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# [54] COLOR TUBE HAVING GROUND PLANE BETWEEN FOCUS ELECTRODES AND SCREEN GRIDS

**1 Claim, 2 Drawing Figs.**

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[51] **Int. Cl.** ..... **H01j 29/02,** H01j 29/06, H01j 1/00
[50] **Field of Search** ..... 313/82, 313

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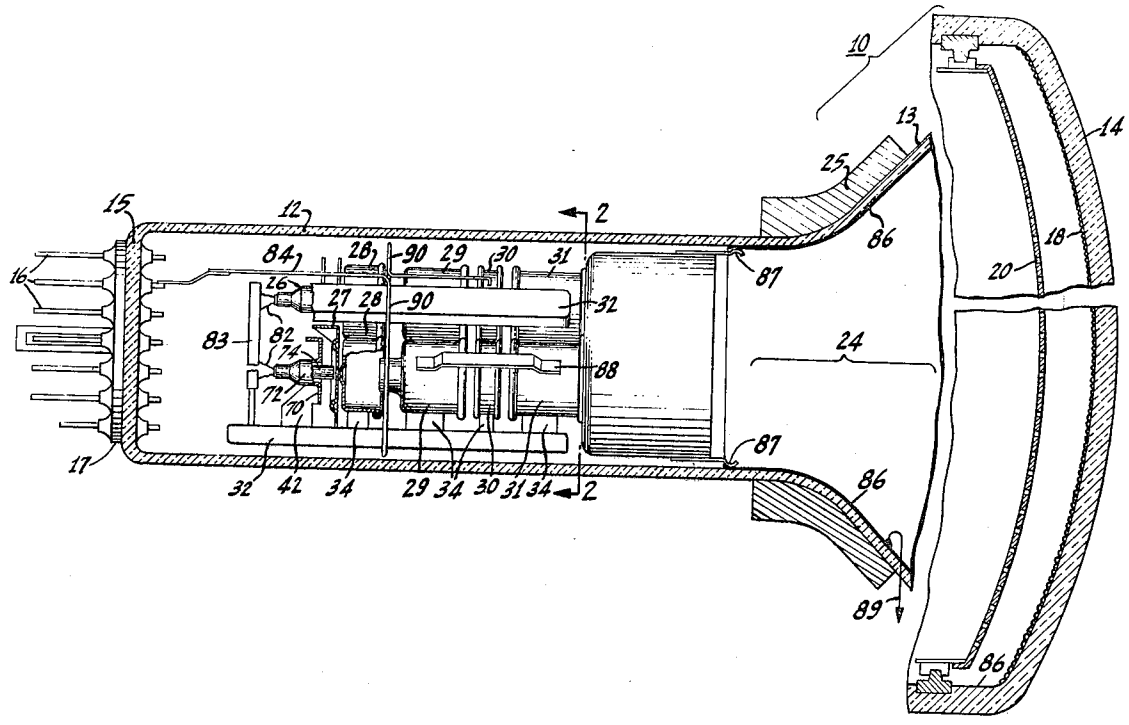
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**ABSTRACT:** A color picture tube having a glass envelope neck portion containing a triple-beam electron gun assembly, comprising a group of low-voltage electrodes and an adjacent group of high-voltage electrodes for each beam, is provided with a low-voltage suppressor ring surrounding and spaced outwardly from and disposed substantially in the plane of the beam accelerating gaps between the next adjacent low- and high-voltage electrodes, for establishing a transverse ground plane at those gaps and thereby shielding the external surfaces of the low-voltage electrodes from the high electric fields of the first high-voltage electrodes. In the example given, the low-voltage electrodes for each beam include a cathode, control grid and screen grid, and the high-voltage electrodes for each beam include two connected spaced electrodes which cooperate with an intermediate low-voltage electrode to form an "einzel" focus lens, and the suppressor ring is a wire that surrounds the accelerating gaps between the screen grids and the first high-voltage focus electrodes.

A similar suppressor ring is suggested for use in a color picture tube having a bipotential lens, or in a single-beam cathode ray tube such as those used in black-and-white television receivers.

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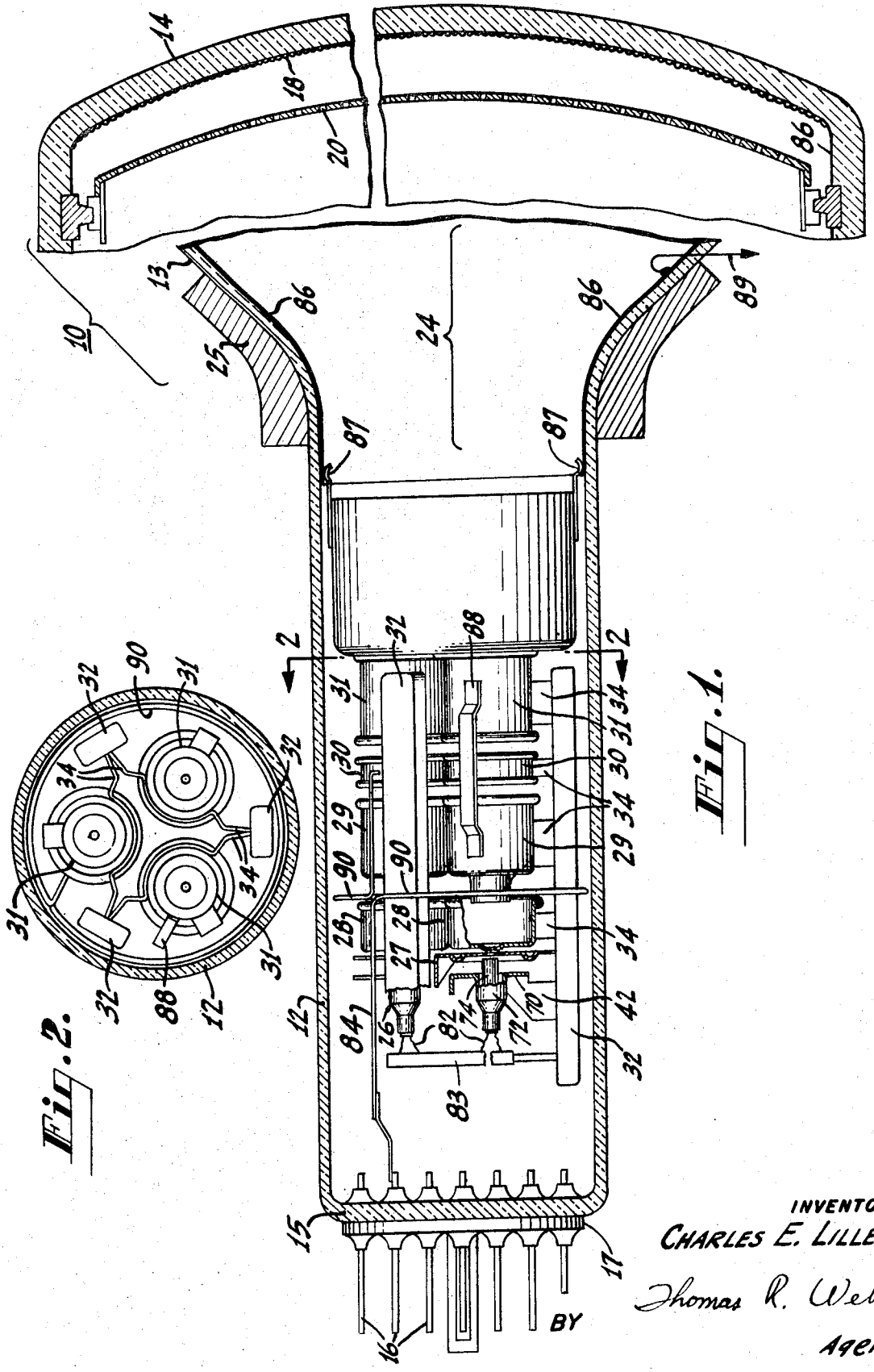



Fig. 1.




Fig. 2.

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# COLOR TUBE HAVING GROUND PLANE BETWEEN FOCUS ELECTRODES AND SCREEN GRIDS

## BACKGROUND OF THE INVENTION

This invention relates to an improved electron gun for a cathode ray tube. The invention is particularly directed to, and will be described for example in, a cathode ray tube having a unitary assembly comprising a plurality of electron guns disposed side by side for projecting and converging a plurality of electron beams onto a luminescent screen. Such electron gun assemblies are, for example, used in direct view color cathode ray picture tubes of the shadow mask type for home television use. However, the invention is also applicable to other color picture tubes, and to single-beam cathode ray tubes for other purposes.

R. H. Hughes U.S. Pat. No. 3,254,251, granted May 31, 1966, discloses a plural electron gun assembly including three similar electron guns disposed in delta array symmetrically about the central longitudinal axis of the cathode ray tube. Each of the electron guns includes, in the order named, axially aligned cathode, control grid, screen grid, focus and anode or accelerating electrodes, which are mounted in fixed relationship on three elongated glass rods. The focus and anode electrodes of each gun are operated at DC potentials of about 5 kv. and 25 kv., respectively, to form a bipotential, electron lens for focusing the beam to a small spot at the screen. A magnetic convergence cage, containing three pairs of magnetic pole pieces for converging the three beams at the screen, is mounted on the three anode electrodes. The plural gun assembly is supported within the tubular glass neck portion of the cathode ray tube envelope by means of stem leads and bulb spacers. This plural gun assembly is used in several commercial color picture tubes, including the 19GVP22, 22KP22, and 25YP22. The smaller 15 inch color picture tubes, e.g. the 15KP22, use a modified plural gun assembly, in which the focus and anode electrodes forming the bipotential focus lens for each beam are replaced by three focusing electrodes operated as an "einzel" or unipotential lens. For this purpose, the two end electrodes are connected together and to the ultor voltage source (e.g. 20 kv. or higher) and the middle electrode is connected to a low or zero voltage source.

In the operation of many tubes, e.g. those involving einzel-type focus lenses, a blue glow forms in the neck of the tube which is fluorescence of the neck glass caused by high-velocity electrons striking the glass. The bombardment of the glass by the electrons releases gases from the glass and causes decomposition and erosion of the glass and other undesired effects. In some cases the glow develops into an arc, which often damages the cathode and/or heater. It appears that the blue glow results from charging of the neck glass and the glass support rods of the guns to accelerating potentials. The manner of charging of the neck and rods is not fully understood. It is probable that the charging is started by the high electric field of the high voltage on the first "einzel" lens electrode (the one nearest the screen grid) producing field emission electrons from the relatively low voltage (e.g. 400 v.) screen grid and accelerating such electrons toward the glass parts. Since the glass has a secondary emission ratio greater than unity, the glass charges up positively on bombardment by electrons and the charge accelerates more electrons to the glass. It is also probable that, as the glass potential increases, thermionic electrons from the cathode and field emission from the control grid and the metallic electrode supports also bombard the glass. These effects sometimes cascade until a breakdown arc occurs which discharges the glass and then the sequence is repeated.

Attempts have been made to prevent undesirable discharges within the gun neck due to wall charging by providing a low-voltage resistive or semiconductive coating on the portion of the neck wall surrounding the gun. However, such attempts have not been satisfactory because such coatings tend to be removed by bombardment by electrons accelerated in a manner similar to that of wall charging.



## SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved cathode ray tube gun.

Another object is to provide an electron gun in which undesirable discharges are minimized.

A further object is to provide a cathode ray tube having means for minimizing charging of the inner wall of the envelope neck.

Another object is to provide means for protecting the cathode and heater from damaging arcs.

In accordance with the present invention, the undesirable glow and/or arcing described above are prevented, or at least greatly reduced, by establishing a transverse ground plane between the next adjacent low-voltage and high-voltage electrodes of a cathode ray tube gun, in the region between the gun electrodes and the surrounding glass wall, without appreciably affecting the acceleration and focusing of the beams. For example, in a plural gun assembly in which three electron guns are mounted in delta array about a central axis with each gun comprising a cathode, control grid, screen grid and three successive focus electrodes, the ground plane is established in a transverse plane located at the beam accelerating gaps between the three screen grids and the three adjacent high-voltage focus electrodes, by means, e.g., of a suppressor ring surrounding and spaced outwardly from and disposed substantially in the plane of those gaps. The radial spacing between the suppressor ring and the beam accelerating gaps should be sufficiently large compared to the width of the gaps that the suppressor ring will not appreciably affect the beams passing through the gun electrodes. In the example shown and described, the suppressor ring surrounds the glass support rods on which the gun electrodes are mounted. The suppressor ring may be closed, split or segmented, and may be a portion of a wire connecting the low-voltage middle focus electrodes with one of the stem leads of the tube.

## BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partial longitudinal section view with parts broken away of a cathode ray tube embodying the invention; and

FIG. 2 is a section view of the electron gun assembly of the tube of FIG. 1, taken on the line 2–2 thereof.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, by way of example, the invention is embodied in a direct view color cathode ray picture tube **10** of the shadow mask type. The tube **10** comprises a glass envelope which includes a tubular neck **12**, a funnel **13**, a faceplate **14**, and a stem structure **15**. A plurality of lead-in pins or stem leads **16**, over which an indexing wafer base **17** is disposed, are sealed through the stem **15**. A mosaic dot phosphor screen **18**, which may be aluminized according to known practices, is disposed on the inner surface of the faceplate **14**. An apertured shadow mask **20** having an array of apertures which is related to the array of phosphor dots of the mosaic screen **18** is mounted adjacent to the screen. A unitary electron gun assembly **22**, comprising three substantially identical electron guns, is disposed in the neck **12** and adapted to project three separate electron beams through a beam deflection zone **24** toward the mosaic screen **18**. A magnetic deflection yoke **25** is provided for establishing beam deflection fields in the deflection zone **24** for scanning the beams in a raster on the screen **18**. As shown in FIG. **2**, the electron guns of the assembly **22** are disposed symmetrically about the central longitudinal axis of the tube **10** in an equilateral triangular (delta) array. Only two of the guns are shown in FIG. **1**.

Each of the three guns comprises a cathode assembly **26**, a control grid **27**, a screen grid **28**, and three successive focus electrodes **29**, **30** and **31**, all of which are mounted in axially spaced relationship along three glass support rods **32**. As shown in FIG. **2**, each of the support rods **32** is disposed alongside a different two of the three electron guns outwardly

therefrom. Only two of the rods are shown in FIG. 1. The screen grids 28 and the three sets of focus electrodes 29, 30 and 31 are supported from the glass rods 32 by support straps 34, as best shown in FIG. 2. The cathode assemblies 26 and the control grids 27 are supported from rods 32 by integral straplike tabs 42, as described in Hughes U.S. Pat. No. 3,254,251. A magnetic beam convergence cage 44 is mounted on the final focus electrodes 31 and cooperates with external magnet means (not shown) to maintain convergence of the three electron beams at all times during their scanning of a raster on the screen 18.

Each cathode assembly 26 comprises a sector-shaped apertured cathode support plate 70 having two integral mounting tabs 42, a cathode support sleeve 72, and a tubular cathode 74 having a transverse end wall 80 carrying an electron emissive coating 81. The cathodes 74 contain heater filaments 82 which are mounted by straps 83 on the glass rods 32. Each control grid 27 comprises a sector-shaped centrally apertured plate 60 and two integral mounting tabs 42.

The stem leads 16 are connected by connections (not shown) to the filaments 82, the cathode assemblies 26, the control grids 27, and the screen grids 28. One of the stem leads 16 is connected by a connecting wire 84 to the middle focusing electrodes 30. An electrically conductive coating 86 on the inner wall of the funnel 13 extends from the luminescent screen 18 into the neck 12 where it makes contact with a plurality of metal spring bulb-spacing elements 87 mounted on the convergence cage 44. The outer two focusing electrodes 29 and 31 are directly connected together by a conductive wire or strap 88. An ultor potential (e.g. 20 kv.) applied to the coating 86 through a lead-in terminal in the wall of the funnel 13, schematically illustrated by the arrow 89, is thus applied to the outer focus electrodes 29 and 31, the convergence cage 44, and the screen 18. The middle focus electrodes 30 are maintained at ground or other low potential by the lead wire 84. Under these conditions, the three focus electrodes 29, 30 and 31 of each gun form an "einzel" lens for focusing the beam at the screen 18.

The cathode ray tube 10 is normally operated with the cathode assemblies 26 and control grids 27 at or near zero DC bias and the screen grids 28 at about 400 v. DC Thus, the potential difference between the first focus electrode 29 and the three preceding electrodes (cathode, control grid and screen grid) in each gun is very high. Nearly all of this high potential difference exists across the accelerating gaps between the screen grids 28 and the first focus electrodes 29. The gun structure described is very satisfactory insofar as producing, accelerating, focusing and converging three electron beams are concerned. However, as stated above, it has been found that many tubes with this type of gun structure tend to produce a blue glow or even a breakdown arc within the tube neck 12 around the gun structure. The glow usually starts in the region beyond the screen grids 28 and spreads back along the neck 12 and/or glass rods 32 to the cathode region.

In accordance with the present invention, the external portions of the screen grids 28, the control grids 27, the cathode assemblies 26, and their metallic supports and leads, are effectively isolated or shielded from the high electric field of the nearby high-voltage focus electrode 29 by establishing a ground plane between the low-voltage and high-voltage electrodes of the gun, in the region between the gun electrodes and the surrounding glass neck wall, without appreciably affecting the electron beams. In the particular gun structure shown for example in the drawing, this ground plane is established by positioning a low-voltage suppressor ring 90 around the gun assembly 22, outside of and in close proximity to the three glass rods 32, and in the plane of the accelerating gaps between the screen grids 28 and the focus electrodes 29. The suppressor ring 90 is spaced outwardly from the beam accelerating gaps a distance sufficiently large compared to the width of each gap that the ring will not appreciably affect the beams passing through the gaps. As shown in the drawing, the suppressor ring 90 may conveniently be an intermediate portion of the wire 84 which applies the low potential to the middle focus electrodes 30. The suppressor ring 90 should be free of sharp points or edges which would be sources of field emission. In general, the ring 90 may be either closed, split or segmented. However, a split ring as shown in the drawing is preferred, to prevent it from coupling to the RF field normally used to heat and out-gas the gun elements during exhaust operations. A further advantage of the split ring shown is that it serves as a flexible connection between the stem lead 16 and the focus electrode 30. Alternatively, the suppressor ring 90 may be connected to ground or a low-impedance low-voltage source independently of the connection 84 to the focus electrodes 30. If the ring is segmented, the segments should be relatively closely spaced, in order to effectively establish the desired ground plane.

The low-voltage suppressor ring 90 greatly reduces the potential gradient on the external surfaces of the low-voltage gun elements other than the middle focusing electrodes 30 and effectively prevents field emission therefrom, and also prevents bombardment of the glass neck 12 and glass rods 32 by electrons thermionically emitted outwardly from the sides of the cathodes 74 (between the cathode support plates 70 and the control grid plates 60). Moreover, any electrons that are emitted by field emission from the external surfaces of the middle focus electrodes 30 are stopped or deflected by the ground plane established by the suppressor ring 90, so that neck or glass rod charging is limited to those regions beyond the suppressor ring. In practice, such charging does not result in the undesired blue glow or arcs which sometimes occur in tubes having no suppressor ring.

While the invention has been described, for example, as embodied in a shadow mask-type color cathode ray tube having a triple beam electron gun assembly having einzel-type focus lenses, it should be understood that the invention is not so limited. A similar suppressor element may be used in a color tube having bipotential focus lenses, or in a single-beam cathode ray tube such as those used in black-and-white television receivers. In tubes having a screen grid, the suppressor ring should be positioned between the screen grid and the surrounding glass wall, in the plane of the gap between the screen grid and the adjacent high-voltage electrode, as in the example shown herein. In tubes having no screen grid, the suppressor ring should be similarly positioned with respect to the gap between the last low-voltage electrode (e.g., the control grid) and the first high-voltage electrode.

I claim:

1. A direct view color cathode ray tube comprising a glass envelope including a faceplate portion containing a mosaic color phosphor screen and a multi-apertured shadow-mask adjacent to said screen, a funnel portion, and a neck portion containing a triple gun assembly for projecting three electron beams toward said mask and screen, said triple gun assembly comprising:

a. three similar electron guns mounted on glass support rods disposed outwardly of said guns, each gun comprising:

1. a group of low-voltage electrodes including a thermionic cathode, an apertured control grid electrode and an apertured screen grid electrode, spaced along a beam path in the order named; and

2. a group of apertured focus electrodes comprising three successive apertured focus electrodes for each gun, the first and third focus electrodes being connected together;

b. means for connecting the first focus electrode next adjacent to said screen grid electrode of each gun to a high-voltage ultor source for establishing a beam accelerating field across the gap between those two electrodes;

c. said glass rods and the inner glass wall of said neck portion being directly exposed to bombardment by electrons emitted by said electrodes; and

d. means, including a low-voltage suppressor ring of wire surrounding said glass rods and said gaps between said

screen grid electrodes and said first focus electrodes and substantially in the plane of said gaps, for establishing a transverse ground plane at said gaps and thereby minimizing said bombardment, and means for connecting each of said suppressor ring and said second focus electrodes to a low voltage source.