

May 22, 1956

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2,747,133

TELEVISION PICKUP TUBE

Filed July 5, 1950

3 Sheets-Sheet 1

Fig. 1.

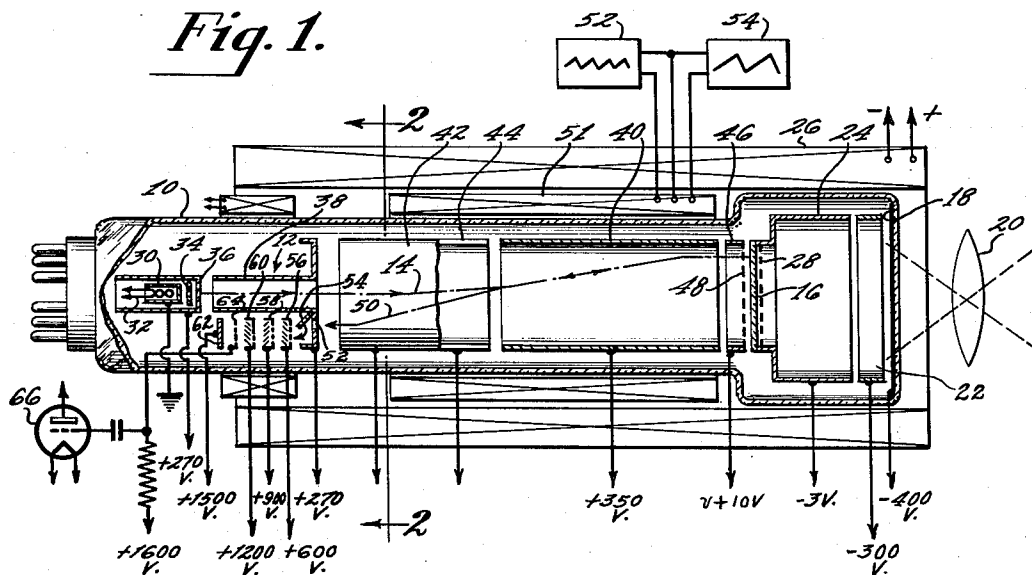


Fig. 2.

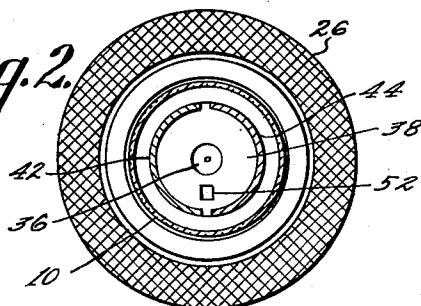
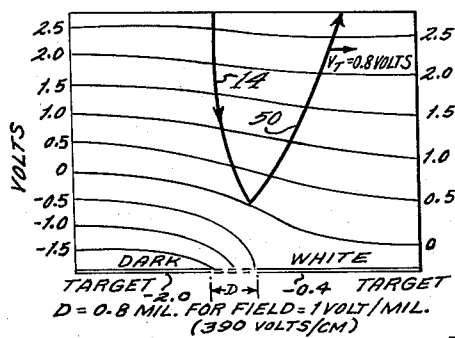


Fig. 3.



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3 Sheets-Sheet 2

Fig. 4.

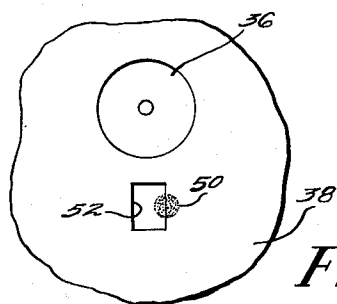
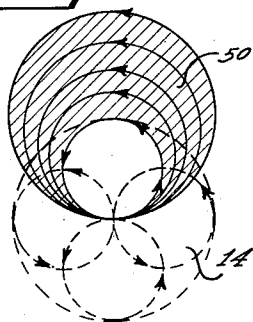


Fig. 6.

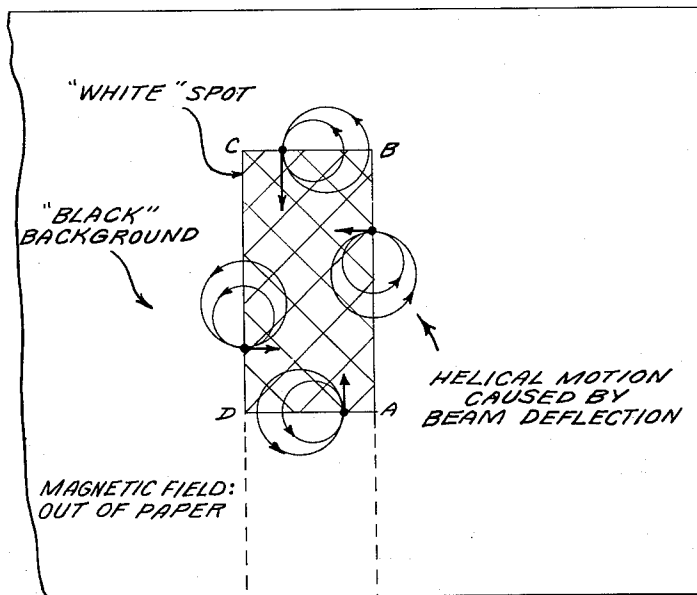


Fig. 5.

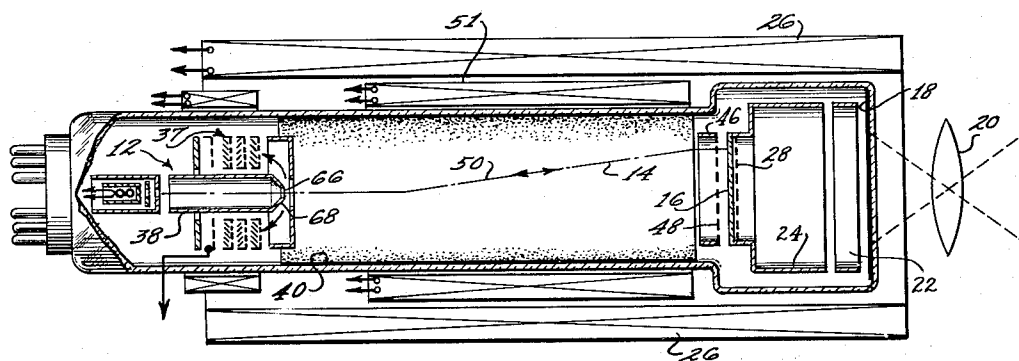


Fig. 7.

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2,747,133

TELEVISION PICKUP TUBE

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Application July 5, 1950, Serial No. 172,065

6 Claims. (Cl. 315—11)

This invention is directed to an electron discharge device which can be utilized as a storage tube. More particularly, the invention is in a type of television pickup tube in which a charge signal may be stored as a charge pattern on a target electrode and an output signal produced for an indefinite length of time.

The invention is directed to a type of signal generating tube in which a charge pattern is established upon a target electrode in accordance to an optical picture focused upon a photocathode of the tube or by other means. The charged target electrode then is scanned by a low velocity electron beam to produce an output or video signal in accordance with the scanning of the electron beam over the target surface and varying according to the charge pattern scanned. The tube is operated in a manner so that the scanning beam is not permitted to strike the target surface to deplete the stored charge on the target. In this manner, several possibilities result. For example, the storage time of the tube for stationary scenes can be arbitrarily increased at will thereby increasing the sensitivity of the tube far beyond that possible with a normal $\frac{1}{50}$ of a second storage time, which is prevalent in conventional camera tubes. Furthermore, it is also possible to interrupt the light or visual input signal to the tube for a length of time without interrupting the output signal generated by the scanning beam. This permits an application in which a signal of one type of scan can be converted to another type of scan, for example, from a radar type scan to television scan. Other advantages of such a tube are apparent from the description below.

It is therefore an object of this invention to provide a signal generating tube having an indefinite length of storage time for the input signal.

It is a further object of my invention to provide a signal generating tube which can convert a signal of one type of scan to a signal of a different type of scan.

It is another object of my invention to provide a camera tube of increasing sensitivity for stationary scenes.

The invention is specifically that of a signal generating tube having a photocathode electrode and upon which is focused an optical picture of a scene to be reproduced. The photoemission from the cathode is directed to an insulator target sheet where by secondary emission, a charge pattern is established. The target electrode is scanned by an electron beam, which is slowed down to zero velocity in front of charged surface of the target electrode. The target is operated slightly negative to the cathode of the electron gun, forming the beam, so that the electron beam does not land on the surface of the target electrode. I have observed that when an electron beam of low velocity scans a charged target surface, it is deflected slightly in the immediate neighborhood of the target by the local potential pattern on the target surface. This deflection is transverse to the direction of approach of the electron beam. Although this transverse deflecting force acts on the electron only while it is within a few mils of the target surface, the paths of the electrons returning toward the gun are considerably influenced by that force and the de-

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flected return beam is widely separated from the undeflected beam as the beam returns to the gun of the tube. By placing a collector electrode in the path of the deflected return beam, it is possible to separate the deflected beam from the undeflected return beam and produce accordingly, a video signal. It is this deflection of a low velocity electron beam by a charge pattern that is utilized in the tube of my invention to produce the desired signal. In the operation of the tube, the electron beam is not permitted to land on the target surface to discharge the charge pattern of this target. Rather, the tube is operated as a storage device in which the charge pattern is maintained as long as desired and also the charge pattern produces a video signal by the deflection effect on the scanning beam.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, but the invention itself will best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view of a camera tube in accordance with my invention;

Figure 2 is a cross-sectional view of the tube in the direction of arrows 2—2;

Figure 3 is a diagrammatic sketch of the deflection effect which is utilized and in accordance with my invention;

Figure 4 is a diagrammatic sketch of the electron paths in the camera tube in accordance with my invention;

Figure 5 is a diagrammatic sketch of the helical motion of the beam returning from the target to the gun caused by the transverse force of the charge pattern on the target;

Figure 6 is an enlarged partial view of the structure shown in Figure 2;

Figure 7 is a longitudinal sectional view of a camera tube in accordance with a modification of my invention;

Figure 8 is a longitudinal sectional view of a camera tube in accordance with another modification of my invention;

Figure 9 is a diagram of operating conditions of the tube of Figure 8;

Figures 10 and 11 are modifications of the target structure of the tube of Figure 8.

Figure 1 discloses a camera tube made in accordance with my invention and as described. The tube of Figure 1 includes an envelope 10 having an electron gun structure 12 at one end thereof for producing an electron beam 14 which is scanned over the surface of a target electrode 16 mounted intermediate the ends of the tube envelope. At the opposite end of envelope 10 is a photocathode electrode 18, which may be formed as a thin semi-transparent coating on the glass end of the envelope 10 and in any manner well known in the art. An optical image of the scene to be televised is focused upon the photocathode through a lens system 20, as shown. The photocathode 18 provides a photoemission from all points illuminated by the optical picture and proportional to the intensity of light focused thereon. This photoemission from cathode 18 is accelerated toward the glass target 16 by positive fields formed by tubular electrodes 22 and 24. Surrounding the envelope 10 of the tube is a coil 26 for providing a uniform magnetic field parallel to the tube axis to cause the photoemission from cathode 18 to pass to target 16 along parallel lines.

Target 16 may be formed of insulating material which has a slight conductivity. Such a target electrode may be very thin glass having a specific resistance in the order of 10^9 to 10^{12} ohm-centimeters and formed in the manner described in U. S. Patent 2,473,220 to Albert Rose. Such a glass target is formed as a very thin sheet

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having substantially no lateral electrical conductivity but a substantial amount of transverse conductivity along its thickness. Closely spaced from the surface of the glass target 16 and between the target and the photocathode 18 is a fine mesh screen 28. Screen 28 as well as glass film 16 may be mounted as are shown on a reduced extension of accelerating electrode 24.

Photoelectrons from the photocathode 18 pass through the fine mesh screen 28 and impinge at relatively high velocity on the glass surface of the target film 16 to produce a secondary emission greater than unity which tends to pass back to the mesh screen 28 for collection.

Electron gun 12 comprises essentially conventional structure consisting of a cathode 30, which is heated to thermionic emission by an enclosed filament 32. A control grid 34 and accelerating electrode 36 form the thermionic emission from cathode 30 into the electron beam 14. The beam is caused to pass through an additional electrode structure 38 which during tube operation is maintained at the same potential as that of accelerating electrode 36, and provides a shield between the electron beam path and a multiplier section 37 to be described. Beam 14 is accelerated toward the target 16 by an additional accelerating electrode 40, which may consist of a tubular member, as shown, or as a conductive wall or coating on the tube envelope. In its passage between the gun 12 and target 16, beam 14 is caused to pass between a pair of separating plates 42 and 44 as shown in both Figures 1 and 2. Immediately in front of the target 16 is provided a decelerating electrode 46 comprising a ring, having a mesh screen 48 connected thereto for decelerating the electron beam to substantially zero potential relative to that of gun cathode 30. Surrounding the tube envelope 10 is a yoke structure 51 comprising two pairs of coils, oppositely disposed, which provide therebetween a pair of magnetic fields perpendicular to each other and to the tube axis. As shown, the pairs of coils are respectively connected to current sources of saw-tooth configuration 52 and 54 to provide line and frame scan of the electron beam over the surface of the target electrode. Such scan of an electron beam is well known in the art and further details will not be described.

Figure 1 discloses a set of voltages which have been applied to the respective electrodes, in a tube similar to that disclosed. These values for the potentials applied are given by way of example only and need not be limiting as other appropriate voltages also can be applied to such a tube.

During tube operation, the electrons of beam 14 are brought to a focus on the target surface by the field of coil 26. The electron beam of the gun is accelerated toward the target electrode and immediately in front of the target is caused to slow down to substantially zero potential by the decelerating electrode 46.

As indicated in Figure 1, the collector mesh screen 28, mounted on electrode 24, is operated at substantially a -3 volts negative with respect to the cathode of gun 12. Photoelectrons from the illuminated areas of photocathode 18 are accelerated through mesh 28 onto the surface of the glass target 16. The secondary electrons bombarded from the target surface by the photoelectrons will be partially collected by grid 28. The uncollected secondaries will fall back to other portions of the target surface and be redistributed. Due to this redistribution of secondary electrons, the target surface 16 will assume, in the "white" areas bombarded by photoelectrons from the brightly illuminated portions of photocathode 18, a charge of approximately 1 volt negative relative to the potential of gun cathode 30. Also, due to the redistribution of secondary electrons, those "dark" portions of the glass target 16 which do not receive photoelectrons from cathode 18 will be discharged to essentially a -3 volts negative potential, or the potential of the collector screen 28. In a similar manner, those portions of the

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glass target 16, which receive electrons from partially illuminated portions of cathode 18 will have potentials lying somewhere between those of the "white" areas and those of the "dark" areas. In this manner, then, a charge pattern is established on the photocathode side of target 16. Due to the extreme thinness of target 16, a corresponding potential pattern is established on the gun side of the glass target 16. In this manner, all portions of the target surface facing the gun 12 are maintained at a potential less than that of the gun cathode 30. Thus, the electron beam 14 between the decelerating mesh 48 and glass target 16 will enter a repelling or reflecting field which is negative to the source or cathode of the electron beam. The electron beam is then reflected back along its incident path toward the cathode of the gun. The returning or reflected electron beam is separated from the incident beam 14 by the separating plates 42 and 44 which are maintained at a difference of potential therebetween. Such beam separation is well known in the art and is shown in Figure 1, in which the returning beam is indicated at 50.

Figure 3 shows schematically the electron paths of the beam 14 as it approaches the target electrode 3 and the reflected beam 50 as it leaves the target surface. Figure 3 also shows a portion of the surface of target 3 in the region between two charged areas, one having a potential of -0.4 volt and the other having a potential of -2.0 volts, for example. The lines shown represent equipotential surfaces in front of this target portion and were obtained by means of an electrolytic plotting tank.

The magnetic field of coil 26 which is usually less than 100 gauss has a negligible effect on the electron paths over the short distance of a few mils considered in the discussion of Figure 3. For example, an electron approaching normal to the target is deflected toward the more positive area and acquires substantially 0.4 volt transverse energy. As shown in Figure 3, the electron beam will be reflected by the equipotential surface of 0.4 volt, and as it leaves the target, it is again deflected so that it acquires a transverse energy equal to 0.8 volt and a transverse displacement along the path shown. Other electrons approaching along different paths would acquire more or less transverse energy. The decelerating field strength and the rate of change of potential along the target affect the amount of transverse energy acquired; stronger fields and less abrupt potential variations giving less transverse energy.

The time the electron spends in the neighborhood of the target is short compared to an electron period in the magnetic field. Hence, the deflecting force at the target may be considered as an impulse giving rise to helical motion in the return beam. This is shown schematically in Figure 4 in which the reflected beam is shown in the hatched area and the incident beam 14 in the unhatched portion of the figure. The electrons of the beam all have varying degrees of small transverse velocity. When such a beam is accelerated through a magnetic field whose lines of force are parallel to the beam path, the transverse component of velocity of each electron causes the electrons of the beam to travel separate spiral paths, all of which pass through a common or nodal point on the beam axis. Figure 4 indicates the electron paths of the incident beam 14 and a deflected beam 50 viewing the beam down its axis. The figure shows the reflected beam portion 50 which has been given a transverse deflection in one direction, which causes the electrons of the beam to follow spiralling paths of varying degrees on that side of the beam axis to which the beam is deflected.

The returning beam 50, in the tube of Figure 1, is directed toward an opening 52 of accelerating electrode 38. This portion of electrode 38 is shown as greatly enlarged in Figure 6. The potential of separating plates 42 and 44 is adjusted so that an undeflected return beam 50 strikes the edge of opening 52 as shown. A portion of the undeflected return beam 50 passes through opening

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52 to strike a first dynode electrode 54 of multiplier section 37. Secondary electrons are bombarded from the surface of electrode 54 and are attracted through four other stages of the multiplier, which are shown respectively at 56, 58, 60 and 62. The multiplier may be of the type disclosed in my Patent 2,433,941 and is not further described here. Secondaries from the final stage 62 of the multiplier are received by a collecting mesh electrode 64 and form a signal pulse, which passes into the circuit of amplifier tube 66, as is well known, to form the video signal output of the tube.

If the reflected beam 50 is deflected in other directions by differences between charged areas on the target surface, and as described above, the beam will change its position to either pass more electrons through opening 52 or more onto the surface of electrode 38 where they are dissipated. In this manner, then, as the electron beam 14 is deflected by the charge pattern on the surface of target electrode 16, the deflections given to the return beam are detected by the variations of the electron current which passing through the opening 52, provides a video output signal from the tube.

Figure 5 illustrates the conditions established by the operation of the tube described in Figure 1. As shown, the hatched area ABCD represents a positively charged "white" spot on the surface of target 16 and established by a corresponding brightly illuminated spot on the photocathode 18. The figure shows the helical motion of the beam electrons resulting from transverse deflection of the electrons by the charge differential at the four boundaries of the "white" area which is shown as surrounded by a "black" background. An electron is displaced farthest from its normal position, when it has rotated through one half of its orbital path. Thus, the aperture 52 must be placed at an antinode in the return beam path to provide a more sensitive detection of the transverse deflection occurring at the target surface. Since an undeflected beam 50 is partially absorbed by electrode 38 and partially passes through to the multiplier, those portions of the target surface, which are both outside and inside of the spot ABCD will have a grey appearance in the picture.

The electrons returning from the boundary A—B of Figure 5 will be reflected toward the aperture to give a bright edge along this line. Similarly, electrons from boundary C—D are deflected away from the aperture 52 giving a dark edge in the transmitted picture. The displacements caused by the boundaries B—C and D—A are parallel to the edge of the multiplier aperture 52 and these boundaries would appear normal. Thus, the separation edge of aperture 52 converts the deflection modulated beam into an amplitude modulated signal, whose value is approximately the derivative of the normal video signal.

This type of output from such a tube, as described above, could conceivably be integrated within a circuit to give a normal signal or could be used directly for certain applications. However, the differentiated signal might even be preferred if the information to be transmitted is of black and white character such as maps or meter readings.

Such a tube as that described in Figure 1 has been used to transmit pictures of a teloran map focused on the photocathode. The target screen potential was adjusted at about 2 volts below gun cathode potential so that the electron beam did not discharge the glass. Whenever the pattern was moved there was no time lag because the redistribution electrons on the photocathode side of the target discharged the previous picture instantaneously. When the picture was removed from the photocathode, the picture would remain 5 or 10 seconds until leakage on the glass target 18 would cause the resolution to deteriorate and eventually discharge it.

The semi-conductivity of the target electrode 16 limits the storage time of such a tube described in Figure 1. However, if the target were of an insulating material such as mica, the storage time could be considerably increased.

By adjusting the potential separating plates 42 and 44,

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the undeflected return beam 50 may be caused to strike entirely on the surface of electrode 38 and be positioned so that deflection of the return beam in one direction only will cause signal electrons to pass through aperture 52. However, the tube may also be operated so that the entire beam 50 passes through aperture 52 and in this case, aperture 52 may have dimensions such that deflection of the beam in any direction or in any two desired directions will cause the beam to strike electrode 38 to varying degrees. These different modes of positioning the return beam relative to the separating edge of electrode 38 will vary the signal derived from the tube.

Thus, it is apparent that the positioning of beam 50 relative to aperture 52 determines the type of signal to be derived from the tube. A condition has been described in Figures 1-6, in which the beam 50 strikes the edge of aperture 52. However, it is possible to provide a tube having a collecting electrode, in which the detection of beam deflection in all directions can be obtained. Such a tube is shown in Figure 7, in which electrodes are indicated by identical reference numerals as used for similar structures shown in Figure 1. However, the accelerating electrode 38 in this case is completely surrounded by the multiplier section, as is shown. Furthermore, the separating plates 42 and 44 are not necessary and the wall electrode 40 has been extended back to accelerating electrode 38. In the operation of the tube of Figure 7, the reflected beam 50 falls back on the same path as the incident beam 14 and tends to pass down the gun axis through accelerating electrode 38. The opening of electrode 38 facing target 16 is restricted to a small aperture 66 formed by a conical portion 68. The aperture 66 is maintained only large enough to permit the incident and undeflected return beams to pass therethrough. If the beam is scanned over a charge pattern established on target 16, it will be deflected in several directions by the potential differences between charged areas as described above. The deflected return beam will then strike the conical portion 68 of electrode 38, which constitutes a first dynode stage of the multiplier section 37. A structure of this type, thus will detect beam deflection in all directions.

The manner of establishing a signal charge pattern on target 16 of the tubes shown in Figures 1 and 7 need not be confined to an image section. It is well known that a charge distribution can be established on an insulating target surface by means of a modulated electron beam, which is scanned over the target surface. That is, the tubes of Figures 1 and 7 can be modified by providing in place of the image sections, an electron gun and scanning coils for scanning the electron beam of the gun over the target surface.

Figure 8 discloses a further modification of my invention in which an orthicon type camera tube may be operated in a similar manner as the tube of Figures 1 and 7. The tube of Figure 8 has similar features to the tubes described above and consists of essentially an envelope 70, an electron gun 72 for forming a beam 74 along the axis of the tube. Around the tube is a single focusing coil 76 providing a field whose lines of force are essentially parallel to the tube axis. In this manner the electrons of beam 74 pass through nodal points, as shown schematically at 77 in the figure, and toward a target electrode 78, which is formed on the end of tube 70. Target 78 comprises a photosensitive electrode such as, for example, a photoemissive mosaic 80, which is capacitively coupled to a transparent conductive film 82 on the outer surface of the tube end. The electron beam is accelerated from the gun 72 toward target 78 by accelerating electrodes 84 and 86, electrically joined together. The target electrode has applied thereto a switching voltage, to be described, from any appropriate circuit 88. The electron beam is scanned over the surface of the target electrode by conventional pairs of deflecting coils represented by a yoke 90.

Figure 9 shows the operating conditions for the tube

just described. A charge pattern is established on the target by turning the electron beam off and applying to the conductive target film 82 a zero potential, relative to the cathode of gun 72. The signal then is laid down on the target from a light source, such as either a scene focused on the photosensitive mosaic 80 or a flying spot kinescope focused on the mosaic. The photoelectron emission from mosaic 80 will establish a charge pattern on the mosaic surface corresponding to the picture focused thereon. The signal light source is next turned off and the voltage of conductive film 82 is switched to substantially 3 volts negative to the cathode 72. The electron beam 74 is then switched on and scanned over the surface of the mosaic 80. Due to the negative potential of the target 78, however, the electron beam will not land but will be slowed down and reflected back toward the gun. Due to the focusing action of the field of coil 76, the reflected or return beam is essentially along the same path as incident beam 74. If the return beam is not deflected by any charge differences on the mosaic surface, it will pass down the tube axis and be trapped or dissipated within electrode 84 and the other gun structures. However, if the beam is deflected from its normal return path, as has been described above for Figures 1 and 7, the return beam will be displaced sufficiently to strike a collector electrode 92, which may be a dynode electrode for amplifying the signal. The secondaries from dynode 92 may be collected by projecting surfaces of the accelerating electrode 86, as is shown in the figure. The signal can be detected and amplified by a circuit including amplifier tube 94.

When it is desired to erase the charged pattern from the target electrode because of loss of definition, or for the purpose of providing another picture on the mosaic, the beam is caused to scan over the surface of the mosaic, pulsing target film 82 to gun cathode potential. At this potential some of the electrons of the beam will land on the target to discharge the target surface and drive the mosaic to cathode potential, after which the beam can be cut off and a new picture projected onto the mosaic surface and the tube operated as described above.

The voltages shown in Figure 8 for the tube are by way of example only and need not be limiting. Also, as shown in Figure 10, the target electrode 78 may be formed on a thin insulating transparent supporting sheet 94, spaced from the end of the tube as is shown. Sheet 94 may be of mica or any other similar material, and on one surface of which is deposited in any well known manner the conductive film 82 and on the opposite, or scanned surface, the mosaic 80.

The photosensitive target of the tube of Figure 8 need not be confined to a photoemissive target but may be one such as disclosed in Figure 11, which uses a photoconductive material. The target 78 of such a tube may be formed by first depositing on a transparent support plate or member 96 a thin transparent conductive coating 98 over which is superimposed a thin layer of photoconductive material 100 such as amorphous selenium in any well known manner. The operating conditions of such a tube are also shown in the chart of Figure 9. The gun must be first turned on with no light signal on the photoconductive target film 100. Simultaneously the target voltage of conductive film 98 is held at substantially 20 volts positive relative to cathode potential. The electron beam 74 is scanned over the photoconductive surface. The electrons of the beam are slowed down by the low potential of the target electrode and strike the target surface well below the first cross-over to drive the target surface to zero or gun cathode potential. The electron beam current is then turned off and the light picture is projected onto the photoconductive target 78. The potential difference between the conductive film 98 at 20 volts and the target surface of film 100 which has been driven to zero or gun cathode potential will provide a current flow through those portions of the photocon-

ductive film 100 which are illuminated by the picture. This photoconductivity will charge the target surface in the order of one or two volts in the light areas. In this manner, then, there is established a charge pattern on the surface of the photoconductive layer 100. The light picture is then turned off and the electron beam turned on and scanned over the target surface. Simultaneously the target voltage is switched to substantially 17 volts in order to drive the positive areas of the photoconductive film 100 to below gun cathode potential and thus prevent the beam from landing on the target surface during scan-sion. Again as described above, the potential differences between charged areas will deflect the beam to provide a modulation of the return beam to the collector electrode 92 of the tube.

While certain specific embodiments have been illustrated and described, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

I claim:

1. The method of generating a signal with a discharge device comprising a target electrode, said method comprising the steps of, scanning said target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts below the potential of the source of said electron beam to prevent landing of said beam on the target electrode and to reflect said beam from said target, establishing a charge distribution pattern on said target electrode to deflect said scanning beam from its reflected path, separating from the reflected beam electrons deflected by the charges on said target electrode and collecting only deflected electrons to provide a signal.

2. The method of generating a signal with a discharge device comprising a target electrode, said method comprising the steps of, scanning said target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts below the potential of the source of said electron beam to prevent landing of said beam on the target electrode and to reflect said beam from said target, establishing a charge distribution pattern on said target electrode to deflect said scanning beam from its reflected path, separating electrons deflected by the charge pattern from the reflected beam, and collecting a portion of said reflected beam not deflected by the charge pattern on said target electrode to provide a signal.

3. The method of generating a signal with a camera tube comprising a target electrode, said method comprising the steps of, scanning said target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts negative to the potential of the source of said electron beam to prevent landing of the beam on the target electrode and to reflect said beam from said target, establishing a charge distribution pattern on said target electrode corresponding to an optical scene to deflect said scanning beam from its reflected path, separating from the reflected beam electrons deflected by the charge pattern on said target electrode, and collecting only reflected beam electrons to provide a signal.

4. The method of generating a signal with a camera tube comprising a photosensitive target electrode, the method comprising the steps of, scanning said photosensitive target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts negative to the potential of the source of said electron beam to prevent landing of the beam on the target electrode and to reflect the beam from said target, establishing by a photoelectric effect a charge distribution pattern on said target electrode corresponding to an optical scene to deflect said scanning beam from its reflected path, separating the deflected electrons from said reflected beam, and collecting only deflected electrons to provide a signal.

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5. The method of generating a signal with a camera tube comprising a photoemissive target electrode, the method comprising the steps of, scanning said photoemissive target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts negative to the potential of the source of said electron beam to prevent landing of the beam on the target electrode and to reflect the beam from said target, establishing by photoemission a charge distribution pattern on said target electrode corresponding to an optical scene to deflect said scanning beam from its reflected path, separating the deflected electrons from said reflected beam, and collecting only deflected electrons to provide a signal.

6. The method of generating a signal with a camera tube comprising a photoconductive target electrode, the method comprising the steps of, scanning said photoconductive target electrode with a low energy electron beam, biasing said target electrode to a potential in the order of several volts negative to the potential of the source of said electron beam to prevent landing of the

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beam on the target electrode and to reflect the beam from said target, establishing by photoconductivity a charge distribution pattern on said target electrode corresponding to an optical scene to deflect said scanning beam from its reflected path, separating the deflected electrons from said reflected beam, and collecting only deflected electrons to provide a signal.

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