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Kerr et al.

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[54] **SHIELDED CATHODE RAY TUBE ELECTRON GUN**

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[52] **U.S. Cl.** ..... **313/70 C,** 313/239, 313/313

[51] **Int. Cl.** **H01j 29/50**

[58] **Field of Search** ..... 313/239, 241, 313, 313/70 R, 70 C

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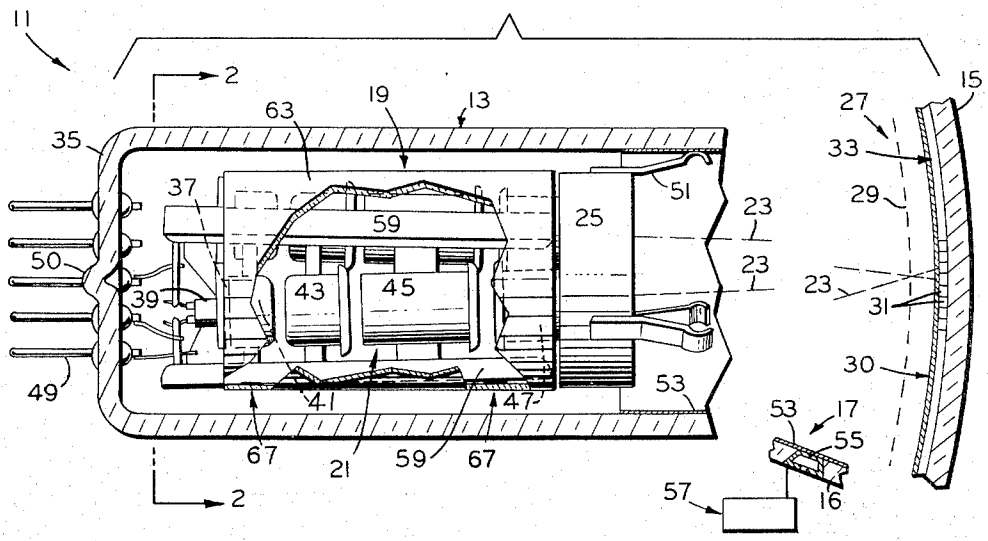
[57] **ABSTRACT**

An improved electron gun structure is provided for use in a cathode ray tube wherein insulative shielding is arranged to substantially encompass at least a portion of the plural electrode arrangement of the gun assembly. Such shielding, being dimensioned to be spaced from the interior surface of the envelope neck portion, is suitably positioned and retained relative to the support rods of the gun structure in a manner that the shielded gun assembly is inserted as a unit into the envelope neck portion during tube fabrication.

8 Claims, 6 Drawing Figures



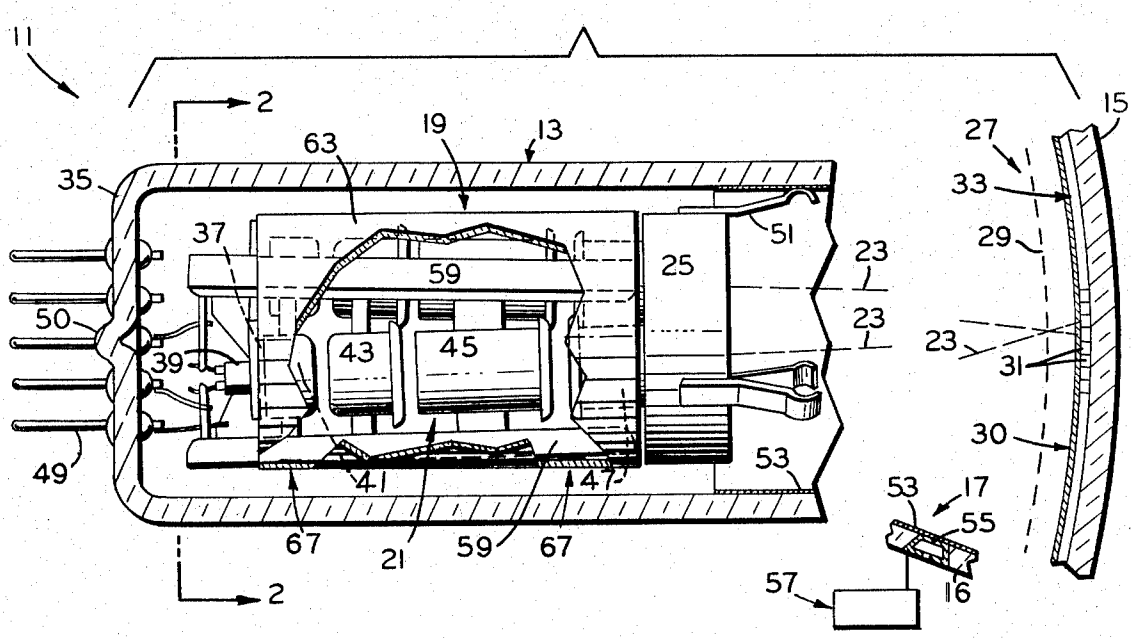


Fig. 1

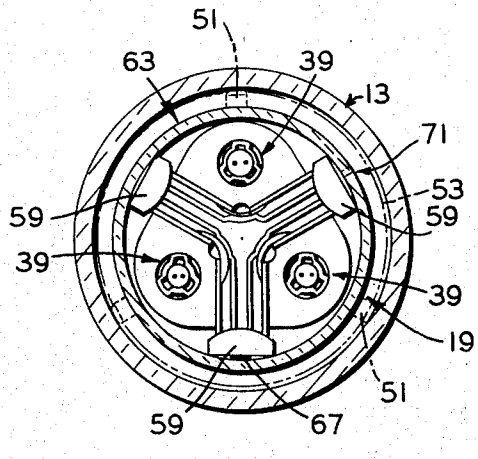


Fig. 2

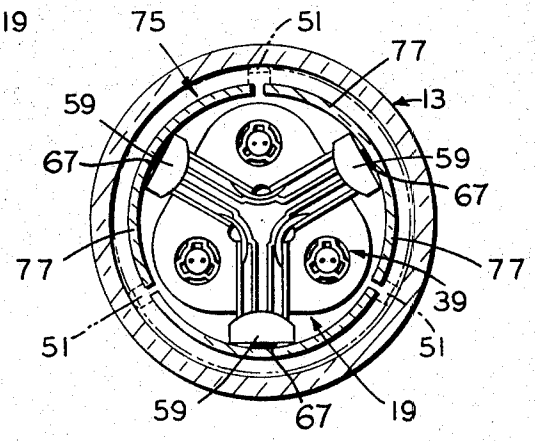


Fig. 3

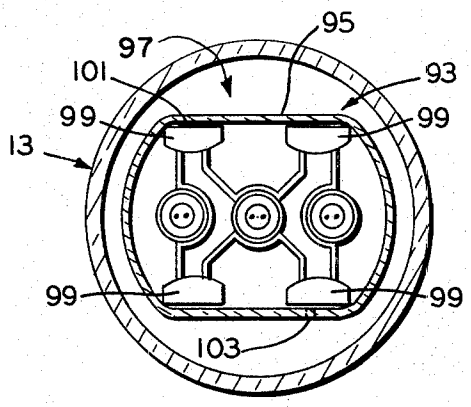


Fig. 4

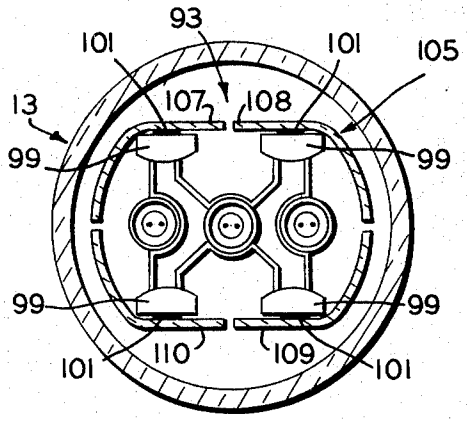


Fig. 5

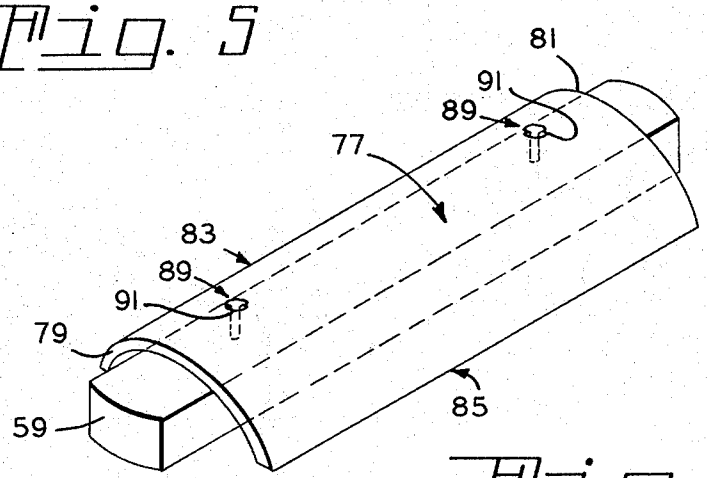


Fig. 6

SHIELDED CATHODE RAY TUBE ELECTRON GUN

BACKGROUND OF THE INVENTION

This invention relates to cathode ray tube electron gun structures and more particularly to an electron gun structure incorporating shielding means to provide improved operational characteristics.

During the operation of cathode ray tubes, stray or uncontrolled electron emission and undesired arcing or electrical leakage conditions sometimes develop within the electron gun structure, or in the immediate region thereof. Such conditions not only cause annoying distractions, evidenced in the visual display of the tube, but may also produce deleterious results to the tube per se and/or to the operating circuitry associated therewith. The undesirable stray emission, arcing and leakage circumstances result from a combination of factors that contribute in varying degrees. Such factors include extraneous projections within the gun structure resultant from electrode welding, the release of priorly absorbed gases from the gun structure during tube operation, the migration of gettering material, and the presence of minute foreign particles. Of these factors an attempt to eliminate or minimize spurious welding projections is effected by improved welding procedures. Efforts to reduce the possible prevalence and release of unwanted gas from the gun and tube structure is made by employing refined degassing techniques both prior to and during tube processing. Due to the nature of the tube envelope, and the usually inherent structural contents thereof, the problem of reducing and eliminating the prevalence of minute foreign particles therein and the possible migration of gettering material has a more elusive solution. For example, the interior of the funnel portion and the upper portion of the neck region is normally coated with an electrical conductive material that is sometimes prone to flake in tiny particles. In addition, conventional aluminizing of the forward portion of the envelope may result in the occasional presence of loose bits of aluminum within the envelope. In the usual procedure for fabricating a cathode ray tube, the envelope portion is prepared wherein portions of the interior have been carbon coated, the screen suitably formed on the interior of the viewing panel or other support medium, and the aluminum film disposed thereover as desired. The electron gun assembly, which is supported on a stem closure wafer having an exhaust tubulation therein, is inserted into the open neck portion of the envelope, whereupon the stem wafer is peripherally sealed to the open end of the envelope neck. During subsequent processing of the tube, gases from within the envelope are evacuated via the exhaust tubulation. This exhaust procedure effects an outgoing flow of gas and gas-borne particles past the electron gun structure which makes this assembly particularly vulnerable to possible residual environmental contamination. These factors, in addition to the possibility of subsequent getter migration, are conducive for the development of pernicious arcing, stray or field emission, electrical leakage or the potential generation of a deleterious plasma discharge path of ionized gas in the operable tube.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and provide an improved cathode ray tube electron gun structure that is less prone to stray emission, electrical leakage and arcing.

Another object is to provide an electron gun structure that has provisions for protecting at least some of the electrode areas from environmental contaminants within the tube.

A further object is to provide a cathode ray tube having improved operational characteristics.

The foregoing objects are achieved in one aspect of the invention by the provision of an improved cathode ray tube electron gun structure. A group of sequentially associated electrodes are arranged to provide at least one beam of electrons. A plurality of glass support rods are spatially oriented peripheral to the electrode arrangement to effect support and affixed positioning thereof. An insulative shielding means is arranged in a substantially encompassing manner about at least a portion of the supported electrodes. The shielding is telescoped over the gun structure in a manner to be positioned and retained relative to the support rods to provide shieldings for the gun assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial plan view showing the neck section and screen portions of a plural-gun color cathode ray tube embodying the invention;

FIGS. 2 and 3 are sectional views of FIG. 1 taken along the plane 2—2 thereof illustrating embodiments of the invention;

FIGS. 4 and 5 are sectional views oriented similarly to FIG. 2 but showing embodiments of the invention related to a plural in-line gun structure; and

FIG. 6 illustrates one means of shield attachment to a support rod.

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 aforedescribed drawings.

With reference to FIG. 1, in describing one embodiment of the invention, there is shown pertinent portions of a typical three-gun color cathode ray tube 11 as employed in producing visual displays such as television. The neck portion 13 is suitably connected to an oppositely disposed face panel portion 15 by an intermediate funnel portion of which only the high voltage connection area 17 is shown. Within the neck portion 13 there is positioned an electron gun assembly 19 having three individual gun structures 21 of which only two are revealed in FIG. 1. The gun assembly embodiment as further delineated in FIGS. 1 and 2 is a delta arrangement, but such is not to be considered limiting as the invention is also applicable to single gun structures or other plural gun arrangements to be subsequently described herein. In the embodiment 19 presently considered, each of the individual electron guns generates, forms and focuses a discrete beam of controlled electrons 23 which traverses the magnetic convergence assembly 25 terminally positioned on the mount assembly. This convergence assembly imparts positional corrections to the beams 23 as are necessary for directing them in optimum paths to achieve convergence at the plane of the aperture mask 27. By this convergence, the individual beams 23 are positioned to pass through the

apertures 29 therein; whereupon they penetrate the usually-present reflective aluminum film 30 therebeneath, and thence they impinge and excite the proper dot patterns 31 of the cathodoluminescent screen 33 disposed on the interior surface of the face panel 15. Each of the individual gun structures 21 of the electron gun assembly 19 is made up of a sequential longitudinal arrangement of related electrodes. For example, starting with the base or stem closure end 35 of the tube 11 the first or adjacent electrode is a cathode assembly structure 37 which contains an indirectly heated cathode 39; sequentially positioned therefrom is a first or control grid 41, a second grid 43, a third grid 45, and a fourth or terminal grid 47, respectively. Functionally, the cathode 39 generates a beam of electrons 23 which is modulated by the control grid 41, initially accelerated by the second grid 43, focused by the third grid 45, and imparted with final velocity by the terminal high voltage grid 47. Electrical connection is made to all of the electrodes, except the terminal grid 47, by a plurality of electrode connectors or leads 49 which are hermetically sealed in the stem closure base of the tube 35, wherein also is evidenced the sealed exhaust tubulation 50. In the case of the terminal grid 47, electrical connection is made through a plurality of resilient snubbers 51 which are peripherally affixed to the contiguous magnetic convergence assembly 25. These snubbers serve to both axially center the electron gun assembly 19 in the neck portion 13 of the tube and make high voltage electrical connection to the internal conductive coating 53 lining the upper part of the neck portion 13 and extending therefrom over the interior surface of the funnel portion 16, a portion of which is shown. A high voltage connector means 55 is hermetically sealed in the aforementioned funnel portion 16 to connect the internal conductive coating 53 to an external high voltage source 57. The respective electrode arrangements of the individual guns 21, making up the electron gun assembly 19, are affixed to and supported by a plurality of insulative glass support rods 59. For example, in the embodiment shown in FIGS. 1 and 2, an arrangement of three spatially related longitudinal support rods is employed.

An insulative shielding means 63, formed for example of a glass material, is arranged to substantially encompass at least a portion of the electron gun assembly 19. The shielding is spaced from the interior surface of the envelope neck portion 13 and located relative to the support rods 59 being telescoped or fitted longitudinally over the rods and positioned by attachment means associated with at least one of the rods. As shown in FIGS. 1 and 2, the glass shielding means 63 is substantially cylindrical in shape and is affixed to one of the rods 59 by attachment means 67 in the form of at least one area of bonding frit applied therebetween. Attachment of the shielding sleeve 63 is preferably effected on one rod to allow for possible differential expansions of the gun assembly 19 and the encompassing glass shielding 63 that may result from the processing temperatures encountered during tube fabrication. It is desired that the shielding be substantially snug-fitting on the support rods 59. To achieve this end and to compensate for expansion differentials, a longitudinal slit 71 may be incorporated in the device as indicated in FIG. 2.

Another embodiment of the shielding means is illustrated in FIG. 3, the view of which is of similar orientation in the mount structure to that delineated in FIG. 2. The shielding means 75, in this instance, is formed of a plurality of curved glass leaves 77. As shown, three substantially similarly shaped leaves are positioned in a cooperating manner about the electron gun assembly 19 to collectively provide a peripheral encompassment of at least a portion of the gun structure. Reference is made to FIG. 6 wherein a type of leaf construction is further detailed. Each of the leaves 77 has two opposed substantially arcuate end-oriented edges 79 and 81, and two opposed substantially straight side-oriented edges 83 and 85, respectively. The three curved leaves 77 are collectively arranged with the side edges being adjacently positioned in a lateral relationship to effect the encompassing shielding 75. In this embodiment, each of the curved leaves 77 is attached to a respective individual support rod 59. Appropriate modes of attachment are, for example, areas of compatible high temperature glass frit suitably disposed between adjacent surfaces of the leaf and the support rod. Another attachment means is evidenced in FIG. 6 wherein a plurality of locating pins 89 embedded in the support rod 59 project therefrom to mate with compatible apertures 91 in the shielding means. Circumspect terminal swaging of the pin projecting beyond the shielding surface or the discrete application of a high temperature bonding frit to the pin-aperture region consummates attachment.

Additional embodiments of electron gun shielding are depicted in FIGS. 4 and 5 wherein shielded in-line gun structures 93 are shown. These views are likewise oriented similar to that of FIG. 2. In FIG. 4, the shielding sleeve 95 is substantially rectangular in shape and encompasses an electron gun assembly 97 which in this instance utilizes four similar support rods 99. Attachment of the shield 95 to the related support rods is effected to one of the rods by a suitable deposition of frit 101 or by the pin-aperture arrangement 89, 91 as illustrated in FIG. 6. As with the embodiment shown in FIG. 2, a longitudinal slit 103 can be incorporated into the sleeve to facilitate aforedescribed differential expansion characteristics and effect close adherence of the shielding means to the gun assembly.

In FIG. 5, another form of plural-leaf type shielding 105 is illustrated wherein formed leaves 107, 108, 109 and 110 are separately attached to the individual support rods 99 as, for example, by frit 101 or by a pin-aperture arrangement 89,91.

THe glass materials associated with the electron gun and neck portions of a color cathode ray tube, for example, have melting points well above the temperatures encountered during the processing, wherein the gun assembly 19 is discretely subjected to elevated temperatures, usually by induction heating, to aid in degassing the elements comprising the assembly structure. The glass of the support rods 59, 55 is usually a high silica containing material having a softening point in the neighborhood of 820°–830° centigrade; while the glass composition of the neck portion 13 of the color tube 11, which is further removed from the metallic mass of the gun structure, is normally a high lead content material exhibiting a softening point in the region of 630°–640° centigrade.

During tube processing, the glass support rods are subjected to heat that is both conducted and radiated from the heated metallic electrodes of the gun assembly 19, and may, for example, reach temperature levels

in the region of 500° centigrade. Therefore, the processing temperatures encountered by the shielding means peripherally contiguous to the support rods may be somewhere in the neighborhood of 450° centigrade. Thus, the glass material comprising the various embodiments of shielding encompassments should have a softening point characteristic in excess of 500° centigrade. In each structural embodiment it is preferred that compatible coefficients of thermal expansion to be evidenced for the glass material of the shielding means and for that of the support rods, to which the respective shielding is affixed, and also for the bonding frit when such means of attachment is utilized.

After the basic rod-supported electrode assembly is carefully constructed in a manner to contain a minimum of contaminants, the scrupulously cleaned and substantially degassed shielding means are applied and affixed to the gun assembly. The shielding may cover the most vulnerable portion or the whole of the gun assembly, as may be desired. The shielded gun assemblies are then stored in a clean controlled environment until the time when they are inserted and sealed into the tube envelopes as part of the tube fabrication procedure. It is also in keeping with the concept of the invention for the shielding means to afford an additional advantage, wherein the composition of the glass material is of a nature to provide absorptive shielding of spurious radiations which may, in certain instances, be projected from the electron gun. While the shielding means tends to minimize the entrance of the aforedescribed contaminant materials into the gun assembly, there is the possibility that some contaminants may be present therein before the shielding is applied thereto. In the type of electron gun exemplified in FIG. **1**, the fourth grid **47** operates at a much higher potential than the third grid **45**. Thus, if undesirable conditions are present in the gun structure, *x*-radiations are apt to emanate therefrom in particularly the vicinity of grid three-grid four electrodes, such radiations being primarily due to stray or field emission bombardment of environmental contaminants and electrode surfaces in that region. Therefore, if radiation absorptive compounds are incorporated in the shielding glass composition, an additional advantage is achieved. Such controlling constituents, in amounts necessary to achieve the degree of desired radiation shielding results, are in the form of at least one metallic compound, an oxide for instance, selected from the group consisting essentially of lead, barium and strontium.

Thus, there is provided a shielded cathode ray tube electron gun structure wherein conditions are less conducive for the generation of stray emission, electrical leakage, arcing and the emanation of spurious radiation. The shielding means affords protection for the mount assembly from environmental contaminants, and as a result provides improved operational characteristics.

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.

What is claimed is:

1. An improved electron gun structure for use in a color cathode ray tube having an envelope formed of a neck portion, a funnel portion and a face panel portion whereupon a cathodoluminescent screen is disposed, said electron gun structure being constructed for subsequent orientation within the neck portion of said envelope and comprising:

a plurality of longitudinal arrangements of associated electrodes related in a manner to subsequently provide for generating, forming and focusing a plurality of beams of electrons toward said cathodoluminescent screen;

a plurality of glass support rods spatially oriented peripheral to said electrode arrangements to provide support and affixed positioning for said related electrodes in said gun structure;

a common magnetic convergence assembly contiguous to and extending forward of the terminal electrodes of said gun structure, and having resilient means peripherally associated therewith to effect the subsequent centering of said electron gun structure in the neck portion of said envelope; and

insulative glass shielding means arranged in a substantially encompassing manner about said supported electrode arrangements, said shielding being dimensioned to be spaced from the interior surface of said envelope neck portion when said gun is inserted therein to provide shielding for said electrodes, said glass shielding means being positioned and retained in contiguous bonded relationship to at least one of said support rods in said gun structure, said shielding being oriented immediately to the rear of said convergence assembly.

2. An electron gun structure according to claim **1** wherein said insulative shielding means is fitted longitudinally over the glass support rods and positioned by plural pin attachment means associated with at least one of said rods.

3. An electron gun structure for use in a color cathode ray tube according to claim **1** wherein said insulative shielding means are in the form of a plurality of curved glass leaves whereof each has two opposed substantially arcuate end oriented edges and two opposed substantially straight side oriented edges, said side edges being adjacently positioned in a lateral relationship to collectively form a peripheral encompassment of the plural beam electron gun structure, each of said leaves being attached to an individual of said support rods.

4. An electron gun structure for a color cathode ray tube according to claim **1** wherein the composition of said insulative shielding glass contains an x-radiation absorptive material in the form of at least one metallic compound selected from the group consisting essentially of lead, barium and strontium.

5. A plural beam color cathode ray tube comprising:

an envelope having face panel, funnel and neck portions;

a patterned cathodoluminescent screen disposed on the interior surface of said face panel;

a plural beam electron gun structure located within said envelope neck portion in a manner to project a plurality of electron beams toward said patterned screen, said gun structure being formed of a plurality of sequential arrangements of associated electrodes positionally related by several spatially oriented longitudinal glass support rods;

a common magnetic convergence assembly contiguous to and extended forward of the terminal electrodes of said gun structure and having resilient

means peripherally associated therewith to center said electron gun structure in the neck portion of said envelope; and

insulative glass shielding means arranged in a substantially encompassing manner about said electron gun structure and spaced from the interior surface of said envelope neck portion to provide shielding for said electrodes, said shielding means being positioned and retained in bonded attachment to said gun structure support rods immediately to the rear of said convergence assembly.

6. A color cathode ray tube according to claim **5** wherein said electron gun shielding means is in the form of a sleeve fitted longitudinally over the glass support rods of said electron gun structure in a contiguous manner and positioned thereon by plural pin attachment means associated with at least one of said rods, said glass sleeve material having a softening point in excess of substantially 500° centigrade.

7. A color cathode ray tube according to claim **5** wherein said electron gun insulative shielding means are in the form of a plurality of curved glass leaves whereof each has two opposed substantially arcuate end-oriented edges and two opposed substantially straight side-oriented edges, said side edges being adjacently positioned in a lateral relationship to collectively form a peripheral encompassment of said electron gun structure, each of said leaves being attached to an individual of said support rods, the material of said glass leaves having a softening point in excess of substantially 500° centigrade.

8. A color cathode ray tube according to claim **5** wherein the composition of said electron gun insulative shielding glass contains an *x*-radiation absorptive material in the form of at least one metallic compound selected from the group consisting essentially of lead, barium and strontium.

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