

5 COLOR PICTURE TUBE AND INLINE ELECTRON GUN.

The present invention relates to a color picture tube and an inline electron gun.

10 An inline electron gun is one designed to generate or initiate preferably three electron beams in a common plane and direct those beams along convergent paths in that plane to a point or small area of convergence near the tube screen. In one type of inline electron gun shown
15 in U. S. Patent 3,873,879, issued to Hughes on March 25, 1975, the main electrostatic focusing lenses for focusing the electron beams are formed between two electrodes referred to as the first and second accelerating and focusing electrodes. These electrodes include two
20 cup-shaped members having bottoms facing each other. Three apertures are included in each cup bottom to permit passage of three electron beams and to form three separate main focus lenses, one for each electron beam. In a preferred
25 embodiment, the overall diameter of the electron gun is such that the gun will fit into a 29mm tube neck. Because of this size requirement, the three focusing lenses are very closely spaced from each other, thereby providing a severe limitation on focus lens design. It is known in
30 the art that the larger the focus lens diameter, the less will be the spherical aberration which restricts the focus quality.

In addition to the focus lens diameter, the spacing between focus lens electrode surfaces is important, because greater spacing, which provides a more gentle voltage
35 gradient in the lens, also reduces spherical aberration. Unfortunately, greater spacing between electrodes beyond a particular limit (typically 1.27mm) generally is not permissible because of beam bending from electrostatic charges on the neck glass penetrating into the space between

45

1 the electrodes, which causes electron beam misconvergence.
In GB-A-2086649 (U.S. Patent Application Serial
Number 201,692, filed October 29, 1980 by Hughes
and Marks), an electron gun is described wherein the
5 main focus lens is formed by two spaced electrodes. Each
electrode includes a plurality of apertures therein, equal
to the number of electron beams, and also a peripheral rim,
with the peripheral rims of the two electrodes facing each
10 other. The apertured portion of each electrode is located
within a recess set back from the rim. The effect of this
main focus lens is to provide the gentle voltage gradient
sought to reduce spherical aberration. Because of the
asymmetrical shape of the peripheral rims of the two
15 electrodes, horizontal and vertical focus voltage components
for the inner and outer guns are not the same. In the
vertical direction, the center electron beam experiences
more focusing action than the beams at the sides, where
the focusing geometry is bounded in part by a circular arc.
20 This is because the penetration of the vertical field is
greater in the slot formed by the peripheral rims than at
the circular boundary. Likewise, the horizontal focusing
component at the outer electron beams may be more active
than at the center beam, because the horizontal field falls
25 away more rapidly at the sides of the peripheral rims than
within the center of the recessed cavity. Therefore, there
is a need to modify the peripheral rim geometry to balance
the focus fields acting on the electron beams.

According to the invention, there is provided
30 a color picture tube having an inline
electron gun for generating and directing three
electron beams, a center beam and two side beams,
along coplanar paths toward a screen of said tube,
said gun including a main focus lens for focusing
35 said electron beams, the main focus lens being formed
by two spaced electrodes in each of which a recess is defined
by a bottom portion of the electrode disposed
transversely to the coplanar paths of said beams with
three in-line apertures therethrough, through which

- 1 respective ones of the beams pass, and by a
peripheral rim upstanding from the bottom portion
which peripheral rim has a transverse portion
parallel to the bottom portion the peripheral rims of
5 the two electrodes facing each other;

wherein the transverse portion of at least
one of the electrodes is narrower at the side beam
paths than at the center beam path, measured
perpendicular to the plane containing the electron
10 beam paths.

Examples in accordance with the invention are illustrated
in the drawings in which:

FIGURE 1 is a plan view, partly in axial section, of a
shadow mask color picture tube in accordance with the invention.

- 15 FIGURE 2 is a partial axial section view of an
embodiment of the electron gun shown in dashed lines in
FIGURE 1.

FIGURE 3 is an axial sectional view of the G3
and G4 electrodes of the electron gun of FIGURE 2.

- 20 FIGURE 4 is a front view of the G4 electrode taken
at line 4-4 of FIGURE 3.

FIGURE 5 is a plan view of the stigmators on the
G4 electrode taken at line 5-5 of FIGURE 2.

- 25 FIGURE 6 is an axial sectional view of the G4
electrode of another embodiment of the electron gun shown in
dashed lines in FIGURE 1.

FIGURE 7 is a front view of the G4 electrode of
FIGURE 6.

- 30 FIGURE 1 is a plan view of a rectangular color
picture tube having a glass envelope 10 comprising a
rectangular faceplate panel or cap 12 and a tubular neck
14 connected by a rectangular funnel 16. The panel
comprises a viewing faceplate 18 and peripheral flange or
35 sidewall 20 which is sealed to the funnel 16. A mosaic
three-color phosphor screen 22 is carried by the inner
surface of the faceplate 18. The screen is preferably
a line screen with the phosphor lines extending
substantially perpendicular to the high frequency raster

17

- 4 -

1

line scan of the tube (i.e., normal to the plane of FIGURE 1).
A multiapertured color selection electrode or shadow mask
24 is removably mounted, by conventional means, in
5 predetermined spaced relation to the screen 22. An
improved inline electron gun 26, shown schematically by
dotted lines in FIGURE 1, is centrally mounted within the
neck 14 to generate and direct three electron beams 28
along coplanar convergent paths through the mask 24 to the
10 screen 22.

15

20

25

30

35



48

- 5 -

1 The tube of FIGURE 1 is designed to be used with
an external magnetic deflection yoke, such as the yoke 30
schematically shown surrounding the neck 14 and funnel 12
5 in the neighborhood of their junction. When activated,
the yoke 30 subjects the three beams 28 to magnetic fields
which cause the beams to scan horizontally and vertically
in a rectangular raster over the screen 22. The initial
plane of deflection (at zero deflection) is shown by the
10 line P-P in FIGURE 1 at about the middle of the yoke 30.
Because of fringe fields, the zone of deflection of the
tube extends axially, from the yoke 30 into the region of
the gun 26. For simplicity, the actual curvature of the
deflection beam paths in the deflection zone is not shown
15 in FIGURE 1.

The details of an embodiment of the gun 26 are
shown in FIGURES 2
through 5. The gun comprises two glass support rods 32 on
which the various electrodes are mounted. These electrodes
20 include three equally spaced coplanar cathodes 34 (one
for each beam), a control grid electrode 36 (G1), a screen
grid electrode 38 (G2), a first accelerating and focusing
electrode 40 (G3), and a second accelerating and focusing
electrode 42 (G4), spaced along the glass rods 32 in the
25 order named. Each of the G1 through G4 electrodes has
three inline apertures therein to permit passage of three
coplanar electron beams. The main electrostatic focusing
lens in the gun 26 is formed between the G3 electrode 40
and the G4 electrode 42. The G3 electrode 40 is formed
30 with four cup-shaped elements 44, 46, 48 and 50. The open
ends of two of these elements, 44 and 46, are attached to
each other, and the open ends of the other two elements,
48 and 50, are also attached to each other. The closed
end of the third element 48 is attached to the closed end
3 of the second element 46. Although the G3 electrode 40
is shown as a four-piece structure, it could be fabricated
from any number of elements, including a single element
of the same length. The G4 electrode 42 also is cup-shaped,
but has its open end closed with an apertured plate 52.

The facing closed ends of the G3 electrode 40 and the G4 electrode 42 have large recesses 54 and 56, respectively, therein. The recesses 54 and 56 set back the portion of the closed end of the G3 electrode 40 that contains three apertures, 58, 60 and 62, from the portion of the closed end of the G4 electrode 42 that contains three apertures, 64, 66 and 68. The remaining portions of the closed ends of the G3 electrode 40 and the G4 electrode 42 form rims 70 and 72, respectively, that extend peripherally around the recesses 54 and 56. The rims 70 and 72 are the closest portions of the two electrodes 40 and 42. It has been found that the vertical focusing action on the center electron beam can be decreased by reducing the width of the rim 72 on the G4 electrode 42, the divergent side of the electrostatic lens formed in and between the recesses 54 and 56. As shown in FIGURE 4, the recess 56 in the G4 electrode 42 is wider at the side beam paths than at the center beam path, the width being measured perpendicular to the plane containing the electron beam paths. It also has been found that the horizontal focusing action on the two outer beams can be decreased by decreasing the length of the recess 56 in the G4 electrode.

The electrode gun 26 of FIGURE 2 provides a main focusing lens having substantially reduced spherical aberration compared to that of prior guns discussed above. The reduction in spherical aberration is caused by an increase in the size of the main focus lens. This increase in lens size results from recessing the electrode apertures. In most prior inline guns, the strongest equipotential lines of the electrostatic field are concentrated at each opposing pair of apertures. However, in the gun 26 of FIGURE 2, the strongest equipotential lines extend continuously from between the rims 70 and 72, so that the predominant portion of the main focus lens appears to be a single large lens extending through the three electron beam paths. The remaining portion of the

main focus lens is formed by weaker equipotential lines located at the apertures in the electrodes. The performance and advantages of an electron gun similar to the electron gun 26 are discussed in above-cited GB-A-2086649 (US Patent Application Serial Number 201,692.)

There is a slot effect astigmatism formed by the main focusing lens as a result of penetration of the vertical focusing field through the open areas of the recesses. This effect is caused by the greater compression of vertical equipotential lines than of horizontal equipotential lines. The field penetration causes the focus lens to have greater vertical lens strength than horizontal lens strength. A correction is made for this astigmatism in the electron gun 26 of FIGURE 2 by the inclusion of a horizontal slot opening at the exit of the G4 electrode 42. One particular embodiment has the slot width one-half the lens diameter and is spaced from the opposite surface of the G4 electrode at 86 percent of the lens diameter. This slot is formed by two strips 96 and 98, shown in FIGURES 2 and 5, welded to the apertured plate 52 of the G4 electrode 42 so as to extend across the three apertures therein in the plate 52.

To statically converge the two outer beams with the center beam, the length "E" of the recess 56 in the G4 electrode 42 is slightly greater than the length "F" of the recess 54 in the G3 electrode 40 (FIGURE 3). The effect of the greater recess length in the G4 electrode 42 is the same as that discussed with respect to the offset apertures in U. S. Patent 3,772,554, issued to Hughes on November 13, 1973.

Some typical dimensions for an electron gun such as the electron gun 26 of FIGURE 2, but without the slot formed by strips 96 and 98, are presented in the following table.

51

1

- 8 -

TABLE

5	External diameter of tube neck - - - - -	29.00mm
	Internal diameter of tube neck - - - - -	24.00mm
	Spacing between G3 and G4 electrodes 40 and 42 - -	1.27mm
	Center-to-center spacing between adjacent apertures in G3 electrode 40 (A in FIGURE 3) - - - - -	6.6 mm
10	Inner diameter of apertures 58, 60 and 62 in G3 electrode 40 (B in FIGURE 3) - - - - -	5.4 mm
	Width at center beam path of recess 56 in G4 electrode 42 (C in FIGURE 4) - - - - -	6.30mm
15	Width near outer beam paths of recess 56 in G4 electrode 42 (D in FIGURE 4) - - - - -	7.02mm
	Length of recess 56 in G4 electrode 42 (E in FIGURE 3) - - - - -	20.7 mm
	Length of recess 54 in G3 electrode 40 (F in FIGURE 3) - - - - -	20.2 mm
20	Depth of recess in the electrodes 40 and 42 (G in FIGURE 3) - - - - -	1.65mm
	Width of G3 electrode - - - - -	6.99mm

25 In various other inline electron gun embodiments, the depth "G" of the recesses in the electrodes 40 and 42 may vary from 1.30mm to 2.80mm, and the depths of these recesses in the two electrodes 40 and 42 may vary from each other.

30 Although the G4 electrode 42 of the gun 26 embodiment of FIGURES 2 through 5 is shown as a single, cup-shaped element, it could be fabricated from, e.g., two elements. Thus, FIGURES 6 and 7 depict a G4 electrode 100 of another embodiment of the electron gun 26 shown in
35 FIGURE 1. The G4 electrode 100 comprises a first,

- 1 plate-like element 102, containing three apertures 104,
106 and 108 therein, and a second, tub-shaped rim element
110 attached to the first element 102 comprising a wall
portion 116 upstanding from the element 102, and a portion
5 114 extending inwardly perpendicular to the plane of the
beam paths. The second element 110 has an opening 112,
facing the G3 electrode (not shown) of the gun. The first
element 102, in combination with the second rim, element
110 defines a large recess 118 in the G4 electrode 100.
10 The recess 118 acts to set back the portion of the G4
electrode 100 that contains the three apertures 104, 106
and 108 from the aperture-containing portion of the G3
electrode. Similarly to the rim 72 of the G4 electrode
42 as shown in the Figure 4, the portion 114 of the rim
15 element 110 of the G4 electrode 100 shown in Figure 7 is
narrower at the side beam paths than at the center beam
path.

53

1 CLAIMS:

1. A color picture tube having an inline electron gun for generating and directing three electron beams, a center beam and two side beams, along coplanar paths toward a screen of said tube, said gun including a main focus lens for focusing said electron beams, the main focus lens being formed by two spaced electrodes in each of which a recess is defined by a bottom portion of the electrode disposed transversely to the coplanar paths of said beams with three in-line apertures therethrough, through which respective ones of the beams pass, and by a peripheral rim upstanding from the bottom portion which peripheral rim has a transverse portion parallel to the bottom portion the peripheral rims of the two electrodes facing each other;

wherein the transverse portion of at least one of the electrodes is narrower at the side beam paths than at the center beam path, measured perpendicular to the plane containing the electron beam paths.

2. A tube according to claim 1 wherein the recess in said one electrode wider at said side beam paths than at said center beam path, measured perpendicular to said plane containing said electron beam paths.

3. A tube according to claim 1, wherein the said rim comprises a wall portion upstanding from the said bottom portion and the said transverse portion, which is spaced from the bottom portion by the wall portion, and extends inwardly of the recess perpendicular to the said plane.

4. An electron gun substantially as hereinbefore described with reference to Figures 2 to 5 optionally as modified by Figures 6 and 7.

5. A color picture tube substantially as hereinbefore described with reference to Figures 1 to 5 optionally as modified by Figures 6 and 7.

