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PHOTOCONDUCTIVE PICKUP TUBE HAVING AN ELECTRICALLY ISOLATED MESH ASSEMBLY

Filed Aug. 30. 1960

2 Sheets-Sheet 1

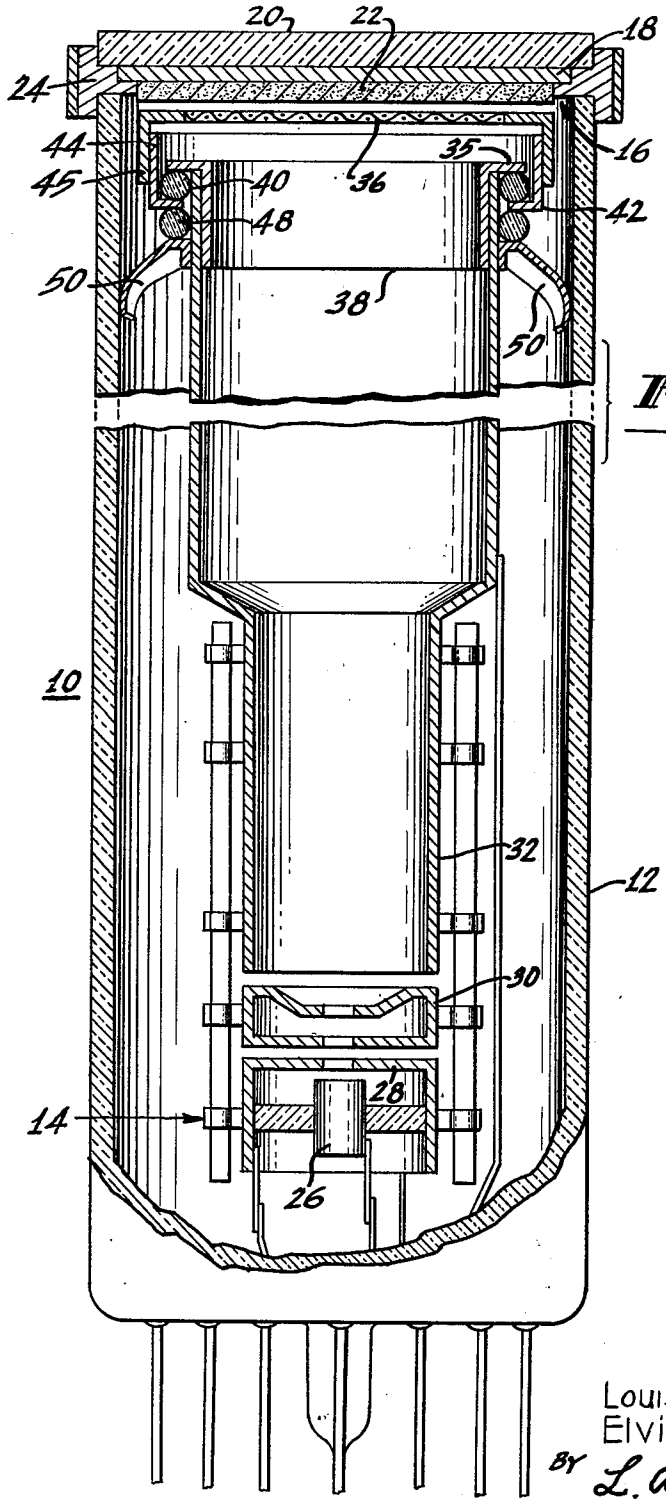


Fig. 1.

INVENTORS
Louis D. Miller &
Elvin M Musselman
BY L. A. Larsen
ATTORNEY

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2 Sheets-Sheet 2

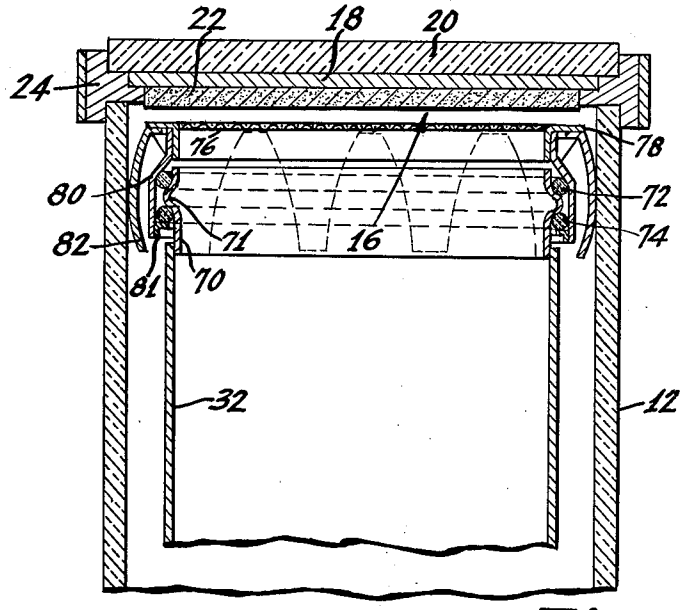
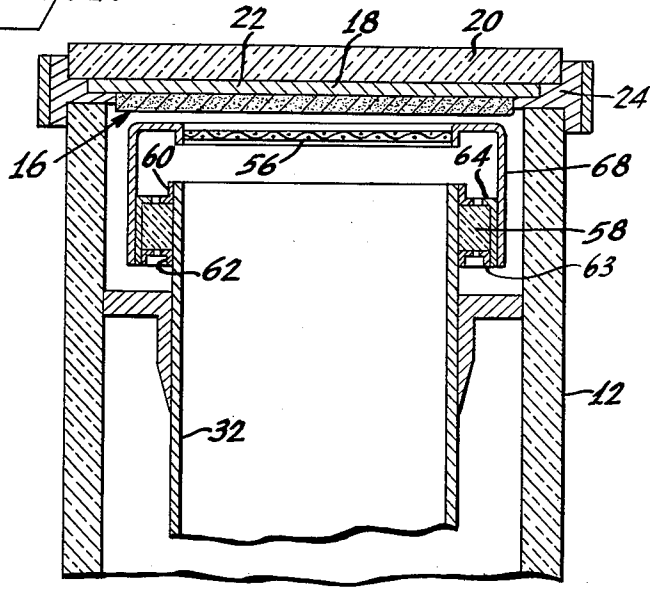


Fig. 3.

Fig. 2.



INVENTORS
Louis D. Miller &
Elvin M Musselman

BY L. A. Larsen

ATTORNEY

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PHOTOCONDUCTIVE PICKUP TUBE HAVING AN ELECTRICALLY ISOLATED MESH ASSEMBLY

Louis D. Miller and Elvin M. Musselman, Lancaster, Pa., assignors to Radio Corporation of America, a corporation of Delaware

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This invention relates to pickup or camera tubes of the type using a photoconductive material as the photosensitive element. In particular, this invention relates to an improved photoconductive pickup tube including a novel means for mounting the decelerating mesh screen electrode.

One of the several known types of pickup tubes generally comprises an evacuated tubular envelope enclosing an electron gun and a photoconductive target electrode. The target electrode is supported upon a transparent support member, which normally is the optically clear transparent face plate sealed to the end of the envelope and facing the electron gun. The target electrode includes a transparent conductive coating, or signal electrode, on the gun side of the transparent support member and a photoconductor comprising a deposit of photoconductive material on the transparent conductive coating. Photoconductive materials are materials which change their electrical conductivity in response to incident radiations. These materials have a relatively high electrical resistance when in the dark and a relatively high electrical conductivity when exposed to the light or other radiations of a selected frequency. Closely spaced from the surface of the photoconductive material, on the side thereof that is exposed to the electron beam, is a fine mesh screen or beam decelerating mesh electrode.

One of the problems that has limited the resolution of pickup tubes of the type briefly described above, is the problem of secondary electron emission from the decelerating mesh electrode. One of the conventional methods of operating tubes of this type is the so called low velocity beam method, wherein the accelerating potential of the electron beam is of the order of 300 volts or less, and the electron beam is decelerated by the mesh screen as it approaches the photoconductor. Even when using this low velocity method of operation, secondary electrons are emitted from the decelerating mesh screen. Various attempts have been made in the past to eliminate this secondary electron emission. These attempts have included increasing the electron transparency of the decelerating mesh, and forming the decelerating mesh screen electrode of a material having a low secondary emission factor. However, none of these attemps completely eliminates the secondary electron emission from the decelerating mesh screen electrode.

A further problem in the operation of a conventional type photoconductive camera tube is that there is a certain amount of picture shading that occurs between the center and edge of the scanned photoconductive surface. This shading occurs because of the fact that the electrons that are deflected from the axis or center of the tube have a slightly lower velocity than those traveling along the axis of the tube. Because of this difference in electron velocity, spurious variations or shading of an output signal can at times be observed.

A still further problem encountered in the operation of a photoconductive type pickup tube is that residual gas atoms remain in the tube after it is evacuated and these atoms will produce positive ions, when bombarded by the electron beam. The positive ions may tend to flow, in a field free space, toward the target electrode. If these positive ions should land on the target electrode a further spurious signal or noise is produced.

It is therefore an object of this invention to provide an improved photoconductive type pickup tube.

It is a further object of this invention to provide a novel photoconductive camera tube characterized in its high resolution, freedom from shading effects, and freedom from positive ion bombardment of the target electrode.

These and other objects are accomplished in accordance with this invention by providing a photoconductive camera tube wherein the decelerating mesh screen electrode is physically supported by and electrically insulated from a final tubular focusing electrode. Due to this structure, secondary electrons generated by the electron beam striking the mesh screen electrode can be collected by the mesh screen electrode. Also, an electron lens can be produced, during tube operation, between the focusing electrode and the decelerating mesh screen electrode, to improve the center to edge picture shading. Still further, a potential may be applied to the decelerating mesh screen electrode to repel positive ions back toward the electron gun where they are relatively harmless. The particular structure of this invention is such that it is rigid, can readily be mass produced and is free of any materials which would tend to contribute dirt or other contaminants to the photoconductive target electrode.

The invention will be more clearly understood by reference to the accompanying two sheets of drawings wherein:

FIG. 1 is a longitudinal sectional view of a photoconductive type of pickup tube showing one embodiment of this invention;

FIG. 2 is an enlarged fragmentary sectional view of another embodiment of this invention;

FIG. 3 is an enlarged fragmentary sectional view of still another embodiment of this invention.

Referring now to FIG. 1 in detail, there is shown a photoconductive pickup tube **10** of the Vidicon type which includes improvements in accordance with this invention, as will be pointed out hereinafter. The tube **10** comprises an elongated, evacuated envelope **12** having an electron gun **14** in one end thereof, and positioned substantially on the axis of the tube. The electron gun **14** is for the purpose of producing an electron beam and directing the beam towards a target electrode **16**. The target electrode **16** comprises a transparent electrical conductor **18** supported upon a transparent end or face plate **20** of the envelope **12**. On the transparent electrical conductor **18** there is provided a photoconductive member **22**. The photoconductive member is made of a material, the resistance of which decreases when exposed to radiant energy. Many photoconductive materials are known for many different spectral regions and a conventional material for the visible spectrum is antimony trisulfide, for example. The transparent conductor **18** may be any material which is transparent to the radiations to which the photoconductor **22** is responsive and by way of example, a conventional material for the visible range is tin-oxide. The transparent conductor **18** is electrically connected to a sealing ring **24**. A potential applied by the sealing ring to the conductor **18** during tube operation will cause the conductor to function as an output electrode or signal plate.

The electron gun **14** comprises a thermionic cathode **26**, a control grid **28**, an apertured accelerating electrode **30**, and a focusing electrode **32**, or G_3 electrode. The parts of the tube that have been described in detail are conventional. In the conventional photoconductive type pickup tube the tubular focusing electrode **32** is electrically connected to a fine mesh screen that spans the end of the focusing electrode and is electrically connected thereto.

In accordance with this invention, a fine mesh screen

36 is physically supported by, but electrically insulated from the focusing electrode 32 so that a potential may be applied to mesh screen electrode 36 that is different from the potential that is applied to the focusing electrode 32. The focusing electrode 32 has an annular flanged member 38 secured thereto. The flanged member 38 is L-shaped in cross section. One leg of the L is welded to the inner periphery of the focusing electrode 32 at the end of electrode 32 remote from the electron gun 14. The other leg of the L extends over the one end of the electrode 32 to form an annular lip 35 adjacent to this end of the electrode 32. Pressed against the annular lip 35 and coaxial around the outer periphery of the G_3 electrode 32, is a ring-like electrically insulating member 40. One example of a material which may be used to form the insulating member 40 is glass that is formed to rather accurate dimensions. For example, a glass ring having a diameter of approximately 0.060 inch through its solid portion and an overall inside diameter of about 0.75 inch, has been found to be suitable as a support member 40. Abutting the ring support member 40 is a flanged lip 42 of an electrically conductive mesh support ring 44. Secured to the outer periphery of the mesh support ring 44 is a second mesh support ring 45, which has a free end extending axially beyond the end of the second mesh support ring 44, the end of which in turn extends axially beyond the one end of the focusing electrode 32. Spanning the mesh support ring 45 at its free end and affixed thereto, such as by spot welding, is the decelerator electrode mesh screen 36.

Butting against the lip 42 on the mesh support ring 44 is a second ring-like electrical insulating member 48. The ring member 48 may be similar in size and construction to the ring 40. Pressing the ring 48 into firm contact with the lip 42 and pressing the lip 42 into firm contact with the insulating member 40 and the lip 35 of the focusing cylinder 32 is a bulb spacer 50. The bulb spacer 50, during manufacturing, is firmly pressed against the insulating member 48 to firmly fix the mesh ring in position and then the bulb spacer is fixed, e.g. by spot welding, to the walls of the electrode 32. The inner diameter of the lip 42 is larger than the outer diameter of the electrode 32. The thickness of the insulating ring 40 is sufficiently large so that the inner edge of the lip 42 cannot touch the electrode 32.

It should be noted that the position of the mesh screen 36 is firmly fixed with respect to the decelerating electrode 32 by the above described arrangement. It should also be noted that the insulating members 40 and 48 extend around the periphery of the focusing electrode 32 so that the mesh screen 36 is rigidly fixed at all points around the tube axis. Also, since the insulating ring 40 is of a substantially uniform cross-sectional dimension, which may be rectangular or round as shown, and since the lip 35 and the lip 42 on the mesh support ring 44 are both held in position that is substantially normal to the axis of the envelope, the mesh screen 36, is electrically insulated from the decelerator electrode 32 and is firmly positioned substantially normal to the tube axis.

The members 38, 44 and 45 may be made of metallic materials such as a nickel-chromium alloy, and have a thickness such as 0.015 inch or less. The spacing between the scanned surface of the photoconductor 22 and the mesh screen 36 may be adjusted as desired during the manufacture of the tube 10. A conventional spacing between the mesh screen 36 and the photoconductor 22 is .090 inch.

Connected to the mesh support ring 44 is a lead-in (not shown) which extends through the stem of the envelope for the purpose of applying a potential during tube operation to the mesh screen 36. During tube operation, assuming that the cathode 26 is at ground potential, typical operating voltages for the tube 10 are as follows: approximately minus 50 volts for the control grid 28, approximately 300 volts for the accelerator grid 30, and approximately 280 volts for the beam focus electrode 32. With potentials such as these, the preferred operation in accordance with this invention is to apply approximately 305 volts to the decelerator mesh screen 36 and approximately 50 volts to the signal plate 18.

The tube 10, in accordance with this invention, when utilizing the structure as illustrated, provides improved picture definition as compared to conventional pickup tubes. One of the reasons for this is that secondary electrons that are displaced from the mesh screen 36 by the electron beam from the gun 14 are collected by the mesh screen 36. The vast majority of secondary electrons have a velocity of less than approximately 10 volts when using conventional operating potentials. When the mesh screen 36 and the focusing electrode 32 are at the same potential, the secondary electrons tend to pass through the screen and land on the photoconductor thus causing spurious signals. When using this invention, and since the difference in potential between the focusing electrode 32 and the mesh screen 36 is preferably greater than the 8 volt energies of the secondary electrons, the secondary electrons will tend to be collected by the mesh screen and an improved picture definition will result.

A further advantage of this invention is that improved focus is produced due to an advantageous electron lens. The electron lens is formed as a result of the difference in potential existing between the focusing electrode 32 and the mesh screen 36. This electron lens is stronger adjacent to the envelope walls, since the field is more concentrated due to the close spacing in this region, and therefore, the field is more effective adjacent to the envelope walls. Because the field is more effective in this region, the field tends to focus the electron more near the envelope walls than near the tube axis. This more concentrated effect substantially eliminates the problems of shading of the beam.

A still further advantage of this invention is that positive ions resulting from residual gas which remains in the envelope, and which has been ionized by the beam, will tend to be repelled by the positive mesh screen 36. In the prior art tubes, the positive ions of the residual gas tended to drift in what amounted to a field free space formed by the unipotential structure of the mesh screen and the focusing electrode 32.

It should be noted that the electrode support structure in accordance with this invention is preferably made of glass and metal. The reason for this preference is that materials such as ceramics and micas, as well as many other known materials, tend to contribute dirt or other contaminants to the tube structure which might fall onto the mesh screen or onto the photoconductor causing a spot in the reproduced picture. Still further, it should be noted that the radial space occupied by the mesh screen support ring 44 and by the insulator rings 40 and 48 is relatively small so that this invention can be practical with conventional sized decelerating electrodes 32 and conventional sized envelopes 12.

Referring now to FIG. 2, there is shown a fragmentary sectional view of an embodiment of this invention wherein a mesh screen electrode 56 is electrically isolated from a tubular decelerating electrode 32 by a single insulating ring 58 of rectangular cross section. In this embodiment, a flanged member 60 is spot welded to the G_3 electrode 32, the insulator ring 58 is pressed against the flanged member 60 and a second flanged member 62 is then firmly pressed against the insulator 58 and secured, e.g. by spot welding, to the focusing electrode 32.

A pair of flanged members 63 and 64 are provided on the outer periphery of the insulating member 58 which clamp the insulating member 58 and are spot welded together. When this has been done, an inverted cup shaped mesh support member 68 may be spot welded to the flanged members 62 and 64, after the support member 68 has been properly positioned with respect to the

decelerating electrode **32** and with respect to the photoconductive target **16**.

Referring now to FIG. 3, there is shown an embodiment of this invention wherein a support ring **70** is positioned partially within and secured to the end of the focusing electrode **32**. The support ring **70** has a dimpled portion **71** so that a pair of electrically insulating rings **72** and **74** may be spaced apart around the periphery of the support ring **70** and abutting this dimpled portion. The decelerating mesh electrode **76** is supported on a mesh support ring **78** which in turn is supported by a funnel shaped support ring **80**. The support ring **80** is formed in such a manner that the glass ring **72** is pressed by the conical portion of support ring **80** against one side of the dimple **71**. Also, the support ring **80** has a retainer ring **81** fixed thereto and spaced from the focusing electrode **32** and so positioned that the insulator ring **74** is pressed, by the retainer ring **80**, against the opposite side of the dimple **71**. Thus, the mesh **76** is securely fixed with respect to the decelerating electrode **32**. A bulb spacer **82** is also affixed to the mesh support ring **78** to position the electrodes within the envelope **12**. In this embodiment, the glass rings **72** and **74** may be split but should extend substantially around the envelope axis to provide nearly complete and substantially uniform support. The inclined surfaces on the support **80** and the dimpled surface **71** permit the use of slightly smaller diameter insulating rings **72** and **74** as compared to the diameter of the rings used in the embodiments shown in FIGS. 1 and 2.

In all of the embodiments of the electrically isolated mesh screen assembly in accordance with this invention, materials are used which are free from contaminants that would harmfully affect the photoconductive target. Also, it should be noted that the insulating member, or insulating members, which may be round or rectangular in solid cross section, are arranged coaxially around the axis of the decelerating electrode so that a uniform peripheral support is given to the mesh screen electrode. Thus, the mesh screen electrode is securely fixed around the circumference of the decelerating electrode so that any mispositioning of one side of the mesh screen electrode, with respect to the decelerating electrode or the target **16**, is prevented. In all of the embodiments of this invention, the decelerating mesh screen is provided with a separate lead-in so that a potential may be applied thereto, during tube operation, that is different from the potential applied to the tubular decelerating electrode, and the problems of secondary emission, bad shading, as well as the harmful effects of positive ions are eliminated.

What is claimed is:

1. A photoconductive pickup tube comprising an evacuated envelope, a photoconductive target in said envelope, an electron gun in said envelope for directing an electron beam toward said photoconductive target and having an axis, said electron gun terminating adjacent to said photoconductive target, a mesh screen electrode positioned between said electron gun and said photoconductive target, said mesh screen electrode being supported by and electrically insulated from said electron gun by means including an electrical insulator extending substantially around said axis of said electron gun.

2. A camera tube comprising an evacuated envelope having an axis, an electron gun in one axial end of said envelope for producing an electron beam, a photosensitive target electrode in the other axial end of said envelope, a mesh screen electrode positioned in the path of said beam and substantially normal to said axis, said mesh screen electrode being supported by but electrically insulated from a portion of said electron gun by means including an insulating member positioned substantially coaxial with said envelope.

3. A photoconductive pickup tube comprising an evacuated envelope, an electron gun having an axis and disposed in one portion of said envelope for producing an electron beam, a target electrode in another portion of said envelope and positioned substantially normal to said axis and in the path of said electron beam, said gun including a first hollow tubular electrode positioned coaxially with said gun and adjacent to said target electrode, a mesh screen electrode, and means for physically supporting while electrically insulating said mesh screen electrode on said hollow tubular electrode, said means comprising a pair of electrically insulating members extending substantially coaxially around the axis of said envelope and around said hollow tubular electrode, said means further comprising a support ring for said mesh screen electrode, a portion of said support ring being sandwiched between said electrically insulating members.

4. A photoconductive pickup tube comprising an elongated tubular envelope, an elongated tubular electron gun having an axis and disposed within said envelope, a photoconductive target electrode positioned within said envelope substantially normal to said axis and adjacent to one end of said electron gun, a mesh screen electrode positioned between said target electrode and said one end of said electron gun, and means for physically supporting said mesh screen electrode on a part of said electron gun while electrically insulating said mesh screen electrode from said part of said electron gun, said means including an annular electrical insulating member extending around said axis and around said part of said electron gun and fixed thereto, and a mesh screen support ring secured to said electrically insulating member.

5. A photoconductive pickup tube comprising an elongated envelope having an axis, an electron gun in one end portion of said envelope and extending substantially along said axis, a photoconductive target electrode in said envelope and substantially normal to said axis, an apertured mesh screen electrode positioned between said electron gun and said target electrode and substantially normal to said axis, means for rigidly retaining said mesh screen electrode on a portion of said electron gun while electrically insulating said mesh screen electrode from said portion of said electron gun, said means comprising: a portion of said electron gun having a dimple, two electrical insulating members each extending substantially around said axis and around said portion, and each of said electrical insulating members being positioned on a different side of said dimple, a hollow truncated conical shaped mesh screen support member, the narrowing diameter of said support member pressing against one of said insulating members, and a retaining ring fixed to the inner surface of said support member and pressing against the other one of said insulating members.

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