Aug. 27, 1940. H. A. IAMS 2,213,179

TELEVISION TRANSMITTING DEVICE

Filed July 29, 1939 2 Sheets-Sheet 1

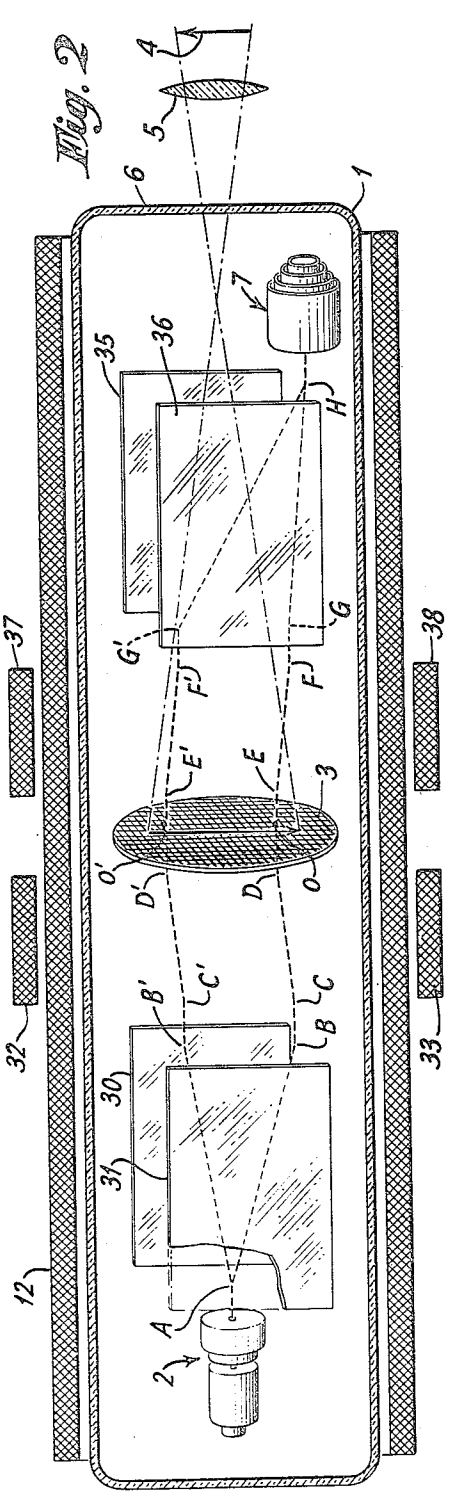


Fig. 2

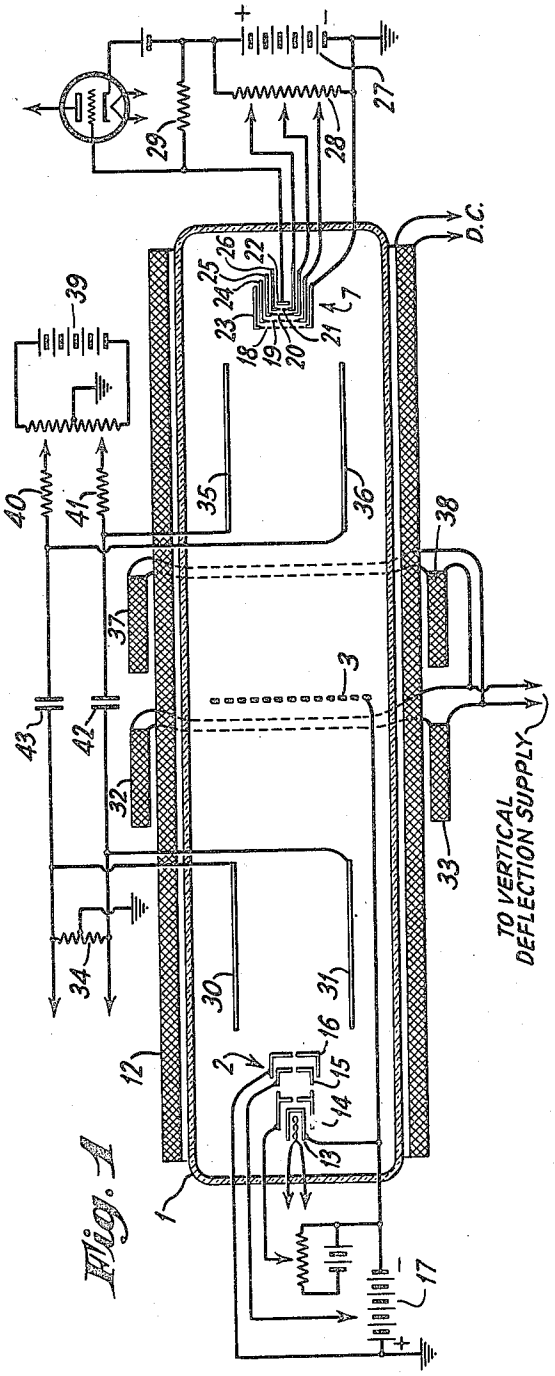


Fig. 1

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Fig. 3

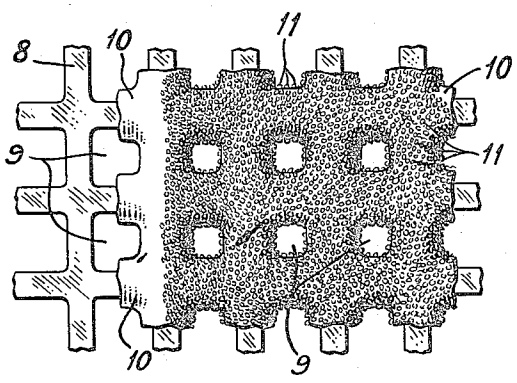
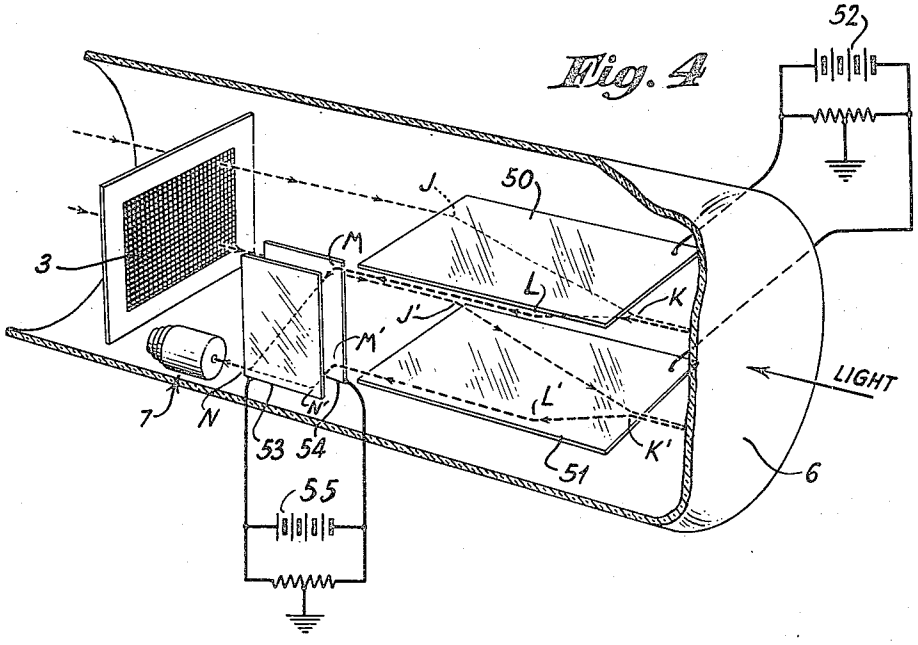


Fig. 4



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UNITED STATES PATENT OFFICE

2,213,179

TELEVISION TRANSMITTING DEVICE

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Application July 29, 1939, Serial No. 287,260

9 Claims. (Cl. 178—7.2)

My invention relates to television transmitting tubes and is more particularly directed to tubes of the low velocity electron scanning beam type.

Television transmitting tubes of the low velocity electron beam scanning type have been made in which a combination magnetic-electrostatic deflection system including electrostatic plates wholly immersed in a uniform axial magnetic field shifts the beam in a plane parallel to the plates to scan a mosaic electrode to generate picture signals. An electrostatic image representative of an optical image is formed on the mosaic electrode and scanned by an electron beam having a velocity approaching zero in the vicinity of the mosaic electrode. Since the electrons of the beam approach the mosaic electrode at low velocity, they are modulated in accordance with the electrostatic image, a portion of the electrons of the low velocity beam returning to an electron collecting electrode to generate picture signals. In the operation of such tubes it is desirable to have the electron beam of such intensity that the mosaic electrode is completely discharged during one sweep of the beam, irrespective of the light intensity on the mosaic electrode. As a consequence, the quantity of electrons returning to the electron collecting electrode is relatively large so that some noise may be generated by the relatively large electron flow. A further disadvantage possessed by the tubes of the prior art has been the difficulty experienced in the proper adaptation of electron multiplying arrangements within television transmitting tubes of the low velocity electron beam scanning type, since by the use of such arrangements the noise signal is greatly increased.

It is an object of my invention to provide a television transmitting tube of the low velocity electron beam scanning type wherein only the picture modulated electrons are collected for utilization purposes. It is another object of my invention to provide such a tube wherein the electrons which are not modulated in accordance with the picture may be separated from the picture modulated electrons. It is a further object to provide a tube wherein electron multiplication may be utilized to its fullest advantage and wherein the signals may be amplified by electron multiplier arrangements while keeping the noise distortion at a minimum value.

In accordance with my invention an electrostatic image corresponding in electrostatic energy distribution to the light distribution of an optical image is formed on a target of the picture grid mosaic type which is scanned with a low velocity electron beam from an electron source such as an electron gun, the electrons not reaching the target and not modulated by the electrostatic image being returned from the target and collected, while the electrons of the beam which are modulated in accordance with the electrostatic image pass through the target and are directed to an electron multiplier where the energy representative of these modulated electrons may be multiplied and utilized to provide television signals. More particularly in accordance with my invention, I provide a structure which separates the electrons representative of signal energy from other electrons generated during the normal operation of the tube, thereby maintaining a very low noise level and consequent high signal to noise ratio in the output circuit of the device.

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

Fig. 1 is a cross-sectional view of a television transmitting tube and circuit embodying my invention, Fig. 2 is an elevation perspective view of the tube shown in Fig. 1, Fig. 3 is a plan view showing in enlarged detail a portion of the electrode structure shown in Figs. 1 and 2, and Fig. 4 is a plan perspective view of a tube incorporating a modification of my invention.

In general, the apparatus of my invention comprises an elongated evacuated envelope having a target of the picture grid mosaic type wherein the apertures of the picture grid are surrounded with a great number of mutually insulated photosensitive particles. The picture grid is positioned so that one side of it may be scanned by an electron beam and that it may also have focused upon it an optical image of the object of which a picture is to be transmitted. The electron beam preferably has a velocity approaching zero in the vicinity of the picture grid so that the grid may have maximum control of the electrons of the beam and to prevent the emission of secondary electrons from the surface of the grid. On the opposite side of the picture grid from that side which is scanned by the low velocity electron beam I provide means to collect the electrons passing through the grid and to neutralize the deflection received by the electrons during the scanning operation so that the electrons passing through the grid may be collected over a relatively small area. In operation elemental areas of the mosaic electrode acquire electrostatic potentials proportional to the intensity of the light

incident thereon, thus particles of the picture grid which are more highly illuminated acquire the more positive electrostatic charges with respect to the unilluminated particles, and these charges which represent an electrostatic image of a picture to be transmitted are used to control the flow of electrons through the picture grid. The electrons passing through the picture grid are directed to a point or a small area preferably out of the range of the light rays forming the optical image on the picture grid, at which point or area they are collected by an electron collecting electrode. The collecting electrode may be surrounded by an electron multiplier to obtain increased output. Intermediate and extending wholly between the electron gun and the electron collecting electrode I provide a uniform magnetic field having lines of force extending in the direction of the undeflected electron flow and means within the field to generate electrostatic fields which scan the electron beam over the picture grid and cause the electrons passing through the picture grid to be dedeflected so that they may be collected over the relatively small area occupied by the electron collecting electrode.

Referring particularly to my tube structure shown in Figs. 1 and 2, the tube includes an elongated evacuated envelope 1 enclosing at one end an electron gun assembly 2 adapted to project electrons toward a picture grid mosaic electrode 3 located near the midsection of the tube and so positioned that an optical image such as represented by the arrow 4 may be focused thereon through the lens system 5 and the window 6 of the envelope. Adjacent the window 6 and preferably displaced from the optical path between the lens 5 and the picture grid mosaic electrode 3 I provide an electron collector and multiplier structure 7 to collect electrons from the electron gun 2 which pass through the apertures of the picture grid mosaic electrode. The picture grid may be made of a porous insulating structure, with or without a base metal. One form of picture grid may be made as follows: The picture grid mosaic electrode 3, as best shown in Fig. 3, is formed from an apertured foundation 8 such as an apertured metal sheet or a closely woven wire mesh screen having a number of interstices or apertures 9 which are provided in sufficient quantity to satisfy the requirements of the device such as the requirements for picture definition. More specifically, the foundation 8 comprises a perforated metal sheet which may to advantage have 150–200 or more apertures 9 per linear inch if the tube is to be suitable for reproducing a television image in good detail. The apertures are preferably square or rectangular in shape, and the foundation 8 may to advantage be rolled and treated with acid to increase the area of the interstices or apertures 9 as described by W. H. Hickok in U. S. Patent 2,047,369. The foundation is provided on one side with a coating of insulation 10 such as enamel on which the photosensitive mosaic of mutually separated and insulated particles 11 is deposited. The choice of insulating material depends on whether the tube is to be used in applications wherein the scene or image to be transmitted varies slowly or rapidly in degrees of brilliance or whether the scene to be transmitted is in motion or not. In astronomical work, for instance, in which a minute or longer might be allowed for generating the electrostatic image on the picture grid or mosaic, the resistance of the insulation 10 may be very high. For television work, however, the resistance may be made lower to assist in the dissipation of the charges acquired in response to a focused optical image so that most of this charge can be dissipated within the time of scanning one picture frame which in conventional systems is approximately $\frac{1}{30}$ second.

Prior to insulating the foundation I find it advantageous to clean it thoroughly and, if made of oxidizable material such as nickel, to then oxidize it slightly by heating it in air and, if made of nickel, until it assumes a greenish color probably due to a film of nickel monoxide. The foundation is then coated on one side only with the coating of insulation 10 having the desired electrical resistance. In spraying the foundation, care should be taken that the enamel does not flow through the interstices or apertures 9 to the opposite side of the foundation. I therefore prefer to perform the spraying operation with the perforated foundation held horizontally and with the spraying gun below the foundation so that the enamel is prevented by gravitation from overflowing the upper surface of the foundation. The uncoated side of the foundation should be cleaned such as by wiping with a dry cloth to remove any of the particles which may have fallen on this surface. The sprayed foundation is then fired in air at about 900° C. to fuse the enamel into a smooth glassy coating. The enamel may be built up on the foundation to the desired thickness by applying the enamel in several thin coats and firing the foundation after each coat is applied. Instead of spraying the insulation on the foundation member, insulating materials such as cryolite or calcium fluoride may be vaporized on the clean foundation. Following the formation of the coating of insulation 10 on one side and on the walls of the apertures of the foundation, I provide the insulated surface with a mosaic of a great number of mutually separated and insulated metal particles 11. These particles may be deposited by a number of methods such as by dusting an easily reducible metal compound which, if silver, may be silver oxide on the insulated surface and reducing the compound to a metal. Another method which I have found equally advantageous for providing the metal particles 11 is to deposit, for example by vaporization, a thin film of metal and to break this metal film up into the particles 11 by a suitable heat treatment. These and other methods for forming small metal particles are disclosed in U. S. Patent 2,065,570. Following the formation of the mosaic of metal particles on the insulated side of the foundation and referring again to Figs. 1 and 2, the foundation is suitably supported near the midsection of the envelope 1 so that the insulated surface of the foundation provided with the particles 11 faces the window 6 preferably in a plane normal to the axis of the tube and normal to the axes of the electron gun 2 and the electron multiplier 7. As a last step in the preparation of the mosaic and following the introduction of the other electrodes yet to be described within the tube, the tube is evacuated and the metal particles 11 of the picture grid mosaic are photosensitized in a manner well known in the art such as by oxidizing the particles and subjecting them to caesium vapor followed by suitable heat treatment.

Surrounding the envelope 1 and extending over the space separating the electron gun 2 from the electron multiplier 7 I provide a magnetic coil 12 to generate a magnetic field having lines of force extending substantially from one end of the en-

velope to the other, the lines of force being substantially perpendicular to the picture grid mosaic electrode 3.

The electron gun 2 is of a conventional type and comprises a cathode 13 from which electrons may be drawn, a control electrode 14 connected to the usual biasing battery, and a first anode 15 maintained positive with respect to the cathode 13. The electron stream leaving the first anode 15 is concentrated into an electron scanning beam focused on the uninsulated surface of the picture grid mosaic electrode by the axial magnetic field generated by the coil 12 and by the electrostatic field from a second anode 16 which is preferably an apertured tubular member partially surrounding the first anode 15. The first anode 15 and second anode 16 are maintained at the desired positive potentials with respect to the cathode by a battery 17, and the cathode is preferably connected directly to the foundation 8 of the picture grid mosaic electrode so that this foundation member may be maintained at cathode potential, although it may be maintained slightly positive or negative if so desired.

The electron multiplier 7 may be of well-known design such as a structure comprising a number of perforated electrodes such as the wire mesh screens 18, 19, 20 and 21 interposed in the order named between the picture grid mosaic electrode 3 and an electron collecting electrode or anode 22. These wire mesh screens are constructed of material having good secondary electron emitting properties, for example, of bright nickel. The wire mesh screens 18—21 may, for ease in assembly, be supported by concentric metallic cylinders 23, 24, 25 and 26 which are in good electrical contact with the respective wire mesh screens and connected to a potential source such as a battery 27 through a bleeder resistance 28, the wire mesh screen 18 and its associated supporting cylinder being connected to ground and consequently to the anode 16. The electron collecting electrode 22 is connected through an output impedance 29 to the input electrode of a translating device and to the positive terminal of the battery 27 so that signals generated in the tube may be amplified and applied to a transmission network as well known in the art.

In accordance with my invention, I provide means between the electron gun 2 and the picture grid mosaic electrode 3 to scan the beam of electrons generated by the gun 2 over the picture grid mosaic electrode, and on the opposite side of the picture grid mosaic electrode and between this electrode and the electron multiplier 7 I provide means to counterbalance or neutralize either all or a portion of the deflection produced by the first-named deflection means so that the electrons passing through the picture grid mosaic electrode are directed to the relatively small area occupied by the electron multiplier 7.

More specifically in accordance with my invention, I provide between the picture grid mosaic electrode 3 and the electron gun means to deflect the beam over the mosaic comprising a pair of plates 30—31 wholly immersed in the magnetic field generated by the coil 12 to deflect the beam in one direction and a pair of magnetic coils 32—33 to deflect the beam in a direction substantially normal to the direction of deflection produced between the plates 30—31. The plates 30—31 are preferably supplied with the horizontal deflection potentials from a suitable source, the plates being connected to such a source and to ground through a center-tapped resistor 34. Further in accordance with my invention, I provide, on the opposite side of the picture grid mosaic electrode from the electron gun 2, similar means for deflecting electrons of the beam which pass through the interstices or apertures of the picture grid mosaic, this deflection being in the opposite direction to the deflection produced between the plates 30—31 and by the coils 32—33. This means may comprise a further set of deflection plates 35—36 and a similar set of deflection coils 37—38. The deflection produced by the coils 37—38 is preferably equal and opposite to that produced by the coils 32—33, while with respect to that produced by the plates 30—31, is determined by the positioning of the multiplier 7.

As mentioned above, I prefer to locate the electron multiplier 7 out of the optical path between the lens system 5 and the picture grid mosaic so that light from any desired source may be focused without interference upon the picture grid mosaic electrode. Thus, while the electron multiplier 7 might for certain applications be provided within the tube in line with the electron gun 2 and along the axis of the tube, such applications being for use with short focal length wide aperture lens arrangements, I prefer to locate the multiplier as indicated above and displace the electrons passing through the interstices or apertures of the photo grid mosaic electrode by coupling the deflection neutralizing plates 35—36 to a source 39 of direct current potential through the resistors 40—41. The deflection plates 35—36 are cross-connected to the horizontal deflection supply and to the plates 30—31 through the coupling capacitors 42—43 in such a manner that for a given deflection in one direction by the plates 30—31, the deflection between the plates 35—36 will be sufficient to direct the electrons to the multiplier 7. The coils 37—38 are similarly cross-connected to the coils 32—33 to provide equal and opposite deflection of the electrons of the beam from the gun 2 which pass through the interstices or apertures of the picture grid mosaic electrode 3. It will be apparent that for symmetrical location of the electron multiplier 7, that is, where the multiplier is located along the longitudinal axis of the electron gun and envelope, that the reversed deflection potentials supplied to the plates 35—36 with respect to the plates 30—31 are sufficient to neutralize the deflection and deflect the beam to the electron multiplier, provided the length of the two pairs of plates 30—31 and 35—36 are equal. It is therefore desirable to make these sets of plates of equal length, although if of unequal length, the plates 35—36 may be supplied with opposite but unequal deflection voltage impulses. Where the desired construction is used, that is, where the multiplier is offset from the axis of the gun, the direct current potential supplied by the potential source 39 should be made just sufficient to add a deflection component to the field between the plates to additionally deflect the beam over a distance equal to the distance the multiplier is offset from the axis.

During the operation of the tube shown in Figs. 1 and 2 and referring particularly to Fig. 2, the electron beam generated by the electron gun 2 is under the control of the longitudinal magnetic field generated by the coil 12. For purposes of explanation, I have assumed two conditions of operation showing the deflected beam between the plates 30—31 as following either the path A—B or the path A—B' while it is between the plates 30—31, these paths being representative of

two conditions of horizontal deflection of the beam. The two paths, A—B and A—B', are in the same plane and in a plane parallel with the plates 30—31, this plane being referred to as the plane of deflection between the plates 30—31. After the beam leaves the field between the plates, it is constrained by the magnetic field generated by the coil 12 and follows a path such as represented for the two conditions of deflection as the paths B—C and B'—C' which are parallel to the magnetic field generated by the coil 12. The beam is then deflected in directions perpendicular to the said plane of deflection between the plates 30—31 along the paths C—D and C'—D' by the magnetic coils 32—33. After the beam has been deflected by the coils 32—33, the beam is again acted upon only by the longitudinal magnetic field and follows paths parallel to the magnetic field of the coil 12 to the picture grid mosaic electrode along D—O and D'—O'. It will be noted that the point O' is directly above the point O, this being a condition when the magnetic field produced by the deflection coils 32—33 is of the same intensity for both degrees of horizontal deflection along the paths C—D and C'—D'.

An optical image such as represented by the arrow 4 is, during operation, focused on the picture grid mosaic electrode to cause various areas thereof to develop an electrostatic image or picture replica of the optical image. Depending upon the average intensity of the charges surrounding the apertures of the picture grid mosaic at points O and O', the electrons flowing along the paths D—O and D'—O' will be repelled or attracted in direct proportion to the intensity of this charge, and the intensity of the beam from the electron gun and the potential difference between the foundation 8 and cathode 13 may be so adjusted that for zero illumination no electrons pass through the picture grid mosaic electrode, under which conditions any increase in illumination will cause a proportionate increase of electrons to pass through the mosaic electrode. The electrons which pass through are therefore picture modulated in accordance with the charge surrounding the aperture through which they passed. The electrons then follow the paths O—E and O—E', being under the influence of the magnetic field generated by the coil 12 and are dedeflected by the field produced by the coils 37—38 by an amount equal to and in a direction opposite to that deflection produced by the coils 32—33. The coils 32—33 and 37—38 are positioned as shown in Fig. 1, the showing in Fig. 2 being displaced from their actual position for the sake of clarity in the figure. The paths F—G and F'—G' are likewise parallel, since at the points F and F' the beam passes out of the influence of the dedeflection coils 37—38 and is under the influence of the axial magnetic field produced by the coil 12. The beam then passes into the dedeflection electrostatic field produced between the plates 35—36 at the points G—G'. As pointed out above, the plates 35—36 are cross-connected with the plates 30—31 and are supplied with a direct current potential so that the beam while passing along the path G—H and G'—H' is not only subjected to a dedeflection field but to a constant electrostatic field which directs the electrons toward the electron multiplier 7. It is obvious that should the multiplier be aligned with the electron gun and tube axis the only field necessary to generate between the plates would be the dedeflection field. However, with the construction shown, the deflection field is substantially overcome by the D. C. field along the path from G to H, whereas from point G' to H the dedeflection field and D. C. field is cumulative. It will therefore be appreciated that for any beam deflection produced by the plates 30—31 and the coils 32—33 the electrons which pass through the picture grid mosaic electrode will not only be dedeflected but will be directed toward the electron multiplier 7 over a relatively small area directly in front of the electron multiplier. These electrons at this point are still under the influence of the field produced by the coil 12, and they therefore follow parallel paths into the electron multiplier where the energy representative of these electrons may be multiplied, collected and applied to the input electrode of the amplifying device connected across the impedance 29. While I have referred to certain paths as being parallel, such as the paths B—C, B'—C', D—E, etc., the fields produced by the deflection plates and the deflection coils may actually overlap, which would cause the horizontal and vertical deflection to merge over a portion of the beam paths.

I have mentioned above that I prefer to position the electron multiplier 7 out of the optical path between the lens system 5 and the picture grid mosaic electrode 3. It will, of course, be obvious that for some applications utilizing my device only a small amount of the light used to form the optical image will be intercepted by the electron multiplier 7 even if it is in the optical path between the lens system and picture grid mosaic electrode. For such applications I may therefore desire to have the multiplier axially aligned with the electron gun, in which case it is not necessary to apply any direct current potential to the plates 35—36, since for such an arrangement, the electrons need not be displaced during the deflection produced by the plates 35—36.

Referring to Fig. 4 which shows another modification of my invention and in which the corresponding structure shown in Figs. 1 and 2 is similarly referenced, the tube comprises an electron gun structure 2, deflection plates 30—31 and deflection coils 32—33 similarly positioned with respect to the picture grid mosaic electrode 3 so that this electron gun and deflection plate structure is not shown. The plates 50—51 are similar to the plates 35—36 and occupy similar positions, that is, the plates 50—51 are in planes parallel with the plates 30—31 and are connected to a source of D. C. potential such as the battery 52. Between the plates 50—51 and the picture grid mosaic electrode 3 I provide a second pair of deflection-neutralizing plates 53—54 in planes perpendicular to the planes of the plates 50—51 and offset from the picture grid mosaic electrode so that an optical image may be focused thereon through the space separating the plates 50—51. Near one edge of the plates 53—54 I provide the electron multiplier 7 similarly connected to a potential source and output circuit as shown in Fig. 1. The electron multiplier in this modification is preferably slightly below the deflection plates 53—54 so that the electrons flowing between the plates may be directed outside of the electrostatic field between the plates to the multiplier.

In the operation of my device as shown in Fig. 4, an electrostatic image formed on the picture grid mosaic controls the flow of electrons through the apertures or interstices of the mosaic electrode in a manner similar to that previously de-

scribed. The constant potential applied between the plates 50—51 deflects the beam along the path J—K or J'—K', whereupon the electrons pass out of the field between the plates and follow paths toward the window 6. The window, however, due to previous scansions of the beam, has acquired a potential substantially equivalent to the potential applied to the cathode 13 and directs the electrons back toward the plates 50—51. As the electrons approach the space separating the plates 50—51 they are again subjected to the constant electrostatic field between the plates 50—51 and are deflected such as along the paths K—L or K'—L', leaving the field between the plates 50—51 at the points L and L'. Since the magnetic coil 12 extends over the tube shown in Fig. 4 in the same manner and for the same purpose as shown in connection with Figs. 1 and 2, the electrons, after reaching the points L and L' out of the electrostatic field between the plates 50—51, follow paths controlled solely by the axial magnetic field which directs them toward and between the plates 53—54 along the paths L—M and L—M'. The plates 53—54 are connected across a source of direct current potential, such as a battery 55, to produce a uniform electrostatic field between the plates, and the plates are also wholly immersed in the axial magnetic field produced by the coil 12. Under this combined field the motion of the electrons between these plates is in a plane parallel with the plates, and the beam follows paths to points outside of the field between the plates 53—54 to the points N and N'. From the points N and N' the beam goes directly to the electron multiplier 7, since it is under the sole influence of the axial magnetic field.

It will be appreciated that the plates 50—51 are utilized to absorb the deflection component such as the horizontal deflection produced by the plates 30—31 and that the plates 53—54 are utilized to absorb the other deflection component such as the vertical deflection produced by the coils 32—33. It is therefore obvious that the dedeflection coils 37—38 shown in connection with Figs. 1 and 2 are not needed in the construction of Fig. 4, since their function is performed by the plates 53—54.

While I have mentioned that the window 6 after a few scansions of the electron beam acquires a potential substantially equivalent to the potential applied to the cathode 13 and tubes have been operated without any special precautions being taken to maintain the window 6 at cathode potential, it may be desirable to provide a light transparent conductive coating which is connected to a potential at or near that of the cathode 13 on the inner surface of this window, although I have found such a coating to be unnecessary and furthermore undesirable, since it absorbs a small proportion of the light projected through the window and upon the picture grid mosaic electrode. Furthermore, while I have not shown any conductive wall coating on the cylindrical portion of the envelope 1 between the electron gun 2 and the window 6, such a conductive coating is preferably used to prevent the accumulation of an electrostatic charge on this portion of the interior of the envelope.

While I have indicated the preferred embodiments of my invention and have indicated the specific application as directed to cathode ray television transmitting tubes, it will be apparent that my invention is by no means limited to the purpose of television transmission and that many variations may be made in the particular structure disclosed without departing from the scope of the invention as set forth in the appended claims.

I claim:

1. A television transmitting tube comprising a mosaic electrode having mutually separated apertures of elemental picture area for the passage of an electron beam and mutually separated and insulated photo-sensitive particles surrounding said apertures to generate an electrostatic image of an optical image projected on said electrode along an optical axis normal to the surface of said electrode, means to generate an electron beam of elementary picture area cross section and to direct said beam in a direction toward and normal to the surface of said electrode, means to scan said beam over said apertures in horizontal and vertical direction components, an electron collecting electrode to collect electrons of said beam passing through said apertures, means to generate a magnetic field having lines of force extending between said electron gun and said collecting electrode a pair of oppositely disposed electrostatic deflection plates along a portion of the path of the electrons passing through said mosaic electrode to generate a field opposing one direction of scanning imparted to said beam to remove the said one direction component of scanning from said electrons, and additional deflection means along a portion of the path of the electrons passing through said mosaic electrode to generate a field opposing the other direction of scanning imparted to said beam to remove the other direction component of scanning and to direct said electrons to said collecting electrode.

2. A television transmitting tube having an electron gun to generate a beam of electrons, a perforated light sensitive mosaic electrode in a plane normal to the undeflected path of said beam to control the flow of the electron beam in accordance with electrostatic charges formed thereon in response to an optical image focused on the said electrode along an optical axis normal to the surface of said electrode, an electron collecting electrode on the opposite side of said mosaic electrode from said electron gun to collect electrons controlled by and passing through said mosaic electrode, means to generate a magnetic field having lines of force extending between said electron gun and said collecting electrode, a first pair of electrostatic deflection plates wholly immersed in said magnetic field between said electron gun and said mosaic electrode to deflect the beam over said mosaic electrode in a direction parallel with said plates and a second pair of deflection plates on the opposite side of said mosaic electrode from said electron gun to neutralize the deflection imparted by said first deflection plates to the electrons of said beam passing through said mosaic electrode and to direct the electrons passing through said mosaic electrode to said electron collecting means.

3. A television transmitting tube comprising an elongated envelope, a picture grid mosaic electrode adapted to have an optical image focused thereon along an optical axis which is normal to the surface of said mosaic electrode, said electrode being positioned intermediate the ends of said envelope, means including an electron source to generate a beam of electrons and direct said beam toward one side of said mosaic electrode in a direction normal to the surface of said mosaic electrode, a first system of electro-

static field generating plates between said electron source and said mosaic electrode to deflect and scan the beam over said mosaic electrode, a second system of electrostatic field generating plates on the opposite side of said mosaic electrode from said electron source, the plates of said second system being positioned parallel with the plates of said first system and adapted to be electrically cross connected with the plates of said first system to deflect the beam in a direction opposite to the deflection produced by said first system, a magnetic electron beam focusing coil extending axially over said envelope and enclosing the said systems of deflection plates and means to collect the electrons deflected by said second system of plates to develop signals representative of an optical image focused on said mosaic electrode.

4. A television transmitting device having an electron gun to develop an electron beam, an electron collecting electrode to collect electrons from said electron gun, a magnetic electron beam focusing coil extending over the space separating said electron gun from said collecting electrode to generate a magnetic field parallel with the undeflected path of said electron beam a perforated light-responsive mosaic electrode having an extended surface, said mosaic electrode being positioned in a plane normal to the undeflected path of said beam and between said electron gun and said collecting electrode, deflection field generating means between the gun and mosaic electrode to deflect the beam in two mutually perpendicular directions, additional field generating means including a pair of oppositely disposed deflection plates surrounded by said focusing coil along the path of the beam between said mosaic electrode and said collecting electrode to deflect the beam in two mutually perpendicular directions and means to energize both of said deflection means to generate substantially equal and opposite fields so that the directions of deflection in each of said mutually perpendicular directions is substantially equal and opposite to direct said beam to said collecting electrode.

5. A television transmitting device having two sets of deflection plates, each set comprising a pair of oppositely disposed plates, a light sensitive perforated mosaic electrode intermediate the sets of deflection plates in a plane normal to a longitudinal axis extending between said sets of deflection plates, an electron gun to generate and direct an electron beam through the space separating one set of plates through the mosaic electrode and through the other set of plates, means to apply equal and opposite deflecting potentials to the plates of said two sets of plates so that the deflection imparted by the said one set of plates to the electrons passing through the mosaic electrode is neutralized by the deflection between the said other set of plates, and means to collect electrons from said electron gun passing through said mosaic electrode after the electrons have been deflected by said other set of plates.

6. A television transmitting tube comprising an elongated envelope, a picture grid mosaic electrode extending in a plane normal to the longitudinal axis of said envelope across the midsection of said envelope, and adapted to have an optical image focused thereon along an optical axis normal to the plane of said mosaic electrode, a magnetic electron focusing coil surrounding said envelope positioned to provide a magnetic field having lines of force extending along parallel paths substantially from one end to the other of said envelope, an electron gun to develop and project a beam of electrons normal to the plane of, toward and through said mosaic electrode, deflection means between said electron gun and said mosaic electrode to deflect the electron beam from said gun over said mosaic electrode, an electron collecting electrode on the opposite side of said mosaic electrode from said electron gun to collect electrons of said electron beam passing through said mosaic electrode, and further deflection means effective over the path of the electrons passing through said mosaic electrode electrically cross connected with said first mentioned deflection means to neutralize the deflection of the beam received prior to passing through said mosaic electrode, said further deflection means being positioned to direct the electrons passing through said mosaic electrode to the said electron collecting electrode.

7. A device for generating television signals comprising an elongated envelope including a window, an apertured mosaic electrode foundation opposite said window positioned in a plane normal to the longitudinal axis of said envelope, a mosaic of mutually separated and insulated photo-sensitive particles supported by the side of said foundation facing said window to develop an electrostatic image in response to an optical image focused thereon, an electron gun axially aligned with the longitudinal axis of said envelope and adjacent the end of the tube opposite said window to generate and direct a beam of electrons perpendicularly incident upon the opposite side of said foundation, an electron focusing coil to generate a magnetic field having lines of force extending in a direction normal to the plane of said mosaic electrode over substantially the entire length of said envelope, means including a pair of oppositely disposed deflection plates wholly immersed in said magnetic field one on either side of a portion of the path of the electron beam between said gun and mosaic electrode, means to energize said plates with beam deflecting potentials to scan said beam over said mosaic electrode, an electron multiplying structure to multiply the electrons from said gun passing through said mosaic electrode foundation located between said window and said foundation and a second pair of deflection plates wholly immersed in said magnetic field electrically cross connected with said first mentioned plates to direct the electrons passing through said mosaic electrode foundation to said electron multiplying structure.

8. A television transmitting device comprising an elongated envelope, a light sensitive picture grid mosaic electrode intermediate the ends of said envelope and extending in a plane normal to the longitudinal axis of said envelope, a magnetic coil surrounding said envelope to generate a magnetic field having lines of force extending through said envelope for substantially the entire length thereof, an electron gun axially aligned with the longitudinal axis of said envelope and on one side of said mosaic electrode to generate and direct an electron beam through said mosaic electrode, an electron multiplying structure on the other side of said mosaic electrode to receive electrons passing through said mosaic electrode, a pair of electrostatic deflection plates and a pair of magnetic coils in the order named between said gun and said mosaic electrode to gen-

erate beam deflection fields, a second pair of electrostatic deflection plates and a second pair of magnetic coils positioned in the order named between said electron multiplying structure and said mosaic electrode, a source of beam deflection potential connected to the first mentioned pairs of plates and cross connected to said second pair of plates and a source of beam deflecting current connected to the first mentioned pairs of coils and cross connected to said second pair of coils, to first deflect the beam in mutually perpendicular directions by said first mentioned plates and coils and to neutralize the beam deflection with said second pairs of plates and coils thereby directing said beam to said electron multiplying structure.

9. A television transmitting device comprising an elongated evacuated envelope, two pairs of mutually parallel deflection plates, a picture grid mosaic electrode between said pairs of plates, an electron gun axially aligned with the longitudinal axis of said envelope, more remote from said mosaic electrode than one of said pairs of plates and positioned to direct a beam of electrons parallel with said longitudinal axis between the said one pair of plates, through said mosaic electrode and between the other pair of plates, means to generate a magnetic field having lines of force extending between the plates of said pairs of plates in directions parallel with said plates, means to energize the said one pair of deflection plates with deflection potentials to deflect the beam over said mosaic electrode, a third pair of deflection plates mutually perpendicular to said pairs of plates in the space separating said mosaic electrode and the said other pair of plates and out of a direct line between said mosaic electrode and said last mentioned plates, a source of direct current potential connected across said other pair of plates to direct the electron beam between said third pair of plates, an electron collecting electrode between said third pair of plates and said mosaic electrode, and a source of direct current potential connected across said third pair of plates to direct the electrons from said gun passing between said pairs of plates and through said mosaic electrode to said collecting electrode.

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