

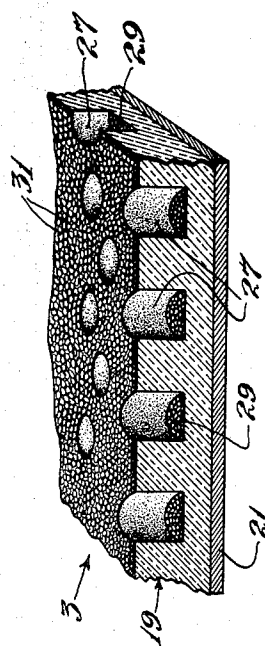
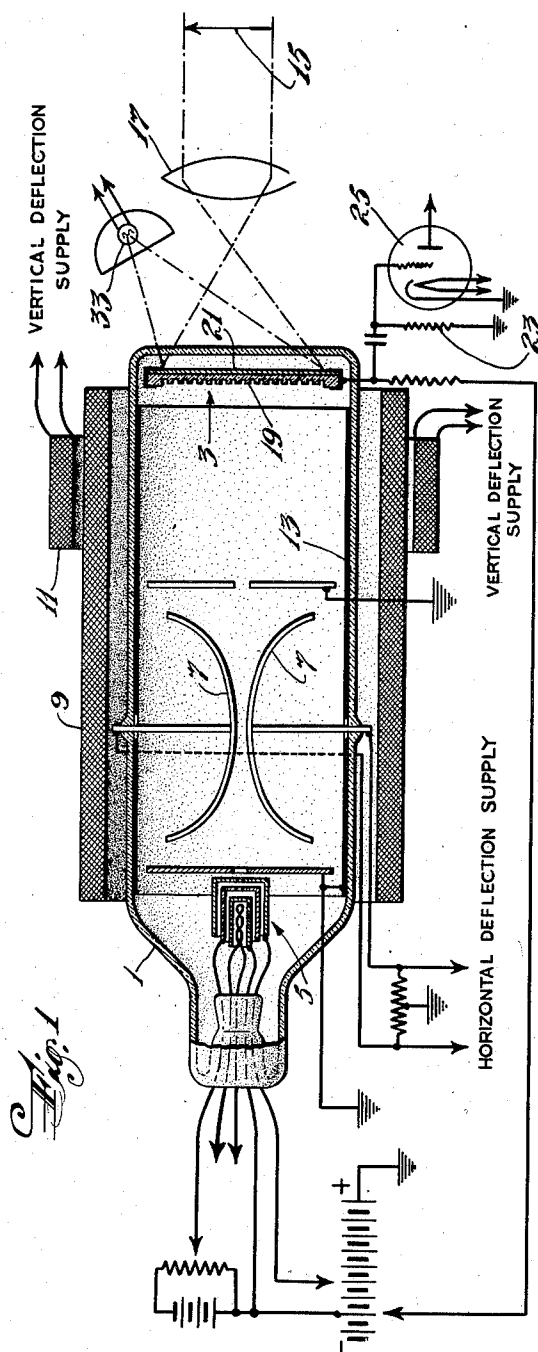
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H. B. LAW

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TELEVISION TRANSMITTING APPARATUS

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TELEVISION TRANSMITTING APPARATUS

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10 Claims. (Cl. 178—7.2)

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My invention relates to television transmitting apparatus and particularly to tubes of the low velocity electron scanning type and to improved electrode structure for such tubes.

Tubes of the low velocity electron beam scanning type, such as described by Iams and Rose in their U. S. Patent No. 2,213,175, utilize a mosaic electrode of the conventional type which, when subjected to light representative of an optical image, emits electrons to develop an electrostatic image which is discharged by a low velocity electron scanning beam. Inherently such tubes have higher sensitivity than similar tubes scanned by a high velocity electron beam inasmuch as no secondary electrons are produced which tend to neutralize the electrostatic image between successive scans of the beam. It has been proposed to utilize a perforated target of the image control type wherein an electrostatic image is formed to control the flow of low velocity electrons through the apertures as described by Iams in U. S. Patent No. 2,213,179. Such tubes are difficult to construct and in addition not all of the electrons from the beam passing through the apertures are picture modulated. Furthermore, such tubes usually require longer focal length lenses for projecting light on the apertured image electrode inasmuch as space must be provided within the envelope for collection of electrons thereby increasing the distance between the target and the associated optical lens system.

Among the objects of my invention are to provide a photoelectric apparatus having a high output, to provide a photo-electric tube and structure of the mosaic type which may be operated without the introduction of spurious signals, to provide television apparatus wherein the output signal may be increased notwithstanding relatively low levels of image illumination, and to provide more efficient television transmitting tubes whereby higher signal output therefrom may be obtained. These and other objects, features and advantages of my invention will become apparent from the following description and the accompanying drawing wherein:

Figure 1 is a longitudinal sectional view of a television transmitting tube embodying my invention; and

Figure 2 is a greatly enlarged fragmentary view of a type of target electrode made in accordance with my invention and shown in the tube of Figure 1.

I will refer in the following description to only one particular type of structure suitable for developing and scanning a low velocity electron

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beam over a target so that it should be understood that the description of the tube structure, with the exception of the target structure, is in no sense limiting. However, it is desirable to scan my target with a low velocity electron beam, inasmuch as the features and advantages of my invention do not accrue to their fullest extent when utilizing a beam of sufficiently high velocity to develop copious secondary electron emission on the scanned surface of the target.

Considered broadly, the apparatus made and operated in accordance with my invention comprises an evacuated envelope having means to develop an electron beam of elemental picture area cross-section which is scanned over a novel type of target. The target is of the charge-storage type; that is, electrostatic charges are developed over the surface which are neutralized in a definite time and space sequence by the low velocity electron beam, the target having two separate and distinct photo-emissive structures, one of which controls the emission of the other. The photo-emissive structures are each of the photo-emissive mosaic type, one of which controls the emission from the other, the signal developed by the discharge of the controlled mosaic being the larger factor in developing the picture signals, the control mosaic being subjected to the optical image light and developing upon scan a minor portion of the useful television signal. In addition, the two mosaics have different photo-electron emissive spectral responses so that the response of the control mosaic may be to light of one color, whereas the controlled mosaic responds to light of a different color.

Referring specifically to my tube structure shown in the drawing, the tube comprises an evacuated envelope 1 enclosing at one end a target or mosaic electrode 3 and at the opposite end an electron gun assembly 5 adapted to project electrons toward the mosaic electrode. The electron gun may be identical with that shown by Iams in his aforesaid patent and need not be described here in detail except to note that the gun includes an electron emissive cathode, a control grid electrode and an anode. The electron beam developed by the electron gun 5 is accelerated and horizontally deflected by a pair of electrostatic deflection plates 7 in the presence of an electromagnetic field developed by the coil 9 and vertically deflected by the magnetic field developed by the coils 11. The envelope 1 is preferably provided with a conductive coating 13 on the inner wall which is operated at or near the potential applied to the anode of the electron

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gun. It will be appreciated that either full electromagnetic or electrostatic deflection may be utilized either with or without the longitudinal magnetic field developed by the coil 8, although this longitudinal field is beneficial in directing the low velocity electrons normally of the target surface, inasmuch as the equilibrium potential of the target is maintained substantially at the electron gun cathode potential to decelerate the electrons of the beam to substantially zero velocity adjacent the target surface.

The target 3 is positioned so that its front surface, or surfaces hereinafter described, may be scanned by the electron beam and have projected thereon, preferably from the opposite side, light from an object 15 through a lens system 17. Fundamentally, the target 3 includes an insulating foundation 19 facing the electron gun 5 and a semi-transparent, conductive coating or signal plate 21 from which the signal impulses are collected. The signal plate 21 is connected through an output impedance 23 to substantially cathode potential and to a translating device 25 preferably of the thermionic type for amplification of the signal developed across the output impedance 23.

In accordance with my invention as best shown in Figure 2, the target or mosaic electrode 3 comprises an insulating foundation 19 having on one side thereof the conductive coating or signal plate 21, the foundation 19 being so constructed as to provide surfaces for two spatially separated photo-electric mosaic structures as shown in the drawing. The foundation 19 is imperforate but has a number of recesses 27, the bottom surfaces of which are in relatively close proximity to the signal plate 21. These proximal surfaces are provided with photo-electrically sensitive elements 29 which may be of the continuous photo-sensitive type and which, in the aggregate, comprise a mosaic closely spaced from the signal plate 21. The surface of the foundation 19 further removed from the signal plate 21 bears a mosaic of mutually separated particles 31 surrounding the recesses 27 containing the elements 29. This structure may be defined as two photo-sensitive mosaics lying in different parallel planes to one side of and at unequal distances from the signal plate. Further in accordance with my invention these two mosaics have different spectral sensitivity, the mosaic comprising the elements 29 having a sensitivity in the red or infra-red portion of the spectrum so that when subjected to red light, electrons are emitted by the elements, the mosaic particles 31 having a photo-electric response different from the elements 29 and preferably over the blue portion of the spectrum.

The foundation 19 is of insulating material, such as a thin sheet of glass, and I have described in my co-pending application, Serial No. 463,065, filed October 23, 1942, one method of manufacture wherein a thin sheet of glass approximately 0.004 inch in thickness is provided with depressions or bubbles extending only partially through the thickness of the glass. Fundamentally, this method comprises coating one surface of the glass with a volatilizable tacky material holding in place a great multiplicity of small preferably uniformly sized silicon carbide particles. The coated sheet of glass bearing the particles is then fired to produce a great multiplicity of bubbles in the glass sheet, whereupon the glass sheet may be cooled and the particles removed by dissolving the particles in hydrofluoric acid. These bubbles

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form recesses, the bottom surfaces of which may be coated with photo-electrically sensitive material preferably chosen to be sensitive to red light. The remaining area of the glass sheet not originally bearing the silicon carbide particles is then provided with a mosaic of mutually separated and insulated particles which may be photo-sensitized to be electron-emissive when subjected to blue light.

More particularly, I prefer to form the foundation for the red sensitive mosaic first, such as by placing the sheet 19 in an evacuated envelope and vaporizing and depositing silver over the entire surface thereof followed by cleaning the silver from the top surface around the recesses 27. Alternatively, finely divided silver oxide may be dusted over the bottoms of the recesses followed by removal of the oxide which settled on the top surface of the sheet 29. Silver is chosen for the elements 19 since it is ideally suited as a foundation for a red photo-sensitive structure. Following the removal of the excess silver or silver oxide from around the recesses, I deposit on the top surface a photo-sensitive foundation particularly suitable for forming a blue sensitive surface. For example, antimony may be vaporized and condensed upon this top surface by inclining the sheet 19 to an antimony source so that the bottom areas in the recesses are shielded from antimony deposition by the side-walls of the recesses thereby forming a coating of antimony on the top surface of the sheet 19. Following these operations the sheet is baked at a temperature sufficient to cause the antimony and silver depositions to break up into individually separated mosaic particles. It is not necessary that the silver in the recesses be sub-divided into particles although such an action is not detrimental inasmuch as the silver in each recess is separated and insulated from that in adjacent recesses and from the antimony by the side-walls of the recesses. Following the preparation of the foundation sheet 19, a thin film of platinum or other metal may be applied to the rear surface of the sheet to form the signal plate 21, whereupon the electrode assembly thus formed is sealed within the envelope 1 which is then exhausted. The silver foundation or elements 29 are then superficially oxidized. Caesium or other alkali metal is then introduced within the envelope from an external source not shown and condensed upon both the silver and antimony. Such treatment produces a mosaic comprising the elements 29 highly photo-sensitive to red light in the recesses 27 and a mosaic highly sensitive to blue light comprising the particles 31.

In operation, I subject the target electrode 3, as best shown in Figure 1, to red or infra-red light, such as from an external source or lamp 33, to liberate electrons from the elements 29. However, little, if any, electron emission occurs from the mosaic particles 31 because these particles are sensitive substantially only to shorter wave-length light. The object 15 is then illuminated with predominantly blue light and light reflected from the object 15 is then projected to form an image of the object or scene to be transmitted on the mosaic particles 31 to liberate electrons therefrom. Since the elements 29 are sensitive only to the red, and since the illumination of the object 15 preferably contains little, if any, red light, no electrostatic image from the mosaic comprising the elements 29 is produced by this blue light. Simultaneously with these operations, the front surface

including both the top surface of the foundation sheet 19 and the bottom walls of the recesses 27 are scanned by the low velocity electron beam. In the absence of blue light, some of the beam electrons are collected by the mosaic particles 31 rendering these particles negative. However, still in the absence of blue light, the negative charges acquired by the particles 31 from the beam suppress the emission from the elements 29 notwithstanding their illumination by the red light from the lamp 33. However, in the presence of the blue optical image light, the particles 31 acquire positive charges which allow the escape of electrons from the elements 29. This action occurs between successive scans of the target by the electron beam so that following such action, the next scan discharges both the particles 31 and the elements 29 to develop a signal in the capacitively associated signal plate 21.

The electrostatic image developed over the extended area occupied by the particles 31 will control the formation of the electrostatic image consisting of the charges on the elements 29 since the elements 29 emit in accordance with the positive charges of the particles 31. However, the red light source 33 may be of any desired high intensity, and consequently, the absolute value of the charges acquired by the elements 29 is not dependent upon the light intensity reflected by the object 15. Only the distribution of the charges on the elements 29 is controlled by the image light, and for this reason the energy available to develop the television signal is limited only by the intensity of the red light source and the quantum efficiency of the elements 29. The mosaic elements 29 are closer to the signal plate 21 than are the mosaic particles 31 and the capacity of the elements 29 to this signal plate will be greater than that of the particles 31. Preferably the capacity of the particles 31 to the signal plate and elements 29 is low and may be further decreased by increasing the thickness of the foundation 19 thereby increasing the distance between the mosaics and between the particles 31 and the signal plate 21. The proximity of the elements 29 to the signal plate 21 provides even greater signal output upon discharge of these elements by the beam than would the particles 31, both because of their proximity to the signal plate 21 and due to the higher available electrostatic image intensity due to the lack of any limitation of the optical image light producing this electrostatic image. Consequently, television transmitting tubes made in accordance with my invention provide a higher output signal and more efficient operation and, since there is no generation of secondary electrons by the low viscosity electron beam, no spurious signals due to secondary electron distribution are produced.

While I have described my invention with particular reference to one type of structure suitable for developing a low viscosity beam and have shown the mosaic target electrode as being illuminated from the side opposite that which is scanned, it will be appreciated that other dispositions may be made such as by illuminating the target with image light and/or with the red light on the scanned side thereof. Furthermore, various modifications of my invention will occur to those skilled in the art and I do not wish to be limited in the practice of my invention except as set forth in the appended claims.

I claim:

1. Apparatus for developing television signals comprising a cathode ray tube having electron gun means to develop an electron beam, and an oppositely disposed target, said target comprising a foundation having a great multiplicity of recesses extending partially through the thickness of said foundation and facing said electron gun, a red photo-emissive structure in said recesses, a blue photo-emissive mosaic on the surface of said foundation surrounding said recesses and an electrically conductive coating on the opposite side of said foundation from said recesses.

2. Apparatus for developing television signals comprising an evacuated envelope, an electron gun within said envelope, to generate an electron beam and an imperforate target electrode in the path of said electron beam adapted to decelerate said beam to substantially zero velocity in the direction of said beam and adjacent the surface of said target electrode, said target comprising a foundation having recesses distributed over the surface thereof and facing said electron gun, a mosaic photo-emissive to blue light surrounding said recesses, a mosaic photo-emissive to red light in said recesses and electrically insulated from said blue sensitive mosaic by the walls of said recesses, and an electrically conductive signal plate electrode on the opposite side of said foundation from said blue light sensitive mosaic.

3. Apparatus for developing television signals comprising an evacuated envelope, a target within said envelope adapted to be scanned by an electron beam, said target including an imperforate foundation of insulating materials, portions of which are thinner than other surrounding portions thereof, a mosaic photo-emissive to light of relatively short wavelength on the thicker portions of said foundation, a mosaic photo-emissive to light of longer wavelength on the thinner portions of said foundation and a signal plate electrode in capacitive relation with each of said mosaics, the capacitance to the mosaic sensitive to longer wavelength light being greater than the capacitance to the other mosaic.

4. Apparatus for television transmission comprising a target foundation of electrically insulating material, a multiplicity of depressions over one surface of said foundation, a great multiplicity of antimony particles surrounding said depressions in said foundation, a mosaic comprising a coating of silver in each of said depressions, an alkali metal on said particles and on said silver mosaic to sensitize said particles to blue light and said silver to red light and a signal plate parallel to said foundation and spaced closer to said silver mosaic than to said particles.

5. Apparatus for developing television signals comprising an electron gun to develop an electron beam, a target having a signal plate and two-emissive mosaic exposed to said electron beam and lying in different substantially parallel planes to one side of and at unequal distances from said signal plate, the mosaic at the greater distance being electron-emissive to light of shorter wavelength than the other mosaic, means to project relative short wavelength light representative of an optical image on the mosaic of shorter wavelength sensitivity, means to project light of longer wavelength and of substantially constant intensity on the other mosaic and means to scan said electron beam over both of said mosaics to develop television signals representative of said optical image light.

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6. Apparatus for developing television signals comprising a tube having electron gun means to develop an electron beam, and a target electrode exposed to said means, said target electrode comprising a foundation member, a multiplicity of depressions over the surface exposed to said electron gun means, a multiplicity of minute antimony particles surrounding said depressions, a coating of silver in said depressions electrically insulated from said antimony particles, said coating in said depressions constituting a mosaic, elemental areas of which are surrounded by said antimony particles, a coating of alkali metal on said particles and on said silver in said depressions to photo-sensitize said particles to blue light and said silver to red light, and a light permeable electrode in higher capacitive relation with said silver in said depressions than with said particles, means to project blue light representative of an optical image on said particles, means to project red light of substantially constant intensity on the silver in said depressions and means to scan said electron beam over the exposed surface of said target electrode to develop signals representative of said optical image light.

7. In apparatus for developing television signals comprising a target having throughout its surface a multiplicity of individual points photo-emissive substantially only to light of a predetermined band of frequencies and an additional multiplicity of individual points photo-emissive substantially only to light of a different band of frequencies, means for projecting light of the first-mentioned band of frequencies from an object to be televised onto said target, means for projecting light of the second-mentioned band of frequencies onto said target independently of said object, a signal plate capacitatively associated with said target, a transmission circuit connected to said signal plate and means for scanning said points by a cathode beam to produce signals in said circuit.

8. In apparatus for developing television signals comprising a target having throughout its surface a multiplicity of individual points photo-emissive substantially only to light of a predetermined band of frequencies and an additional multipli-

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city of individual points photo-emissive substantially only to light of a different band of frequencies, means for projecting light of the first-mentioned band of frequencies from an object to be televised onto said target, means for projecting light of the second-mentioned band of frequencies onto said target independently of said object, a signal plate capacitatively associated with said target, the capacity between said signal plate and the second-mentioned points being greater than that between it and the first-mentioned points, a transmission circuit connected to said signal plate and means for scanning said points by a cathode beam to produce signals in said circuit.

9. In apparatus for developing television signals comprising a target having throughout its surface a multiplicity of individual points photo-emissive substantially only to blue light and an additional multiplicity of individual points photo-emissive substantially only to red light, means for projecting blue light from an object to be televised onto said target, means for projecting red light onto said target independently of said object, a signal plate capacitatively associated with said target, a transmission circuit connected to said plate and means for scanning said points by a cathode beam to produce signals in said circuit.

10. In apparatus for developing television signals comprising a target having throughout its surface a multiplicity of individual points photo-emissive substantially only to blue light and an additional multiplicity of individual points photo-emissive substantially only to red light, means for projecting blue light from an object to be televised onto said target, means for projecting red light onto said target independently of said object, a signal plate capacitatively associated with said target, the capacity between said signal plate and the second-mentioned points being greater than that between it and the first-mentioned points, a transmission circuit connected to said plate and means for scanning said points by a cathode beam to produce signals in said circuit.

HAROLD B. LAW.

Certificate of Correction

Patent No. 2,401,786.

June 11, 1946.

HAROLD B. LAW

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 6, lines 61 and 62, claim 5, for the words "two-emissive mosaic" read *two photo-emissive mosaics*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of March, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.