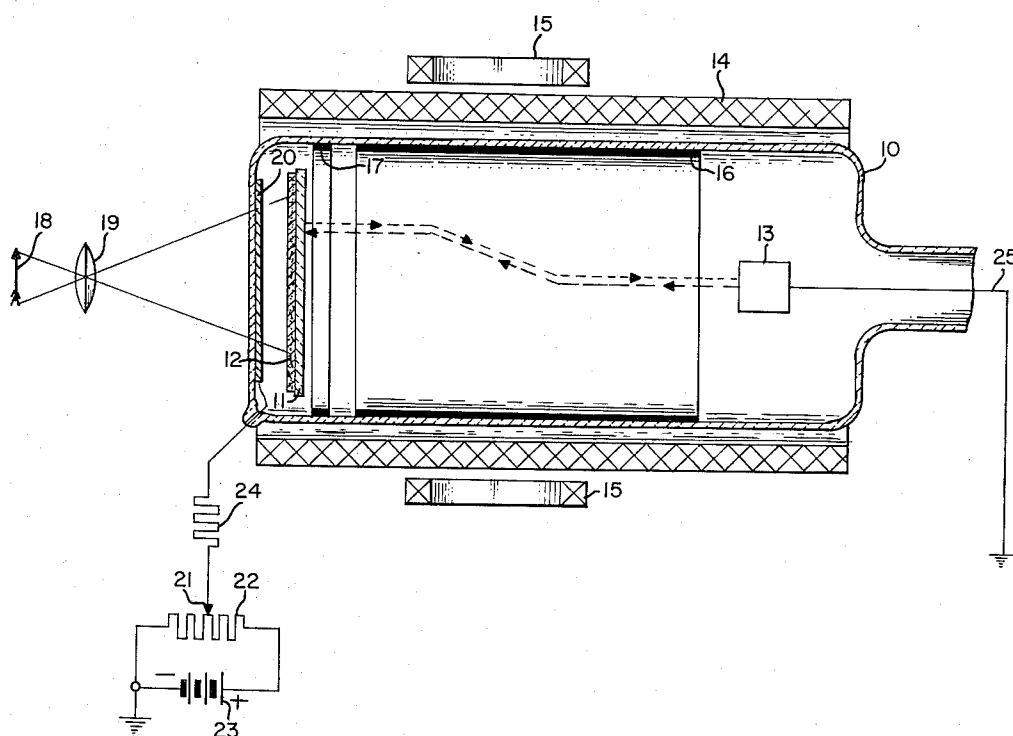


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G. S. P. FREEMAN
IMAGE-CONVERTING DEVICES

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IMAGE-CONVERTING DEVICES

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This invention relates to image-converting devices such as television pickup tubes or the like, and more particularly to such devices of the orthicon type comprising a target electrode carrying a photosensitive mosaic on one surface and means for scanning the opposite surface with a low-velocity electron beam.

While television pickup tubes of the orthicon type afford numerous advantages over other known types of image-converting devices, faulty operation is sometimes encountered when a brilliant illumination is suddenly impressed upon the photosensitive mosaic. When the mosaic suddenly receives brilliant illumination, as from a photographer's flash lamp or the like, the potential of the target electrode is suddenly driven strongly positive, and the tube reaches an unstable state of operation before the operator is able to stop down the camera objective lens. This effect manifests itself as a fogging of the televised image and necessitates shutting down the camera for a short time to restore the mosaic to its normal equilibrium potential near that of the scanning beam cathode in order to permit subsequent image conversion.

It is a primary object of the present invention to provide an improved image-converting device of the orthicon type in which such faulty operation is precluded, either in whole or in part.

An image-converting device constructed in accordance with the present invention comprises a target electrode including a thin layer of semi-conducting material having a photosensitive mosaic supported on one surface thereof. A capacitive electrode of conductive material is disposed in substantially parallel space relation with and in close proximity to the photosensitive mosaic, and means are provided for scanning the surface of the semiconductive layer opposite the mosaic with a beam of low-velocity electrons. Preferably, the capacitive electrode is maintained at a potential slightly positive with respect to the equilibrium potential of the target electrode to cause the capacitive electrode to collect photoelectrons emitted by the mosaic, thereby to prevent the potential of the target electrode from rising substantially above a predetermined value equal to the sum of the capacitive-electrode potential and the emission velocity of the photoelectrons originating at the mosaic.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in connection with the accompanying drawing, in which the single figure is a side view, partly schematic and partly in section, of an illustrative embodiment of the invention. In the drawing, certain elements of the tube are shown very much out of proportion with respect to other elements for the purpose of clearness of illustration.

As shown in the drawing, an image-converting device constructed in accordance with the invention comprises an evacuated envelope 10 within which is supported a target electrode including a thin layer or diaphragm 11

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of semi-conducting material, such as glass or aluminum oxide which has been suitably treated to render it slightly conductive. The semi-conductive layer is made sufficiently thin (of the order of 0.0002-inch, for example) to permit leakage of electrical charges transversely from one surface to the other in less than one frame period ($\frac{1}{30}$ -second under present television standards) but does not permit lateral charge conduction to any appreciable extent in that short interval. A mosaic 12 of photo-sensitive material is disposed on one surface of semi-conductive layer 11 to complete the target electrode structure. The composite target electrode may be of the type conventionally used in ordinary orthicon pickup tubes and may be supported within envelope 10 by any suitable means (not shown), as for example, by means of a resilient mounting ring peripherally engaging the inner wall of the envelope. As in conventional orthicon pickup tubes, an electron gun 13 is supported within envelope 10 and serves to provide an electron beam which is collimated by means of a long solenoid 14 surrounding envelope 10, and which is caused to scan the surface of the target electrode opposite mosaic 12 by electromagnetic scanning coils 15 or equivalent means. The final anode of the scanning beam system may conveniently assume the form of a conductive coating 16 on the inner wall of envelope 10. Moreover, a decelerating electrode 17, which may also assume the form of a conductive coating on the inner wall of envelope 10, is provided between accelerating electrode 16 and semi-conducting layer 11 to reduce the beam velocity to a value near zero as the electrons approach the target electrode.

That portion of the illustrated embodiment thus far described corresponds essentially to a conventional orthicon pickup tube of a type well known in the art. When light from an optical image 18 is directed onto photosensitive mosaic 12, as by means of a lens system represented schematically by a single lens 19, a space-modulated charge image is produced on the target electrode by virtue of the electron deficiency resulting from photo-emission from mosaic 12 in proportion to the intensity of illumination at each picture point. When the opposite surface of the target electrode is scanned with a low-velocity electron beam from electron gun 13, the scanning electrons are returned toward the electron gun in proportion to the local charge at the point where the scanning beam approaches the target electrode. In order to obtain an output signal of useful amplitude, it is customary to include an electron multiplier arrangement (not shown) in the electron gun 13. Such electron multipliers are well known to the art and may assume, for example, the form illustrated and described in the copending application of George Stanley Percival Freeman, Serial No. 122,925, filed October 22, 1949, for "Target Electrodes for Use in Television Pickup Tubes or the like," and assigned to the present assignee.

While a conventional orthicon of the type described provides quite satisfactory image conversion under most operating conditions, it has been found that sudden brilliant illumination of the photosensitive mosaic, which may for example be caused by a photographer's flash lamp or the like, causes the equilibrium potential of the target electrode to rise above that of the cathode of the scanning electron gun, thereby causing fogging of the televised image.

In accordance with the present invention, a capacitive electrode 20 of conductive material is disposed in substantially parallel space relation with, and in close proximity to, photosensitive mosaic 12 and is maintained at a potential slightly positive with respect to the desired target electrode equilibrium potential, in order substantially to prevent instability and fogging in response to sudden brilliant illumination of the mosaic. Preferably,

capacitive electrode 20 may assume the form of a thin light-transparent conductive film or a very fine conductive mesh structure supported on the inner surface of the end wall of envelope 10, so that light from the optical image 18 may be directed on photosensitive mosaic 12 through the capacitive electrode 20. Electrode 20 may be maintained at the desired potential by connecting it to a variable tap 21 on a potentiometer 22 connected in parallel with a suitable bias voltage source, here represented as a battery 23, one terminal of which is grounded. An output load resistor 24 may be included in the circuit between capacitive electrode 20 and variable tap 21. The cathode of electron gun 13 may conveniently be grounded, as by means of lead 25, to provide a reference potential with respect to which the potential of capacitive electrode 20 may be adjusted.

In operation, in the absence of external light directed onto the photosensitive mosaic 12, the target electrode is maintained at a potential very near that of the cathode of electron gun 13 by the action of the low-velocity scanning electrons. When light is focussed onto mosaic 12 from image 18, photoelectrons are emitted from the mosaic in proportion to the local light intensity and are collected by capacitive electrode 20 which is maintained slightly positive with respect to the gun cathode. By disposing the target electrode with photosensitive mosaic 12 in substantially parallel relation with, and in close proximity to, capacitive electrode 20, saturation of the photoemission is obtained with only one or two volts positive potential applied to electrode 20. When any element of photosensitive mosaic 12 rises to a potential equal to the sum of the potential of electrode 20 and the emission velocity (about $1\frac{1}{2}$ volts), space charge saturation occurs in the space between mosaic 12 and electrode 20, and no further potential rise of the target electrode may be effected. Thus, the equilibrium potential of the target electrode can never rise above a potential corresponding to the sum of the potential applied to electrode 20 and the emission velocity of the photoelectrons, even under the brightest illumination. By maintaining the potential of electrode 20 at a low positive value with respect to the desired target electrode equilibrium potential, operation such that secondary emission caused by impact of the scanning beam remains always below unity ratio with respect to the primary electrons is insured. Thus, the potential of semi-conducting layer 11 is stabilized, and instability and fogging of the televised image are avoided.

Output signals may be derived in the conventional manner by means of an electron multiplier included in electron gun 13 for collecting and amplifying the return electron beam, or, if desired, by means of a load impedance 24 connected to capacitive electrode 20. In the latter instance, the output signal is developed by the load impedance connected to electrode 20 by virtue of the capacitive action of that electrode with respect to photosensitive mosaic 12.

Thus, the invention provides a new and improved image-converting device of the orthicon type in which instability is substantially avoided by preventing the equilibrium potential of the target electrode from rising more than a predetermined amount above the potential of the cathode of the scanning electron gun. In this manner, fogging of the televised image is avoided, even under conditions of the most brilliant illumination.

While a particular embodiment of the present invention has been shown and described, it is apparent that various changes and modifications may be made, and it is therefore contemplated in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. An image-converting device comprising: an imperforate target electrode including a thin layer of semi-conducting material having a photosensitive mosaic sup-

ported on one surface thereof; a capacitive electrode of conductive material disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; means for scanning the surface of said layer opposite said one surface with a beam of low-velocity electrons; and means for maintaining said capacitive electrode at a potential slightly positive with respect to the equilibrium potential of said target electrode to cause said capacitive electrode to collect photoelectrons emitted by said mosaic, whereby the potential of said target electrode is prevented from rising substantially above a predetermined value equal to the sum of said first-mentioned potential and the emission velocity of said photoelectrons.

2. An image-converting device comprising: an imperforate target electrode including a thin layer of semi-conducting material having a photosensitive mosaic supported on one surface thereof; a light-permeable capacitive electrode of conductive material disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; means for projecting an optical image through said capacitive electrode onto said photosensitive mosaic to produce a space-modulated charge image on said target electrode; means for scanning the surface of said layer opposite said one surface with a beam of low-velocity electrons; and means for maintaining said capacitive electrode at a potential slightly positive with respect to the equilibrium potential of said target electrode to cause said capacitive electrode to collect photoelectrons emitted by said mosaic, whereby the potential of said target electrode is prevented from rising substantially above a predetermined value equal to the sum of said first-mentioned potential and the emission velocity of said photoelectrons.

3. An image-converting device comprising: an imperforate target electrode including a thin layer of semi-conducting material having a photosensitive mosaic supported on one surface thereof; a light-permeable capacitive electrode of conductive material disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; means for projecting an optical image through said capacitive electrode onto said photosensitive mosaic to produce a space-modulated charge image on said target electrode; means for scanning the surface of said layer opposite said one surface with a beam of low-velocity electrons; means for maintaining said capacitive electrode at a potential slightly positive with respect to the equilibrium potential of said target electrode to cause said capacitive electrode to collect photoelectrons emitted by said mosaic, whereby the potential of said target electrode is prevented from rising substantially above a predetermined value equal to the sum of said first-mentioned potential and the emission velocity of said photoelectrons; and a load impedance coupled to said capacitive electrode for deriving electrical output signals representing said space-modulated charge image in response to scanning of said target electrode by said beam.

4. An image-converting device comprising: an imperforate target electrode including a thin layer of semi-conducting material having a photosensitive mosaic supported on one surface thereof; a capacitive electrode of conductive material disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; and means for scanning the surface of said layer opposite said one surface with a beam of low-velocity electrons.

5. An image-converting device comprising: an imperforate target electrode including a thin layer of semi-conducting material having a photosensitive mosaic supported on one surface thereof; a light-transparent conductive film disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; and means for scanning the surface of said layer

opposite said one surface with a beam of low-velocity electrons.

6. An image-converting device comprising: an imperforate target electrode including a thin layer of semiconducting material having a photosensitive mosaic supported on one surface thereof; a light-transparent conductive mesh electrode disposed in substantially parallel space relation with and in close proximity to said photosensitive mosaic; and means for scanning the surface of said layer opposite said one surface with a beam of low-velocity electrons.

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