June 14, 1966 I. T. SALDI 3,256,455

CAMERA TUBE TARGET WINDOW EPOXY SEAL

Filed April 26, 1965

FIG.1.

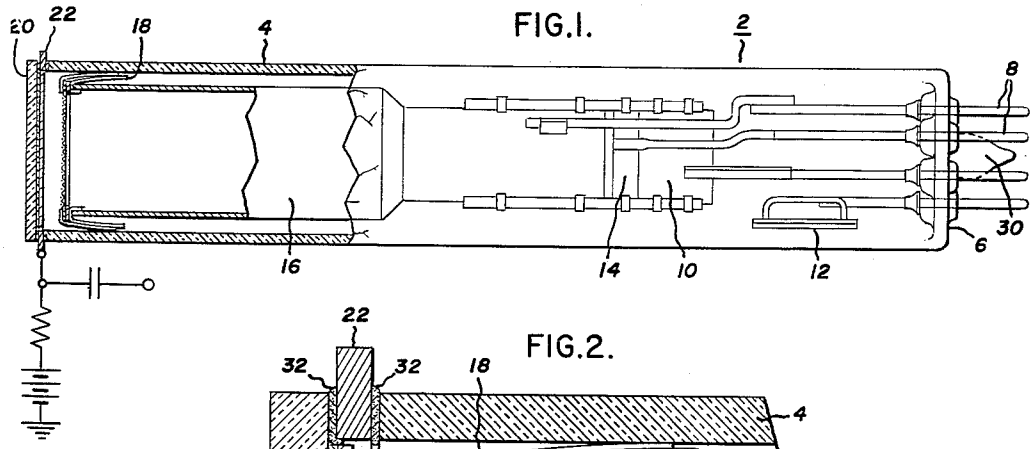


FIG.2.

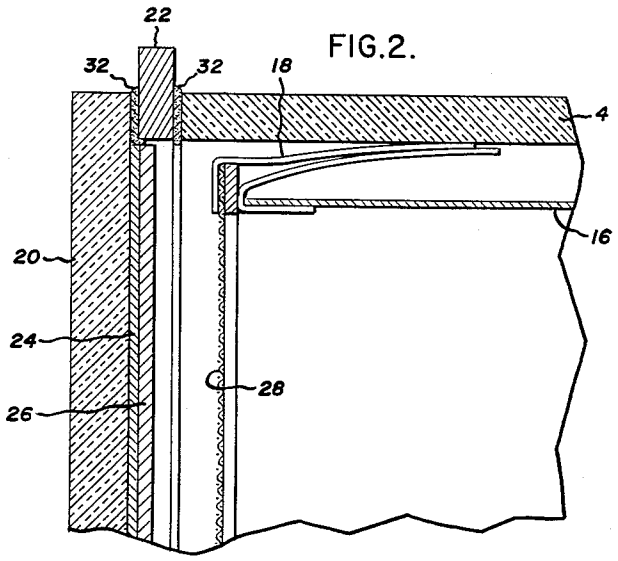
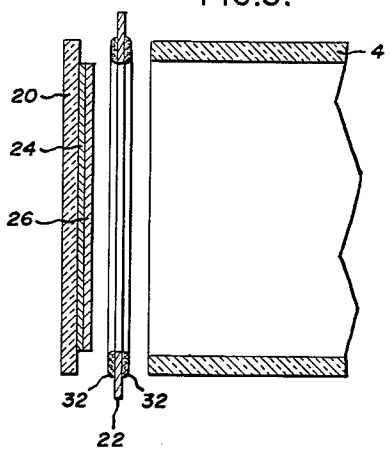


FIG.3.



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CAMERA TUBE TARGET WINDOW EPOXY SEAL

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The present invention relates to improvements in electron discharge devices for picture signal generator which employ a photosensitive element of the photoconductive type. More particularly, the invention relates to an improved envelope seal and method of assembling such tubes. This application is a continuation-in-part application of copending application Serial No. 152,503 filed November 15, 1961, and assigned to the same assignee as the present invention.

Picture signal generating or camera tubes are known which include an evacuated envelope provided with a transparent window on the interior surface of which is supported a transparent electrode and a photoconductive target element. In the operation of such tubes a charge pattern is formed on the photoconductive element representative of the pattern of intensity of light passing through the window, and neutralization of this charge pattern by a scanning electron beam provides an electrical output signal representative of the video information or light pattern.

In such camera tubes of the prior art the electron beam generating, focusing and accelerating means occupy the major portion of the space within the envelope, and the envelope is usually of cylindrical shape, with the viewing window carrying the photoconductive layer forming one end wall of the cylinder, and the electrode leads being sealed through a header or stem which closes the other end of the cylinder. One of the problems in manufacturing such camera tubes is the formation and effective incorporation within the tube of a photoconductive target layer which has a desirably high degree of uniformity in dimensions, in photosensitivity, and in electrical properties.

A principal object of the present invention is to provide a camera tube of the photoconductive target type having a photoconductive target of enhanced uniformity and sensitivity.

Another object is to provide an improved method of manufacturing and assembling camera tubes of the photoconductive target type.

Another object is to provide, in a camera tube having an evacuated envelope and wherein a photoconductive target-supporting viewing window forms a portion of said envelope, improved means for sealing said window to the remainder of the envelope.

It is a still further object of this invention to provide an epoxy resin seal for the face plate of a photoconductive camera tube.

These and other objects of the present invention will be apparent from the following description and the accompanying drawing wherein

FIG. 1 is a view, partially broken away in axial section, of a camera tube of the photoconductive target type constructed in accordance with the present invention;

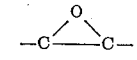
FIG. 2 is an enlarged fragmentary sectional view of a portion of the structure shown in FIG. 1;

FIG. 3 is an exploded view of certain of the parts shown in FIGS. 1 and 2.

Referring to the drawing, a photoconductive target-type camera tube constructed in accordance with the present invention includes an envelope 2 having a cylindrical barrel portion 4, which may be glass, closed at one end by a header or stem 6 through which extend leads 8 for supporting an electrode assembly including an electron gun 10, a getter 12, and the usual control, focusing and accelerating electrodes 14, 16. Final accelerating electrode 16 is supported at its forward end by springs 18 engaging the interior wall of the envelope. The forward end of the cylindrical portion of the envelope is closed by a target window 20. Between the marginal portion of the target window and the adjacent end of the cylinder 4 is sandwiched an electrically conductive signal ring 22 through which the electrical output signal of the tube is obtained, as is well understood by those skilled in the art. On the interior surface of the target window 20 there is deposited an electrically conductive transparent coating 24 (FIG. 2) electrically connected to the signal ring. Formed on the coating 24 is a layer of photoconductive target material 26 such as, for example, antimony trisulfide. Closely spaced opposite the target and parallel thereto is a mesh electrode 28. A decelerating electrostatic field is established between the mesh electrode and the target during tube operation so as to provide a soft landing on the target for the scanning electron beam, as is well understood by those skilled in the art.

The stem or header may be joined to the cylinder 4 by a conventional glass-to-glass seal and the stem is also provided with a tubulation 30 through which the envelope may be exhausted and ultimately completely closed.

It is known that photoconductive target materials or elements such as target 26 are deleteriously affected by high temperatures in excess of, for example, 150° C. According to one preferred form of this invention, target window 20 is permanently hermetically sealed to the signal ring 22 portion of the envelope by a butt-type seal 32 made of a sealing material which may be completely processed at temperatures below that having any deleterious effect on the target 26 or other portions of the tube. Such a sealing material according to the invention is a mixture of finely divided metal and an epoxy resin having a vapor pressure of less than about 10^{-5} millimeters of mercury at a temperature of 75° C. The proportion of resin in such mixture may vary, with the balance being substantially finely divided metal such as silver, aluminum, et cetera, and a preferred formulation is about 20% by weight epoxy resin with a filling of about 80% by weight powdered silver. Preferably at least a part of the epoxy resin should be of a type somewhat flexible when cured, such as to absorb stresses established by any slight mismatch in thermal expansion of the seal components. One such sealing material which is suitable is available commercially as "Isochemduct 2.5" from the Isochem Resins Co. of Providence, R.I. Chemically, the term epoxy means a three-member ring containing one oxygen and two carbon atoms arranged as follows:



The epoxy resin is a molecule which contains, on the average, more than one of these groups. A more comprehensive description is found in Insulation, December 1960, pp. 87–101. Bisphenol A and novolacs epoxy resins have been employed with good results.

The signal ring 22 may be sealed to the cylinder 4 by the same means as window 20 is sealed to ring 22. Both the seal of ring 22 to the cylinder 4 and the window 20 to the ring 22 may be made simultaneously, or the ring 22 may be first separately sealed to the cylinder 4 by the sealing material herein described or by metal-to-glass sealing techniques if desired.

In the making of the seals between the target window 20 and signal ring 22, or between the cylinder 4 and signal ring 22, the sealing surfaces are first carefully cleaned, then coated with the uncured sealing material, joined, and retained in sealed position long enough for the seals 32 to cure a solidified condition. If desired, suitable

supporting fixtures or clamps may be employed to hold the parts while the sealing material is curing. A seal 32 can be cured at room temperature or curing may be accelerated by subjecting the joined parts and sealing material to a heat treatment at a temperature of for example 60° C. The heat sensitive photoconductor is this protected from high processing temperatures. Once the target window and the signal ring are sealed to the cylindrical portion of the tube envelope, the assembled tube then may be processed by standard techniques of exhaust, bakeout, getter flash, and so forth to complete the manufacture. This invention also permits the stem and electron gun assembly to be presealed to the envelope. Accordingly, the flushing gases, for example nitrogen, and high temperatures associated with this sealing are no longer critical features to the photoconductive material.

It will be appreciated that the foregoing seals 32 and sealing technique affords a number of advantages. First, the most critical portion of the tube, namely the photoconductive target 26, may be formed on the target window by an evaporative process which is not hampered by the space limitations which prevail when the target window is earlier sealed to the cylindrical portion 4 of the envelope. Thus it will be readily appreciated that much more effective control of the evaporation process can be had economically, with resulting enhanced uniformity of the target in terms of physical dimensions, light sensitivity and electrical properties. Moreover a plurality of targets may be formed simultaneously by a single evaporation process, with resulting obvious economies. Additionally the targets may be readily inspected, tested and measured to any desired degree conveniently and cheaply prior to assembly to the remaining portion of the tube, and any which are not acceptable may be inexpensively rejected quite independently of the remaining portion of the tube.

Tubes having seals as above described have been found to have substantial resistance to thermal shock, completely acceptable vacuum tightness and satisfactorily low outgassing properties for desirably long life.

It will be appreciated by those skilled in the art that the invention may be carried out in various ways and may take various forms and embodiments other than those illustrative embodiments heretofore described. Accordingly it is to be understood that the scope of the invention is not limited by the details of the foregoing description, but will be defined in the following claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a camera tube including an evacuated envelope, an electron beam generating means disposed in said envelope, a target window arranged to form a portion of the wall of said envelope in the path of said electron beam, an electrode on the interior surface of said window, a layer of photoconductive material on the interior surface of said electrode, and a thin hermetic seal between the marginal portion of said window and the remainder of said envelope, said seal comprising an electrically conductive mixture of epoxy resin and finely divided metal interspersed therein, said epoxy resin have a vapor pressure of not more than about 10^{-5} millimeters of mercury at 75° C.

2. In a camera tube including an evacuated envelope, an electron beam generating means disposed in said envelope, a target window arranged to form a portion of a wall of said envelope in the path of said electron beam, a transparent electrode on the interior surface of said window, a layer of photoconductive material on the interior surface of said transparent electrode, and a thin hermetic butt-type seal between the marginal portion of said window and the remainder of said envelope and in electrical contact with said transparent electrode, said seal comprising an electrically conductive mixture of a powdered metal and an epoxy resin having a vapor pressure of not more than 10^{-5} millimeters of mercury at 75° C.

3. In a camera tube including an evacuated envelope, an electron beam generating means disposed in said envelope, a target window arranged to form a portion of the wall of said envelope in the path of said electron beam, a transparent electrode on the interior surface of said window, a layer of photoconductive material on the interior surface of said transparent electrode, and a thin butt-type seal between the marginal portion of said window and the remainder of said envelope and in electrical contact with said transparent electrode, said seal comprising an electrically conductive mixture of about 20% by weight epoxy resin and about 80% by weight powdered silver interspersed therein, said epoxy resin having a vapor pressure of not more than about 10^{-5} millimeters of mercury at 75° C.

4. The method of manufacturing a camera tube comprising the steps of in the order recited

(a) permanently sealing a stem including a premounted electron gun into one end of an envelope having its other end open,

(b) forming a transparent signal electrode on one face of a target window,

(c) evaporating a layer of photoconductive material on said signal electrode, and

(d) sealing said target window to said other end of said envelope with an electrically conductive mixture of epoxy resin and finely divided metallic material.

5. In an electron discharge device for picture signal generation, an envelope having a cylindrical end, a target window arranged for closing said end of said envelope, a transparent conductive electrode supported directly on the interior surface of said target window, a photoconductive target overlaying said transparent electrode, an annular metallic signal transmisison member extending between said end of said envelope and the marginal portion of said window and hermetically sealed to said end of envelope, and an electrically conductive hermetic seal between said annular member and said window marginal portion and forming an electrically conductive path between said transparent electrode and said annular signal transmission member, said seal comprising an electrically conductive mixture of a finely divided metal and an epoxy resin.

6. The invention as recited in claim 5 wherein said epoxy resin seal is also employed between said annular member and said envelope.

7. In an electron discharge device for picture signal generation, an envelope having a cylindrical end, a target window arranged for closing said end of said envelope, a transparent conductive electrode supported directly on the interior surface of said target window, a photoconductive target overlaying said transparent electrode, an annular metallic signal transmission member extending between said end of said envelope and the marginal portion of said window, an electrically conductive thin hermetic annular seal positioned concentrically between said annular member and said window marginal portion and forming an electrically conductive path between said transparent electrode and said annular signal transmission member, said seal comprising an electrically conductive mixture of about 80% by weight of finely divided silver and 20% by weight of an epoxy resin having a vapor pressure of not more than 10^{-5} millimeters of mercury at 75° C., and a thin hermetic annular epoxy resin seal concentrically positioned between said annular member and said envelope.

8. A method of assembling a photoconductive pickup camera tube comprising in the order recited

(a) hermetically sealing an electron gun structure to one open end of an open ended envelope,

(b) hermetically sealing a preformed photoconductive target window assembly to the other end of said envelope by means of an epoxy resin seal,

(c) thereafter completing the assembling by exhaust, bakeout, getter flashing processes.

9. For use in a photoconductive pickup camera tube the combination of a target assembly comprising

(a) an optically transparent window,

(b) a transparent signal electrode coating on said window,

(c) a layer of photoconductive material on said signal electrode,

(d) an annular electrode joined coaxially to said window,

(e) said joining consisting essentially of a finely divided metal filled epoxy resin hermetically sealing said annular electrode to said window and

(f) said seal providing an electrical connection to said transparent electrode.

10. The invention as recited in claim 9 wherein said seal includes a metal filler of finely divided metal taken from the class consisting of aluminum and silver, and said epoxy has a vapor pressure of less than about 10^{-6} millimeters of mercury at a temperature of 75° C.

11. A method of assembling a photoconductive pickup camera tube comprising in the order recited

(a) hermetically sealing a glass electron gun stem structure to one end of a tubular glass envelope,

(b) forming a transparent signal electrode layer on a window structure,

(c) forming a photoconductive target material layer on said signal electrode layer,

(d) placing a signal ring electrode in concentric abutting relationship with and between said window and the open end of said tubular glass envelope,

(e) applying a thin layer of low vapor pressure epoxy resin having a finely divided metal filler therein to provide electrical conductivity to at least one side of said signal ring between said window and said envelope,

(1) said epoxy resin being of a flexible type,

(f) hermetically sealing said ring to said window by means of said epoxy resin,

(g) curing said epoxy resin at an elevated temperature below 150° C.,

(h) thereafter flash gettering, exhausting, and baking out said tube at a temperature less than about 150° C.

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