

ELECTRON GUN ASSEMBLY

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5 This invention relates to an electron gun assembly and particularly to an electron gun assembly for use in a multi-beam cathode ray tube in which a plurality of bead straps are utilized to secure the bead straps to at least two support rods.

10 A cathode-ray tube, for example, a television picture tube, usually employs at least one electron gun with an indirectly-heated cathode assembly. Most color television picture tubes employ three such guns. That type of assembly includes a disc-shaped cathode substrate
15 having an electron-emissive coating on the obverse surface thereof and a grid closely spaced from the coating. A coated-wire resistance heater is closely spaced from the other reverse surface of the substrate. The substrate may be supported on a tubular member, which may also contain the heater with two legs of the heater
20 extending therefrom. All of the parts are attached to a pair of common insulating support rods.

Each leg of the heater is indirectly affixed to a common support rod via a heater bead strap. Unlike the
25 grids of the electron gun which are secured between the pair of support rods, each heater bead strap is attached to only one of the support rods. In order to attach the heater bead strap to the support rod, a claw is formed in one end of the bead strap, and the claw is embedded into
30 the support rod at an elevated temperature. Frequently, the claw of the heater bead strap is loosely embedded into the support rod so that the heater is free to move during electron gun operation. Such movement, particularly in a multi-beam cathode ray tube having a
35 plurality of cathodes, produces variations between cathodes and adversely affects the electrical characteristics of the electron gun. Additionally, the movement of the heater bead strap may generate particles

1 from the support rod. Such particles are undesirable since they may cause spots on the screen of the tube.

5 The present invention as set forth in the appended claims provides an improved electron gun assembly wherein means for generating and directing at least one electron beam along a beam path are spaced along a plurality of insulating support means and are attached thereto by attachment means including
10 a main body portion having a pair of closely spaced apart grasping members so configured and angulated (herein meaning disposed at an angle to the body portion or each other) as to increase the retention of the attachment means to the insulating support means.

15 In the drawings:

FIGURE 1 is a broken-away, front elevational view of a prior art electron gun assembly.

20 FIGURE 2 is a broken-away, front elevational view of a portion of the prior art electron gun assembly of FIGURE 1, including an indirectly-heated cathode assembly.

FIGURE 3 is a front plan view of a novel heater bead strap.

25 FIGURE 4 is a side elevational view along section line 4-4 of FIGURE 3.

FIGURE 5 is a broken-away, front elevational view of a portion of an electron gun assembly including an indirectly-heated cathode assembly and the novel heater bead straps in accordance with the present invention.

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35 FIGURE 1 shows structural details of a prior art electron gun assembly mounted in the neck of a cathode-ray tube (CRT). The structure is similar to that described in U.S. Patent 3,873,879, issued to Hughes on March 25, 1975. Except for differences in the
claw

1 structure of the heater and/or cathode assembly bead
straps, the prior art electron gun assembly and the
electron gun assembly in accordance with the present
invention can utilize the same structure; consequently, the
5 detailed description of the structure depicted in FIGURE
1 is applicable to both.

The electron gun is housed in an evacuated
glass envelope 11, which in a complete CRT includes a
rectangular faceplate panel and a funnel having a neck 13
10 integrally attached thereto. A glass stem 15, having a
plurality of leads or pins 17 extending therethrough, is
sealed to and closes the end of the neck 13. A base 19
is attached to the pins 17 outside the envelope 11.

An in-line beaded bipotential electron gun
15 assembly 21, centrally mounted within the neck 13, is
designed to generate and project three electron beams
along coplanar convergent paths having a common,
generally longitudinal direction toward the viewing
screen. The gun assembly comprises two electrically
20 insulating glass support rods or beads 23a and 23b, from
which the various electrodes are supported to form a
coherent unit in a manner commonly used in the art.
These electrodes include three substantially equally
transversely-spaced coplanar cathode assemblies 25 (one
25 for producing each beam), a control-grid electrode 27
(also referred to as G1), a screen-grid electrode 29
(also referred to as G2), a first accelerating and
focusing electrode 31 (also referred to as G3), a second
accelerating and focusing electrode 33 (also referred to
30 as G4), and a shield cup 35, longitudinally-spaced in
that order along the rods 23a and 23b. The various
electrodes of the gun assembly 21 are electrically
connected to the pins 17 either directly or through metal
ribbons 37. The gun assembly 21 is held in a
35 predetermined position in the neck 13 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 13. The

1 internal coating 41 extends over the inside surface of
the funnel and connects to the anode button (not shown).

Each of the support rods 23a and 23b is a
5 parallelepiped member about 11 mm (millimeters) wide by
about 48 mm long by about 4.25 mm thick. The rods 23a
and 23b are formed by compacting or pressing a suitable
glass powder in a mold. The rods are fired or glazed
10 after molding to outgas the material, to fix the
dimensions of the rods, and to strengthen the rods and
make them less likely to chip or crack. The support rods
23a and 23b each have a mounting surface 45 and a beading
support surface 47. A chamfer of about 30° is molded
15 into both longitudinally-extending edges of the rods
adjacent to the beading support surface 47 to facilitate
the subsequent beading operation. The various electrodes
25-33 each include support tabs which are embedded into
the mounting surfaces 45 of the support rods 23a and 23b.
At least two indexing cavities 49 and 51 are formed into
20 each beading support surface 47 of the support rods 23a
and 23b during the molding operation. The indexing
cavities 49 and 51 are located on the center line of the
longitudinal bead axis and facilitate aligning the
support rods during the beading operation. The beading
25 operation is described in U.S. Patent 4,341,545,
issued to Hale on July 27, 1982.

30 As shown in FIGURE 2, the cathode assembly 25
comprises a cathode cup including a sidewall 53 and an
integral endwall 55, which is the cathode substrate. The
sidewall 53 is welded to one end of a cylindrical cathode
sleeve 57, which is welded at its other end to a cathode
35 eyelet 59. A cathode support 61 is welded to the cathode
eyelet 59 and embedded on each side thereof in the glass
support rods 23a and 23b. The outer or obverse side of
the endwall 55 carries a layer 63 of electron emissive
material. A double-spiraled coated wire resistance

heater 65 is located in the sleeve 57. Two heater legs or ends 67 and 69 of the wire heater 65 extend beyond the sleeve 57 and are welded to attachment means including two tab legs 71 and 73, which are welded to two heater connectors 75 and 77, respectively. The heater connectors 75 and 77 are welded to two heater bead straps 79 and 81, respectively. The heater bead straps 79 and 81 are embedded in the glass support rods 23a and 23b, respectively.

The ends of the heater bead straps 79 and 81, which are embedded in the glass support rods 23a and 23b, comprise claw-like members spaced apart along the rods. In the prior art structure, shown in FIGURES 1 and 2, the claws have blunt ends 83 and square corners 85, with a claw cavity 87 designed to capture glass during the beading operation so as to retain the heater bead straps 79 and 81 within the support rods 23a and 23b, respectively. The claw design of FIGURE 2 is quite successful in capturing glass; however, the square corners 85 of the claws cause high stress concentrations in the glass support rods 23a and 23b which result in mechanical and electrical failures. Additionally, the square corners 85 cause a great amount of viscous drag during insertion of the claws into the glass support rods 23a and 23b in the beading operation.

An improved heater bead strap 101 is shown in FIGURES 3 and 4. The improved heater bead strap 101 comprises a main body portion 103 having a distal end 105 and a proximal end 107. The proximal end 107 includes a bifurcated portion or claw comprising a pair of closely spaced apart grasping members 109 and 111 curving towards each other and defining a cavity 112 therebetween. The cavity 112 typically comprises about 60 percent of the width of the proximal end 107 of the heater bead strap 101. The outer edge 113 of each of the grasping members 109 and 111 is formed to have a radius which is typically equal to about the width of one of the grasping members at the narrowest point thereof. Typically, the outer edge has a radius of about

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1 0.51 mm and the inner edge 115 is formed to have a radius
in the order of 0.13 mm to 0.25 mm. To further reduce the
viscous drag of the grasping members 109 and 111, the
forward edge of each grasping member between its inner
5 and outer edges, 115, 113, forms an acute angle _____
_____ with respect to the length of the support rod
in which it will be embedded. To further improve the
retention of the improved heater bead strap 101 within
the support rods, the grasping members 109 and 111 are
10 angled with respect to the main body portion 103 of the
strap 101. Both grasping members 109 and 111 are shown
in FIGURE 4 to have a mutually opposite angulated offset
of about 5 to 30 degrees with respect to the main body
portion 103; however, in extraction tests, which measure
15 the force required to pull the heater bead strap 101 from
the glass support rod, it has been determined that with
only one of the grasping members angulated with respect
to the main body portion 103 of the heater bead strap
20 101, the glass support rod usually fails before the
grasping members of the heater bead strap 101 can be
extracted from the support rod. Table I summarizes the
results of tests performed on the improved heater bead
strap 101.

TABLE I

25	SAMPLE	PENETRATION FORCE kg	EXTRACTION FORCE kg
	A	1.54	15.0*
	B	1.36	14.2+

30 *four of five samples pulled glass
+one of five samples pulled glass

35 In the first series of tests indicated as
Sample A, 5 heater bead straps of the improved design
were embedded in multifirm support rods identical in
composition to the support rods 23a and 23b described
herein. Only one of the grasping members 109 and 111 had
an angulated offset of about 16 degrees with respect to
the main body portion 103 of the heater bead strap 101.
Sample B comprises 5 heater bead straps similar to those
of sample A except that neither of the grasping members
109 and 111 was angulated with respect to the main body

1 portion 103 of the strap 101. For each of the straps in
 samples A and B, the proximal end 107 of the bead strap
 101 was embedded a distance of about 1.78 mm into a glass
 5 support bead identical in composition to the support rods
 23a and 23b. Both the force required to achieve a
 penetration of 1.78 mm and the force required to extract
 the bead strap samples in a direction normal to the
 surface of the support rod were determined, with the
 averages indicated in Table I. Note that in four out
 10 of five instances in sample A, with one of the grasping
 members angulated about 16 degrees with respect to this
 body 103 of the strap 101, the grasping members 109 and
 111 pulled or removed a portion of the glass support bead
 during the extraction test. In other words, the
 15 retention strength of the improved claw exceeded the
 strength of the support bead.

For comparison purposes, the penetration and
 extraction forces were measured on an electrode support
 structure similar in design to that shown in Figures 5
 20 and 6 of U.S. Patent 4,096,408, issued to Bozzay et al. on
 June 20, 1978. The widely spaced pair of support
 tabs described in that patent lacks the
 retention provided by the present novel angulated
 grasping members. The patent
 25 discloses that the support tabs are relatively narrow and
 spaced apart a distance that is preferably equal to
 at least one-half the maximum width of the electrode.
 Three sets of samples C, D and E were
 prepared. Each set of samples included 10 parts. In
 30 sample C, each of the 10 parts had a support structure
 comprising two widely spaced tabs that were straight
 relative to the body of the electrode. Sample D
 comprised a support structure of the same configuration
 as that of sample C; however, the tabs were angulated
 35 about 16 degrees with respect to the body of the
 electrode. Sample E was similar to sample C except that
 the tabs were torsionally rotated or deflected about 30
 degrees. The average penetration force and extraction

1 force for each set of samples were measured, with the
average values listed in TABLE II. In none of the
samples was the retention of the tabs in the glass
5 support bead great enough to cause the tabs to pull glass
during the extraction test. As in the tests summarized
in TABLE I, the samples C, D and E had a tab penetration
distance of about 1.78 mm, and the glass support beads
were identical in composition to the support rods 23a and
10 23b.

TABLE II

SAMPLE	PENETRATION FORCE	EXTRACTION FORCE
	kg	kg
C	0.36	6.9**
D	0.36	5.9***
15 E	0.82	12.35

**two of ten straight tabs were loose in the glass support rod
***five of ten angled tabs were loose in the glass support rod

A comparison of Tables I and II indicates that
superior retention, as measured by extraction force, was
20 achieved using the novel heater bead straps 101 with
angulated grasping members 109 and 111. The poor
retention of the widely spaced tabs of samples C, D and E
can be explained by the inability of the widely spaced
tabs to capture any glass in the area between the tabs.
25 In effect, the tabs of samples C, D and E acted
separately rather than as a securing system like the
closely spaced grasping members 109 and 111 of the heater
bead strap 101.

While the invention is described in terms of a
30 heater bead strap,
it should be clear to one skilled in the
art that the angulated grasping structure may be utilized
on other elements of the electron gun, such as the cathode
assembly support and the claws of the electrode members
35 which are embedded in the support rods 23a and 23b. By
way of illustration, FIGURE 5 shows a cathode assembly
125 including a cathode support 161 embedded in the
support rods 23a and 23b and having an angulated grasping

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1 member with an offset identical to that described herein
for the heater bead strap 101.

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1 CLAIMS:

1. An electron gun assembly having means for generating and directing at least one electron beam along a beam path, said generating and directing means being
5 spaced along a plurality of insulating support means and including attachment means which, to facilitate securing to said insulating support means, includes a main body portion having a pair of closely spaced apart grasping members, each of said grasping members having a forward
10 edge lying at an acute angle with respect to said support means, an inner, leading, edge with a first radius r_1 , and an outer edge with a second radius, r_2 , where $r_1 < r_2$, said edge radii and said acute angle reducing the viscous drag on said grasping members during embedment into said
15 insulating support means, the general planes of said pair of grasping members forming an acute angle with respect to each other to increase the retention of said attachment means to said insulating support means.

20 2. A multi-beam electron gun assembly for use in a cathode ray tube, said gun assembly including a plurality of indirectly heated cathode assemblies and at least two spaced successive electrodes having aligned apertures therein for passage of a plurality of electron
25 beams, said cathode assemblies including a plurality of cathode heaters which are attached to at least two electrically insulating support rods by a plurality of heater bead straps, each including a main body portion having a bifurcated portion comprising a pair of closely
30 spaced apart grasping members defining a cavity therebetween, each of said grasping members having a forward edge lying at an acute angle with respect to said support rods, an inner, leading, edge with a radius r_1 , and an outer edge with a radius, r_2 , where $r_1 < r_2$, said
35 edge radii and said acute angle providing means to reduce the viscous drag on said grasping members during embedment into one of the insulating support rods,



1 the general plane of at least one member of said pair of grasping members forming an acute angle with respect to said main body portion to increase the retention of said heater bead straps to said insulating support rods.

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3. An electron gun assembly as in claim 1 or 2 wherein the general plane of at least one of the grasping members makes an angle of between about 5 and 30 degrees with respect to said main body portion.

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4. An electron gun assembly as in claim 1 or 2 wherein both of said members of said pair of grasping members are formed with their general planes at an acute angle with respect to said main body portion.

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5. An electron gun assembly as in claim 4 wherein said pair of grasping members are formed with their general planes angled in mutually opposite directions with respect to the main body portion, each making an angle of between about 5 and 30 degrees with respect thereto.

6. An electron gun assembly as in claim 3 or 5 wherein said angle with respect to the main body portion is about 16 degrees.

7. An electron gun assembly substantially as hereinbefore described with reference to Figures 3-5 of the accompanying drawings.

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