

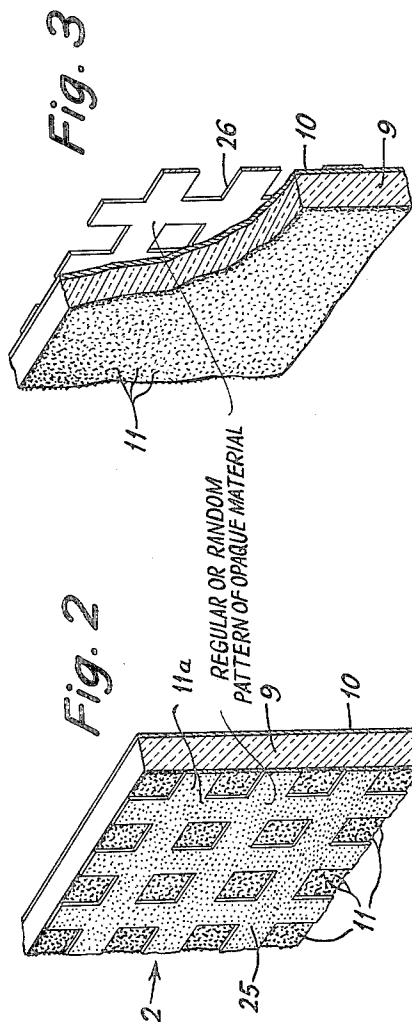
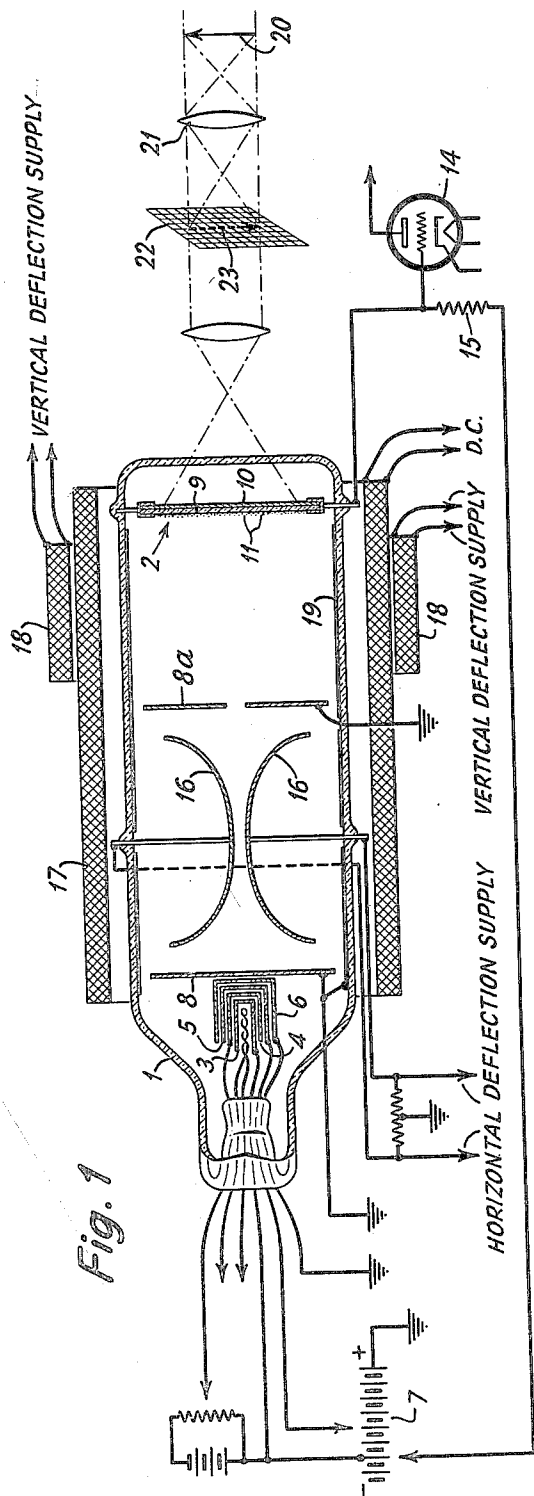
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TELEVISION TRANSMITTING SYSTEM

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TELEVISION TRANSMITTING SYSTEM

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Our invention relates to television transmitting tubes and systems and particularly to systems utilizing low velocity electron beam scanning tubes.

Tubes of the low velocity electron beam scanning type, such as disclosed in our U. S. Patents 2,213,174-5 and referred to as "Orthicon" tubes and wherein an insulated surface is scanned by a beam of low velocity electrons, give a signal output which is proportional to the brightness of an optical image focused upon the target. Thus it may be stated that the "gamma" of the device is unity. Unity gamma may be desired for many purposes, but when certain scenes which contain objects having high contrast and greatly different brightness levels must be transmitted over a television system capable of handling only a limited range of signals, a non-linear output, or a gamma less than unity, from the pick-up tube and system may be preferable.

No special precautions need to be taken in tubes utilizing high velocity electron beams such as of the "Iconoscope" type in order to attain these objectives because the voltage difference between the mosaic and the collecting electrode is, at most, a few volts, so that the maximum voltage which the mosaic can reach by emitting photo-electrons is limited. Further, the lighted areas collect increasing numbers of the redistributed secondary electrons (caused by the electron scanning beam) as the mosaic becomes more positive. This also reduces the voltage attained by the mosaic.

In the usual "Orthicon" type of tube, the potential of the accelerating electrode may be several hundred volts higher than that of the target, and there is no redistribution of secondary electrons over the mosaic. The strong electric field draws away from the mosaic substantially all the photo-electrons which are emitted, which contributes to high sensitivity but makes the signal output proportional to the light. Such a mode of operation imposes no early limit to the voltage which a brightly lighted area can reach. In the operation of such devices a time lag in discharge of the mosaic may occur after the tube has been subjected to intense high lights. Thus, in televising indoor sporting events, photographers' flash lights often cause excessive charging of the mosaic which is only neutralized after a successive number of scanings by the electron beam, resulting in loss of the picture just at the time when the action is most desired. While it is possible to operate the tube with the accelerating electrode coating only a few volts positive with respect to the target and thereby alter these conditions, this solution results in considerable loss in sharpness of the transmitted picture.

In is an object of our invention to provide a television transmitting tube and system of the low

velocity electron beam scanning type wherein the signal output of the tube is non-proportional to the incident light of an optical image. It is another object to provide a tube and system wherein the gamma of the system is less than unity. It is a further object to provide a tube and system of the type described having limited output which will generate television signals representative of both high and low values of incident light, and it is a still further object to provide a tube wherein electrostatic charges representative of an optical image having high contrast and greatly different brightness levels may be utilized with greatly reduced time lag effects.

A better understanding of our invention will be obtained and other objects, features and advantages will appear from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a longitudinal sectional view of a television transmitting tube embodying our invention,

Figure 2 is a view of a mosaic electrode suitable for practicing our invention, and

Figure 3 is a view of another type mosaic electrode by which our objects may be obtained.

Considered broadly, the apparatus of our invention comprises an evacuated envelope having a target preferably of the mosaic type at one end and an electron gun surrounded by an electron collecting electrode or electrodes at the opposite end of the tube. The target, if of the mosaic type, is provided on its front surface with an extremely large number of mutually insulated photo-electrically sensitized particles, and it is so positioned that it may be scanned by an electron beam from the gun and that it may have focused thereon an optical image of the object of which a picture is to be transmitted. The potential between the electron gun and target is so adjusted that the electron beam is projected at relatively low velocity and directed upon the target at extremely low or substantially zero velocity, that is, with a velocity approaching zero at the point of impact therewith. In operation, elemental areas of the mosaic electrode acquire electrostatic potentials proportional to the intensity of the light incident thereon; thus, particles of the mosaic which are more highly illuminated acquire the more positive electrostatic charges with respect to the unilluminated particles, and these positive charges which represent an electrostatic image of a picture to be transmitted are neutralized by the low velocity electron scanning beam. Intermediate and extending wholly between the electron gun and target electrode we provide a uniform axial magnetic field and means within the axial field to generate an electrostatic field to scan the beam over the target without producing undesirable deflection or distortion effects.

Referring specifically to our tube structure shown in the drawing, the tube comprises an evacuated envelope 1 enclosing at one end a target or mosaic electrode 2 and at the opposite end an electron gun assembly adapted to project electrons toward the mosaic electrode.

The electron gun assembly is of the conventional type and comprises a thermionic cathode 3 from which electrons may be drawn, an apertured cold electrode, such as a control electrode 4 connected to the usual biasing battery and a first anode 5 maintained positive with respect to the cathode 3. The electron stream leaving the first anode 5 is accelerated at relatively low velocity and further accelerated and directed upon the front surface of the target or mosaic electrode by a second anode 6 which is preferably an apertured tubular member partially surrounding the first anode 5. The first anode 5 and the second anode 6 are maintained at the desired positive potentials with respect to the cathode by a battery 7. The anodes 5 and 6 are not for the purpose of focusing the electron beam, in fact, any electrostatic focusing of the beam is detrimental in the presence of the magnetic field described later which maintains the beam in a focused condition because such electrostatic focusing impacts transverse velocity to the electrons, thereby introducing defocusing effects. To avoid this difficulty the anodes 5 and 6 may be operated at the same potential or only one of these anodes may be incorporated in the structure. Closely adjacent the electron gun and between the anode 6 and the target we provided a centrally apertured electron collecting electrode 8 to which the electrons of the beam not reaching the target are directed through the slotted shield 8a.

The mosaic electrode 2 which faces the electron gun in accordance with one teaching of our invention may be of the conventional type as shown in Figure 1, and except for the modified types shown in Figures 2 and 3 comprises a substantially transparent sheet of insulation such as the mica sheet 9 having on its rear surface a translucent or semi-transparent electrically conducting signal plate or film 10, the opposite surface of the mica sheet being provided with an exceedingly great number of mutually separated photosensitive particles 11. In making the mosaic electrode we make the mica sheet 9 of the desired area having a uniform thickness of approximately .002 inch and as a first step coat one side of the sheet with a film of metal of sufficient thinness as to be substantially transparent so that an optical image may be focused on the photosensitive particles 11. The mosaic of mutually separated particles may be formed by vaporizing and condensing a film of silver on the front surface of the mica sheet 9. The condensed silver film is then broken up into the mutually separated particles 11 by suitable heat treatment followed by oxidation and sensitization such as by caesiating. Such a process is described by Leonard Klatzow in U. S. Patent 2,178,233 and alternative processes by S. F. Essig in U. S. Patents 2,020,305 and 2,065,570. The conducting film 10 is connected to the input electrode of a translating device 14 and to the battery 7 through the impedance 15 so that the potential of the conducting film 10 may be maintained substantially at cathode potential. If, however, signals of an opposite polarity are desired, the translating device 14 and output impedance 15 may be similarly connected in the circuit of the collecting electrode 8 to ground.

The electron beam developed by the electron gun is scanned in one direction over the mosaic electrode by a pair of deflection plates 16-16, preferably formed as described in our above-mentioned patent, the plates being connected to a source of deflection potential and to ground through a center-tapped resistor of from 1 to 10 megohms. The electrostatic field produced between the plates 16 in combination with a coaxial magnetic field deflects the electron beam over the mosaic electrode 2 in a direction perpendicular to the plane of the drawing of Figure 1. The coaxial magnetic field is preferably generated by a magnetic coil 17 which is of slightly larger diameter than the envelope 1 and extends over and beyond the space between the electrode 8 and the mosaic electrode 2. Deflection of the electron beam in a direction normal to that proposed by the plates 16 may be accomplished by a pair of deflection coils 18-18, this latter deflection preferably being the frame or vertical deflection since in standard television systems the frame deflection is at lower frequency and the horizontal line deflection produced by the plates 16 should preferably be at the higher of the two frequencies. Electrons from the electron gun are thus scanned in two mutually perpendicular directions and are accelerated by the anodes and the accelerating electrode or wall coating 19. However, since the signal plate or film 10 is operated at or near cathode potential, the electrons of the beam are decelerated and approach the mosaic with substantially zero velocity. It will be understood that our invention is not limited to this particular type of low velocity electron beam scanning tube but that other types such as those utilizing full magnetic deflection of the electron beam may be utilized with equal advantage.

In accordance with our invention the output vs. light input characteristic or gamma of television transmitting tubes having a strong electrostatic field at the photosensitive target is controlled by establishing over the surface of the target a regular or random pattern of localized areas which remain at or near a fixed potential when other localized areas of the target are exposed to light such as light representative of an optical image. Such a pattern has negligible effect upon the photo-emission from the other areas of the target until the said other areas have attained a detectable positive voltage under the influence of the light. As the positive voltage tends to build up due to high lights of the optical image the regular or random pattern of areas begins to serve the function of a grid and begins to suppress the photo-emission. Finally, when the emitting areas have charged far enough positive, such as due to very bright high lights, the retarding potential due to the regular or random pattern is as great as the emission velocity of the photo-electrons, and further photo-emission is suppressed.

More particularly, and in accordance with one modification of our invention, the regular or random pattern of tiny areas which remain at or near a fixed potential when the target is exposed to light may be formed photo-optically. Thus, in accordance with our invention, minute shadows may be cast on the mosaic electrode 2, the shadows being formed by deletion of light from the optical image over tiny areas thereof taken either at random or over a regular pattern. Referring to Figure 1, which shows optical apparatus suitable for practicing our invention, the conven-

tional mosaic electrode 2, previously described, is subjected to light in the form of an optical image such as represented by the arrow 20. The optical image is focused such as by a lens system 21 upon an apertured light opaque screen 22 to form a real image 23 of the original optical image or arrow 20. Light passing through the screen 22 will be representative of the original image except that it will consist of small areas of light and shadow, the areas of light still being representative of the original optical image. The image 23 is then focused through the semi-transparent signal plate 10 and upon the photosensitive particles 11 of the mosaic electrode 2 to form thereon an optical image of the original image or arrow 20 made up of small areas of light with areas of shadow cast by the screen 22 therebetween. In operation, the photosensitive particles 11 over the illuminated areas will liberate electrons causing the particles occupying these areas to become more positive; however, the unilluminated areas, that is, the areas in the shadow of the screen 22, will remain at a potential determined by the previous scanning of the electron beam, and since the electron beam approaches the particles 11 with substantially zero velocity, intermediate photosensitive particles in shadow will retain their relatively negative potential. Since the particles adjacent the illuminated particles retain a fixed charge which is relatively negative, the loss of photo-electrons from the illuminated particles is controlled in accordance with the charges on these particles. Thus, as the charges become more positive, the photo-electrons are retarded and finally when the emitting areas have charged sufficiently positive that the retarding potential developed by the unilluminated areas is as great as the emission velocity of the electrons, the photo-emission is reduced to zero.

We have described above the use of optical apparatus for obtaining our objects in combination with a low velocity electron beam scanning tube of the "Orthicon" type having a conventional mosaic-type electrode. Our invention is not limited to this particular arrangement inasmuch as the mosaic electrode itself may be modified to produce a tube having gamma less than unity. In accordance with this teaching of our invention and referring to Figure 2, the mosaic electrode may comprise the sheet of mica 9 or other substantially transparent insulator having on one side thereof the semi-transparent electrode or signal plate 10. The opposite side, however, that is, the side facing and scanned by the electron beam, is provided in addition to the photosensitive particles 11 with a metallic structure 25 in the form of intersecting metal strips having apertures therein exposing areas of the insulating foundation or mica sheet 9 carrying the mutually separated and insulated photosensitive particles 11. The metallic structure 25 may be connected to a source of potential or may float at the potential acquired by collection of low velocity electrons from the scanning beam. The metallic structure 25 operates in the same manner as the modification of our invention described above, limiting the emission from the photosensitive particles deposited on the mica foundation. While we have shown the particles 11 on the front surface of the mica sheet 9, the particles are preferably over the entire exposed surface as shown in Figure 2 at 11a. Thus the metallic mesh-like structure may be applied to the sheet of mica first and the particles 11 formed

both on the exposed areas of the mica and also on the metallic mesh. Not only is this structure more easily made, but it offers definite advantages in that the control of emission from the illuminated areas is more uniform.

A further modification of a mosaic electrode whereby the objects and features of our invention may be obtained is shown in Figure 3 wherein the mica foundation 9 supports the photosensitive particles 11 on the side facing the electron gun. The opposite side of the sheet of mica 9 is provided with the semi-transparent signal plate 10 and, in addition, a network of opaque material 26 through which various areas of the semi-transparent signal plate are exposed. The signal plate in this modification of our invention may be omitted provided this material is electrically conducting, so that a signal may be applied to the output device 14. The signal plate 10, however, may be used in the modification of Figure 3 when the network 26 is of non-conducting material. Thus, the electrode may be provided with a semi-conducting metallic film on which is deposited the opaque material either in the form of continuous lines or material deposited at random, such as by spraying "Aquadag" or other finely divided opaque material thereon.

While we have described in connection with Figure 3 the use of opaque material on the reverse side of the mica foundation 9, it is obvious that the opaque material may be embedded in a sheet of insulation and still serve its desired purpose. Likewise, opaque particles may be deposited on the front surface of the insulating foundation, leaving areas of the foundation exposed. The photosensitive mosaic in this case is deposited both upon the opaque areas and on the exposed portions of the insulating foundation. Target electrodes made in accordance with these latter teachings operate in the same manner as the structure shown in Figure 3, the principal purpose being to subdivide the optical image into small discrete areas of light mixed with areas in shadow.

In operation the shadowed areas exert a control on the photo-emission liberated from the illuminated areas, effectively limiting the maximum potential which the illuminated areas can acquire by loss of photo-electrons. Thus, as described above, the areas most highly illuminated will acquire a smaller charge in proportion to the light incident thereon than particles receiving a smaller amount of light. Thus, as intensity of the optical image increases, a smaller signal will be generated in the high lights with respect to the incident light than on less illuminated areas with respect to the light on these areas. The signal output of the device will still vary with respect to the light and shade areas of the optical image to be transmitted, but the signal will no longer be proportional to the incident light established in the high lights of the image wherein the signal is reduced by the suppression of photo-emission from the highly lighted areas of the mosaic.

In all of the modifications referred to above the size of the shadows cast, such as by the screen 22 in the modification of Figure 1, the metallic structure 25 of Figure 2, and the opaque particles of Figure 3 should be such that there are at least as many shadows, lines or particles per inch as there are in the scanning pattern followed by the electron beam in scanning the target. Although the random arrangement of

non-emitting areas may be used, it is usually preferable to use a predetermined pattern such as a series of crossed parallel lines. Such a pattern of metal lines may be copied from a master film by following a photo-engraving process which we believe to be novel. The mica sheet or insulating foundation may be prepared by pouring "Cold Top Enamel" as furnished by the N. Bechak Company, New York city, or other soluble light sensitive emulsion on the mica sheet followed by draining and drying. The mica sheet is then exposed to light, using the master film as a mask. The sensitive and partially exposed film is developed and the emulsion washed away from the unexposed areas. A film of metal such as platinum is then sputtered or condensed on the remaining emulsion, whereupon the mica is fired at a temperature of 800° C. to decompose the soluble emulsion coating. The coated mica is then lightly brushed with a camel's-hair brush or other material and the metal deposited on the bare mica remains, while the part formerly covering the emulsion material brushes off.

The shape of the signal vs. light curve, and consequently the gamma, may be controlled by varying the spacing between the non-emitting areas, their width and their tendency to emit photo-electrons. Thus, in the modification shown in Figures 2 and 3 the material comprising the elements 25 and 26 may be made highly opaque to sharply limit the signal output, or somewhat translucent to give a more nearly linear characteristic. In the case of non-emitting areas on an insulating surface such as shown in Figure 2 the photo-electric suppressing effect increases as the size of the areas is decreased to the order of the thickness of the insulation. When the size of the opaque areas is reduced further, both capacitance to the adjacent emitting areas and the leakage of charge over the surface of the mosaic act to make the whole illuminated area rise in potential uniformly. In the structure shown in Figure 3, however, the opaque grid-like structure 26 should be as close to the plane of the mosaic particles as possible so that the shadows cast thereon are sharply limited for effective control of the gamma. Similarly, the areas of shadow or non-emitting areas from the structure of Figure 3 decrease the gamma as the size of the non-emitting areas decreases to the order of the mica or foundation thickness.

It will be perfectly obvious to those skilled in the art that our invention does not relate to television transmitting tubes utilizing high velocity electron beams. In tubes of the high velocity beam type, such as those known by the trade name "Iconoscope," the electron beam is focused and directed upon the mosaic electrode with a velocity equivalent to substantially 1000 electron volts inasmuch as the signal plate is operated at the final accelerating electrode potential. Such an electron beam liberates secondary electrons in excess of the number of primary electrons comprising the beam and the entire electrode floats at a potential determined by the redistribution of these secondary electrons, which is a potential within a few volts of the final accelerating electrode potential. It is therefore of no advantage to utilize our invention in combination with such high velocity beam tubes because the electron beam impinges both upon the illuminated and unilluminated areas of the mosaic electrode causing secondary electron emission therefrom. However, in tubes of the low velocity type referred to previously as "Orthicon" tubes, the elec-

tron beam approaches the mosaic electrode with substantially zero velocity and no secondary electrons are liberated from this electrode. Furthermore, the average potential of the elemental areas of the mosaic is highly negative with respect to the final accelerating electrode potential so that a strong electrostatic field is available to withdraw photo-electrons from the mosaic particles and the charges retained by the unilluminated areas effectively control the emission from the illuminated areas, resulting in definite improvement in accordance with our invention.

While we have indicated the preferred embodiments of our invention of which we are now aware and have also indicated only one specific application for which our invention may be employed, it will be apparent that our invention is by no means limited to the exact forms illustrated or the use indicated, but that many variations may be made in the particular structure used and the purpose for which it is employed without departing from the scope of our invention as set forth in the appended claims.

We claim:

1. In a television transmitting system including a tube having a cathode to emit a beam of electrons and a mosaic target of photosensitive particles substantially all of which are exposed to said beam and adapted to be scanned by said beam, means to scan said beam in two coordinate directions over said target, means to maintain said cathode and substantially all of said particles in the absence of light and during scansion of said beam at substantially the same potential whereby the electron beam is unable to impinge said particles, means to project light representative of an optical image on said target to develop a positive electrostatic image on said target, and means to maintain small localized areas of said target mixed with areas representative of said optical image at substantially the potential of said cathode to limit the photo-emission of illuminated areas on said target whereby the emission of photo-electrons is made non-linear with light intensity.

2. In a television system including a tube having means to generate a beam of electrons and a photosensitive mosaic electrode adapted to be scanned by said beam, means to scan said beam in two coordinate directions over said mosaic electrode, means to project said beam of electrons on said mosaic electrode with a velocity approaching zero in the vicinity of said electrode whereby electrons of said beam during scansion thereof drive the entire mosaic of said electrode to substantially the potential of said cathode whereby additional electrons are unable to impinge on said electrode in the absence of light thereon, means to project an optical image of a scene on said mosaic electrode and means to subdivide the optical image on said electrode into small discrete areas of light mixed with areas in shadow without screening said beam from the areas in shadow whereby the areas of said mosaic electrode in shadow are maintained at substantially the potential of said cathode during operation of said tube.

3. In a television system a cathode ray tube having a cathode to emit a beam of electrons, a photosensitive target of mosaic particles directly exposed over its entire surface to receive electrons of said beam, a signal electrode in capacitive relation with said particles, and means to scan said beam in two mutually perpendicular directions over said target, means to maintain

said cathode and said signal plate at substantially the same potential, whereby electrons of said beam scanned over said target following initial scans thereof and in the absence of light on said target cannot reach said particles notwithstanding the exposure of said particles to said beam, means to project an optical image of a scene to be televised through said signal plate and upon said particles to form a positive electrostatic image on said target, and means to break up said optical image into alternate areas of light and shade said areas alternating from light to shade over said target in both directions of scanning, the said areas of light being representative of said optical image, whereby the areas of said target which are in shade are maintained at substantially cathode potential to limit the emission of electrons from adjacent illuminated areas.

4. In a television system including a tube having a cathode to emit electrons as a beam, a mosaic target of photosensitive particles, a signal plate in capacitive relation with said particles, means to maintain said signal plate at substantially the potential of said cathode to cause electrons to approach said target with substantially zero velocity in the absence of light on said particles, means to project an optical image of a scene to be televised on the particles of said mosaic target to cause emission of photoelectrons therefrom resulting in a positive electrostatic image being formed on said target and means comprising an apertured opaque member interposed in the path of said optical image but removed from the path of electrons comprising said beam, said member being of such configuration as to intercept areas of the optical image and break said image into areas of light larger than the size of said particles mixed with areas in shadow larger than the size of said particles to maintain the areas of said mosaic target in shadow at substantially cathode potential.

5. In a television transmitting system including a tube having a cathode to emit a beam of electrons, a mosaic target in the path of said beam, a substantially transparent signal electrode capacitively associated with said target, means to accelerate said electron beam, means including an electrical connection between said electrode and said cathode to decelerate said electron beam to substantially zero velocity adjacent said mosaic target, means to project light representative of an optical image through said substantially transparent signal electrode and on said mosaic target to liberate photo-electrons from and charge elemental areas of said target positive with respect to said cathode, and means deposited on said signal plate to intercept predetermined areas of light forming the optical image on said target and limit the positive charges acquired by illuminated elemental areas of said mosaic target whereby the photoelectrons liberated from said mosaic target are no longer proportional to the light representative of said optical image.

6. In a television transmitting system including a tube having a cathode to emit a beam of electrons, an anode to accelerate said electrons, a mosaic of mutually separated photosensitive particles in the path of said beam, a semi-trans-

parent electrode adjacent the side of said particles opposite said cathode, light opaque material covering portions of said electrode and masking light from said particles projected through said electrode, means to maintain said electrode at substantially cathode potential to decelerate the electrons emitted by said cathode following acceleration thereof, and means to project light representative of an optical image through said semi-transparent electrode, beyond said light opaque material and upon small localized areas of said mosaic particles.

7. In a television system including a tube having a cathode to emit electrons as a beam, a mosaic target of photosensitive particles, a signal plate capacitively associated with said particles, means to maintain said cathode and said signal plate at substantially the same potential to limit the velocity of said electrons to a velocity approaching zero adjacent said target, means to project an optical image representative of a scene to be televised on said target of mosaic particles, a perforated light opaque barrier associated with said signal plate and in the path of light representative of said optical image to subdivide said optical image into small areas of light spaced apart by small areas in shadow, said barrier being outside of the path of said beam whereby electrons of said beam may reach the photosensitive particles in shadow and impart a negative charge to said areas in shadow and limit electron emission from the illuminated areas of said target.

8. The method of limiting the generation of television signals comprising developing minute electrostatic charges representative of an optical image over small separated areas in space, developing an electron beam, charging intermediate areas between said separated areas negative with electrons of said beam thereby developing electrostatic charges negative with respect to said first-mentioned charges, exposing both said first-mentioned and said negative electrostatic charges to the action of said electron beam and sequentially discharging said first-mentioned charges and simultaneously with said discharging maintaining said negative electrostatic charges substantially constant.

9. The method of generating television signals comprising developing a discontinuous electrostatic image of positive electrostatic charges representative of separated areas of an optical image, developing an electron beam, charging intermediate areas between and coplanar with said separated areas negative by directing said beam on said intermediate areas thereby developing negative electrostatic charges coplanar with and in the discontinuous areas of said electrostatic image, and simultaneously maintaining the said negative electrostatic charges substantially constant while discharging sequential elemental areas of said discontinuous electrostatic image, and developing television signals limited by the difference in electrostatic potential between elemental areas of said discontinuous electrostatic image and said negative electrostatic charges from the discharging of said discontinuous electrostatic image.

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