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G. K. TEAL

2,339,662

TELEVISION TRANSMITTER

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FIG. 2

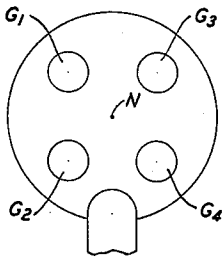


FIG. 1

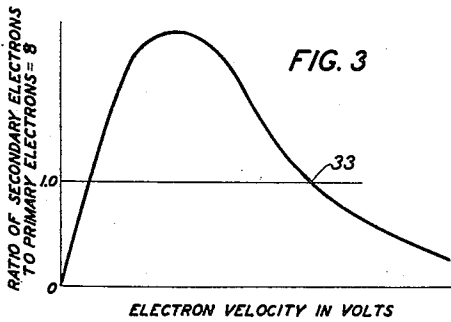
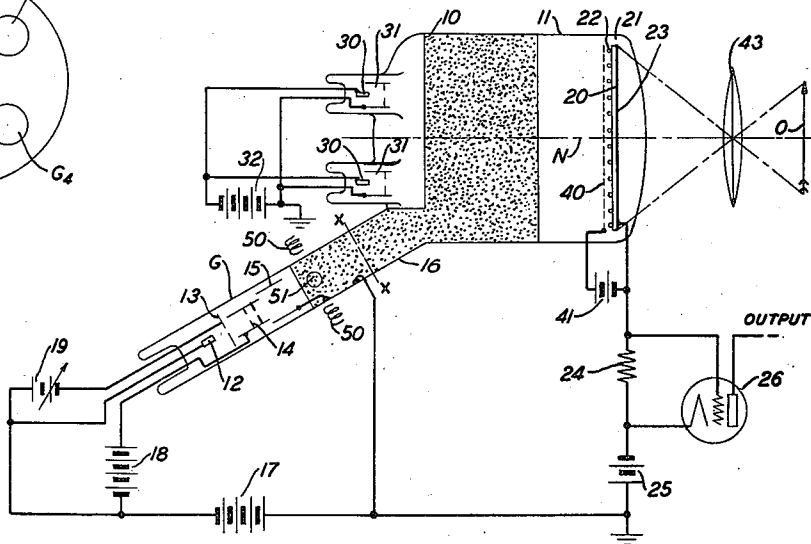


FIG. 4

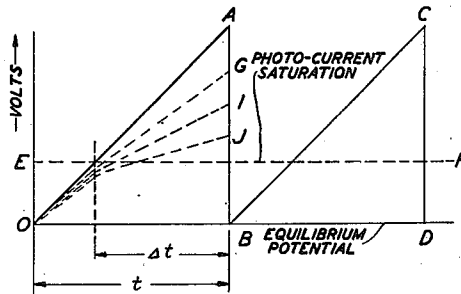
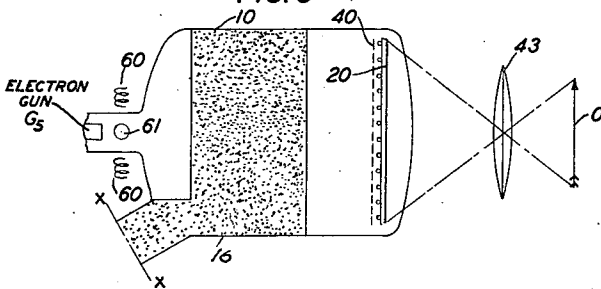


FIG. 5



INVENTOR
G. K. TEAL
BY *Chas. Sprague*
ATTORNEY

UNITED STATES PATENT OFFICE

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TELEVISION TRANSMITTER

Gordon K. Teal, Mountain Lakes, N. J., assignor
to Bell Telephone Laboratories, Incorporated,
New York, N. Y., a corporation of New York

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15 Claims. (Cl. 178-7.2)

This invention relates to electron discharge devices and methods of operating them and more specifically to electron camera tubes for television.

In Patent 2,147,760, issued February 21, 1939, to Vance et al., there is disclosed a television camera tube of the type in which an image of the picture to be transmitted is formed upon a mosaic of minute light-sensitive elements supported on and insulated from a common metallic back plate, each element being the cathode of a photoelectric cell and a collecting electrode within the tube common to these elements forming a common anode for the array of small cathodes. Each of the photoelectric cell cathodes acquires a potential, as electrons are emitted therefrom to the collecting electrode, which has a value depending upon the intensity of the light striking it. The mosaic is scanned by a cathode ray beam whereby picture current appears in an output circuit, the current having a strength depending upon said potentials of the light-sensitive elements. The sensitivity of this cathode ray transmitter tube is improved by applying a negative polarizing potential to the light-sensitive elements by providing the tube with an auxiliary source of electrons and spraying these electrons upon the light-sensitive mosaic. In the Vance et al. arrangement, the electrons are projected towards the mosaic at a comparatively low velocity whereby a negative potential is built up on the light-sensitive elements to produce an increased potential difference of polarizing voltage between the cathode and anode of each photoelectric cell. The Vance et al. arrangement, however, has an inherent disadvantage due to the fact that low velocity electrons are difficult to control.

It is an object of the present invention to provide an electron discharge device in which this disadvantage is avoided and to methods of operating an electron discharge device to avoid this disadvantage.

In accordance with the present invention, there is provided an electron discharge device having a primary electron mosaic target upon which an optical image is projected, means for scanning the mosaic target with a beam of primary electrons, and means for spraying the target with electrons of such high velocity that the secondary emitting ratio of the mosaic surface for this velocity is less than 1. In this arrangement, a potential is built up on the photoelectric cell elements or cathodes as in the Vance et al. arrangement but the disadvantages inherent in the use of low velocity electrons have been re-

moved, the high velocity electrons having much simpler and surer control means. The distribution of electrons striking the surface is, in this case, not dependent on space charges formed in front of the mosaic but is fixed by conscious design of the focusing systems producing the electron spray. Moreover, a greater difference in potential between the mosaic and the collector electrode may be established by this method than by the use of low velocity electrons.

In one embodiment of the invention, shown by way of example to illustrate the principles of novelty thereof, a mosaic of semi-transparent photosensitive globules is deposited on a dielectric such as glass or mica, while a semi-transparent conducting layer is coated on the back side of the dielectric. The radiations from the object are introduced from the rear of the mosaic while in front of the mosaic is a fine mesh grid which establishes a fixed potential in the plane immediately in front of the mosaic. A conducting coating adjacent the mosaic collects secondary electrons emitted therefrom. The collector potential is made positive relative to the potential of the grid in front of the mosaic so that electrons which are emitted from the mosaic and proceed as far as the grid are then strongly accelerated to the collector electrode. One electron gun generates an electron beam which scans the mosaic with electrons having velocities such that their secondary emitting ratio is greater than 1 for the particular mosaic material. One or more auxiliary electron guns are also provided to spray electrons over the mosaic at a velocity sufficiently high that the secondary emitting ratio of the surface for this velocity is much less than 1. The current density in the spray is made sufficient to rapidly drive a positive element to a negative potential thereby causing complete withdrawal of the photoelectrons from the element during a major portion of the scanning cycle.

In a modification, the auxiliary spray gun or guns are replaced by one or more guns which allow a beam of electrons to sweep the mosaic plate a line or a few lines behind the scanning beam.

In another modification, a high current but very low velocity spray is generated by one electron gun and a very high velocity spray is generated by another electron gun. The purpose of the very low velocity spray in this case is to drive the area just behind the beam several volts negative very quickly. It builds up a space charge in front of the mosaic from which many electrons will be "sucked" into the region of maxi-

mum positive potential just behind the scanning beam.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which:

Fig. 1 shows a television transmitter system in accordance with the invention;

Fig. 2 is a partial side elevational view of the tube shown in Fig. 1;

Figs. 3 and 4 are graphical representations to aid in explaining the invention; and

Fig. 5 shows a modification of the system of Fig. 1.

Referring more specifically to the drawing, there is shown, by way of example to illustrate the principles of novelty of this invention, a television transmitting system employing an electron discharge device 10 together with certain of its associated circuits. The tube 10 preferably comprises a highly evacuated container 11 enclosing an electron gun G consisting of a cathode 12, a control electrode 13, and accelerating and focusing anodes 14, 15 and 16. The anode 16 preferably comprises a conducting coating around a portion of the inner walls of the tube 10 which coating is connected within the tube to the anode 15 and through an opening in the wall of the tube to the positive terminal of a source 17, the negative terminal of which is connected to the cathode 12. A source 18 places a positive potential on the anode 14 with respect to the cathode while the variable source 19 provides a means of control for the potential between the cathode 12 and the control element 13. The potentials of the various elements of the electron gun G are chosen so that a beam of high velocity electrons, but not high enough to have a secondary emitting ratio of less than 1 from the target, is focused to a small spot at the plane of the target.

A target 20 is provided for the electrons generated by electron gun G. The target 20 preferably comprises a glass or mica plate 21 coated on the side nearest the gun G with a very thin coating 22 of the photosensitive material, such as, for example, semitransparent globules of caesium-antimony. On the other side is preferably coated a very thin coating 23 of any suitable conducting material, such as platinum or aluminum. The coating 23 constitutes the signal plate, and it is connected through a signal resistor 24 and a source of potential 25 to the conducting coating 16. The target 20 may be made by any well-known method. The resistor 24 may be connected in the input circuit of an amplifier 26, the output circuit of which is connected to suitable apparatus, not shown, for transmitting the signal to a receiving station.

Within the tube 10 are also disposed a plurality (see Fig. 2) of supplementary guns G₁, G₂, G₃ and G₄. The supplementary guns are of relatively simple construction; for example, each may comprise a cathode 30 and an anode 31. Heating potential for the cathode 30 may be supplied by a suitable source, not shown, while accelerating potential between the cathode and anode of each gun may be supplied by the source 32, the voltage of which is large enough so that the electrons striking the mosaic 20 from each of the supplementary guns are of sufficiently high velocity that the secondary emission ratio δ is much less than 1. Reference will now be made to the curve shown in Fig. 3 wherein the ratio of secondary electrons emitted from the mosaic

to the number of primary electrons striking it (this ratio being indicated by δ) is plotted against electron velocity in volts. The curve for the mosaic 20 shows that the ratio δ is less than 1 for very low velocities and also for very high velocities above the cross-over point 33. In accordance with the present invention the potential applied to the anode 31 with respect to the cathode 30 of at least one of the supplementary guns is sufficiently high so that the electrons strike the target 20 at a velocity which, measured in volts, is higher than the voltage at the cross-over point 33 in Fig. 3. The guns G₁, G₂, G₃ and G₄ are preferably arranged so that their longitudinal axes are normal to the surface of the mosaic 20 and so that their longitudinal axes are equidistant from the normal N to the center of the mosaic 20. The guns G₁, G₂, G₃ and G₄ spray electrons over the surface 22 of the mosaic 20 and leave the elements negatively charged due to the fact that more primary electrons from these guns strike the mosaic than there are secondaries caused to be emitted by the impingement of these primary electrons upon the target. The guns may be arranged so that the spray covers the entire target.

In front of the mosaic 20 there may be arranged a mesh grid 40 which by means of a source 41 is preferably placed at a positive potential with respect to the mosaic signal backing plate but which is negative with respect to the potential of the collector electrode 16. Electrons which are emitted from the mosaic and proceed as far as the mesh grid 40 will then be strongly accelerated to the collector electrode 16. The field between the grid 40 and the collector 16 is always such as to draw electrons away from the mosaic because of the difference in potential between these electrodes. The field between the grid 40 and mosaic changes depending on the spray of electrons charging the surface negative with respect to the grid. The collector electrode 16, if desired, may be replaced by a first electrode in an electron multiplier which is located in a side tube (not shown) adjacent the mosaic structure.

Radiations from an object or field of view C are applied to the mosaic target by means of the lens system schematically represented by the single lens 43. Because of the fact that the coatings 22 and 23 are semitransparent, the radiations from the object can effect the photosensitive material in the coating 22. By this means it is possible to separate the object radiations from the electron gun systems.

In order to cause the electron beam of the gun G to scan, in turn, every elemental area of the field on the mosaic target 20, suitable deflecting means such as, for example, two sets of magnetic deflecting coils 50 and 51, are provided. Through one set of the magnetic coils are applied saw-tooth current waves of framing frequency and through the other set of coils saw tooth current waves of line scanning frequency are passed. Any suitable sweep circuits (no shown) may be used to generate the horizontal and vertical deflecting currents.

Before explaining the operation of the tube of this invention, it may clarify the situation to consider the deficiencies of the iconoscope tube which does not have supplementary electron beams spraying the mosaic target. The scanning beam leaves an element charged about +3 volt relative to the collector electrode. It cannot be come charged by light shining on it until it receives some electrons from other parts of the mc

saic. Such electrons may be either photoelectrons or secondary electrons. It is evident, therefore, that the total number received and the rate at which they are received vary with time because of change in the picture content and changing location of the scanning beam with respect to the mosaic. The result is a transmitted picture with poor contrast and low signal strength and very bad spurious shading.

The operation of a tube made in accordance with this invention is such as to overcome most of the above-mentioned deficiencies of the usual iconoscope. This may be seen by referring to Fig. 4. Negative potentials of the mosaic relative to the grid are plotted upwards and the X-axis represents time. The line which appears as the time axis is not actually zero mosaic potential but is for a slightly positive mosaic potential, that is, the equilibrium potential. The dotted line EF parallel to the time axis OD represents a mosaic potential such that all of the photoelectron current from the mosaic element is drawn to the grid 40. Now consider an element which has just been scanned by the beam from the gun G. It will again be struck by the beam after a frame period, as shown in Fig. 4. After each scanning it is left at the same equilibrium potential. In order to raise the efficiency of storage of signal, the potential of the element is driven negative by the uniform spray of high speed electrons of which δ is much less than 1. This spray is obtained from one or more guns of the type such as G₁, G₂, G₃ and G₄. The current density in the spray is made sufficient to cause complete withdrawal of photoelectrons during a major portion of the scanning cycle, that is, during the interval Δt indicated in Fig. 4. If no light from the object or field of view O is on an element during the scanning interval then the potential of the element changes approximately linearly with respect to time as indicated by the lines OA and BC in Fig. 4. If, however, the element is losing photoelectrons due to incidence of light on it, then the potential changes in a manner such as is represented by one of the dotted curves OG, OI, or OJ. Thus at the end of a scanning interval the element must be driven positive to the equilibrium potential from a more negative potential if it has not been illuminated than when it has light incident upon it. The signal is proportional to the light falling on the element. The signal resistor 24 receives the signal current, as in the case of the operation of the usual iconoscope, and this current may be amplified and transmitted to the receiving station in accordance with well-known practice.

In order to keep the electrical noise from the tube 10 at a minimum it is desirable to minimize the current from the beam G and the spray from the guns G₁, G₂, G₃ and G₄. This can be effected by keeping the elementary capacity low by using a thick dielectric support.

It is evident that the principles of this invention are not limited to the arrangement shown in Fig. 1 as high speed electron sprays may be used equally well in more conventional types of tube such as the more usual iconoscope in which radiations from the object are applied to the same side of the mosaic as the scanning beam. It is also evident that similar results may be obtained by replacing the guns G₁, G₂, G₃ and G₄ or any of them by a beam which sweeps the mosaic target 20 a line or a few lines behind the scanning beam. Such an arrangement is shown in Fig. 5. In this arrangement

the portion to the left of the line X—X is the same as the portion to the left of the line X—X in Fig. 1 so has not been repeated. The mosaic target 20 is similar to the one shown in Fig. 1. In Fig. 5 the guns G₁, G₂, G₃ and G₄ have been replaced by a single gun schematically represented by the reference character G₅ which may be similar to the gun G shown in Fig. 1 except that the potentials applied to the final anode are such that the electrons as they reach the target have a velocity such that the secondary emitting ratio is much less than 1 at the mosaic target 20. The beam generated by the gun G₅ is deflected by the coils 60, 60 and 61, 61 in two component directions at right angles to each other to cause this beam to scan in turn every elemental area of the field on the mosaic target 20, the currents in these coils being of saw-tooth wave form and of appropriate frequency to produce this result. The currents in the coils 60 and 61 are preferably phase synchronized by any convenient means with those in the coils 50 and 51 so that the beam is one line or several lines behind the scanning beam from the gun G. The operation is otherwise the same as in the structure shown in Fig. 1.

In another modification, two of the auxiliary guns, for example, such as guns G₁ and G₄, may be replaced by high current but very low velocity guns of similar construction but having a lower potential applied between the anode and the cathode thereof. The purpose of the very low velocity spray in this case would be to drive the area just behind the beam several volts negative-ly quickly.

The use of any of the above methods results in a camera tube with greater sensitivity, improved contrast, and less spurious signals due to low speed photo and secondary electrons and line sensitivity than shown by the usual iconoscope. Moreover, the use of one of these methods of producing an accelerating potential at the mosaic permitting employment of relatively high velocity scanning electrons is a desirable improvement over methods which require scanning by low velocity electron beams. Control of the spray electrons is much greater due to the use of high velocities instead of the low velocities of previous arrangements. Moreover, it is possible to drive the mosaic more negative than is the case with low velocity electron sprays.

Various other changes may be made in the embodiments above described without departing from the spirit of the invention, as indicated in the appended claims.

What is claimed is:

1. The method of operating a cathode ray tube of the highly evacuated type having a mosaic of light sensitive elements electrically insulated from each other and from a supporting surface and having an anode common to said elements, which method comprises scanning said mosaic element by element with a beam of high velocity electrons, and also applying to said mosaic additional high velocity electrons of such velocity and in such number that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and the potentials of said elements shifted in a negative direction with respect to the potential of said anode.

2. The method of operating a cathode ray tube of the highly evacuated type having a mosaic of light sensitive elements electrically insulated from each other and from a supporting surface

and having an anode common to said elements, which method comprises scanning said mosaic element by element with a beam of high velocity electrons, and simultaneously applying to all elements of said mosaic additional high velocity electrons of such velocity and in such number that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and the potentials of said elements are shifted in a negative direction with respect to the potential of said anode.

3. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for applying additional high velocity electrons to said mosaic, said additional electrons being of such high velocity that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode.

4. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, means for spraying said mosaic with high velocity electrons, said last-mentioned high velocity electrons being of such velocity that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode.

5. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for lowering the potential of said mosaic comprising means for scanning said mosaic element by element with additional high velocity electrons.

6. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for lowering the potential of said mosaic comprising means for scanning said mosaic element by element with additional high velocity electrons, said last-mentioned scanning means being synchronized with said first-mentioned scanning means but being out of phase therewith.

7. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for applying additional high velocity electrons to said mosaic, said addi-

tional electrons being of such high velocity that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode, said last-mentioned means comprising a plurality of supplementary electron guns.

8. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for applying additional high velocity electrons to said mosaic, said additional electrons being of such high velocity that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode, said last-mentioned means comprising a plurality of supplementary electron guns, the axes of which are substantially equally spaced from the normal to the center of the scanning field on said mosaic target.

9. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, and means for applying additional high velocity electrons to said mosaic, said additional electrons being of such high velocity that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode, said last-mentioned means comprising a plurality of supplementary electron guns, the axes of said supplementary guns being normal to the surface of said mosaic target.

10. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic target comprising a plurality of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, an electron collecting electrode, means for spraying said mosaic with a high current of very low velocity electrons, and means for spraying said mosaic with high velocity electrons, said last-mentioned high velocity being such that the ratio of secondary electrons released from said elements to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to the collecting electrode.

11. In a cathode ray device, means for generating a beam of high velocity electrons, a mosaic of light-sensitive elements electrically insulated from each other and from a supporting surface, means for causing said beam of high velocity electrons to scan said mosaic element by element, means for collecting electrons from said mosaic, means for generating a second beam of high velocity electrons, and means for causing said second beam to scan said mosaic element by element after said first beam to drive the mosaic to nega-

tive potential quickly, said velocity of said second electron beam being such that the ratio of secondary electrons released from the element to primary electrons impinging thereon is less than unity and in such number that said elements assume a negative potential with respect to said collecting electrode.

12. In combination, an evacuated container having mounted therein a mosaic target of light sensitive elements electrically insulated from each other and from a supporting electrode, means in said container for generating a beam of high velocity primary electrons and for causing said beam to scan every elemental area in turn of a field on said mosaic, means for applying radiations from an object or field of view to said target, means within said container for collecting secondary electrons emitted from said mosaic target when impacted by primary electrons from said beam, said primary electrons having such velocity and number that said emission of secondary electrons leaves each element immediately after it has been scanned by said beam of primary electrons at an equilibrium potential which is positive with respect to the potential of said

electron collecting member, and electron generating means for applying additional high velocity electrons to said mosaic in such quantity and at a velocity, higher than those in said scanning beam, such that the potential of each of said elements is made negative with respect to that of the collecting electrode.

13. The combination of elements as in claim 12 in which said additional high velocity electrons are continuously sprayed over the entire field on said mosaic target.

14. The combination of elements as in claim 12 in which said additional high velocity electrons are applied to said target from a plurality of electron guns, the axes of which are symmetrically placed around the normal to the center of said field.

15. The combination of elements as in claim 12 in which said additional high velocity electrons are applied by means of a beam adapted to scan said field on said target at the same rate as said first beam of high velocity electrons but out of phase therewith.

GORDON K. TEAL.