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**[54] ELECTRON GUN HAVING CONCAVE COINED
GRID AND ANNULAR RIB
3 Claims, 4 Drawing Figs.**

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R, 69 C, 70 C, 348, 83 X

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ABSTRACT: A plural electrode electron gun comprises a cathode and related first and second grid electrodes having compatibly shaped adjacent functional surfaces. The apertured functional portion of the first grid is formed in a concave manner with the concavity thereof facing away from the cathode; the first grid having an aperture concavely coined within the concavity. The superfluous material resultant from the aperture coining is utilized adjacent thereto in forming an axially oriented annular rib which is shaped to protrude within the concavity. The second grid electrode has a compatibly shaped functional portion formed to functionally cooperate with the concave portion of the first grid electrode.

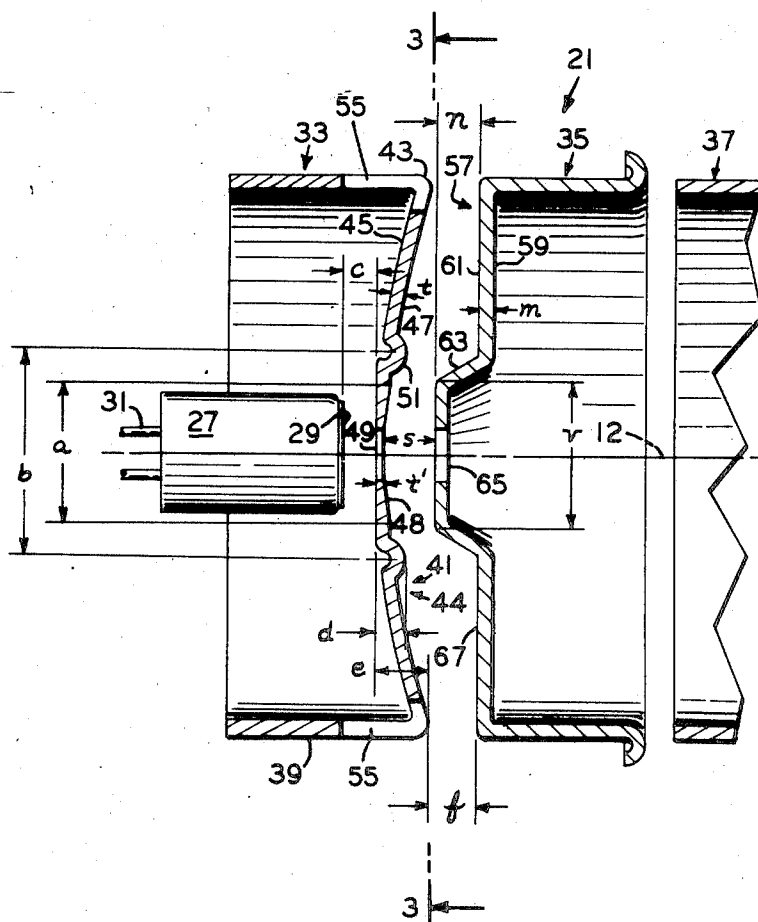


Fig. 3

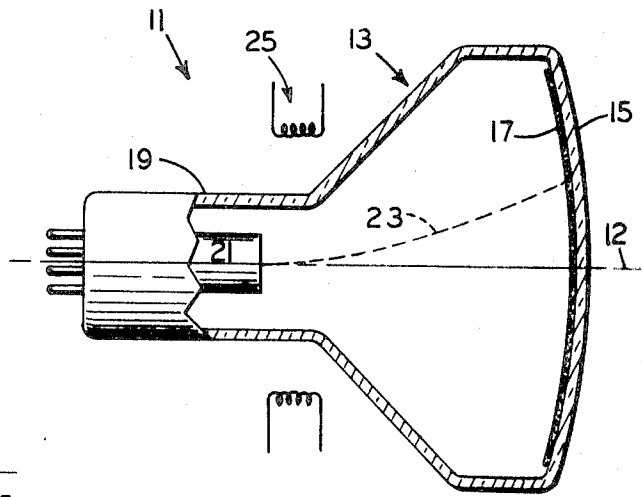
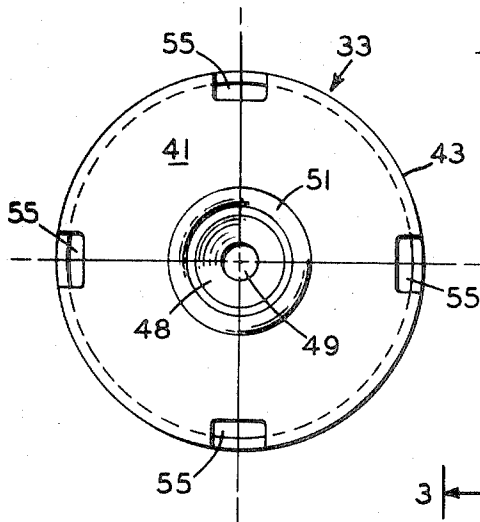


Fig. 1

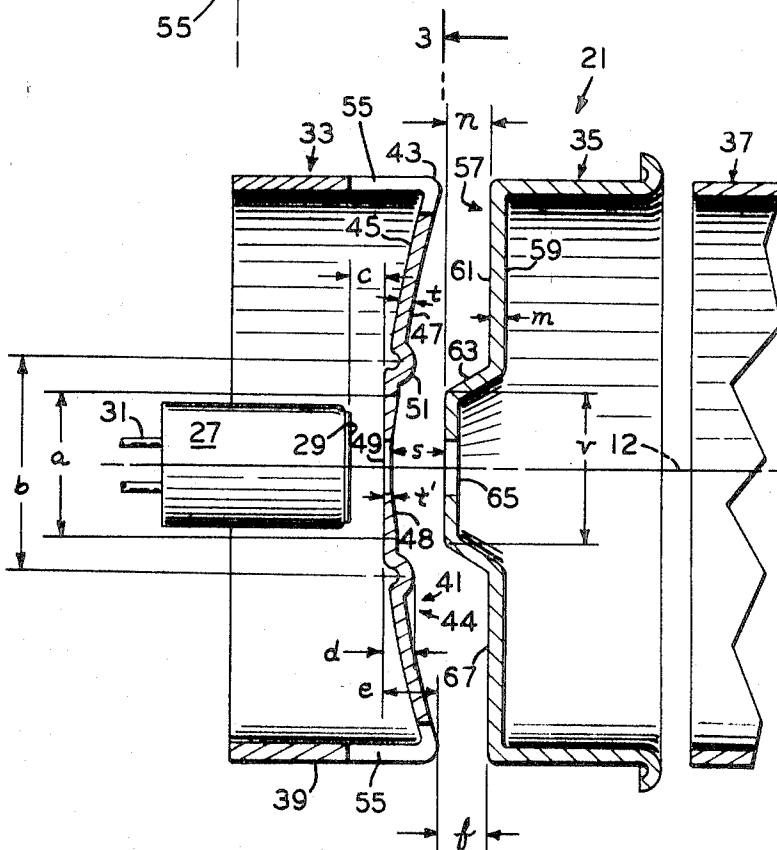


Fig. 2

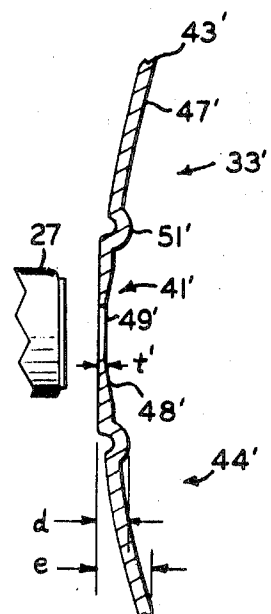


Fig. 4

ELECTRON GUN HAVING CONCAVE COINED GRID AND ANNULAR RIB

BACKGROUND OF THE INVENTION

This invention relates to cathode ray tubes and more particularly to the relationship between the first and second grid electrodes in an electron gun structure.

In certain types of CRT electron guns most of the cathode structure is usually encompassed by a cup-shaped first grid electrode wherein the apertured closed end is usually planar. In those instances where a thin first grid aperture is desired, a coined aperture shaping may be employed wherein the superfluous material resultant from coining is usually accommodated in an annular take-up-rib formed adjacent the coining which promotes flattening of the aperture. This rib is also intended to function as a strengthening structure in an endeavor to minimize in-and-out expansive and contractive thermal movement of the substantially planar closed end of the grid, but positional stability is difficult to maintain when a planar surface is adjacent the heated cathode. Any in-and-out movement of the functional planar grid surface is deleterious as it directly affects consistent spacing between the first and second grid apertures. Since the critical spacing between the apertured surfaces of the first and second grid electrodes is usually of a relatively close dimension, it has been conventional practice to form the first grid rib inwardly away from the outer surface thereof.

In first grids employing a regular uncoined aperture, one or more inspection openings have been sometimes incorporated into the sidewall or skirt portion of the first grid electrode to facilitate visual inspection and adjustment of the spacing between the cathode and the first grid aperture. When coined apertures are employed, the inherent inwardly extending take-up-rib obstructs the view of the cathode-grid aperture spacing and thereby eliminates the desired utility of the inspection opening.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and to provide an improved cathode ray tube electron gun structure wherein the functional surfaces of the first and second grid electrodes have a discretely formed relationship.

A further object is to provide an electron gun structure wherein the cathode to first grid electrode spacing can be expeditiously effected and substantially stabilized.

Another object is the provision of a first grid electrode structure wherein the apertured end closure and skirt portions are formed in a manner to achieve and maintain accurate spacing of the cathode positioned therein.

The foregoing objects are achieved in one aspect of the invention by the provision of an electron gun comprising a cathode and a plurality of sequential electrodes including first and second grid electrodes having adjacent related functional surfaces. The functional portion of the first grid is formed in a concave manner to provide a concavity of defined depth. A beam defining aperture therein has the immediately surrounding material reduced in thickness by concave coining oriented within the concavity. The superfluous material resultant from the coining is utilized in forming an axially oriented annular rib which protrudes within the concavity adjacent the coined aperture. Thus, there is no rib material extending beyond the flattened surface of the aperture toward the cathode. The second grid electrode has an apertured functional portion that is formed to be compatible with the concave functional portion of the first grid.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a cathode ray tube wherein the invention is utilized;

FIG. 2 is an enlarged sectional view of a portion of the electron gun structure employing the invention;

FIG. 3 is a plan view illustrating the end closure portion of the first grid electrode taken along the line 3—3 of FIG. 2; and

FIG. 4 is a sectional view of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

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 aforesaid drawings.

With reference to the drawings, there is shown in FIG. 1, a cathode ray tube 11 having an axis 12 and comprising an envelope 13 whereof the face plate or viewing panel 15 has a cathodoluminescent screen 17 formed on the inner surface thereof. Positioned within the neck portion 19 of the envelope is at least one electron gun structure 21, not detailed, which includes a cathode and a plurality of sequentially arranged electrodes. These cooperating electrode elements are formed and spaced to provide the source, acceleration and control of the electron beam 23 which is controllably deflected by coils 25, positioned externally of the envelope, to effect predetermined impingement on the screen 17 and thereby provide an image display raster therein. As shown, the axes of the electron gun 21 and the tube 11 are substantially coincidental, but such axes relationship is not intended to be limiting.

In referring to FIG. 2, there is shown an enlarged sectional view of the rear portion of the electron gun structure 21 which is oriented in the neck portion 19, not shown. This portion of the electron gun 21 comprises a thermionic cathode structure 27 having an external electron emissive area 29 and an internally positioned heating element 31. By way of illustration, a substantially cup-shaped first grid electrode 33 is shown but is not to be considered limiting. This first grid is positioned to encompass at least part of the cathode 27. A second grid electrode 35 is oriented in spaced axial relationship to the first grid 33, and a first anode electrode 37, a portion of which is shown, is spacedly positioned therebeyond. Conventional means, such as studs and glass rods, are utilized to support these several electrodes in axial alignment, but since such support means are not part of the invention they are not illustrated in the drawings. To add clarity to the description, certain illustrative dimensions will be given in the course of this specification, but in no manner are they to be considered limiting.

In greater detail, with reference to FIGS. 2 and 3, the first grid electrode 33, which for example may be formed from nonmagnetic stainless steel of substantially 0.007 inches thickness, has a substantially cylindrical skirt portion 39 and a functional or end closure portion 41 which is integrally joined to the skirt portion 39 at a common peripheral transition rim 43. The functional or closure portion 41, which has a material thickness "t", is formed as an inwardly oriented concave shaping providing a concavity 44 of defined depth "e" to impart strengthened positional stability to the closure having inner and outer surfaces 45 and 47 respectively. A beam-shaping aperture 49 is formed as a substantially axially oriented bore in the concave closure portion 41, and the closure material thickness immediately surrounding the aperture 49 is reduced by a concave coining 48 within the concavity 44 relative to the outer surface 47 of the closure portion 41. By this coining operation a beneficial reduction in thickness of material "t" is achieved at the aperture 49. This reduced aperture thickness in conjunction with the distance "c", such as 0.005 inches, between the emissive portion 29 of the cathode 27 and the inner surface 45 of the first grid functional or closure portion 41 constitutes a critical dimension (c+t') which is desirably small, being in the order of 0.008 inches. The concave coining 48 or gradual reduction in material thickness is effected within a substantially axially oriented circular area diametrically dimensioned by a "a" which may be approximately 0.090 inches. The superfluous material displaced as a result of the coining operation is utilized in the forming of an axially oriented annular support rib 51 which protrudes within the concavity 44 as part of the outer surface 47 of the closure adjacent the coined area 48. This annular rib 51 is laterally

defined by a diametrical dimension "b" having a value such as 0.150 inches. It has an overall height "d" of approximately 0.015 inches which is less than the overall concavity depth "e" of the closure 41, that being approximately 0.020 inch. At no time should the support rib 51 extend above the plane of the peripheral rim 43.

At least two substantially diametrically opposed inspection windows 55 are formed in substantially the skirt portion 39 at substantially the peripheral transition rim 43. By being edged into the periphery of the closure portion 41 these window areas 55 afford ample unobstructed viewing of the cathode area 29 in relation to the inner surface of the beam forming aperture region 49. By this means the cathode can be accurately positioned and inspected.

A second grid electrode 35 having a material thickness such as 0.007 inches is spacedly positioned relative to the concave outer surface of the first grid electrode 33, as denoted by the spacing "f" of approximately 0.025 inches. The second grid functional or end closure portion 57 has inner and outer surfaces 59 and 61 respectively with a substantially uniform material thickness therebetween. An axially related central portion 63 having an axial aperture 65 therein is formed to protrude outwardly from a substantially flat circumferential portion 67, by a dimension "n", toward the concavity of the first grid electrode 33. This protruding dimension "n" may be for example 0.020 inch, which in conjunction with the spacing of "f" provides the desired interelectrode aperture spacing "s". In keeping with the invention, the dimension "n" may be larger or smaller than the spacing "f" depending on the interelectrode spacing "s" desired. In this instance, the central protruding portion 63 has diametrical dimension "v" which is less than the diametrical dimension "b" of the first grid annular support rib 51, but there may be grid relationships wherein "v" is greater than "b".

The electron gun structure 21 further comprises a substantially cylindrical first anode electrode 37 located screenward of and in spaced axial relationship to the second grid electrode 35. Additional sequentially positioned cooperating electrodes may be included in the gun structure in accordance with the particular gun design utilized.

With reference to FIG. 4, there is shown another embodiment of a first grid electrode structure 33' wherein the skirt portion is eliminated. Such grid construction is sometimes utilized in certain types of gun assemblies. By this invention, the function portion 41' is concavely formed to provide a concavity 44' having a defined depth "e". The coined aperture 48' and the supporting rib 51' are structures similar to counterparts already described. The annular rib 51' protrudes within the concavity 44', but does not extend above the plane of the peripheral rim 43'. A first grid of this structure is suitably positioned by support means, not shown, which are extended in a conventional manner beyond the peripheral rim 43' to be embedded, for example, in commonly employed glass support means, not detailed.

Thus, an improved cathode ray tube electron gun structure is provided wherein the functional closure surface 41 of the first grid electrode 33 is discretely formed to effect a stabilized cooperative relationship with the compatibly formed second grid electrode 35. Additionally, the first grid electrode 33 is formed in a manner to facilitate optical adjustment of the cathode thereby expeditiously effecting cathode-to-first-grid electrode spacing of desired accuracy. While the aforescribed structural recitations are applicable to cathode ray tube electron guns of any size, they are particularly advantageous in constructing miniaturized gun assemblies having critically close electrode spacings and utilizing electrode apertures of small sizes, for example, those of 0.020 inch and smaller.

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 scope of the invention as defined by the appended claims.

I claim:

1. A cathode ray tube electron gun having a cathode and a plurality of sequential electrodes formed and spaced therein to provide the source, acceleration and control of an electron beam, said gun having an axis and comprising in combination: a first grid electrode spacedly positioned relative to said cathode, said first grid having a functional portion with an axis therethrough, said portion being formed in a concave manner having a defined depth with the concavity thereof facing away from said cathode, a beam control aperture formed as a substantially axial bore through said functional portion, said material thickness immediately surrounding said aperture being of reduced thickness provided by concave coining of the material relative to the outer surface of said concavity; an axially oriented annular rib formed in said functional portion in a manner to protrude within said concavely adjacent said coined aperture therein, said protruding rim being of a height not exceeding the depth of the concavity of said functional portion; and a second grid electrode having an axis and a functional portion protruding outwardly toward the concavity of said first grid electrode, said functional portion having a diameter less than that of said annular rib.

2. A cathode ray tube electron gun according to claim 1 wherein said first grid electrode is formed as a substantially cup-shaped structure having a substantially cylindrical skirt portion joined to said concave functional portion at a common peripheral transition rim; said concavity formed functional portion providing an end closure for said cup-shaped structure.

3. A cathode ray tube electron gun according to claim 2 wherein said substantially cup-shaped first grid electrode has at least two substantially opposed inspection openings formed in said skirt and functional portions at substantially the peripheral transition rim thereof.

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