminate strip forming a partial loop of the material therebetween. Such bilaminate material comprises a first lamina of an active metallic alloy contiguously bonded along a common interface to a second lamina of a passive alloy material. The active alloy portion, upon being subjected to a predetermined temperature during tube processing, undergoes a metallurgical phase transformation effecting a volume change therein. The definite modification of the shaping of the positioning device thus effected exerts positive and sustained positioning of the heater element within the cathode structure in a manner to provide uniform spacing between the end of the heating element and the closure portion of the cathode.

14 Claims, 11 Drawing Figures

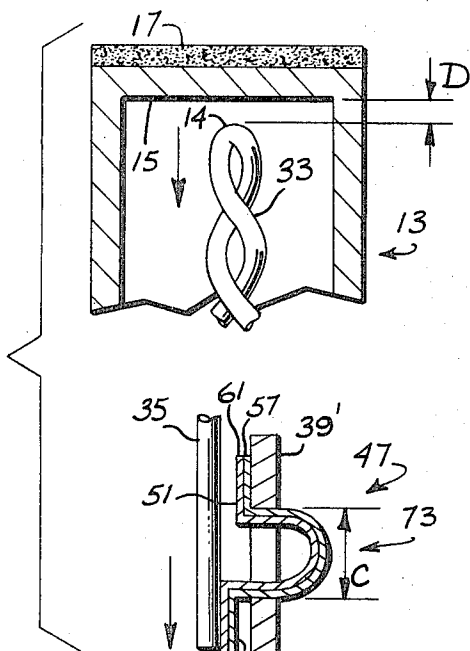


Fig. 4

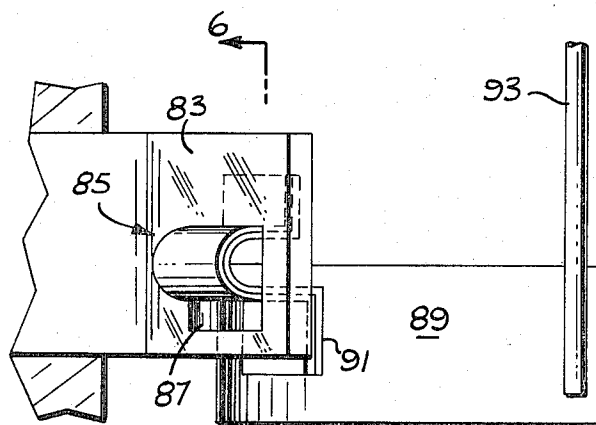


Fig. 5

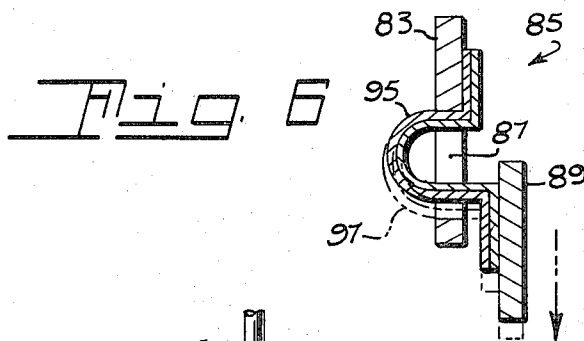


Fig. 6

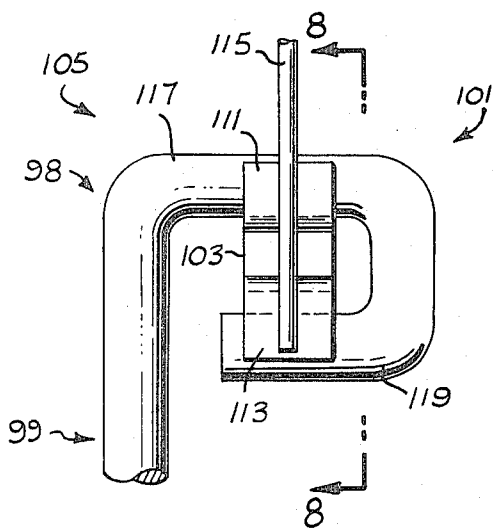


Fig. 7

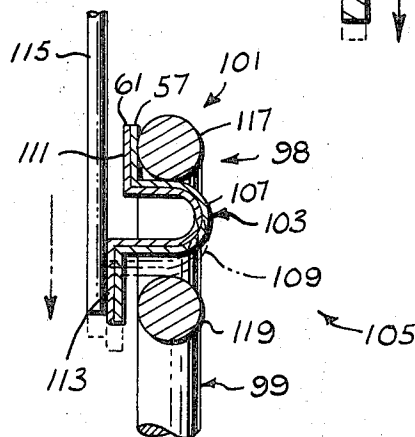


Fig. 8

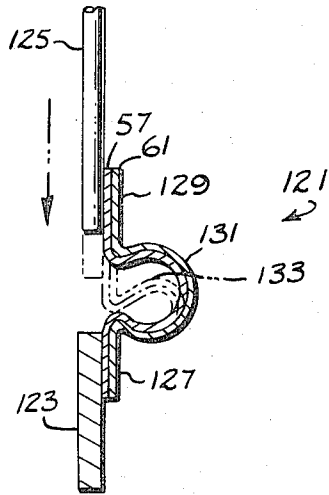


Fig. 9

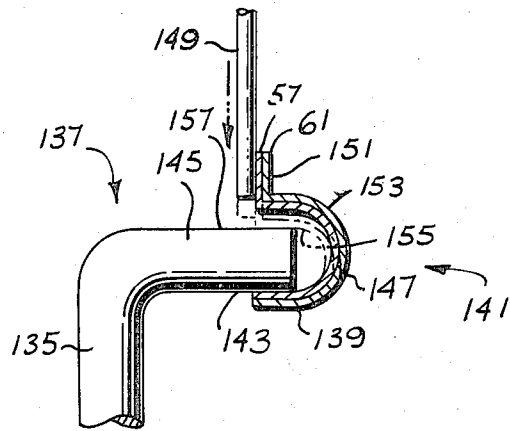


Fig. 10

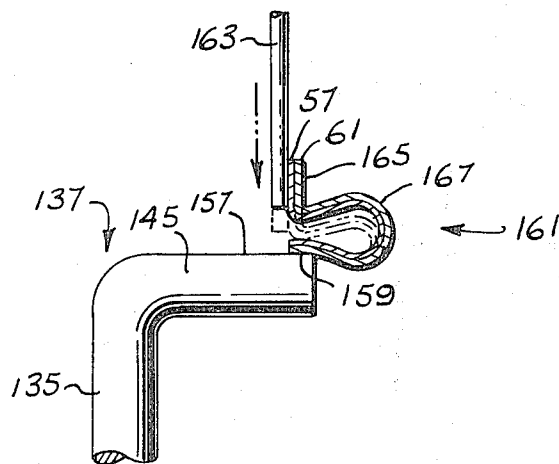


Fig. 11

MEANS FOR POSITIONING A HEATING ELEMENT WITH A THERMIONIC CATHODE STRUCTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

The bilaminate material and representative alloys, utilized in the structural concepts of this invention, are the subject of separate co-pending patent applications: Ser. No. 206,124, filed Dec. 8, 1971, now U.S. Pat. No. 3,743,485 and a continuation-in-part application Ser. No. 373,400, filed June 25, 1973, by Arnold J. Gottlieb, and George A. Majesko and assigned to the Wilbur B. Driver Company, Newark, New Jersey, which is a subsidiary of the assignee of the present invention.

BACKGROUND OF THE INVENTION

This invention relates to means for positioning a heating element within a thermionic cathode structure and more particularly to means for effecting positive positioning of a heating element within an end-emissive tubular cathode structure as employed in a cathode ray tube electron gun.

In end-emitting cathode structures as conventionally utilized in cathode ray tube electron guns, the spacing between the terminal end of the cathode heating element and the interior surface of the end closure portion of the tubular cathode is of important significance. The heating element will measurably elongate within the tubular cathode due to the heat encountered during tube processing and subsequent operation. For example, the heating element when turned on may reach operating temperature in approximately 10 seconds, and may elongate in the order of 4 mils. Typically, the cathode per se may reach operating temperature in approximately 30 seconds and elongate in the order of 5 mils. Therefore, unless the heating element is initially spaced at least approximately 4 to 5 mils from the interior surface of the closure it will jam against the enclosure soon after turn-on. Such jamming resulting from multiple on-off switchings may cause the heater coating to crack, chip, abrade or otherwise wear away at the point of contact with the cathode surface, thus promoting heater-cathode leakage and shorts and thereby reducing the useful operating life of the tube. In addition, if there is insufficient spacing between the end of the heating element and the cathode closure surface, the heater may jam against the planar closure with sufficient force to cause the closure to bow outward thereby changing the cathode-to-grid electrode spacing and consequently the tube operating cut-off voltage. Furthermore, the resultant bow in the end-surface of the cathode closure may be of a degree to loosen the emissive coating thereon causing it to chip or flake off thereby deleteriously affecting the critical emission life of the cathode ray tube.

Conventionally, in the current state of the art, spacing between the heating element and the end-emissive surface of the cathode is achieved to a marked degree by human judgment. Usually an operator inserts the heating element into the cathode, welds the heater element attachment portions to the related supporting brackets or appropriate stem leads, and then pulls the heater out of the cathode a slight desired amount in the order of 5 or more mils to effect end-spacing therebetween, by bending the leads or support brackets ac-

cordingly. While the experienced operator attains a degree of proficiency in this exacting procedure, the technique is a haphazard one and may result in too great a spacing to adversely affect heater-to-cathode heat transfer or too little spacing to aggravate jamming of the heating element against the cathode surface.

This type of adjustment is prone to the inexactitudes of human judgment. Thus, the heater-to-cathode spacing may vary considerably especially when a number of operators are involved in the assembly operation.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and to provide an improved means for effecting predetermined positive positioning of the cathode heating element within the cathode structure. Another object is to provide positive and sustained positioning of the heater element within the cathode while achieving substantially uniform spacing therebetween by means minimizing the factor of human judgment.

These and other objects and advantages are achieved in one aspect of the invention by providing means for positioning the heater element within the cathode wherein at least one heater positioning device is affixed between fixed heater support means and the connective extremities of the cathode heating element. The heater positioning means is formed of a bilaminate metallic material of predetermined flexure performance shaped to have an upper attachment portion of one end thereof and a lower attachment portion at the opposite end with an acutely curved bend of bilaminate strip forming a partial loop of the material therebetween.

The bilaminate material of said device comprises a first lamina of active alloy material contiguously bonded along a common interface to a second lamina of a passive alloy material. The active lamina portion of the material undergoes a metallurgical phase transformation at a predetermined temperature during tube processing to effect a change in shape thereby modifying the bilaminate means which imparts a positional movement to the heating element within the cathode thereby effecting positive and sustained orientation of the heating element therein. The contractive movement thus attained by the positioning means provides substantially uniform spacing between the end of the heating element and the related cathode surface.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a prior art plan view of that portion of a cathode ray tube electron gun wherein the invention is concerned;

FIG. 2 is an enlarged partial plan view illustrating the initial relationship of the heating element to the end of the cathode and initially showing the distally related cathode heating element positioning devices of the invention;

FIG. 3 is a sectional view of the cathode heating element positioning device taken along the line 3-3 of FIG. 2;

FIG. 4 is an enlarged partial view delineating the secondary shaping of said heater element positioning device and the resultant spacing thereby obtained between the heating element and the end of the cathode;

FIG. 5 is an enlarged view of one embodiment of the invention wherein a conductive bracket member is

bonded to the lower attachment portion of the positioning device;

FIG. 6 is a sectional view of the positioning device taken along the line 6—6 of FIG. 5;

FIG. 7 is another embodiment of the invention wherein the partial loop formation of the positioning device is oriented within a compatible terminal shaping of a rod-like support member;

FIG. 8 is a sectional view of the device taken along the line 8—8 of FIG. 7; and

FIGS. 9, 10, and 11 are additional embodiments of the invention wherein the partial loop of the positioning device is fabricated to exert a closing action upon metallurgical phase transformation of the active material.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

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

With reference to the drawings, there is shown in FIG. 1 the electron generating portion 11 of a prior art cathode ray tube electron gun. The partially illustrated electron gun structure is comprised of at least one thermionic end-emissive tubular cathode 13 having a closed terminal end 15 with electron-emissive material 17 disposed on the exterior surface thereof. The open end of the cathode 19 is inserted into and affixed to a compatibly dimensioned portion of a cathode shielding eyelet 21. The cathode assembly thus formed is supported by locative means 23 embedded in longitudinal beads or insulative support members 25 of which only two are shown for clarity of illustration. Other electrode components of the gun structure are similarly supported and affixed to the longitudinal support members in spaced axial alignment by use of support straps 27 embedded therein according to recognized prior art procedures. The end-emissive tubular cathode 13 functions to generate a beam of electrons 29 which is modulated by the related control grid 31 whereupon the electron beam is further accelerated and focused by a plurality of sequentially oriented grid elements not shown. An insulated thermionic cathode heating element 33 is suitably disposed within the end-emissive tubular cathode 13, being positioned through the open end 19 thereof. As illustrated, the conventional cathode heating element has two separate connective extremities, 35 and 37 respectively, projecting from the cathode forming supportive connections which are affixed to respective individual strap-like support members 39 and 41, which in turn have suitably formed portions 63 and 65 embedded in the longitudinal insulative support beads 25. According to the prior state of the art, the assembly operator makes a slight downward positional adjustment of the support members 39 and 41 thus slightly withdrawing the terminal end of the heating element from the closure surface of the cathode to provide the necessary spacing therebetween.

For a description of an exemplary embodiment of the invention, reference is made to FIGS. 2, 3, and 4 of the drawings. The invention relates to means for positioning a cathode heating element 33 within an end-emissive tubular cathode 13 in a manner to effect predetermined spacing between the end of the heating ele-

ment 14 and the closure surface of the cathode 15. To achieve this advantageous uniformity of spacing, the two separate connective extremities 35 and 37 of the heating element 33 are affixed to a pair of like heating element positioning devices, 47 and 49 respectively, that are in turn attached to the separate and fixed heater support means 39' and 41'. Each of the positioning devices is a structure formed of a continuous strip of bilaminate metallic material 50 of predetermined flexure performance, the material being shaped to have an upper attachment portion 51 at one end and a lower attachment portion 53 at the opposite end thereof with an acutely curved bend of bilaminate strip forming a partial loop of material 55 therebetween. Each of these positioning devices has one of its attachment portions affixed to a respective connective extremity 35 or 37 of the heating element 33 with the other attachment portion of the device being attached to a respective one of the fixed heater support means. The strip of bilaminate material 50 comprising each device is formed of a first lamina 57 of active alloy material which is contiguously metallurgically bonded along a common interface 59 to a second lamina 61 of a passive alloy material. The active alloy material is of a composition that upon being subjected to a predetermined temperature undergoes a metallurgical phase transformation which effects a volume change therein. The passive material is of a composition that remains in a substantially stable single metallurgical phase state throughout the temperature range wherein the aforementioned predetermined temperature is included. The predetermined temperature level at which the metallurgical phase transformation takes place is above any of the temperatures encountered by the bilaminate material 50 during fabrication and forming of the heater positioning device and subsequent assembly, and incorporation of the formed device into the electron gun structure, but is of a thermal level encountered during subsequent tube processing. The bilaminate material and the representative alloys comprising the same are the subject of a separate patent application, Ser. No. 206,124, filed Dec. 8, 1971, and a continuation-in-part patent application, Ser. No. 373,400, filed June 25, 1973, by Arnold J. Gottlieb and George A. Majesko and assigned to the Wilber B. Driver Company, Newark, New Jersey, which is a subsidiary of the assignee of the present invention. These patent applications disclose bilaminate materials for utilization in existing structures wherein the characteristics of the materials provide improved results thereof. In the present application, the generic bilaminate material of application Ser. No. 206,124 is put to new usage in newly designed cathode heating element positioning devices for usage in cathode ray tube electron gun structures to provide results heretofore unattained.

The bilaminate heater positioning devices of the invention are initially formed to have a defined primary shape per se prior to being incorporated into the electron gun structure. This primary shaping is retained by each of the positioners during the electron gun assembly procedure, but upon being subjected to the phase transformation temperature during tube processing, the change in phase of the active lamina material modifies the shape of the bilaminate positioning device to form a secondary structural shape thereof. This change in shape imparts a positional movement to each of the connective extremities of the heating element which retracts the end 14 of the heating element from the end

closure portion 15 of the cathode thereby effecting a positive and sustained location of the heating element within the cathode 13. The amount of retractive movement of the device is regulated by stop means associated with each of the positioning devices so that determinate positioning of the heating element is uniformly achieved. The embodiment of the heater positioning devices 47 and 49 as shown in FIGS. 2, 3, and 4 has the active material lamina portion 57 of the bilaminate material 50 oriented to be the other lamina of the loop formation of the bilaminate structure. Such orientation of the active lamina provides an opening action of the partial loop of the device upon phase transformation of the material.

The heater support means 39' and 41' are a plurality of fixed individual strap-like members each having supportive portions similar to those shown in FIG. 1 and denoted as 63 and 65, such being embedded in the longitudinal insulative support members of the electron gun structure in a manner that the plane of the heater support means 39' is substantially in a plane parallel with that of the heater connective means 35. Each of the strap-like support members has an aperture therein 67 and 69 fashioned to accommodate substantially the partial loop portion 55 of the heater positioning device. With particular reference to FIGS. 3 and 4, this aperture is dimensioned larger than the primary shaping 71 of the partial loop portion 55 to provide stop means for the secondary structural shaping 73 thereof which is resultant from the phase transformation of the active material. In the present embodiment, the active material lamina 57 of the device is proximal to the strap-like support member 39' with the upper attachment portion 51 of the device being affixed thereto. The respective heater element connective extremity 35 is bonded to the lower attachment portion 53 of the positioning device. In FIG. 3, the primary dimension of the partial loop 55 of the positioning device is indicated by A, the tolerance dimension B is the measure of the distance between the lower side 75 of the loop and the bottom wall 77 of the aperture and delineates the allowable amount of movement of the device as provided by the stop means of the aperture. For example, this spacing may be in the order of 5 or more mils.

In assembling the device into the electron gun structure, the loop portion 55 of the device is positioned within the defined aperture 67 and the upper attachment portion 51 bonded to the heater support member 39' with the upper side 79 of the loop abutting the top wall 81 of the aperture; both devices of the pair being similarly mounted. The operator then inserts the cathode heating element 33 within the open end 19 of the tubular cathode in a manner that the terminal end 14 of the heating element touches the closure portion 15 of the cathode, whereupon the tube connective extremities 35 and 37 are welded to the lower attachment portions of the respective positioning devices. FIG. 4 illustrates the secondary shaping 73 of the positioning device after it has been subjected to the phase transformation temperature; the expanded dimensioning of the loop being referenced as C. The secondary shaping of the loop utilizes the stop aspect of the aperture, whereupon the terminal end 14 of the heating element is retracted from the end closure of the cathode to provide the desired spacing D therebetween.

Another embodiment of the invention is illustrated in FIGS. 5 and 6 wherein a short support member 83 has

a positioning device 85 accommodated in an aperture 87 therein similar to that described in the aforementioned embodiment. A conductive bracket member 89 is bonded to the lower attachment portion 91 of the positioning device and extended therefrom to the region relative to the open end of said cathode whereat a connective extremity 93 of a respective heating element is affixed. In this embodiment the conductive bracket member 89 can be extended to accommodate a connective extremity from each of two respective heating elements as in a series connection arrangement. In FIG. 6 the primary shaping 95 of a positioning device 85 is delineated with the secondary shaping 97 phantom therein to show the downward movement of the conductive bracket member 89.

A further embodiment of the invention, shown in FIGS. 7 and 8, is utilized when the electron gun structure employs heater support means that are in the form of a plurality of rod-like members 99 extending from an associated supportive stem closure member, not shown, and spacedly oriented relative to the open end of the cathode, not shown. Each of these rod-like stem leads or support members 99 has a terminal portion formed to provide a substantially P-shaped terminal structure. The opening in the P-shaped termination is formed to substantially accommodate the partial loop portion 103 of the heating element positioning device 105, and is formed to be dimensionally larger than the primary shaping 107 of the partial loop of the device to provide stop means for the secondary structural shaping 109 of the device. The active lamina portion 57 of the bilaminate material 50 is oriented proximal to the rod-like support member 99 with the upper attachment portion 111 of the positioning device being affixed thereto, while the lower attachment portion 113 accommodates jointure with the heating element connective extremity. In FIG. 8, the stop means afforded by the upper and lower horizontal portions, 117 and 119 respectively, of the P-shaped formation are shown relative to the respective primary 107 and phantom secondary 109 shapings of the positioning device 105.

Other embodiments of the cathode heating element positioning means are delineated in FIGS. 9, 10, and 11. In these embodiments of the invention, the partial loop of a positioning device is fabricated to exert a closing action upon metallurgical phase transformation of the active lamina material. In each of the positioning devices shown in the beforementioned figures, the active material lamina portion of the bilaminate heater positioning device is oriented to be the inner lamina of the partial loop formation thereof.

With reference to FIG. 9, the illustrated embodiment of the positioning device 121 is particularly adaptable for usage in an electron gun structure employing a plurality of longitudinal insulative support members utilized to integrate the structural components thereof. Such a structure has been previously described in this specification wherein the heater support means are a plurality of fixed individual strap-like members 123 embedded in respective longitudinal support members, not shown, in a manner that the plane of the heater support means 123 is substantially in a plane parallel to that of the heater connective extremity 125. As illustrated the lower attachment portion 127 of the device is affixed to one of the fixed strap-like support members 123 while a connective extremity 125 of a respective heating element is affixed to the upper attachment

portion 129 of the positioning device. The primary shaping of the loop portion of the device is denoted by 131, while the secondary shaping 133 thereof, resultant of metallurgical phase transformation of the active lamina material, is shown in phantom wherein the upper attachment portion 129 abuts the lower attachment portion 127. Thus, the lower attachment portion forms stop means to restrict the downward movement of the bilaminate positioning structure 121.

The embodiment of the invention as illustrated in FIG. 10, is utilized in an electron gun structure employing, for example, heater support means in the form of a plurality of rod-like members 135 extending from an associated supportive stem closure member, not shown, and spacedly oriented relative to the open end of the cathode, not shown. Each of these rod-like support members 135 has extremital portions formed to provide a substantially L-shaped structure 137. In this instance, the lower attachment portion 139 of the heating element positioning device 141 is affixed to the undersurface 143 of the terminal region of the horizontal portion 145 of the L-shaped formation of the rod in a manner that the end of the rod-like member is oriented partially within the open loop of the positioning device. The thickness of the end portion of this rod-like member is less than the internal primary dimension of the loop portion of the device. A connective extremity 149 of a respective heating element is affixed to the upper attachment portion 151 of the device. Upon being subjected to the metallurgical phase transformation temperature, the primary shaping 153 of the device changes to the secondary shaping 155 whereby the loop of the device tends to close as shown in phantom in FIG. 10 thereby stopping against the upper surface 157 of the rod member 135.

A further embodiment of the invention as illustrated in FIG. 11, is used in an electron gun structure similar to that described for FIG. 10 wherein a plurality of rod-like supportive members 135 are extended from an associated stem closure member, not shown, to the region relative to the open end of the cathode. The terminal portion of each of the rod-like support members is likewise formed as a substantially L-shaped structure 137. In this particular embodiment, the lower attachment portion 159 of the positioning device is affixed to the upper surface 157 of the end region of the horizontal section 145 of the L-shaped structure. A connective extremity 163 of the cathode heating element is affixed to the upper attachment portion 165 of the device, which in its primary shaping 167 is oriented in substantially close relationship to the lower attachment portion 159 of the device. Upon consummation of the metallurgical phase change of the active material of the device, the upper attachment portion 165 is contracted to abut the lower attachment portion 159, thereby providing stop means for the retractive movement of the device 161.

In each of the aforementioned embodiments of the invention, the predetermined temperature at which the active alloy lamina of the bilaminate material of the device undergoes the desired metallurgical phase transformation, is above the temperature level encountered in toto by the bilaminate material during fabrication of the positioning device and subsequent incorporation thereof into the electron gun structure of the tube assembly. As previously stated, the active alloy portion of the bilaminate material is one that has a phase transfor-

mation temperature that is within the thermal range encountered during subsequent tube processing.

In an operating cathode ray tube electron gun, the region wherein the cathode heating element positioning device is oriented reaches a maximum temperature in the neighborhood of 280° C; but during processing of the tube, the positioning device is subjected to a varied range of temperatures. For example, during the hermetic sealing of the electron gun structure into the neck portion of the envelope, a temperature of approximately 300° C is reached; during the initial stages of the exhaust or gaseous evacuation procedure a thermal level in the vicinity of 250° C is encountered, and when the ensuing associated heater conditioning takes place, the temperature in the region of the device is elevated to the vicinity of 700° C. During subsequent cathode aging, the device reaches a temperature of approximately 650° C. Upon considering the foregoing range of thermal levels, it is preferred that the metallurgical phase transformation of the active lamina material of the device will take place at a temperature level encountered early in the tube processing procedure so that the advantageous shaping effects resultant from the transformation can be beneficially utilized in effecting a positive and sustained location of the heating element within the cathode during the remaining stages of the tube processing procedures.

In fabrication of the bilaminate material for the device, an exemplary alloy suited for the active lamina portion is an iron-nickel alloy consisting essentially of 32 to 33 percent by weight of nickel with the balance being iron. The metallurgical phase change transformation temperature of this alloy is approximately 300° C. One example of a passive alloy material, for use with the above-noted active lamina material, is another iron-nickel alloy consisting essentially of about 36 percent by weight of nickel, with the balance being iron. Another suitable passive material for use in this bilaminate combination is 1010 steel.

When the aforescribed bilaminate material is subjected to the phase transformation temperature, the active material lamina portion of the device undergoes a crystal structure transformation from the martensitic phase to the austenitic phase whereat the active material shrinks in volume thereby deforming and inducing flexural stress in the bilaminate material causing particularly the loop portion of the device to arcuately deform from the primary shaping to the secondary shaping, the movement of which is restricted by the respective stop means. As previously mentioned, the active and passive alloy materials of the bilaminate device are selected to have phase transformation temperature of the active material within the tube processing temperature range, that is, preferably above about 300° C and below about 700° C. In other words, the passive material should remain in a stable metallurgical phase throughout the temperature range encountered by the material which should be up to substantially 800° C. When the critical temperature of the phase transformation is attained, a modification of the primary shaping of the structure of the device is triggered by the active material, and such change of shape is substantially permanently retained by the structure, the coefficients of thermal expansion of the active and passive laminae being substantially equal. Thus the added flexural stress of the transformed material of the positioning device will be sustained against the stop means regardless of

the temperatures normally encountered thereafter in further tube processing and subsequent tube operation. In each of the described embodiments of the positioning device, the respective attachment portions thereof are bonded to a fixed support means or a heating element connective extremity by suitable affixture such as, for example, by a spot welding technique. While the welding temperature so encountered may be momentarily in the order of 1200° C, only a minute and inconsequential area of each attachment portion will be transformed or deformed by the phase transformation. In each instance, the flow of heat from the immediate weld area can be minimized by the use of heat sink means, such as temporary clamp-type metallic probes.

Several embodiments of the cathode heating element positioning device have been shown and described whereby predetermined positive and sustained location of the heating element can be achieved to provide uniformity of spacing between the terminal end of the heating element and the end closure portion of the cathode. This desired sustained positioning of the heating element within the end-emissive cathode is expeditiously accomplished in a predetermined manner by the phase structure transformation of a active lamina portion of the bilaminate material comprising the device. The several cathode heating element positioning devices and associated stop means herein described are adaptable for usage in a variety of types of cathode ray tube electron gun structures including both single and multiple gun manifestations.

While there has 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 modifications may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. In a cathode ray tube electron gun structure utilizing at least one thermionic end-emissive tubular cathode having a closed terminal end with electron emissive material exteriorly disposed thereon and accommodating therein a heating element having two separate connective extremities projecting from the open end of said cathode, means for positioning said cathode heating element within said cathode to effect predetermined orientation of said heating element therein, said means comprising:

fixed heater support means spatially related to the open end of said cathode structure in a manner to provide separate support for each of said heating element connective extremities; and

at least one heating element positioning device formed of a continuous strip of bilaminate metallic material of predetermined flexure performance shaped to have an upper attachment portion at one end thereof and a lower attachment portion at the opposite end with an acutely curved bend of bilaminate strip forming a partial loop of said material therebetween, said device having one attachment portion affixed to a respective connective extremity of said heating element and the other attachment portion to one of said fixed heater support means, said bilaminate material being formed of a first lamina of active alloy material contiguously metallurgically bonded along a common interface to a second lamina of a passive alloy mate-

rial, said active alloy material upon being subjected to a predetermined temperature undergoes a metallurgical phase transformation effecting a volume change thereof, said passive material remaining in a substantially stable single metallurgical phase state throughout a temperature range wherein said predetermined temperature is included, said predetermined temperature being above the temperature encountered in toto by said bilaminate material during fabrication of said heater positioning device and the incorporation thereof into said electron gun structure, said predetermined temperature being a thermal level encountered during subsequent tube processing, said bilaminate heater positioning device having a formed primary shape effected prior to incorporating into said electron gun structure, the active lamina portion of said primary shaped positioner upon reaching a predetermined temperature during tube processing transforms to said metallurgical phase thereby modifying the shape of said bilaminate positioning device to form a secondary structural shape thereby imparting a positional movement to said heating element within the cathode to effect a positive and sustained location of said heating element therein.

2. The heating element positioning means according to claim 1 wherein said heating element positioning device has defined stop means associated therewith to restrict the movement of said bilaminate structure to a predetermined amount during said metallurgical phase transformation.

3. The heating element positioning means according to claim 2 wherein a pair of like bilaminate devices are utilized for each heating element, and wherein each of the separate connective extremities of the heating element is affixed to a separate related attachment portion of a respective device.

4. The heating element positioning means according to claim 3 wherein the active material lamina portion of said bilaminate heater positioning device is oriented to be the outer lamina of said partial loop formation of the bilaminate structure.

5. The heating element positioning means according to claim 4 wherein said electron gun structure employs a plurality of longitudinal insulative support members to integrate the structural components thereof, and wherein said heater support means are a plurality of fixed individual strap-like members embedded in said longitudinal support in a manner that the plane of said heater support means is substantially in a plane parallel with that of the heater connective means, and wherein each strap-like support member has an aperture therein to accommodate substantially said partial loop of said heater positioning device, said aperture being dimensioned larger than the primary shaping of said partial loop to provide stop means for the secondary structural shaping thereof, said active lamina being proximal to said strap-like support member with the upper attachment portion of said positioning device being affixed thereto.

6. The heating element positioning means according to claim 5 wherein a connective extremity of a respective heating element is affixed to said lower attachment portion of said positioning device.

7. The heating element positioning means according to claim 5 wherein a connective extremity of a respective heating element is affixed to a conductive bracket

member bonded to the lower attachment portion of said positioning device and extending therefrom to the region relative to the open end of said cathode.

8. The heating element positioning means according to claim 4 wherein said electron gun structure employs heater support means in the form of a plurality of rod-like members extending from an associated supportive stem closure member and spatially oriented relative to the open end of said cathode, each of said rod-like support members having a terminal portion formed to provide a substantially P-shaped structure, the opening in said P-shaped terminal portion being formed to accommodate substantially the partial loop of said heater positioning device, said opening being dimensionally larger than the primary shaping of said partial loop to provide stop means for the secondary structural shaping thereof, said active lamina being proximal to said rod-like support member with the upper attachment portion of said positioning device being affixed thereto.

9. The heating element positioning means according to claim 3 wherein the active material lamina portion of said bilaminate heater positioning device is oriented to be the inner lamina of said partial loop formation of the bilaminate structure.

10. The heating element positioning means according to claim 9 wherein said electron gun structure employs a plurality of longitudinal insulative support members to integrate the structural components thereof, and wherein said heater support means are a plurality of fixed individual strap-like members embedded in said longitudinal support in a manner that the plane of said heater support means is substantially in a plane parallel with that of the heater connective means, and wherein the lower attachment portion of said positioning device is affixed to one of said strap-like support members, and wherein a connective extremity of a respective heating element is affixed to the upper attachment portion of said positioning device.

11. The heating element positioning means according to claim 9 wherein said electron gun structure employs heater support means in the form of a plurality of rod-like members extending from an associated supportive stem closure member and spatially oriented relative to the open end of said cathode, each of said rod-like support members having a terminal portion formed to provide a substantially L-shaped structure, the lower attachment portion of said positioning device being af-

fixed to the undersurface of the terminal region of the horizontal portion of said L formation in a manner that the end of the rod-like member is oriented partially within the open loop of said positioning device, the thickness of the end portion of said rod-like member being less than the internal primary dimension of the loop portion of said device, the upper attachment portion of said device having a connective extremity of the heating element attached thereto.

12. The heating element positioning means according to claim 9 wherein said electron gun structure employs heater support means in the form of a plurality of rod-like members extending from an associated supportive stem closure member and spacedly oriented relative to the open end of said cathode, each of said rod-like support members having a terminal portion formed to provide a substantially L-shaped structure, the lower attachment portion of said positioning device being affixed to the upper surface of the end region of the horizontal section of said L structure, the upper attachment portion of said device having a connective extremity of the heating element affixed thereto, said upper attachment portion of said positioning device being oriented in the primary shaping thereof in substantially close relationship to said lower attachment portion whereby consummation of the metallurgical phase change of the active material provides abutment between the upper and lower attachment portions thereby providing stop means for the contractive embodiment of said device.

13. The heating element positioning means according to claim 1 wherein the predetermined phase transformation temperature of said active material lamina portion of said positioning device is above about 250°C and below about 700°C.

14. The heating element positioning means according to claim 1 wherein the active material lamina of said bilaminate positioning device undergoes a crystal structure transformation from the martensitic phase to the austenitic phase at said predetermined temperature, and wherein the coefficients of thermal expansion of said active and passive lamina of said device are substantially equal, and wherein the active material lamina portion shrinks in volume when transforming from the martensitic to the austenitic phases thereby inducing structural movement within the device.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,822,392 Dated July 2, 1974

Inventor(s) Robert J. Bowes and John J. Miller

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, Line 30: "of" should read -- at --.

Column 3, Line 45: "electrons" should read -- electrodes --.

Column 5, Line 10: "other" should read -- outer --.

Column 12, Line 29: "embodiment" should read -- movement --.

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents