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3,278,779

CATHODE-RAY TUBE HAVING AN INSULATING SPACER BETWEEN THE CATHODE AND THE CONTROL GRID

Filed May 17, 1962

FIG. 1

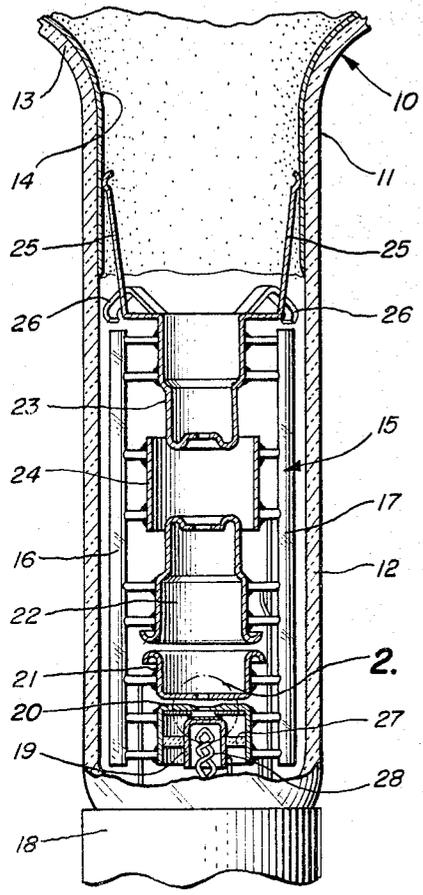


FIG. 2

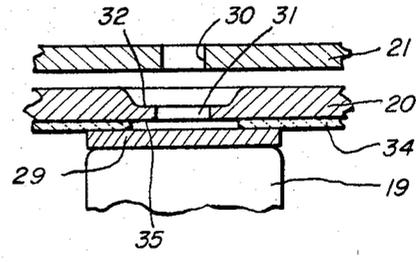


FIG. 3

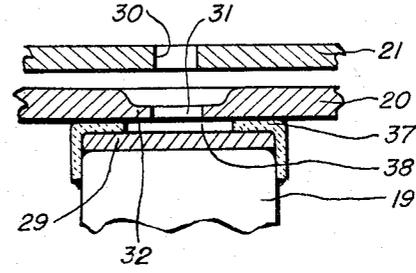


FIG. 4

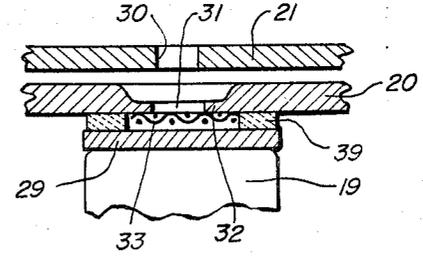


FIG. 6

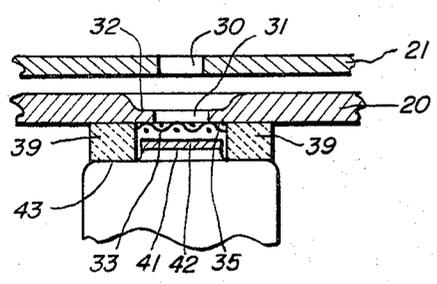
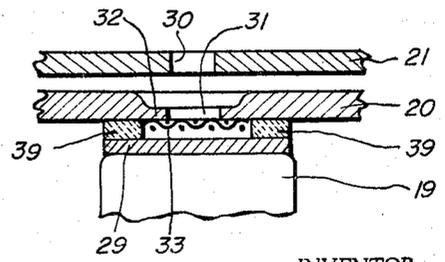


FIG. 5



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CATHODE-RAY TUBE HAVING AN INSULATING SPACER BETWEEN THE CATHODE AND THE CONTROL GRID

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4 Claims. (Cl. 313-82)

This invention relates to a new and improved cathode-ray tube, and more particularly to the structure of an electron gun for a cathode-ray picture tube suitable for use in television receivers and like applications.

In a television receiver and other electronic devices in which intelligence is displayed upon the luminescent screen of a cathode-ray picture tube, it is highly desirable to obtain maximum modulation of the light output of the picture tube in response to a given change in the amplitude of the control signal applied thereto. It is frequently possible to eliminate or, at least to simplify, one or more stages of the receiver if the picture tube experiences a relatively large change in beam current and, therefore, in picture brightness in response to relatively small input signal variations. Stated differently, it is highly desirable that the picture tube have high transconductance. It is also important in many instances, to utilize operating voltages which are relatively low, particularly on those electrodes other than the final anode of the tube. This reduces the requirements imposed upon the power supply of the television receiver and, therefore, reduces its cost.

One electron gun structure that may be advantageously used in cathode-ray tubes of the high transconductance type is described in Patent 3,008,064 issued in the name of W. F. Niklas et al. and assigned to same assignee as the present invention. The electron gun disclosed in that patent comprises a cathode having an electron-emissive surface, and a negatively biased control electrode having an aperture small relative to the cathode emissive surface. For optimum performance of this type of high transconductance gun, the spacing between the cathode and the control electrode should be as small as possible but the minimum effective spacing between the cathode and control electrode is subject to practical limits in order to avoid arc-over between the two electrodes. It has been found that if an insulator is interposed between the adjacent surfaces of these two electrodes a charge may accumulate on the insulation at the grid aperture which will adversely influence the electron beam by impeding its passage through the grid aperture. This disadvantage is obviated by the improved structure of the present invention.

A principal object of the invention, therefore, is to afford a new and improved electron gun for a cathode-ray tube.

Another object of the invention is to afford a new and improved electron gun for a cathode-ray tube of the high transconductance type.

A further object of the invention is to provide an improved electron gun for a cathode-ray tube, which permits construction of the electrodes in simple and economic form.

A specific object of the invention is a high transconductance electron gun for a cathode-ray tube having an improved cathode-control electrode assembly to provide a low cut-off voltage and at the same time unimpeded passage of the electron beam through that assembly.

More particularly the present invention concerns an improvement for a cathode-ray tube which includes a cathode having a cap portion with electron-emissive material deposited thereon and a control electrode including a planar portion of a predetermined thickness oriented sub-

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stantially parallel to the cap portion, the planar portion having an aperture small relative to the cathode emitting surface and spaced a predetermined small distance from the cathode, the distance being less than the predetermined thickness of the planar portion of the control electrode. In accordance with the invention an insulative layer is sandwiched between and in contact with the cathode cap portion and the control electrode planar portion, and is provided with a central aperture coaxially aligned with the control electrode aperture and which insulator aperture effectively has a diameter approximately equal to at least 1.05 times the diameter of the control electrode aperture, but less than the diameter of the cap portion, for accurately and stably positioning the cathode the aforesaid predetermined distance from the control electrode while preventing accumulation of electric charge on said insulative layer in the region of the control electrode aperture.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The organization and manner of operation of the invention, together with further objects and advantages thereof, may be understood by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals identify like elements and in which:

FIGURE 1 is a sectional view, partially cut away, of a cathode-ray tube including a high transconductance electron gun constructed in accordance with one embodiment of the present invention;

FIGURE 2 is an enlarged detail view of a portion of the electron gun taken, as indicated in phantom outline in FIGURE 1 to show the structure of the cathode-control electrode assembly; and

FIGURES 3-6 are enlarged sectional views of the same portion of the electron gun showing other embodiments of the invention, respectively.

The cathode-ray tube **10** illustrated in FIGURE 1 is of the high transconductance type and comprises an envelope **11** having a neck portion **12** of relatively small diameter connected to a large cone section **13** which terminates in a screen area having a suitable coating of luminescent material but since that portion of the tube may be completely conventional and constitutes no part of the subject invention, it has not been shown. A conductive coating **14** extends along the inner wall of the cone section of the envelope and partially into neck section **12** in the usual manner.

An electron gun structure **15** is positioned within neck portion **12** and comprises a series of electrodes which are supported in coaxial alignment with each other in conventional manner by means of insulating support rods **16**, **17**. These rods extend longitudinally and in parallel relation to the beam path which usually corresponds with the axis of the envelope. The electrodes of the gun are disposed across the beam path and have narrow projecting tabs that are anchored to rods **16**, **17** to hold them in a desired space relation. Commencing at the base **18** of the tube and progressing along the beam path in the direction of the screen, these electrodes comprise a cathode **19**, a first control electrode **20**, a second control electrode or first anode **21** and a section anode **22**. Anode **22** is electrically connected to an ultor or final anode **23** and a focusing electrode **24** is disposed between anodes **22** and **23** in encompassing relation to the ends thereof in order to constitute therewith the well-known uni-potential electrostatic lens for focusing the beam. Anode **23** terminates in a series of resilient contact fingers **25** which engage conductive layer **14** to afford an electrical connection between coating **14** and anode **23**. In addition, anode **23** may be provided with other resilient spring fingers **26**

which engage the inner wall of neck section 12 to maintain the electron gun properly aligned within the tube neck.

More particularly, cathode 19 is cylindrical, being open at one end but having the other end closed and suitably coated to constitute an electron emissive surface. The cathode is supported and positioned within control electrode or grid 20 by means of an insulating bushing 27 and a heater filament 28 is disposed within the cathode cylinder as usual. Of course, the other electrodes of the gun are generally cylindrical in form and closure plates may be provided but these plates all have centrally located apertures so that the beam path from the cathode to the viewing screen, is uninterrupted. A number of individual electrode leads connect the several electrodes to assigned ones of a series of pins (not shown) extending from base 18. The cathode-ray tube is also provided with a suitable high voltage connection (not shown) for the application of high voltage to final anode 23.

As thus far described, picture tube 10 is of known construction and may, for example, be similar to that of the above mentioned patent to Niklas et al. It is a high transconductance tube and may be operated with grid 20 negatively biased. The details of the cathode-grid assembly for optimum performance of the tube will be given with reference to FIGURE 2 in which grid 20 is shown as having a portion 32 of reduced thickness. This is the grid portion which accommodates an aperture 31 that is small relative to the cathode emitting surface 29. The spacing from cathode surface 29 to the contiguous surface of grid 20 is smaller than the thickness of the grid at this aperture.

In order to prevent any electrical contact of grid 20 with cathode 19 an insulator filling 34 is provided between these electrodes. This insulator occupies substantially all the space between the emissive surface of the cathode and the contiguous surface of the control electrode, except for a portion which is concentric with grid aperture 31 and has an effective diameter approximately equal to at least 1.05 times the diameter of the grid aperture. In the embodiment of FIGURE 2 insulator 34 is a coating on the surface of grid 20 facing the cathode. In accordance with this invention, there is an uncoated section 35 around grid aperture 31 which prevents the accumulation of an electric charge that may otherwise penetrate grid aperture 31 and adversely effect the passage of the electron beam originating at surface 29 of the cathode. At the same time this insulating coating prevents any contact between the grid and cathode even though the interelectrode space is very small as required for example, in a high transconductance electron gun. It is convenient to control the thickness of insulator 34 to the end that it may also serve to determine and maintain the desired interelectrode spacing.

The insulating coating 34 may be applied by any of a number of conventional techniques such as spraying or by anodizing the surface of grid 20 facing the cathode. When applying the insulation, section 35 of the grid which is to remain uncoated, is masked-off.

As shown in FIGURE 3 the insulating member may take the form of an apertured cap 37 placed over the closed end of the cathode. An aperture 38 is provided in the cap having a diameter at least equal to 1.05 times the diameter of grid aperture 31.

In a further embodiment, FIGURE 4, a wire mesh 33 extends across grid aperture 31, being fixed to grid 20 by any known technique such as welding. Mesh 33 reduces the cut-off voltage of the tube, and because of the close cathode-to-mesh spacing penetration of the electric field from the anode through the control electrode is retained. In this embodiment a ring-shaped insulator 39 fills substantially all the space between the cathode and grid electrodes. The insulator is preferably made of mica, but other materials such as steatite or different aluminum magnesium silicates may be used.

In FIGURE 5 is shown a modification in which the insulator between the cathode and the grid is formed by a ring-shaped protrusion 39 of the cathode as the protrusion may be several times thicker than the emissive surface 29 of the cathode and may be formed by spraying on several layers of insulating material, while masking off the central portion of the cathode.

As shown in FIGURE 6, instead of having a planar surface coated with an electrode emissive material, the cathode may have a central area 41 which protrudes and defines an annular shoulder 43. The electron emissive coating 42 is applied only to the limited area 41 of the cathode. A ring-shaped insulating member 39 of substantially greater thickness than the central section 41 is formed on the shoulder 43 of the cathode. The thickness of member 39 establishes the desired cathode-to-grid spacing while its internal diameter defines an insulating free area 35 around grid aperture 31.

Of course, it is desired that the insulator between cathode and first grid be constructed to minimize a "heat sink" effect at the surface of the cathode which may remove heat from the cathode during the operation of the tube. To that end the insulator is preferably made of a spongy or porous material. Suitable materials include aluminum oxide, magnesium oxide, barium oxide, zirconium oxide, and titanium dioxide.

Typical dimensional data for an electron gun constructed in accordance with the present invention and as illustrated in FIGURE 2 are set forth hereinafter. It is to be understood that this material is presented solely by way of illustration and in no sense as a limitation on the invention.

Thickness of the insulator 34	0.002"
Diameter of grid aperture 31	0.031"
Diameter of the aperture 30 in second control electrode	0.027"
Diameter of area 35	0.040"

This data is applicable to an electron gun for use in a television picture tube operable at an ultor potential of approximately 20,000 volts; the normal operating voltage for the second control electrode is approximately 50 volts while the first control electrode is negatively biased with respect to the cathode.

While particular embodiments of the present invention have been shown and described, it is apparent that various changes and modifications may be made, and it is, therefore, intended in the following claims to cover all such modifications and changes as may fall within the true spirit and scope of this invention.

I claim:

1. In a cathode-ray tube including a cathode having a cap portion with electron emissive material deposited thereon and a control electrode including a planar portion of a predetermined thickness oriented substantially parallel to said cap portion, said planar portion having an aperture small relative to the cathode emitting surface and spaced a predetermined small distance from said cathode said distance being less than said predetermined thickness of said planar portion, the improvement which comprises: an insulative layer sandwiched between and in contact with said cathode cap portion and said control electrode planar portion and having a central aperture coaxially aligned with said control electrode aperture which aperture effectively has a diameter equal to at least 1.05 times the diameter of said control electrode aperture, but less than the diameter of said cap portion for accurately and stably positioning said cathode said predetermined distance from said control electrode while preventing substantial accumulation of electric charge on said insulative layer in the region of said control electrode aperture.

2. In a high transconductance cathode-ray tube including a cathode having a cap portion with electron emissive material deposited thereon and a control electrode

including a planar portion of a predetermined thickness oriented substantially parallel to said cap portion, said planar portion having an aperture small relative to the cathode emitting surface and spaced a predetermined small distance from said cathode, said distance being less than said predetermined thickness of said planar portion, the improvement which comprises: an insulative coating formed on that surface of said planar portion of said control electrode adjacent said cathode cap portion and positioned for contact with said cathode cap portion and having a central aperture coaxially aligned with said control electrode aperture which aperture effectively has a diameter equal to at least 1.05 times the diameter of said control electrode aperture, but less than the diameter of said cap portion for accurately and stably positioning said cathode said predetermined distance from said control electrode while preventing substantial accumulation of electric charge on said insulative layer in the region of said control electrode aperture.

3. In a high transconductance cathode-ray tube including a cathode having a cap portion with electron emissive material deposited thereon and a control electrode including a planar portion of a predetermined thickness oriented substantially parallel to said cap portion, said planar portion having an aperture small relative to the cathode emitting surface and spaced a predetermined small distance from said cathode, said distance being less than said predetermined thickness of said planar portion, the improvement which comprises: a ring-shaped insulating member sandwiched between and in contact with said cathode cap portion and said control electrode planar portion and having a central aperture coaxially aligned with said control electrode aperture which aperture effectively has a diameter equal to at least 1.05 times the diameter of said control electrode aperture, but less than the diameter of said cap portion for accurately and stably positioning said cathode said predetermined dis-

tance from said control electrode while preventing substantial accumulation of electric charge on said insulative layer in the region of said control electrode aperture.

4. In a cathode-ray tube including a cathode having a cap portion with electron emissive material deposited on a limited central area thereof and a control electrode including a planar portion of a predetermined thickness oriented substantially parallel to said cap portion, said planar portion having an aperture small relative to the cathode emitting surface and spaced a predetermined small distance from said cathode, said distance being less than said predetermined thickness of said planar portion, the improvement which comprises: a ring-shaped insulative member sandwiched between and in contact with said non-emitting sector of said cathode cap portion and said control electrode planar portion and having a central aperture coaxially aligned with said control electrode aperture which aperture effectively has a diameter equal to at least 1.05 times the diameter of said control electrode aperture, but less than the diameter of said cap portion, for accurately and stably positioning said cathode said predetermined distance from said control electrode while preventing substantial accumulation of electric charge on said insulative layer in the region of said control electrode aperture.

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