

IMPROVED ELECTRON GUN

The present invention relates to an improved multi-
5 beam electron gun for a cathode-ray tube and particularly to
such a gun with improved stability with variation in spacings
among a plurality of cathode assemblies and two adjacent grid
electrodes. Electron guns, such as used in shadow mask type
color picture tubes, are designed to generate and direct
10 preferably three electron beams along convergent paths to a
small area of convergence near a screen of a tube. Two
general types of guns in most common use are the inline
electron gun, wherein three beams are initiated at three
points in a line; and the delta electron gun, wherein three
15 beams are initiated at the points of a triangle. Each of
these types has three separate cathode assemblies and a series
of electrodes spaced therefrom. The cathode assemblies and
electrodes are held in place relative to each other by
separate attachment to a plurality of glass rods. The
20 electrode closest to the cathode assemblies is called the G1
and is usually a control grid. The next electrode is called
the G2 and is usually a screen grid. The spacings between the
cathodes and these two grids, as well as between the grids
themselves, are very critical. For example, a change as small
25 as 0.001 inch (0.025 mm) in the spacing between a cathode and
the G1 may change the cutoff voltage of the electron gun by
about 60 volts. Unfortunately, during warmup of a tube having
a gun construction as previously described, the spacings between
the cathodes, G1 and G2 vary to some extent. This varia-
30 tion in spacings causes unstable and nonuniform cutoff
voltages for the beams in a gun, thereby changing
the colors which appear on the tube screen. This nonuniformity
among beams requires additional circuitry for correction.
It is desirable to develop a tube wherein the changes in
35 the spacings between the cathode assemblies and the G1 and
G2 electrodes during tube warmup are uniform.

The present invention is an improvement in a multi-
beam electron gun for use in a cathode-ray tube. Such gun
40 includes a plurality of cathode assemblies and at least two

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spaced successive electrodes having aligned apertures therein. The improvement comprises the cathode assemblies and the two electrodes being individually attached to a single ceramic member. The ceramic member is the sole supporting interconnection within the gun between the cathode assemblies and the two electrodes.

In the drawings

FIGURE 1 is a view of an electron gun without a cathode grid subassembly.

FIGURE 2 is a view of a cathode grid subassembly.

FIGURES 3 and 4 are a cutaway side view and a cutaway top view, respectively, of a complete electron gun wherein the subassembly of FIGURE 2 has been inserted in the remaining gun portion of FIGURE 1.

FIGURES 5 and 6 are graphs of cutoff voltage variations for a prior art gun and for a gun constructed in accordance with one embodiment of the present invention, respectively.

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The details of an improved electron gun 10 are shown in FIGURES 1 through 4. FIGURES 1 and 2 show portions of the gun which, when assembled together, form the completed gun of FIGURES 3 and 4. The gun 10 comprises two glass support rods 12, also called beads, upon which various electrodes of the gun are mounted. These electrodes include three equally spaced inline cathode assemblies 14 (one for each beam), a control grid electrode 16, a screen grid electrode 18, a first accelerating and focusing electrode 20, a second accelerating and focusing electrode 22 and a shield cup 24 spaced from the cathode in the order named.

Each cathode assembly 14 comprises a cathode sleeve 26 closed at the forward end by a cap 28 having an electron emissive coating 30 thereon. The cathode sleeves 26 are supported at their open ends within support tubes 32. Each cathode is indirectly heated by a heater coil 34 positioned within the sleeve 26. The heater coils 34 have legs 36 which are welded to heater straps 38 which, in turn, are welded to support studs 40 that are imbedded in the glass rods 12. The control and screen grid electrodes 16 and 18 are two closely

1 spaced elements each having three aligned apertures centered
with the cathode coatings 30. The control grid 16 is
essentially a flat plate having a peripheral rib 42 extending
around the three apertures. The screen grid 18 is formed
from two elements 44 and 46. The first elements 44 is
5 essentially a flat plate with two parallel flanges 48 extend-
ing therefrom. The second element 46 is also essentially a
flat plate except that the central portion of it is slightly
bulged away from the element 44. Both of the elements 44
and 46 have three apertures therein which are aligned with
10 the apertures of the control grid electrode 16.

The tubes 32 of the cathode assemblies are welded
to an annular member 54 to form a plural-cathode assembly
14' which, with the control and screen grid electrodes 16
and 18, constitute respective components of a separate gun
15 sub-assembly 50 shown in Figure 2. All three of these
components are brazed to metalized areas on surfaces of a
single wafer-shaped piece 52 of flat ceramic. The plural-
cathode assembly 14' is connected to the ceramic wafer 52
via the annular member 54, which is brazed to one side of
20 the ceramic wafer. (It should be noted that the tubes 32
also could be welded directly to the ceramic wafer,)

The control grid electrode 16
is brazed to the opposite side of the ceramic wafer 52 along
its peripheral rib 42. The screen grid electrode 18 is
25 brazed to the ceramic wafer at the ends of the two parallel
flanges 48. It can be seen that the spacing between the
control and screen grid electrodes 16 and 18 is directly
related to the height of the peripheral rib 42 and the length of the
flanges 48, since each contacts the same flat surface of the ceramic
30 wafer 52. Once the cathode sleeves 26 have been inserted into the
support tubes 32, and the distance between the cathode coatings 30 and
the control grid electrode 16 is adjusted to that desired, the sleeves
26 are welded to the tubes 32 to form the completed subassembly 50. The
subassembly 50 attaches to the remainder of the gun by welding the screen
35 grid electrode 18 to a support bracket 55 that extends between the two
glass rods 12. The first accelerating and focusing electrode 20
comprises two rectangularly cup-shaped members 56 and 58

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joined together at their open ends. The bottom portions of each member 56 and 58 have three apertures which are aligned with the apertures of the control and screen grid electrodes 16 and 18. The second accelerating and focusing electrode 22 is also rectangularly cup-shaped with the open end of the electrode 22 facing away from the electrode 20. Three apertures also are in the electrode 22. The middle aperture is aligned with the adjacent middle aperture in the electrode 20. However, the two outer apertures are slightly offset outwardly with respect to the outer apertures of the electrode 20 to aid in convergence of the outer beams with the center beam. The shield cup 24, located at the output of the gun 10, has various coma correction members 60 located on its base around or near the electron beam paths.

It should be noted that the present invention centers around the subassembly 50, and that the remainder of the gun may vary greatly from that as shown. For example, the focusing portion of the gun may be as shown in U.S. Patent 3,932,786, issued to F. J. Campbell on January 13, 1976, which discloses a resistive lens gun; or U.S. Patent 3,946,266, issued to T. Saito et al. on March 23, 1976, which shows single aperture focusing electrodes.

The presently disclosed gun construction, where the cathode assembly and control and screen grid electrodes are constructed as a single subassembly on a ceramic substrate, offers considerable advantages over prior art electron gun construction. In most prior art electron guns, each component is separately attached to the glass rods and therefore subjected to the heat required to soften the rods during assembly of parts. In the present embodiment, none of the components in the subassembly is subjected to this heat which is applied during an operation commonly called the "beading" operation. Because of this, none of the subassembly components is distorted as may occur in prior art tubes.

In one type of prior art electron gun, the cathode is constructed as a subassembly with a cup shaped control grid electrode. This subassembly, however, is attached to the glass rods separately from the screen grid attachment. During tube operation, the glass rods become heated and expand.

1 Since the rods are separated, the heating of the rods may
be somewhat dissimilar thereby causing a difference in
expansion. This is only one possible mechanism that may
5 cause variation in electrode spacings and resulting
variation in cutoff voltages of the beams. Such
variation in cutoff voltages, with increasing time from turn-on,
is shown in the graph of FIGURE 5 for a typical prior art
electron gun. The three curves represent the cutoff voltage
10 variations for the red (R), green (G) and blue (B) beams.
Within a particular gun and tube type, the relative
positions of the curves as well as their individual magnitudes
may vary greatly. The mechanism causing these
variations in cutoff voltages for the prior art guns is not
15 fully understood. Since the variations are non-uniform for
different tubes within a tube type, it is believed that a
combination of factors may be involved. Such factors may
include irregular heating of the glass beads causing
irregular expansion and/or some degree of "oil canning" of
20 the grid electrodes as they are heated. The improvement
that can be realized by incorporating an embodiment of the
present invention into an electron gun is readily apparent
from the graph of FIGURE 6. All three beams track each other
relatively closely during tube warmup. It is believed that
25 this improvement in performance during tube warmup results
from the combination of the attachment of the three cathode
assemblies and the control and screen grids to a single
flat ceramic wafer, and the attachment of the ceramic subassembly
to the glass beads in such manner that the uneven heating and
30 expansion of the beads does not affect cathode-grid spacing.



CLAIMS

1 1. A multi-beam electron gun for use in a cathode-ray tube, said gun comprising a subassembly including a plurality of cathode assemblies and successively spaced control grid and screen grid electrodes having aligned apertures therein for passage of a plurality of electron
5 beams, wherein said grid electrodes are attached to one and the same side of a single ceramic wafer and said cathode assemblies are attached to the other side of said wafer, the supporting interconnection thus afforded between said cathode assemblies on the one hand and said grid
10 electrodes on the other hand via said wafer being the sole supporting interconnection therebetween within the gun.

 2. A multi-beam electron gun according to Claim 1 wherein said cathode assemblies are attached to a common
15 member to form a plural-cathode assembly which is attached to said other side of said wafer by said common member.

 3. A multi-beam electron gun according to Claim 1 or 2, wherein said control grid and screen grid electrodes
20 have projections of respectively different lengths extending therefrom, which contact and are surface-attached to said same one side of said ceramic wafer, said projections being of predetermined lengths to establish a desired spacing between said grid electrodes.

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 4. A multi-beam electron gun according to Claim 3, wherein said projections are in the case of said control grid electrode a circumferential rib and in the case of said screen grid electrode flanges extending from ends thereof.

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 5. A multi-beam electron gun according to any preceding claim wherein said ceramic wafer is flat and includes metalized areas on surfaces thereof to which are welded said cathode assemblies, or plural-cathode assembly
35 as the case may be, and the control and screen grid electrodes.



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1 6. A multi-beam electron gun having a cathode/
electrode assembly substantially as hereinbefore described
with reference to Fig. 2 of the accompanying drawings.

5 7. A multi-beam electron gun substantially
as hereinbefore described with reference to the
accompanying drawings as a whole.

8. A cathode ray tube having a multi-beam electron
gun as claimed in any preceding claim.

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