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PHOTOVOLTAIC TARGET

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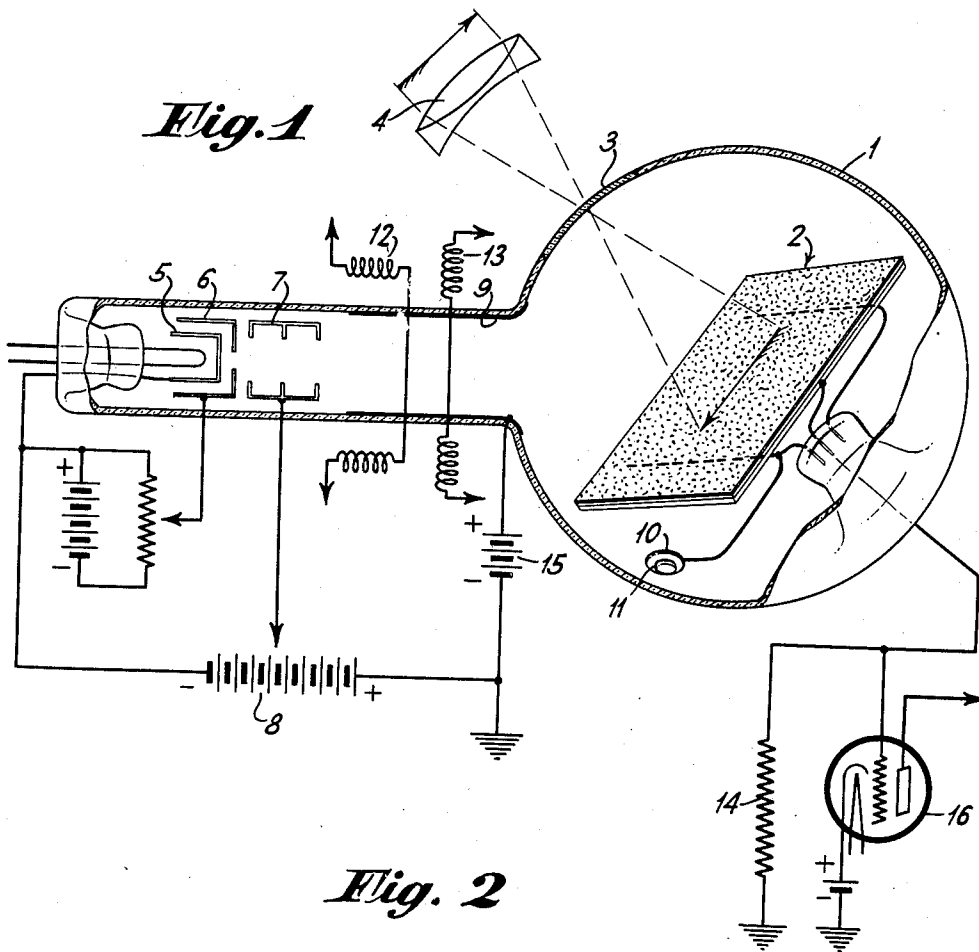
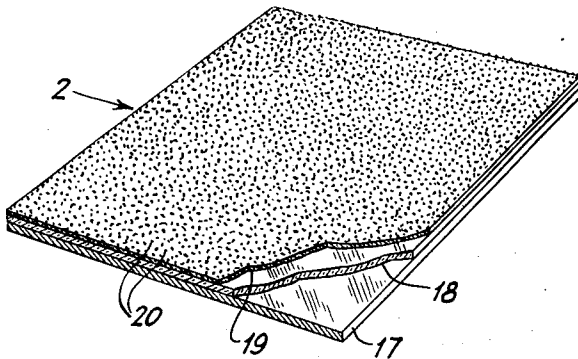


Fig. 2



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PHOTOVOLTAIC TARGET

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6 Claims. (Cl. 250—153)

My invention relates to cathode ray television transmitting tubes, and particularly to light sensitive electrodes for use in tubes of this type.

It is an object of my invention to provide a light sensitive electrode for a television transmitting device which is more easily manufactured than those heretofore used, and which does not require high photosensitivity. Another object of my invention is to provide a light responsive electrode for use in a television transmitting device which shows great uniformity in operation. It is a further object of my invention to provide a light responsive electrode which is not subject to wide variations in photoelectric sensitivity under high electron bombardment during use.

To this end I provide for use in a television transmitting tube a light sensitive target comprising a layer of a semi-conductor in which electrons are liberated by light with a blocking target at its surface, so that photovoltaic action is obtained, project upon the surface of this electrode a light image of an object to be transmitted, and scan the illuminated surface with an electron beam. For this purpose I prefer to make the target with a layer of a semi-conductor such as cuprous oxide, which has been treated to provide a blocking layer on the surface backed by a conducting foundation, such as copper, adjoined to the semi-conducting layer on the side opposite the surface having the blocking layer. In many cases it is desirable to deposit on the blocking layer a mosaic of discrete transparent electrically conducting particles of metal such as caesium, silver, or gold. This electrode assembly is positioned within an evacuated envelope, in such a manner that it may have an optical image projected upon it and also so positioned that it may be scanned by an electron beam.

These and other objects, features and advantages of my invention will appear from the following description taken in connection with the accompanying drawing in which,

Figure 1 is a diagrammatic view illustrating one form of television device incorporating my invention, and

Figure 2 is a view partially in section showing a portion of my new and improved electrode structure shown in Figure 1.

Referring to Fig. 1 the tube which will be described to explain the configuration and operation of my improved electrode structure comprises a highly evacuated glass envelope or bulb 1 with a tubular arm or neck section enclosing a conventional type electron gun and a spherical section enclosing a flat target or electrode 2 so posi-

tioned that its front surface may be scanned by a beam of electrons from the electron gun and also so positioned that it may have projected upon it the optical image to be transmitted. Since the image is produced from an object situated outside the tube, that portion of the spherical section of the tube 1 opposite the target 2 is made optically uniform, such as by providing a window 3 so that the image to be transmitted may be projected upon the electrode 2 with a minimum of distortion by the lens system 4.

The electron gun assembly is of the conventional type and comprises a cathode 5, control electrode 6 connected to the usual biasing battery and a first anode 7 maintained positive with respect to the cathode by a battery 8. The electron stream leaving the cathode 5 under control of the electrode 6 is projected through the anode 7 and accelerated and concentrated into an electron scanning beam of the target 2, by a second anode 9 which is preferably a conductive coating on the surface of the envelope 1 near the neck of the bulb, but removed from that portion of the envelope through which is projected the optical image of the object to be transmitted. A support 10 containing a quantity of caesium-bearing compound 11 is provided adjacent the target, but removed from the path of the optical image projected through the window 3. Conventional deflection means, such as deflection coils 12 and 13 may be used to sweep the beam horizontally and vertically to scan the target 2. It is obvious that conventional electrostatic deflection plates may be substituted for either one or both sets of deflection coils, if desired. The target 2 is connected through the impedance 14 to ground and through the battery 15 to the second anode 9. In operation the current flow in this circuit produces a voltage drop across the impedance 14 which may be impressed upon the input circuit of a translating device 16, further amplified and applied to a transmitting network in a manner well known in the art.

In accordance with my invention I have provided a new method of obtaining television signals utilizing an electrode structure of a new and improved type, as best shown in Fig. 2, in which there is provided a blocking layer of relatively high resistance formed on one surface of a layer of cuprous oxide. More specifically, the electrode construction shown in Fig. 2 includes a metal foundation sheet 17, such as copper, which serves as a signal electrode, and which has on it a thin layer or film 18 of a semi-conductor such as cuprous oxide. In one convenient way of making

this layer the copper plate 17, of suitable size and having a plane and uniform surface, is oxidized in air at a high temperature until the surface is black. After the plate has cooled the outer surface of black cupric oxide is removed by washing the plate in sodium cyanide or nitric acid so as to leave exposed the red cuprous oxide layer 18, which adheres firmly to the copper. The thickness of the layer is not critical, but the layer should be thick enough to be easily visible. That surface of the cuprous oxide layer which is opposite the foundation sheet 17 and on which the image to be transmitted is focused is provided with a blocking layer 19 formed on the surface of the cuprous oxide layer on the oxidized foundation sheet. One convenient way of making this blocking layer is to bombard the oxidized foundation sheet by a glow discharge in a low pressure atmosphere containing hydrogen. Signals may be obtained from such a target if the blocking layer is scanned by an electron beam while an optical image is focused on it, as the blocking layer is of high resistance and seems to form in effect elemental areas which produce signals.

It is usually advantageous to utilize the blocking layer as a carrier for a discontinuous film or layer of metal, such as caesium, silver, or gold. For example, gold may be evaporated on the surface of the blocking layer to form a mosaic of transparent mutually separated particles 20. Only sufficient metal is evaporated to form a discontinuous film, as a continuous film would be electrically conducting in a direction transverse to the plane of the electrode.

The blocking layer may be formed at the same time and by the same operations as the mosaic, if metals such as caesium are used in place of the silver or gold. For example, the foundation sheet 17 bearing the uniform film of cuprous oxide 18 is supported in the tube 1, as shown in Fig. 1, and the tube is then evacuated to a high degree, that is to say, to a pressure of less than 0.1 micron, the electron gun being raised to a high temperature, preferably to a dull red heat by subjecting it to a high frequency field, and the tube in its entirety is baked simultaneously with the evacuation to outgas the component parts of the tube. With the tube still connected to the exhaust pump the cathode is activated in a manner well known in the art, whereupon the pump is disconnected and the caesium-bearing compound 11 is heated to a high temperature to vaporize the caesium which condenses on the surface of the cuprous oxide film 18. The caesium thus applied seems to react with the cuprous oxide and form a blocking layer 19 on the surface of the cuprous oxide layer, and in addition the caesium is thought to condense on the blocking layer as discrete and mutually separated transparent particles 20 separated electrically from the cuprous oxide by the blocking layer 19 which is formed by the reaction of the caesium with the film of cuprous oxide.

An untreated cuprous oxide layer covered with an evaporated layer of metal other than caesium or the like does not provide a suitable electrode; but if metal such as silver or gold is deposited on the oxide layer by cathodic sputtering, instead of by evaporation, a blocking layer is formed between the cuprous oxide and the metal particles. The electrical response of my new and improved electrode is substantially instantaneous under varying degrees of illumination when metals such as silver or gold are used, and the time lag experienced with caesium-treated electrodes is not excessive.

In conventional cathode ray transmitting tubes having a collector electrode and utilizing a mosaic of discrete photo-sensitive particles deposited upon an insulator, such as a sheet of mica backed by a signal electrode, so that the particles form with the signal electrode a plurality of individual condensers which are discharged in a predetermined sequence when scanned by an electron beam, the individual particles of the mosaic when under the influence of a light image to be transmitted acquire electrostatic charges which are proportional to the light intensity thereon. However, I do not utilize this principle of creating a charge on particles or elemental areas of the scanned target by liberating photoelectrons from the particles while under the influence of light. My new target has the property of developing on the individual particles an electromotive force dependent on the intensity of illumination of the blocking layer beneath the particles, which determines the number of electrons transferred to the particles across the blocking layer from the semi-conductor. The cuprous oxide semi-conducting layer 18 has some occluded oxygen in its composition whereas the blocking layer 19 has been shown to be composed of cuprous oxide of very high purity which is formed in place on the exposed surface of the semi-conducting cuprous oxide by deposition of caesium or the sputtering of metals such as silver or gold thereon. The cuprous oxide semi-conducting layer very near the surface of the applied metal apparently has less occluded oxygen than the cuprous oxide near the copper foundation. This deficiency in occluded oxygen accounts for the high electrical resistance of this portion of the cuprous oxide layer and produces what has been referred to as the blocking layer 19. The blocking layer may possibly be the result of the removal of free oxygen by bombardment during the sputtering process. Therefore, while I do not wish to be restricted to any particular theory of operation it seems probable that when the target is dark and the electron beam is absent the particles 20 adjacent the barrier 19 on the cuprous oxide layer 18, take on a potential substantially the same as that of the underlying signal electrode to which the amplifier 16 is connected. This potential may preferably be of the order of 3-10 volts negative with respect to the collector electrode or second anode 9 and is supplied by the battery 15 which is connected between the collector electrode 9 and the plate 17. If now the dark target 2 is scanned by the cathode ray beam having a velocity such that the particles when scanned emit under the impact of the scanning beam more secondary electrons than the number of primary electrons received from the beam, the particle 20 tends to become positive, and reach a peak potential which is positive relative to the potential of the foundation plate 17. It is believed that because the path through the cuprous oxide layer 18 and the blocking layer 19 is only partially conductive, the voltage drop due to current flowing through the layer makes the equilibrium potential of the particle substantially lower than the potential of the collector electrode 9 and higher than the potential of the plate 17, which allows the secondary electrons to be collected by the electrode 9. As long as the beam is on a dark particle there is a steady flow of current between the particle and the collector and the particle remains at a peak potential. After the beam leaves the particle the potential of the particle drifts back toward

the potential of the back plate but is again raised to the peak potential when the particle is again struck by the beam.

If now the particles on the target 2 are illuminated by projecting a light image through the window 3, light passes through the transparent metal particles 20 and illuminates the boundary surface between the layer of cuprous oxide 18 and the blocking layer 19. When the boundary layer is illuminated the particles 20 collect electrons which pass from the semi-conducting electrode or cuprous oxide layer 18 through the blocking layer 19 to the particles 20 and consequently the particles become more negative than when the blocking layer was dark. The extent to which each particle becomes negative depends on the intensity of the illumination, hence the strongly illuminated particles become more negative than neighboring particles which are illuminated to a lesser degree. Under the impact of the scanning beam more electrons are collected by the electrode 3 from those particles which are illuminated to a high degree, than from those which are illuminated to a lesser degree. In my new and improved electrode structure the particles change in potential in a negative direction with respect to the back plate, whereas in a mosaic electrode of the photoelectrically emissive type the particles upon being exposed to light lose electrons causing the particles to become charged in a positive direction with respect to the back plate, with the result that secondary electrons which are released by the scanning beam have a greater tendency to collect on the particles, and the electrode as a whole is less responsive to changing values of illumination than that of the photovoltaic type. Substantially instantaneous electrical impulses or signals, which are dependent on the light intensity, appear in the circuit including the blocking layer 19, the cuprous oxide layer 18, and the foundation plate or signal electrode 17. The resulting potential differences developed across the impedance 14 may be impressed upon the input circuit of a translating device 16, whereupon they may be further amplified and applied to a transmitting network in a known manner.

From the foregoing description it will be apparent that various other modifications may be made in my invention without departing from

the spirit and scope thereof and I desire, therefore, that only such limitations shall be placed thereon as are necessitated by the prior art and set forth in the appended claims.

I claim:

1. A television transmitting tube including an evacuated envelope, a cathode adapted to generate an electron beam, and a target electrode so positioned as to be scanned by said electron beam, comprising a copper foundation plate, a layer of cuprous oxide integral with the said plate, and a discontinuous mosaic of translucent particles of sputtered metal on the exposed surface of said cuprous oxide.

2. A photovoltaic electrode structure for use in television transmitting tubes comprising an electrically conductive base, a layer of semi-insulating material on said base and having on its exposed surface a blocking layer of relatively high resistance, and a discontinuous translucent metallic film on said blocking layer.

3. A photovoltaic electrode structure for use in television transmitting tubes comprising a sheet of metal oxide having on one side a blocking layer of relatively high resistance integral with said oxide sheet, a mosaic of mutually separated electrically conducting translucent particles on said blocking layer, and a metal sheet adjoining the side of said oxide opposite said blocking layer.

4. A target electrode adapted to be scanned by an electron beam comprising a sheet of copper, a layer of cuprous oxide on said sheet having opposite said sheet a surface which is of the blocking layer type, and a mosaic of mutually separated translucent silver particles on said surface.

5. A target electrode adapted to be scanned by an electron beam comprising a copper foundation plate, a layer comprising a lower oxide of copper on the plate, and a discontinuous mosaic of translucent particles of sputtered metal on the exposed surface of said layer of oxide.

6. A target electrode adapted to be scanned by an electron beam comprising a copper foundation plate, a layer of cuprous oxide on said plate, and an evaporated film of caesium of the discontinuous type on the exposed surface of said oxide.

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