Nov. 7, 1967

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3,351,792

QUICK WARM-UP HEAT-SHIELDED CATHODE STRUCTURE FOR CATHODE RAY TUBES

Original Filed Dec. 28, 1964

2 Sheets-Sheet 1

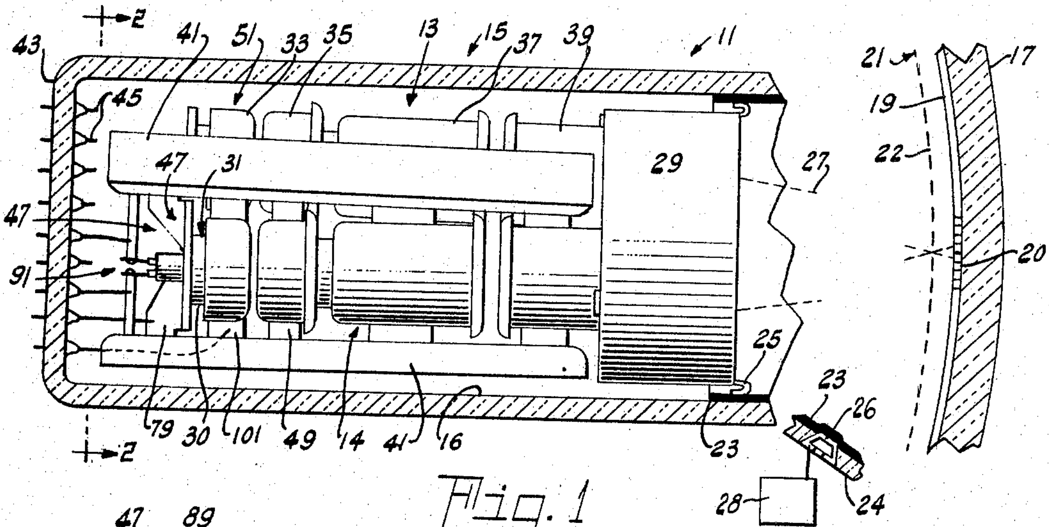

Fig. 1

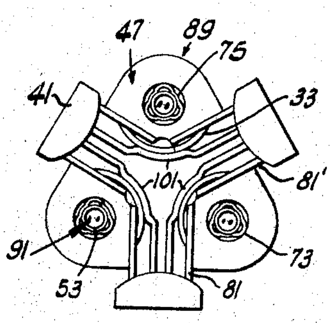

Fig. 2

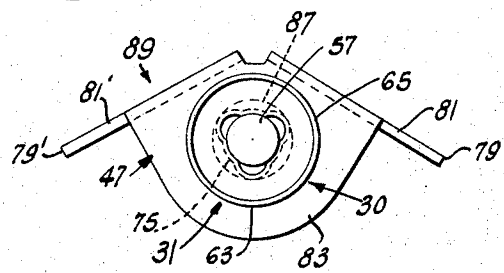

Fig. 3

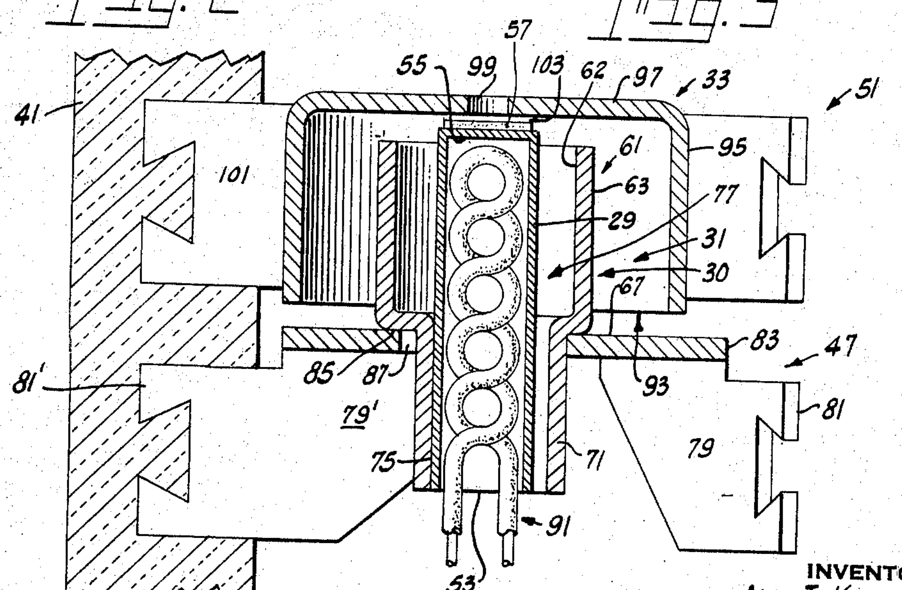

Fig. 4

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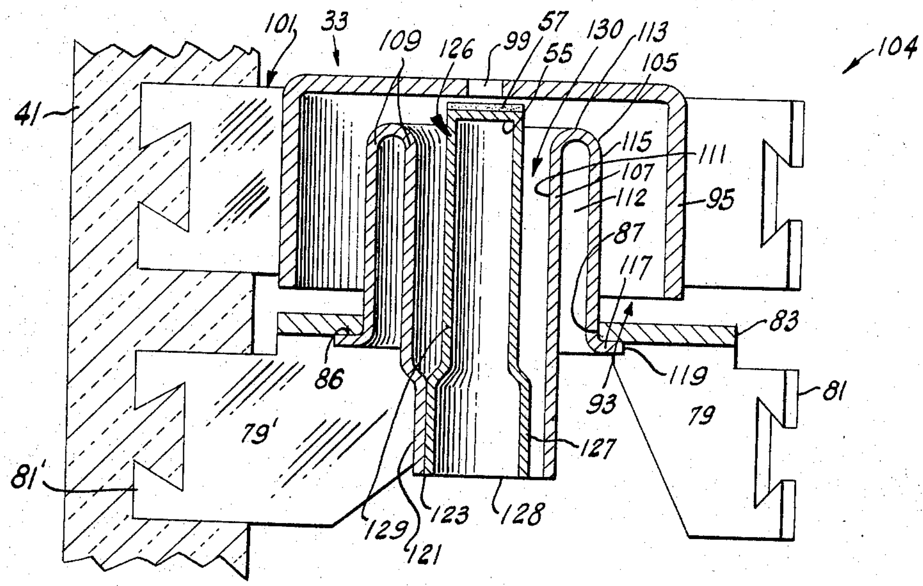

Fig. 5

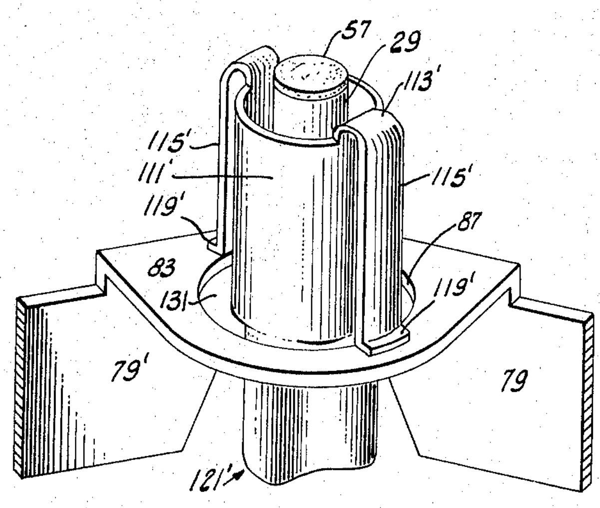

Fig. 6

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3,351,792

Patented Nov. 7, 1967

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3,351,792

QUICK WARM-UP HEAT-SHIELDED CATHODE STRUCTURE FOR CATHODE RAY TUBES

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Continuation of application Ser. No. 421,494, Dec. 28, 1964. This application Mar. 1, 1967, Ser. No. 619,877

5 Claims. (Cl. 313—38)

ABSTRACT OF THE DISCLOSURE

Means for shielding and supporting a cathode in a CRT electron gun wherein the shield means is of tubular shape having open ends and comprising upper and lower portions of different diametrical dimensions. The upper shield portion is spaced from the upper cathode portion, while the lower shield portion has a plurality of longitudinal support means formed therein to provide longitudinal support to the cathode portion affixed therein. Intermediate the open ends of the shield, an exterior planar seating provision is integrally formed of shield material in a manner to provide attachment on an assembly support member.

This application is a continuation of application Ser. No. 421,494, filed Dec. 28, 1964, which is now abandoned.

The invention relates to cathode ray tube electron gun structures and more particularly to improved means for supporting, shielding, and reducing heat losses from the cathodes used therein.

In cathode ray tube art for both monochrome and color applications, it is desired that the heat generated by the cathode heater be utilized to maximum efficiency in an attempt to achieve low power, quick warm-up results. These are difficult results to accomplish, and in addition, deleterious sublimation materials emanating from the cathode tend to aggravate the situation.

By way of example, current tri-color cathode ray tubes, of the apertured shadow mask variety having a separable funnel and a faceplate, conventionally utilize a plurality of electron guns properly oriented and compatibly supported in a unified mount construction. Thus unified gun assembly is sealed into the neck of the cathode ray tube and utilized to generate and control discrete beams of electrons directed to impinge on a multi-dot color phosphor screen lining the interior surface of the faceplate of the evacuated envelope. Each of the several electron guns is usually composed of a plurality of sequentially cooperating electrodes which, beginnning at the base end of the tube, are commonly referred to as the cathode, the first or control grid, the second grid, the third grid, and the fourth grid, respectively. These several componental gun electrodes comprising the mount structure are held in spaced axial alignment by a plurality of insulative beads or side rods and are thus in proximal relationship to these beads and to the inner wall of the neck of the tube. The cathode which is conventionally of a cylindrical shape having a walled end supporting an electron emissive material on the outer surface thereof can be supported within the mount structure in one of several ways. By one method the cathode sleeve is crimped or otherwise affixed within an apertured supporting ceramic which is, in turn, positioned within a cup-shaped control grid. In itself, this ceramic becomes an undesirable heat sink dissipating valuable heat from the cathode. In addition this type of construction provides little, if any, shielding to the cathode. Furthermore, the processing and operational heat to which the structure is subjected tends to loosen the cathode in the ceramic and cause microphonics.

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By another conventional procedure the cathode is partially telescoped into a shorter outer sleeve or eyelet of a larger diameter having, at one end thereof, several relatively small bonding surfaces for securement to the cathode. This type of structure results in a semi-rigid assembly which is prone to loosening of the cathode to the detriment of tube performance. The eyelet sleeve is affixed to a support member which, in turn, is secured to the beads. In this structure the first grid is conventionally of a flat apertured disk-like construction that is separately supported on the beads in spaced axial alignment with the cathode. The open or exposed construction of the cathode results in excessive radiation heat losses from the cathode which adversely affect tube operation. Additionally, an assembly construction of this type allows the walled end of the cathode sleeve with the electron emissive material thereon and a large adjacent segment of the cathode sleeve to be relatively exposed with respect to the beads and to the inner surface of the neck of the tube. During tube operation the walled end portion of the cathode operates at a relatively high degree of temperature with other portions of the cylindrical cathode operating at generally lesser degrees of temperature. These operating temperatures are sufficient to cause sublimation of material from the cathode which following straight line patterns of projection tends to coat the proximal bead and the inner tube neck surfaces with a conductive electrical leakage film that is deleterious to optimum tube performance.

Accordingly, an object of the invention is to reduce the aforementioned disadvantages and to provide an improved electron gun assembly.

Another object is to provide a low power, quick warm-up cathode grid construction having improved cathode-shielding means to reduce the formation of deleterious electrical leakage films resulting from sublimation of material from the cathode.

A further object is to provide an improved cathode-shield-control grid assembly which diminishes excessive heat radiation and conduction losses from the cathode.

Still another object is the provision of an improved cathode-shield assembly which provides rigid support to the cathode.

The foregoing objects are achieved in one aspect of the invention by the provision wherein the cathode is surrounded and plurally supported by longitudinally formed reflective shield means spacedly close thereto. This structure is concentrically telescoped within an inverted control grid and separately affixed to the insulative side rods or mount support beads. The cathode and shield so oriented theretogether enhance the efficiency of the heated cathode and reduce the conductive and radiated heat losses therefrom. The compatibly positioned first grid and cathode-containing shield means react conjunctively to effect optimum shielding of the cathode to prevent sublimation therefrom from forming deleterious electrically conductive leakage film on the beads and other vulnerable adjacent areas.

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 accompanying drawings in which:

FIGURE 1 is a partial plan view showing the neck section and screen portions of a three-gun color cathode ray tube embodying features of the present invention;

FIGURE 2 is a sectional view of FIGURE 1 taken along the plane 2—2;

FIGURE 3 is a plan view showing a top view of the cathode assembly-support member structure;

FIGURES 4 and 5 are enlarged plan views of two embodiments of the invention showing the relationship between the cathode, shield, and control grid; and

FIGURE 6 is a perspective illustrating one form of the embodiment shown in FIGURE 5.

With reference to FIGURES 1 and 4, in describing one embodiment of the invention, there are shown pertinent portions of a typical three-gun color cathode ray tube **11** as used in producing visual displays such as television. The neck portion **15** is suitably connected to an oppositely disposed faceplate portion **17** by an intermediate funnel portion which is not shown. Within the neck portion **15** there is positioned an electron gun assembly **13** having three individual guns **14** of which only two are shown for sake of clarity. Each of these individual electron guns generates a discrete beam of controlled electrons **27** directed to pass through a magnetic convergence assembly **29** terminally positioned on the mount structure. This convergence assembly, the details of which are not shown, imparts positional corrections to the beams **27** as necessary for aligning them in optimum paths to achieve convergence at the plane of the aperture mask **21**. Thus, the individual beams pass through holes or apertures **22** therein for subsequent impingement on proper tri-dot patterns **20** of the phosphor screen **19** lining the interior surface of the faceplate **17** to cause luminescence of the tri-dots **20** in desired hues of red, blue, and green to reproduce the desired visual color display. Each individual gun **14** of the electron gun assembly **13** is composed of a plurality of electrodes which, starting from the base end **43** of the tube **11**, may be referred to as the cathode assembly structure **31** which comprises a cathode sleeve **29** and a cathode shielding eyelet **30**, the first or control grid **33**, the second grid **35**, the third grid **37**, and the fourth or terminal grid **39**, respectively. The cathode shielding eyelet **30**, as will be explained later, performs a plurality of functions, i.e., it conserves cathode heat, minimizes conductive and radiated heat losses therefrom, and aids in controlling the dissipation of cathode sublimation. The cathode **29** in each cathode structure **31** functions to generate a beam of electrons **27** which is modulated by the control grid **33**, initially accelerated by the second grid **35**, focused by the third grid **37**, and imparted with final velocity through effect of the terminal high voltage grid **39**. Electrical connection is made to all electrodes except the terminal grid **39** by connectors **45** hermetically sealed in the base end **43** of the tube **11**. In the case of the terminal grid **39**, electrical connection is made through a plurality of snubbers **25** which are mounted on the magnetic convergence assembly **29** and serve to both axially center the electron gun assembly **13** in the neck portion **15** of tube **11** and make high voltage electrical connection to the internal conductive coating **23** lining the upper part of the neck portion **15** and extending therefrom over the interior surface of the funnel **24**, a portion of which is shown. High voltage connector means **26** is hermetically sealed in the aforementioned funnel portion **24** to connect the conductive coating **23** to an external source of high voltage **28**. The cathode structure **31** is supported on the beads or insulative side rods **41**, of which only two are shown for clarity of illustration, by a cathode assembly support member **47**. The other electrodes **33**, **35**, **37**, and **39** are supported and affixed to the beads **41** in spaced axial alignment by the use of support straps **49** according to recognized prior art procedures. With reference to FIGURES 2, 3, and 4, there is shown the discrete arrangement of the cathode assembly structure **31**, its support member **47** and the related control grid **33** which theretogether forms the shielded cathode-control grid assembly **51**.

In greater detail, the cylindrical cathode sleeve **29** has an open end **53** and an oppositely disposed closed or substantially flat walled end **55** the outer surface of which has a layer of electron emissive material **57** disposed thereon. In this instance, for purposes of illustration, the cylindrical cathode has an outer diameter of nominally

0.088 inch. The open end of the sleeve **29** is inserted into and affixed to a compatibly dimensioned portion of the cathode shielding eyelet **30** which is a duo-dimensioned structure having an overall length shorter than that of said cathode sleeve. The eyelet, formed of nickel or nickel alloy material and having a nominal material thickness of 0.005 inch, has two oppositely oriented open ends designated as upper and lower ends, respectively. The eyelet area adjacent the upper end is substantially a cup-shaped upper portion **61** having a reflective bright or polished inner surface **62** and is formed of a substantially upstanding wall **63** with a terminal edge **65** therearound. This upper portion **61** concentrically merges, through a substantially radially defined planar seating ledge **67**, to a smaller dimensioned tubular open ended lower portion **71**. Integrally formed in the wall **73** of this lower portion are three equispaced support lands **75** inwardly embossed to define an internal longitudinal curvilinear dimension diametrically in the order of 0.089 inch which is sufficient to accommodate the insertion of the aforementioned cathode sleeve **29** thereinto and provide spaced coextensive longitudinal support for the cathode. The cathode **29** is suitably bonded, as by welding, to each of the three spaced lands **75** near the open end **53** thereof. This discrete or limited contact bonding minimizes cathode conductive heat losses and provides a rigidity to the cathode assembly structure **31**. The upper portion **61** of the shielding eyelet **30** has an internal diametric dimension in the order of 0.168 inch which is sufficient to permit the upstanding upper portion wall **63** to encircle the cathode sleeve **29** by a substantially uniform spacing **77** therebetween of approximately 0.040 inch. The closeness of the upper portion eyelet wall to the cathode wall and the bright finish of the interior eyelet surface provides an efficient reflector whereby the heat emitted from the wall of the cathode is in a large measure reflected back to the cathode. The minimization of radiation heat loss in conjunction with the low conduction heat loss through the limited contact bonding lands effects a marked overall reduction in cathode heat loss. This combined conservation of cathode heat noticeably increases the efficiency of the cathode by decreasing the required warm-up time and by promoting a desirably higher and more consistent cathode operating temperature level. Since the height of this upstanding wall is intentionally somewhat less than the length of the cathode extended into the upper portion, the walled end of the cathode having the electron emissive coating thereon protrudes above the terminal edge **65** of the upper portion. This, as will be explained later, facilitates consummating the subsequent precise spacing of the coated cathode relative to the related control grid **33** without the danger of producing an electrical short between the shield and the grid. The cathode assembly support member **47** has two first sections **79** and **79'** with extremities **81** and **81'** formed for attachment to the side rods **41** and the second section **83** formed at a right angle to the first sections to provide on the upper side thereof an eyelet upper bonding surface **85** having the opening **87** substantially centrally defined therethrough. With reference to FIGURE 3, there is shown a top view wherein the walled end **55** of the cathode sleeve **29** is shown in concentric arrangement with the opening **87** and the terminal edge **65** of the cup-shaped upper portion **61** of the shielding eyelet **30**. The lower portion **71** of the eyelet **30** having been inserted through the opening **87** of the second section **83** of the support member **47** is welded or otherwise affixed to the upper bonding surface **85** thereby forming a rigid cathode assembly support structure **89**. Although not shown, the periphery of the opening **87** can be serrated or toothed to provide spaced seating projections for bonding of the eyelet thereto and effect a further reduction in cathode heat conduction losses. A conventional heater **91** is positioned within the cathode sleeve **29** through the open end **53** thereof to provide the necessary operational heat thereto.

A control grid 33 is substantially shaped as a cup having a cylindrical side wall portion 95 with an open end lip 93 therearound and an oppositely disposed closed end 97 with a centrally defined aperture 99 therein. This grid 33, which has an inner diameter larger than the external dimension of the wall 63 of the upper portion 61 of the shielding eyelet 30, is inverted and separately affixed to the beads 41 by a grid support 101 formed to compatibly mate with a portion of the grid side wall 95 for suitable bonding thereto. The inverted grid is telescopingly positioned concentrically over the shielding eyelet 30 and the cathode sleeve 29 mounted therein to provide spaced coaxial alignment between the grid aperture 99 and the walled end 55 of the cathode sleeve 29. As aforementioned, the wall 63 of the upper portion 61 of the eyelet 30 is of a smaller diametric dimension than the side wall portion 95 of the control grid 33. This diametrical difference is of a sufficiency to amply permit the cup portion of the eyelet to be telescopingly interposed in a concentrical manner between the cathode sleeve 29 and the control grid 33. Thus, the cathode is effectively shielded by the conjunctive overlapping of the side walls of the shielding eyelet and the control grid and thus the dissipation of cathode sublimation material is controlled or confined to nonvulnerable areas. Since sublimation paths are substantially straight line projections from the cathode, it is evident in this arrangement that the terminal edge 65 of the upper eyelet portion is spacedly positioned to intercept straight line sublimation projections from the cathode sleeve 29 to the lip 93 of the control grid side wall portion 95. Thus, there is provided optimum shielding of the cathode sleeve 29 from the proximal insulative side rods 41 to inhibit the formation of deleterious electrical leakage films thereon resultant from sublimation of deleterious material from the cathode sleeve 29.

The arrangement of three cathode assembly-support structures is referenced in FIGURE 2 where there is shown a bottom view of the plural electron gun structure taken along plane 2—2 of FIGURE 1. In this illustration, as viewed from the base end 43 of the tube 11, the compatible orientation of the three cathode assembly-support structures 89 and the respective control grids 33 with formed supports 101, are shown as separate attachments to the three electrically insulative side rods or beads 41.

Another embodiment of the invention is utilized in the shielded cathode-control grid assembly 104 illustrated in FIGURE 5 wherein closer spacing between the reflective portion of the cathode eyelet shield and cathode sleeve is achieved. This eyelet embodiment is made of material and gauge similar to that utilized in the first described embodiment, and the upper portion inner surface thereof is also of a bright or polished reflective finish. The duo-dimensioned cathode shielding eyelet 105, with two oppositely oriented open ends, has a substantially cylindrical upper portion 107 formed as a dual wall 109. This wall structure is fashioned from an inner wall 111 doubled back on itself in an outward manner to define a dual wall terminal edge 113 and form an outer wall 115 which may be substantially parallelly spaced, but not necessarily so, from the inner wall 111. This upper portion inner wall has an internal diametric dimension in the order of 0.130 inch. The extremital portion 117 of the outer wall is formed in an outstanding manner to provide a substantially circular seating projection 119 oriented intermediate the open ends of the eyelet 105. The eyelet upper portion 107 merges to a discretely shaped smaller dimensioned tubular open-ended lower portion 121 which has, integrally formed in the wall thereof, in a manner already explained, a plurality of equispaced support lands 123 inwardly embossed to define an internal longitudinal curvilinear dimension diametrically in the order of 0.101 inch which is sufficient to accommodate positioning and affixing therein of the cathode sleeve 126 in a manner similar to that previously described. It will be noted that the cathode 126 is shown as a duo-diameter sleeve having a substantially expanded

lower section 127 adjacent the open end 128 and a diametrically reduced upper sleeve section 129. By way of example, the outer dimension of the expanded section 127 may be in the order of 0.100 inch, and that of the upper section 129 in the order of 0.080 inch. Thus, the expanded cathode section 127 is of an adequate size for positioning within the compatibly dimensioned lower eyelet portion 121 as mentioned. The upper sleeve section 129 is thereby positioned within and encircled by the inner wall 111 of the eyelet upper portion 107; the uniform spacing 130 therebetween being in the order of 0.025 inch. While not shown, this interspacing between the cathode and the eyelet upper portion can be further reduced by use of a cylindrical cathode similar to cathode 29 as utilized in the first embodiment. A cylindrical sleeve having an external diameter of substantially 0.100 inch is seated and affixed within the eyelet lower portion 121 and extended through the upper eyelet portion 107. With this larger cylindrical sleeve, the spacing 130 between the cathode and the upper portion inner eyelet wall 111 will be in the order of 0.015 inch. Thus, the heat reflective surface of the shielding eyelet can be brought close to the cathode sleeve to further improve cathode heat conservation.

In this embodiment the opening 87 in the second section 83 of the aforedescribed cathode assembly-support member 47 is compatibly larger than the outer diameter of the upper outer wall portion 115. This permits positioning of the upper eyelet portion 109 to project upwardly therethrough in a self-centering manner with the circular seating portion 119 contiguously oriented on the underside of the support member 47 for attachment to the under bonding surface 86. The periphery of the opening 87 can be serrated or toothed to effect limited contact surface with the eyelet seating portion 119 and thereby further reduces heat conduction from the shielding eyelet. The conventional control grid 33 as described in the first embodiment is likewise utilized in this embodiment, the dual wall 109 of the upper portion cooperating with the grid side wall 95 in an overlapping telescoping manner to intercept the straight line sublimation projection from the cathode 29. The dual-wall upper portion 107 with the space 112 therebetween is particularly advantageous in reducing radiated heat loss from the cathode. In addition, the long folded back double wall forms a lengthy thermal path which greatly aids in controlling conductive heat loss from the cathode.

While a doubled back dual wall eyelet construction is shown and explained, it is evident that the dual wall feature can be fabricated from two concentrically spaced sleeves peripherally joined together at a common terminal edge 113.

A modification of the dual-wall eyelet embodiment is illustrated in FIGURE 6 wherein the outer wall portion is not continuous but divided into a plurality of outer wall segments 115′ each having an outstanding segment seating projection 119′, two of which are shown. In this embodiment the seating projections 119′ are shown as affixed to the upper bonding surface 85 of support member 47. The centrally defined opening 87, being diametrically larger than the diameter of the lower eyelet portion 121′, provides a substantially uniform spacing 131 between the eyelet lower portion and the periphery of the opening 87. It is obvious that, if desired, the seating projections 119′ can be bonded to the under bonding surface 86 as described for the previous embodiment.

In the various embodiments shown and described, the spacing between the upper portion of the cathode eyelet and the cathode contained therein can be varied in constructional dimensions to provide optimum control of the radiation and conduction aspects of cathode heat as desired for particular operational requirements.

The parts comprising the electron gun assembly 13 are made from materials well known to those skilled in the art and assembled by methods considered conventional to those so versed. The various embodiments shown and described are definite improvements over prior art and provide benefits heretofore unachieved.

While the embodiments of the invention have been shown and described with reference to a three-gun color cathode ray tube, it is not intended that the invention should be restricted to such usage. It is to be clearly understood that this invention is equally adaptable to single or plural gun monochrome usage with equally achievable results.

Thus an electron gun assembly is provided that utilizes therein an improved cathode-shield-control grid assembly that provides a low power, quick warm-up cathode construction wherein the cathode heat is effectively reflected by the shield and utilized to maximum efficiency instead of being dissipated by adjacent elements acting as heat sinks. Thus, this shielded cathode grid assembly diminishes both heat radiation and conduction losses from the cathode to a degree heretofore unachieved, and, in addition, provides rigid support to the cathode. Furthermore, the shield and grid cooperate to control the projection of cathode sublimation materials and thereby inhibit the formation of deleterious electrical leakage films resultant therefrom.

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 modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

I claim:

1. In a cathode ray tube electron gun assembly having at least one electrically insulative rod supporting a plurality of associated electrode elements including an apertured control grid, a related shielded cathode structure comprising:

a cathode sleeve having an open end portion and an opposite walled end portion with electron emissive material terminally disposed thereon;

metallic shield means formed to support and shield said cathode, said shield means being of tubular shape having open ends and comprising upper and lower portions of different diametrical dimensions with an exterior planar seating provision integrally formed of said shield material intermediate said open ends thereof, said lower shield portion having a plurality of spaced apart longitudinal support means formed therein to provide longitudinal support to said open end cathode portion oriented in and attached thereto, thereby forming a shielded cathode assembly with said upper shield portion being spaced from said upper cathode portion; and

a cathode assembly support member having at least one first section with at least one formed extremity attached to said insulative rod and a second section formed at substantially right angles to said first section to provide a shield bonding surface having an opening formed therein of a size to accommodate said assembly with said shield planar seating provision being attached to said second section peripheral to said opening to provide a rigidly supported cathode-shield structure whereby said emissive material is oriented in spaced relationship with said control grid aperture.

2. A shielded cathode structure according to claim 1 wherein said open-ended shield means is in the form of a cup-shaped upper portion formed of a substantially upstanding wall with a reflective inner surface and a smaller dimensioned lower portion, said upper portion concentrically merging through a substantially intermediate radially defined planar seating ledge to said smaller dimensioned lower portion.

3. A shielded cathode structure according to claim 1 wherein said longitudinal support means is in the form of a plurality of equi-spaced support lands inwardly embossed within said lower shield portion to define internal longitudinal curvilinear surfaces providing coextensive support to said attached cathode.

4. In a cathode ray tube electron gun assembly having at least one electrically insulative rod supporting a plurality of associated electrode elements including an apertured control grid, a related shielded cathode structure comprising:

a cathode sleeve having an open end portion and an opposite walled end portion with electron emissive material terminally disposed thereon;

metallic shield means formed to support and shield said cathode, said shield means being of tubular shape having open ends and comprising upper and lower portions of different diametrical dimensions, said upper portion being formed of a dual wall comprising an inner wall and a concentrically oriented outer wall spaced from said inner wall, said walls being formed to integrally joint at a common terminal edge, said outer wall having an extremital portion formed in a substantially outstanding manner to provide a seating projection intermediate said open ends, said upper portion inner wall concentrically merging to a dimensionally different lower portion having a plurality of spaced apart longitudinal support means inwardly formed therein to provide longitudinal support to said open end cathode portion oriented in and attached thereto, thereby forming a shielded cathode assembly with said inner wall of said upper shield portion being spaced from said upper cathode portion; and

a cathode assembly support member having at least one first section with at least one formed extremity attached to said insulative rod and a second section formed at substantially right angles to said first section to provide a shield bonding surface having an opening formed therein of a size to accommodate said assembly with said seating projection being attached to said second section peripheral to said opening to provide a rigidly supported cathode-shield structure whereby said emissive material is oriented in spaced relationship with said control grid aperture.

5. A shielded cathode structure according to claim 4 wherein said outer wall is in the form of individual outer wall segments spaced from one another and said upper portion inner wall, said segments having extremital portions formed in a substantially outstanding manner to provide a plurality of related seating projections intermediate said open ends of said shield, said seating projections being attached to said cathode assembly support member on said second section thereof peripheral to said opening therein.

No references cited.

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