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PHOTOCONDUCTIVE PICKUP TUBE TARGET WITH OPAQUE SECTION FOR MEASURING DARK CURRENT

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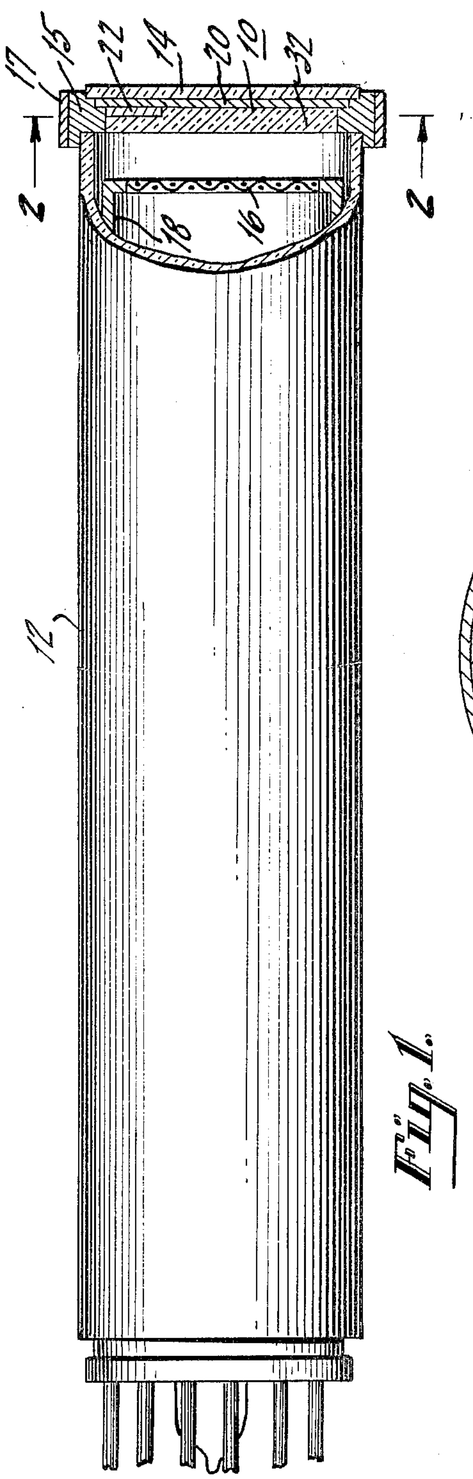

Fig. 1.

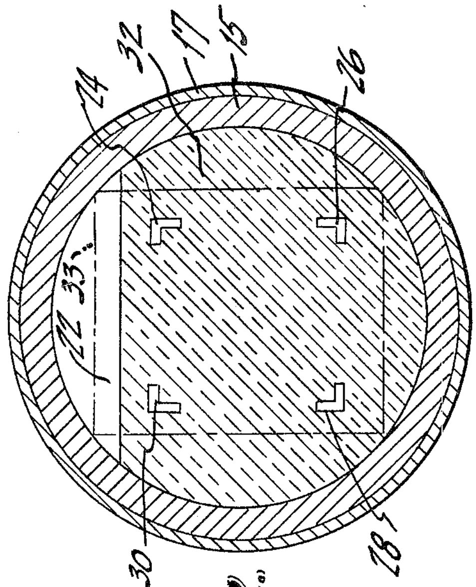

Fig. 2.

INVENTOR.
JOHN F. HEAGY
BY
L. A. Larsen
Attorney

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John F. Heagy, Lancaster, Pa., assignor to Radio Corporation of America, a corporation of Delaware
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The present invention relates to pickup tubes of the photoconductive type, and particularly to a target for such a tube.

A photoconductive pickup tube such as a vidicon normally includes an evacuated elongated envelope having an electron gun in one end thereof adapted to produce a beam of electrons. In the other end portion of the envelope is disposed a target comprising an insulating substrate, a transparent conducting signal plate on the substrate, and a layer of photoconductive material on the signal plate. The beam is caused to scan the target by suitable means such as a system of coordinate electromagnetic deflecting coils positioned outside of the tube envelope.

During operation of a vidicon tube the signal plate is impressed with a positive voltage, which may be 30 volts, for example. When an image is focused upon the photoconductive layer, the lighter portions of the image render elemental areas of the photoconductive layer conductive. However it is found that the photoconductive layer is characterized by some conductivity even in the absence of light thereon. This conductivity is relatively low and is known as the dark current level of the photoconductor.

Although the dark current level of the photoconductor is relatively low, it must be taken into account for proper operation of a vidicon. Thus, where the dark current level at a given temperature of operation is known, the voltages on the signal electrode and on the cathode are adjusted to produce a signal level that is at all times above the dark current level. Such adjustment is feasible due to the fact that a change in the voltage difference between the signal plate and the cathode has an appreciably greatter effect on the dark current level than on the signal level. However, when a vidicon is operated in an ambient characterized by appreciable temperature fluctuation, the dark current level also fluctuates. Such fluctuations occur as a consequence of changes in conductivity of the photoconductive layer in response to temperature changes. Thus, the conductivity increases with increase in temperature and decreases with decreasing temperature. Therefore the fluctuations in the dark current level occur upwardly in response to increase in temperature, and downwardly in response to low temperatures. The upward fluctuations of the dark current level are particularly troublesome. Thus, as such upward fluctuations encroach upon the signal level it may become impossible to distinguish a signal from a non-signal area on the target. In this way, a significant portion of the signal may be lost.

One prior attempt to determine the dark current level during operation of a tube has involved periodic capping of the lens system with which the tube is used. However, the periodic capping technique provides time intervals between the capping periods during which the dark current level is not known. The dark current level may rise to objectionable levels during such intervals and result in undetectable interference with the signal output of the tube. Furthermore, the time required for capping may adversely affect the continuity of the signal.

In some types of vidicon tubes it is desirable to provide on the target thereof, reference means in the form of reticles. One of the purposes of the reticles is to define a particular signal area on the target. To perform this purpose properly it is desirable that the reticles be distinguishable from the signal area during tube operation.

Accordingly, it is an object of the invention to provide a photoconductive type of pickup tube in which the dark current level can be accurately and constantly monitored during tube operations.

It is a further object of the invention to provide a dark current reference area on the target of a photoconductive type of pickup tube.

It is a further object to provide on the target of a photoconductive type pickup tube, indicating means in the form of reticles to define a particular signal area on the target.

Another object is to provide means for determining the dark current level of the photoconductor of a vidicon type tube without adverse effects on the output signal.

A further object is to provide a vidicon tube having on the target thereof a dark current level reference area at a location on the target that is exposed to a scanning beam but displaced from the effective signal area of the target.

A still further object of the invention is to provide a dark current reference area on the target of a vidicon type tube that is effective to provide a true indication of the dark current level under all conditions of tube operation, including operation in ambients of widely different temperatures.

In accordance with the invention, the target for a vidicon, for example, is provided with one or more areas which permit only the flow of dark current during tube operation. Each of such areas on the target comprises a multilayer portion of the target including a layer of conducting material such as tin oxide serving as a signal plate, a layer of bismuth on the layer of tin oxide, and a layer of photoconductive material on the layer of bismuth. One of the multilayer dark current flow areas is effective to provide desirable indications under widely different temperature conditions of operation. Other dark current flow areas may be provided to serve as reticles, if desired.

In the drawing:

FIG. 1 is a side view partly in section of a vidicon type tube embodying the invention, and

FIG. 2 is a section taken through the target along the line 2—2 of FIG. 1 and shows the reticles and the dark current reference area incorporated in the target.

The vidicon tube shown in FIG. 1 is conventional except for the target 10. The tube comprises an elongated glass envelope 12 closed at one end thereof by a transparent faceplate 14 that may be made of glass for example. The faceplate 14 is sealed across the end referred to, by means of an indium ring 15 and clamping ring 17. The target 10 is positioned on the inner face of the faceplate 14. Closely spaced from the target 10 is a mesh screen 16 mounted across one end of a tubular focusing electrode 18. In the other end portion of the envelope 12 is positioned an electron gun (not shown) for providing an electron beam. The electron beam is scanned across the target 10 by suitable means such as electromagnetic coils (not shown) disposed outside of the tubular envelope 12.

The target 10 is a multilayer structure. It includes a relatively thin layer or film 20 (FIG. 1) of a conducting material such as tin oxide in contact with the faceplate 14. This layer of tin oxide is transparent and electrically conductive and serves as a signal electrode. Over the conductive layer 20 are disposed several isolated layers of bismuth. One of these isolated layers of bismuth consists of a layer 22 serving as a dark current reference area. Others of the isolated layers of bismuth consists of four reticles 24, 26, 28 and 30. The reticles serve to define a selected signal area on the target. Over the isolated layers of bismuth and over the exposed layer of tin oxide, is a layer **32** of photoconductive material. The photoconductive material may be a solid layer of a mixture of 67% antimony trisulfide and 33% antimony oxysulfide, by weight.

The area of the target **10** scanned by the electron beam is indicated as the rectangle enclosed by the dashed lines **33** in FIG. 2. This area includes the reticles **24, 26, 28, 30** and the dark current reference area **22**.

The thickness of each of the several layers referred to is as follows. The tin oxide layer **20** should be thin enough to be light transparent and yet sufficiently thick so as to have sufficient lateral conductivity for service as a signal electrode. A satisfactory thickness of the tin oxide layer for the purposes of the invention is about one micron. The thickness of the photoconductive layer should be about three microns for good results. The isolated layers (**22** to **23**) of bismuth should have a sufficient thickness for rendering the layers opaque to light. The minimum thickness for this purpose is 0.5 micron. Any appreciable increase in the thickness of the bismuth layer beyond 0.5 micron is objectionable for several reasons. Such appreciable increase would render the total thickness of the several target layers on the substrate excessive for good adherence on the substrate. It would also introduce objectionable nonuniformity in the overall thickness of the several target layers. This is because each of the signal electrode layer and photoconductive layer is substantially uniform in thickness throughout the area of the target, and an appreciable thick bismuth layer would result in a pronounced step at the edge of the bismuth layer. The total thickness of the several layers of the target would be kept below five microns and preferably at a value of about four and one-half microns to avoid objectionable target peeling.

The tin oxide layer **20** and the photoconductive layer **32** may be applied by conventional evaporation techniques. The isolated bismuth layers are applied as follows.

The faceplate **14** with its initially applied layer **20** of tin oxide is appropriately masked to expose isolated areas to be covered by bismuth. The masking may be effected by holding a clean metal disk against the faceplate, with suitable portions of the disk removed as by etching, to expose only the portions of the faceplate to be coated with bismuth. The masked faceplate is suitably supported in a standard bell jar evacuated to a pressure of approximately 1×10^{-6} millimeters of mercury. Also placed in the bell jar is a tantalum boat filled with either bismuth or bismuth oxide. The boat is slidably positioned, e.g., opposite to the masked faceplate, to direct evaporated bismuth upon the masked surface of the faceplate. In one example the boat was spaced 9 inches from the faceplate. When bismuth is used in the boat it responds in suitable evaporation when the boat is raised to a temperature of about 250° C. in the vacuum ambient referred to. When bismuth oxide is employed in the boat, a higher temperature is used, i.e., 900° C. At this temperature the bismuth oxide is reduced to bismuth before it reaches the masked faceplate. The evolved oxygen is pumped out of the bell jar. The fact that the bismuth or bismuth oxide is in the course of evaporation directed to the masked faceplate precludes major loss by the pumping action. The thickness of the bismuth layer deposited on the masked faceplate may be determined optically by means of a monitoring plate.

It is important that the bismuth layers are over and in contact with the tin oxide layer. This will dispose the bismuth layers between the tin oxide and photoconductor layers. This disposition of the bismuth layers is important because the bismuth layers adhere well to the tin oxide layer, and poorly to either the faceplate substrate or to the photoconductor. Another reason for placing the bismuth layers on the tin oxide layer is that the tin oxide layer is applied at a temperature close to 600° C., which is appreciably above the melting temperature of bismuth which is 271° C.

The use of bismuth to provide a dark current reference area and reticles is of advantage in several respects. Bismuth provides a highly effective light shielding medium so that any current flowing through areas of the photoconductor shielded by the bismuth, provides an accurate indication of the conductivity of the photoconductor in the dark. Bismuth is also electrically conductive so that in combination with the signal plate, it is adapted to provide a true dark current signal. Furthermore, the opacity and conductivity of bismuth persist at substantially the same values over widely different temperature conditions of operation. Another and important advantage as pointed out before, is that bismuth adheres well to the tin oxide coating when applied thereon as a layer having sufficient thickness to provide opacity.

The reticles described in the foregoing provide during operation signal areas easily distinguished by the signals derived therefrom from signals derived from any observable scene. A better indication of the dark current level is provided by the larger area **22**. The appreciably larger area **22** (FIG. 2) exposed to the scanning beam provides an easily measurable indication of such level. If desired, the dark current level indication may be used to automatically adjust signal plate and cathode voltages so that at all times during operation of the tube, the dark current level is below the signal level.

What is claimed is:

1. A photoconductive pickup tube having a target, said target comprising:
- (a) an insulating substrate,
- (b) a conductive layer on said substrate,
- (c) an opaque layer of bismuth on only a portion of said conductive layer, whereby another portion of said conductive layer is exposed, and
- (d) a layer of photoconductive material on said exposed portion of said conductive layer and on said bismuth layer.

2. A photoconductive pickup tube having a target, said target comprising:
- (a) an insulating substrate,
- (b) a light transparent conductive layer on said substrate,
- (c) an opaque layer of bismuth covering only a portion of said conductive layer,
- (d) said layer of bismuth being thinner than said conductive layer, and
- (e) a continuous layer of photoconductive material on both said layer of bismuth and on the portion of said conductive layer not covered by said layer of bismuth.

3. A composite target structure for a photoconductive pickup tube comprising:
- (a) a flat insulating substrate having a target area,
- (b) a plurality of material layers on said target area of said substrate having a total thickness of about 4.5 microns, said layers comprising:
  - (1) a layer of conductive material on said substrate and substantially coextensive with said target area,
  - (2) a layer of photoconductive material substantially coextensive with said layer of conductive material, and
  - (3) a layer of bismuth between said conductive and photoconductive layers, said layer of bismuth extending over only a portion of said target area and having a thickness only sufficient to render said layer of bismuth opaque to light.

4. A photoconductive pickup tube having a target including means defining a signal area, and means defining a dark reference area spaced from said signal area, said last named means comprising:
- (a) an insulating substrate,
- (b) a conductive layer on said substrate,

(c) a bismuth layer on said conductive layer, and
(d) a photoconductive layer on said bismuth layer,
(e) said bismuth layer having sufficient thickness to render it opaque to light,
(f) whereby current flow through said photoconductive layer to said bismuth layer constitutes the dark current level of said photoconductive layer.

5. A photoconductive pickup tube comprising:
(a) an elongated envelope,
(b) a target in one end portion of said envelope, and
(c) an electron gun in the other end portion of said envelope for providing a beam of electrons adapted to be scanned over a predetermined region of said target during operation of said tube, said predetermined region comprising:
  (1) a signal plate,
  (2) a photoconductive layer over said signal plate, and
  (3) a bismuth layer between said signal plate and photoconductive layer and extending across a portion only of the interface area between said signal plate and photoconductive layer at said predetermined region, said bismuth layer having a thickness sufficient to render it opaque to light,
  (4) whereby current flowing through the portion of said photoconductor over said bismuth layer, during operation of said tube, constitutes the dark current level of said photoconductive layer.

6. A target for a photoconductive pickup tube having thereon a plurality of reticled areas in predetermined space relation to a datum area of said target, each of said reticled areas being defined by a structure comprising:
(a) an insulating substrate,

(b) a conducting layer on said substrate,
(c) a bismuth layer on said conducting layer, and
(d) a photoconductive layer on said bismuth layer,
(e) said bismuth layer having a thickness of about 0.5 micron for rendering said layer opaque to light,
(f) whereby said reticled areas are characterized only by dark current flow during operation of said tube and are readily distinguishable from the datum area of said target.

7. A target for a pickup tube having a signal portion and a non-signal portion, said target comprising:
(a) a conducting layer on said signal portion and non-signal portion,
(b) a layer of bismuth only on said non-signal portion of said conducting layer, and
(c) a layer of photoconductive material on said layer of bismuth in said non-signal portion and on said conducting layer in said signal portion,
(d) said bismuth layer having a thickness for rendering it substantially opaque to light,
(e) said layers of bismuth and photoconductive material having a combined thickness of less than five microns for good adherence of said bismuth and photoconductive layers on said conducting layer,
(f) said layer of bismuth being sufficiently thin to preserve a substantially uniform thickness of said signal portion and non-signal portion of said target.

No references cited.

JAMES W. LAWRENCE, *Primary Examiner.*

R. SEGAL, *Assistant Examiner.*