Feb. 13, 1940.

P. S. LESTER

2,189,988

PHOTOELECTRIC DEVICE

Filed Sept. 28, 1937

Fig. 1

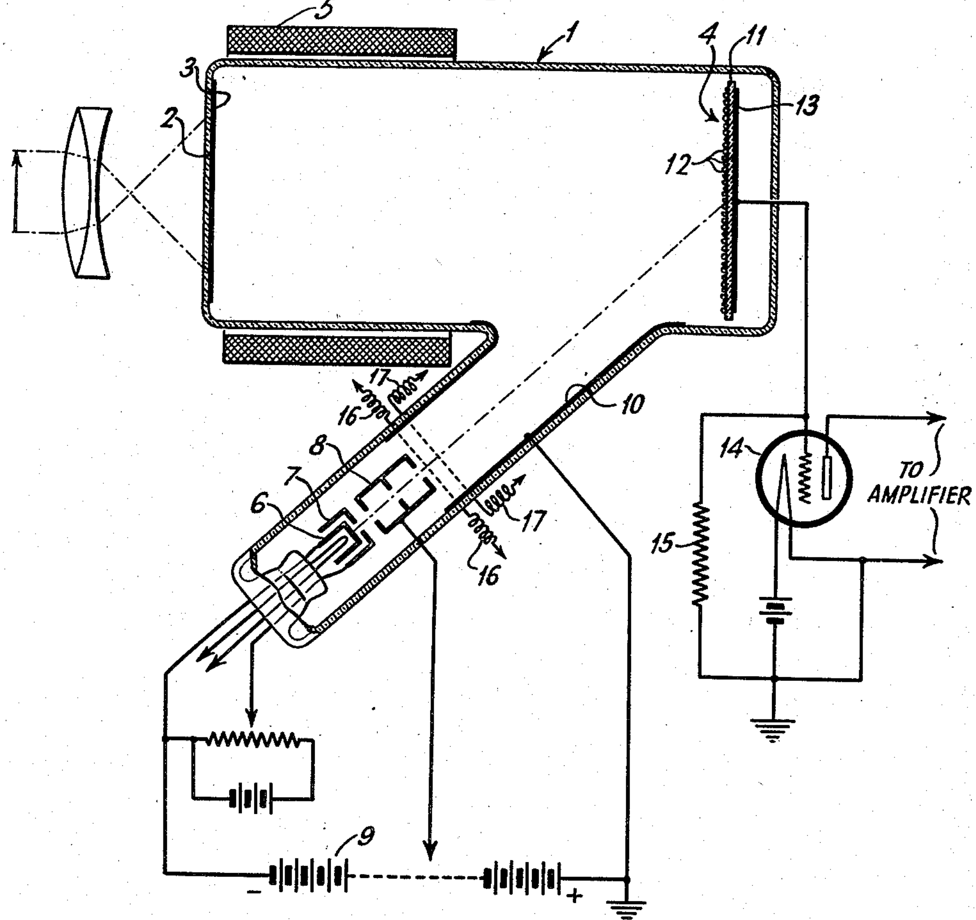
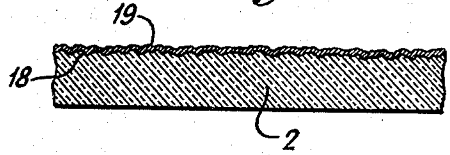


Fig. 2



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UNITED STATES PATENT OFFICE

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PHOTOELECTRIC DEVICE

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3 Claims. (Cl. 250—153)

My invention relates to television transmitting and electron image tubes, and more particularly to tubes utilizing separate photoelectrically sensitive cathodes and scanned targets.

In some television transmitting and electron image tubes of the cathode ray type an optical image is focused upon a semi-transparent photoelectric cathode to liberate streams of electrons which are directed toward and focused upon a target, such as a mosaic electrode, to develop on its surface an electrostatic image which is neutralized by scanning the target or electrode with a cathode ray beam. To intensify the electrostatic image, streams of electrons released from the cathode are directed to a target or mosaic electrode having elemental areas with a high secondary emission coefficient, or ratio of the number of secondary electrons emitted to the number of impinging electrons. For optimum operation the target or mosaic electrode should have elemental areas with a secondary emission coefficient, which is high and is greater than unity. Such targets are, in general, photosensitive. Usually the target has a mosaic surface of individually separated and oxidized silver particles coated with caesium. Such a mosaic surface has the desired high secondary emission coefficient, but is inherently photosensitive, so that when light falls on it photoelectrons are liberated.

In the operation of such a device the optical image to be transmitted is focused upon the semi-transparent photoelectric cathode, and some of the light is unavoidably transmitted through the translucent cathode and falls upon the target or mosaic electrode. If the optical image is focused upon the semitransparent photoelectric cathode the transmitted light which falls upon the photoelectrically sensitive target or mosaic electrode forms an out-of-focus image and electrons are liberated from the target or mosaic electrode in accordance with this out-of-focus image. Such emission of electrons impairs the desired fidelity of transmission.

One object of my invention is to provide a television transmitting tube which has a photoelectrically sensitive cathode facing a mosaic electrode and in which background effects due to light from the photocathode are substantially reduced or eliminated. Another object of my invention is to provide a cathode television transmitting tube of the type which has greater fidelity of transmission than has heretofore been obtainable in such tubes.

In accordance with my invention the semi-transparent photocathode is so made that a negligible amount of the light falling on it is transmitted to the associated photoelectrically sensitive target or mosaic electrode. In one form of my invention the image of an object to be transmitted is focused on a translucent photoelectric cathode formed on a surface which is translucent and suffcently light diffusing to prevent an optical image being formed on an associated target or mosaic electrode. The light diffusing surface may be formed on an interior portion of the tube wall or on a light transparent member within the tube. The primary electron streams liberated from the surface of the cathode are directed to and focused upon the target or mosaic electrode which has individually separated particles having a high secondary emission coefficient, the elements being periodically scanned by a cathode ray beam to discharge them and produce a useful output current.

A better understanding of my invention will be obtained 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 longitudinal view, in cross section, illustrating one form of television transmitting tube embodying my invention, and

Figure 2 is a fragmentary view, in cross section and on a greatly enlarged scale, illustrating the structure of the photoelectrically sensitive cathode shown in Figure 1.

Referring to Fig. 1 a tube made in accordance with my invention comprises a highly evacuated envelope or bulb 1 with an elongated cylindrical or body section and a neck section near one end of the envelope inclined at an acute angle with respect to the cylindrical section. The cylindrical section is closed at each end, the closure at the end opposite the neck section preferably being of optically uniform glass which is sealed to the body section of the envelope or bulb during the manufacturing process to form a window or end section 2 and which has thereon a semitransparent photoelectrically sensitive surface constituting the photocathode 3. Oppositely disposed from the photocathode 3 is a target or mosaic electrode 4 positioned to receive photoelectrons which are liberated from the photocathode 3 and focused thereon by the electron focusing coil 5. An electron gun located in the neck of the bulb is provided to scan the mosaic electrode 4 with a cathode ray beam. The electron gun in the neck of the envelope comprises a cathode 6, control electrode 7 connected to the usual biasing battery, and a first anode 8 maintained positive with respect to the cathode by a battery 9 to produce a cathode ray beam controlled by the electrode 7, projected through the anode 8, and accelerated and concentrated into an electron scanning beam of the target or mosaic electrode 4 by the second anode 10 which is preferably a conducting coating on the inner surface of the envelope 1 in the neck of the bulb.

The mosaic electrode 4 is conventional, and comprises a foundation 11 of mica or other insulating material having on the side facing the photoelectrically sensitive cathode 3 a multiplicity of mutually separated silver particles 12 which are oxidized and coated with caesium to provide a mosaic surface which exhibits high secondary electron emission when scanned by the cathode ray beam. The opposite side of the foundation 11 is coated with a layer 13 of conducting material such as platinum, which serves as a signal electrode and is connected to the grid of a translating device 14 and to ground through the impedance 15. Obviously the mosaic electrode 4 may be of the double-sided type such as disclosed by Hickok U. S. Patent 2,047,369, July 14, 1936 in which case it is desirable to mount the electron gun in axial alignment with the cathode 3 and the mosaic electrode so that the double-sided mosaic electrode is between the gun and the cathode 3.

Conventional beam deflection means such as the deflection coils 16 and 17 or conventional electrostatic deflection plates sweep the beam horizontally and vertically to scan the mosaic electrode 4.

In accordance with my invention, as best shown in Fig. 2, I roughen the inner wall of the optically uniform and transparent end section 2 to provide a translucent light diffusing foundation surface 18 for the semi-transparent photoelectric cathode 3 which emits electrons when illuminated. I have found that such a surface prevents the formation of an optical image upon the target or mosaic electrode 4, and that the photoelectric cathode should adjoin this surface. The inner wall of the glass end section 2 may be roughened to provide the foundation surface 18 by sand-blasting with finely-divided abrasive, by etching with acid, or by any other convenient method whereby a light diffusing surface may be obtained. If the transparent end section 2 is of lime glass it is preferably etched in such a manner as to obtain a roughened surface having a multitude of depressions or pits which are more or less rounded. This kind of etching may be done in two steps; first etching with a relatively strong ammonium bifluoride solution of relatively high acidity, and then re-etching the surface thus formed with a weaker solution which rounds off the depressions and ridges formed by the first etch. A satisfactory etched surface is obtained by using for the first etch a solution containing the following constituents by weight:

	Per cent
Ammonium bifluoride	36
Dextrin (powder)	10
Barium sulphate	28
Sodium bisulphate	5
Water	21

With this mixture, which contains about 12% hydrofluoric acid, the etching time is about 30 seconds at 50° C. For the second etching a water solution containing about 7½% hydrofluoric acid, 2% dextrin, and 40% barium sulphate is kept in contact with the etched glass, for about 30 seconds at 50° C. If the end section 2 is of the hard low expansion glass commercially known as "Pyrex" glass, I prefer to mechanically roughen the surface, for example, by sand-blasting, preferably with finely-ground steel grit until the white light transmission is reduced to about 90% of the original value before the blasting, and then etch the mechanically roughened surface with an acid solution of 5% hydrofluoric acid in water at a temperature of 20° C., for a period of approximately one minute. Good results may also be obtained by immersing the surface in the etching fluids.

Following the formation of the roughened surface I thoroughly wash the surface with warm distilled water. The end section is then sealed into the tube and the tube is evacuated. Silver is then evaporated within the tube and condenses on the surface 18 as a thin film of silver 19 which is sufficiently thin to be semi-transparent to light. The silver film is then oxidized by subjecting the film to a glow discharge in the presence of oxygen until the film becomes practically transparent. Excess oxygen is pumped from the tube, caesium vapor is introduced into the tube, and the tube is baked for about five minutes at approximately 200° C. to sensitize the silver oxide film and form the photoelectric cathode 3. It has been found that with such treatment an excellent electrically conducting photoelectrically sensitive surface is obtained.

In operation an optical image of the object to be transmitted is focused upon the photoelectric cathode 3 to liberate streams of electrons which are directed to and focused upon the mosaic electrode 4 by the fousing coil 5 to form on the mosaic an electrostatic image of the optical image. The mosaic electrode is then scanned by the cathode ray beam generated by the electron gun in the neck section of the tube to neutralize the electrostatic image and produce signalling impulses representative of the electrostatic image.

It will be seen that I have provided a foundation for a photoelectrically sensitive cathode which diffuses the light and prevents the formation of an out-of-focus image on the photosensitive target electrode 4, and that by the use of such a light diffusing foundation it is possible to obviate many of the disadvantages normally attendant upon the operation of television transmitting tubes incorporating a photoelectrically sensitive cathode and a separate mosaic electrode.

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 in an evacuated envelope having a transparent window with an etched light diffusing inner surface a photoelectrically sensitive mosaic electrode oppositely disposed from said window, and a photoelectric cathode adjoining said surface and between said mosaic electrode and said surface.

2. A television transmitting tube including a target electrode capable of emitting electrons when illuminated, a semi-transparent photoelectric cathode opposite and parallel to said target electrode, means to form an optical image on

said cathode, and means consisting of an etched vitreous base between said first-mentioned means and said cathode and adjoining said cathode to diffuse the light of the optical image and prevent its falling on said target electrode as an out-of-focus replica of the optical image.

3. A television transmitting tube including an evacuated envelope with a portion etched so as to be light diffusing, a light sensitive mosaic electrode adapted to emit secondary electrons when bombarded with high velocity electrons, a semi-transparent photoelectric cathode adjoining said etched light diffusing portion oppositely disposed from and facing said mosaic electrode and between said etched light diffusing portion and said mosaic electrode.

PAUL S. LESTER.