

ELECTRON GUN ASSEMBLY

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The electrode members of an inline electron gun assembly are serially arranged to accelerate and focus a plurality of electron beams along spaced, co-planar electron beam paths. The electrode members of the gun assembly are mechanically secured by means of attachment tabs and studs to at least a pair of insulative support rods which extend along the beam paths. Each of the electrode members commonly has several spatially-related apertures formed therein to accommodate the respective electron beams generated within the electron gun assembly. It is important that these several apertures be accurately located and aligned relative to the related apertures in adjacent electrode members, and to the respective electron generating surfaces. During the fabrication of the electron gun assembly, the attachment tabs and studs of the various electrode members are embedded into the temporarily heat-softened insulative support rods, at which time the support rods on opposed sides of the gun assembly are pressured inwardly toward the electrode members to force the attachment tabs and studs into the support rods. The pressure tends to exert a distorting force upon the several deep drawn, cup-shaped electrode members which comprise the main focus lens of the electron gun assembly.

30 Most experience to date with conventional deep drawn, cup-shaped electrodes, having sidewalls up to about 12.7mm long, shows that these electrodes tend to develop a negative or concave "oil-canning" tendency; i.e., the sidewall of the electrode tends to bow inwardly toward the electron beam axes. When studs are welded to opposite

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sides of the sidewall of such electrodes, exact positioning and welding is difficult because of the variable slope and degree of negative "oil-canning" that occurs.

5 An even greater problem has been encountered in
electron guns in which ultra-deep drawn, cup-shaped
electrodes have sidewalls about 19.05mm long. In such
ultra-deep drawn electrodes, a critical thinning of the
sidewall occurs. The apex of the "oil-canning" in these
10 electrodes occurs about 10.16mm from the support flange
located at the open end of the electrode. In the vicinity
of the apex, the sidewall thins from the desired thickness
of about 0.25mm to about 0.19mm. If the "oil-canning" is
negative or concave on both sides of the sidewall, the
15 problem of stud positioning is similar to that of the
shorter deep drawn electrodes described above; however, if
the "oil-canning" of one side of the sidewall is positive
or convex and the other side is negative or concave, or if
both sides exhibit positive or convex "oil-canning", a new
20 phenomenon occurs. During the beading operation in which
the insulative support rods are heated to a molten state
and formed into contact with the attachment tabs and studs
of the electron gun, the positive or convex "oil-canning"
sidewall is forced inward by the stud attached to the
25 sidewall of the previously convex surface.

The inward displacement of the previously convex
sidewall acts like a loaded spring. As soon as the arms
of the beading apparatus retract at the end of the beading
cycle, the compressed sidewall of the electrode tends to
30 return to its previous convex position forcing the
insulative support rods, which are still in a plastic
state, to bulge outwardly. Shear forces are thereby
introduced into the insulative support rods during the
cooling-deflection cycle, causing the support rods to
35 crack in the vicinity of the attachment tabs or studs.

Even in electron guns in which the stress forces
are not sufficiently great to crack the support rods, the
varying degree of "oil-canning" of the sidewalls can cause

a side-to-side displacement or offset of the ultra-deep drawn electrode relative to the other electrode members of the main focus lens. This results in a change of aperture locations relative to those in the adjacent electrode members, and produces deleterious inter-electrode spacing relationships and distortion in the electron beam trajectories.

U.S. Patent No. 4,484,102, issued to J. R. Hale on November 20, 1984, discloses a structure for strengthening the sidewall of a conventional deep drawn electrode. The structure described therein comprises a wedge-shaped shoulder that is formed in opposite parallel sides of the sidewall of a deep drawn substantially rectangular cup-shaped member. The wedge-shaped shoulder projects outwardly at an acute angle of about 45 degrees from the sidewall and extends into the supporting flange of the electrode adjacent to the attachment tabs. This structure is insufficient to prevent flexure of the sidewall of ultra-deep drawn electrodes.

A structure for ruggedizing planar electrode members, which are commonly used as the control and screen grid electrodes of an electron gun assembly, is disclosed in U.S. Patent Nos. 4,049,990 and No. 4,049,991, both issued to F. K. Collins on September 20, 1977. In these patents, intersecting rib-like embossments are formed along the surfaces of the planar electrodes, with at least one of the ribs extending into the attachment tabs. Such a structure strengthens the supporting surface or flange portion of a planar electrode.

In accordance with one aspect of the present invention, there is provided an electron gun assembly for use in a cathode-ray tube, said gun assembly including a beam forming region and a main focus lens for generating and directing a plurality of electron beams along spaced, co-planar beam paths, said beam forming region and said main focus lens being longitudinally spaced along a plurality of insulative support means, said main focus lens including at least one substantially cup-shaped member having a base portion adjacent to one end, a

supporting flange portion substantially parallel to the base portion at the oppositely disposed other end and a sidewall extending therebetween, said supporting flange portion including attachment means to facilitate securing said member to said insulative support means; wherein said sidewall includes a plurality of reinforcing ribs formed therein and extending longitudinally substantially from said one end adjacent to said base portion to said supporting flange portion, to minimize flexure of said sidewall resulting from securing said member to said insulative support means.

In accordance with another aspect, there is provided an electron gun assembly for use in a cathode-ray tube, said gun assembly including three co-planar cathodes, a control grid electrode, a screen grid electrode and at least two focus electrodes longitudinally spaced along at least two glass support rods in the order named, at least one of said focus electrodes comprising a first and a second substantially rectangular cup-shaped members joined together at their open ends, at least one of said cup-shaped members having a supporting flange portion located at the open end and a base portion located adjacent to the opposite end, said base portion being substantially parallel to said supporting flange portion and being connected thereto by a sidewall having opposed sides and opposed end portions, said base portion having three inline apertures therethrough, said supporting flange portion including a plurality of attachment tabs projecting outwardly therefrom, said tabs being adjacent to each of said opposed sides of said sidewall, and at least two studs attached to said sidewall, one stud being attached to each of said opposed sides, said studs and said attachment tabs being embedded into said glass support rods to secure said member thereto; wherein said sidewall includes a pair of reinforcing ribs formed in each of said opposed sides thereof, said ribs extending longitudinally substantially from said supporting flange to the opposite end of said

sidewall to minimize flexure of said opposed sides of said sidewall in the vicinity of said studs during the embedment of said studs and said attachment tabs into said glass support rods, thereby maintaining the parallelism of said base portion and said supporting flange portion.

In the drawings:

FIGURE 1 is a partially broken-away side elevational view of an improved electron gun assembly incorporating a novel cup-shaped electrode having reinforcing means.

FIGURE 2 is a partially broken-away front elevational view of the electron gun of FIGURE 1.

FIGURE 3 is a plan view of one embodiment of the novel electrode of FIGURE 1.

FIGURE 4 is a sectional view taken along line 4-4 of FIGURE 3.

FIGURE 5 is a plan view of a second embodiment of the novel electrode of FIGURE 1.

FIGURE 6 is a sectional view taken along line 6-6 of FIGURE 5.

FIGURES 1 and 2 show structural details of an improved inline electron gun assembly 10 centrally mounted in the neck 11 of a cathode-ray tube, CRT, 13. The CRT 13 includes an evacuated envelope (not shown) closed at the neck end by a glass stem 15 having a plurality of leads or pins 17 extending therethrough. A base 19 is attached to the pins 17 outside the envelope. A faceplate (not shown), having a viewing screen, closes the other end of the envelope. A funnel (not shown) extends between the faceplate and the neck 11 of the envelope.

The inline electron gun assembly 10 is designed to generate and focus three electron beams along spaced, co-planar convergent beam paths having a common, generally longitudinal direction toward the viewing screen. The gun assembly 10 comprises two insulative support means 23, which are preferably glass support rods, by which the various components are supported to form a coherent unit

in a manner commonly used in the art. These components include three substantially equally transversely-spaced, co-planar cathodes 25 (one for producing each beam), a control-grid electrode 27 (also referred to as G1), a
5 screen-grid electrode 29 (also referred to as G2), a first focusing electrode 31 (also referred to as G3), a second focusing electrode 33 (also referred to as G4), and a shield cup 35, longitudinally-spaced in that order along the support rods 23. The electrodes 31 and 33 form the
10 main focus lens of the electron gun assembly 10. The various electrodes of the gun assembly 10 are electrically connected to the pins 17, either directly or through metal ribbons 37. The gun assembly 10 is held in a
15 predetermined position in the neck 11 on the pins 17 and with snubbers 39, on the shield cup 35, which press on and make contact with an electrically conducting internal coating 41 on the inside surface of the neck 11. The
20 internal coating 41 extends over the inside surface of the funnel and connects to the anode button (not shown). A conventional getter assembly (not shown) is attached at one end to the cup 35 and extends in cantilever fashion in the funnel of the envelope.

The first focusing electrode 31 comprises first and second substantially rectangular cup-shaped members 43
25 and 45, respectively, while the second focusing electrode 33 comprises first and second substantially rectangular cup-shaped members 47 and 49, respectively. The cup-shaped members are joined together at their open ends. One of the cup-shaped members 45 is shown in FIGURES 3 and
30 4. The cup-shaped member 45 is an ultra-deep drawn part comprising a supporting flange portion 51, located at the open end, and a base portion 53, located adjacent to the opposite end. The base portion 53 is substantially
35 parallel to the supporting flange portion 51. Three inline beam-defining apertures 55 are formed through the base portion 53. A sidewall 57, having substantially parallel opposed sides 59a and 59b and opposed end portions 61a and 61b, extends between the supporting

flange portion 51 and the base portion 53 of the cup-shaped member 45. As described in U.S. Patent No. 4,484,102, referenced above, at least one protuberance 63 projects outwardly at an acute angle from each of the opposed sides 59a and 59b of the sidewall 57 and extends into the supporting flange portion 51. A plurality of attachment tabs 65 are formed in the supporting flange portion 51, adjacent to each of the opposed sides 59a and 59b of the sidewall 57, to facilitate attaching the cup-shaped member 45 to the glass support rods 23. As shown in FIGURES 1 and 2, a pair of studs 67 are attached to the sidewall 57, one stud to each of the opposed sides 59a and 59b. The studs 67 and the attachment tabs 65 are embedded into the support rods 23. The sidewall 57 of the cup-shaped member 45 has an overall length of about 19.05mm and a nominal thickness of 0.25mm. As discussed herein, in ultra-deep drawn electrodes such as cup-shaped member 45, there is a tendency for thinning to occur in the sidewall 57. The thinned sidewall 57 will "oil-can", i.e., bow either inwardly or outwardly, unless the sidewall is strengthened. It is impractical to increase the sidewall thickness by increasing the thickness of the metal used to fabricate the cup-shaped member, since this causes manufacturing difficulties. Accordingly, the member incorporates a way of increasing the rigidity of the sidewall 57 without introducing other problems. As shown in FIGURES 3-4, reinforcing means, e.g., a plurality of reinforcing ribs 69, are formed in the oppositely disposed sides 59a and 59b of the sidewall 57, to minimize the flexure thereof. The reinforcing ribs 69 extend substantially longitudinally from the protuberances 63 which extend into the supporting flange portion 51 to the opposite end of the sidewall 57 adjacent to the base portion 53. The reinforcing ribs 69 are directed inwardly toward the oppositely disposed ribs on the opposite sidewall.

A second embodiment of the novel cup-shaped member, 145, is shown in FIGURES 5 and 6. In this

embodiment, the reinforcing means may comprise a plurality of reinforcing ribs 169, which are directed outwardly toward the attachment tabs 165, and which extend longitudinally along the sidewall 157 substantially from the supporting flange portion 151 to the opposite end adjacent to the base portion 153. While no protuberances are shown in FIGURES 5 and 6, it should be clear to one skilled in the art that they may be included to provide additional reinforcing of the sidewall 145 adjacent to the supporting flange portion 151.

While the reinforcing ribs 69 and 169 are described with reference to ultra-deep drawn cup-shaped members having a length of about 19.05mm, the reinforcing ribs of the present invention may be used in cup-shaped members of shorter overall length, such as cup-shaped members 43, 47 and 49. It has been determined that the reinforcing ribs 69 and 169 minimize the flexure of the sidewall 57 and 157 during the welding of the studs 67 thereto, and when the cup-shaped members 45 and 145 are attached to the support rods 23, thereby maintaining the parallelism of the base portion to the supporting flange portion of the respective members.

The reinforcing ribs are formed in the cup-shaped member by using, for example, metal stamping techniques known to those skilled in the appropriate art.



CLAIMS:

1. An electron gun assembly for use in a cathode-ray tube, said gun assembly including a beam forming region and a main focus lens for generating and directing a plurality of electron beams along spaced, co-planar beam paths, said beam forming region and said main focus lens being longitudinally spaced along a plurality of insulative support means, said main focus lens including at least one substantially cup-shaped member having a base portion adjacent to one end, a supporting flange portion substantially parallel to the base portion at the oppositely disposed other end and a sidewall extending therebetween, said supporting flange portion including attachment means to facilitate securing said member to said insulative support means; wherein said sidewall includes a plurality of reinforcing ribs formed therein and extending longitudinally substantially from said one end adjacent to said base portion to said supporting flange portion, to minimize flexure of said sidewall resulting from securing said member to said insulative support means.

2. An electron gun assembly as in Claim 1, wherein each of the reinforcing ribs extends from the vicinity of a respective one of the attachment means of said flange portion to said base portion.

3. An electron gun assembly for use in a cathode-ray tube, said gun assembly including three co-planar cathodes, a control grid electrode, a screen grid electrode and at least two focus electrodes longitudinally spaced along at least two glass support rods in the order named, at least one of said focus



1 electrodes comprising a first and a second substantially
rectangular cup-shaped members joined together at their
open ends, at least one of said cup-shaped members having
a supporting flange portion located at the open end and a
5 base portion located adjacent to the opposite end, said
base portion being substantially parallel to said
supporting flange portion and being connected thereto by a
sidewall having opposed sides and opposed end portions,
said base portion having three inline apertures
10 therethrough, said supporting flange portion including a
plurality of attachment tabs projecting outwardly
therefrom, said tabs being adjacent to each of said
opposed sides of said sidewall, and at least two studs
attached to said sidewall, one stud being attached to each
15 of said opposed sides, said studs and said attachment tabs
being embedded into said glass support rods to secure said
member thereto; wherein said sidewall includes a pair of
reinforcing ribs formed in each of said opposed sides
thereof, said ribs extending longitudinally substantially
20 from said supporting flange to the opposite end of said
sidewall to minimize flexure of said opposed sides of said
sidewall in the vicinity of said studs during the
embedment of said studs and said attachment tabs into said
glass support rods, thereby maintaining the parallelism of
25 said base portion and said supporting flange portion.

4. The electron gun assembly as in Claim 3,
wherein said sidewall includes at least one protuberance
formed in each of the opposed sides thereof, said
30 protuberance projecting outwardly at an acute angle from
each of said opposed sides and extending into said
supporting flange, and said reinforcing ribs extending
from said protuberance to the opposite end of the
sidewall.

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5. The electron gun assembly as in Claim 3,
wherein said reinforcing ribs are directly inwardly
towards each other.



6. The electron gun assembly as in Claim 3, wherein said reinforcing ribs are directed outwardly toward said attachment tabs.

7. An electron gun assembly substantially as hereinbefore described with reference to Figures 1,2,3 and 4 or with reference to Figures 1,2,5 and 6.

8. A cathode-ray-tube including an electron gun according to any preceding claim.
