Aug. 27, 1940. A. ROSE 2,213,176

TELEVISION TRANSMITTING TUBE

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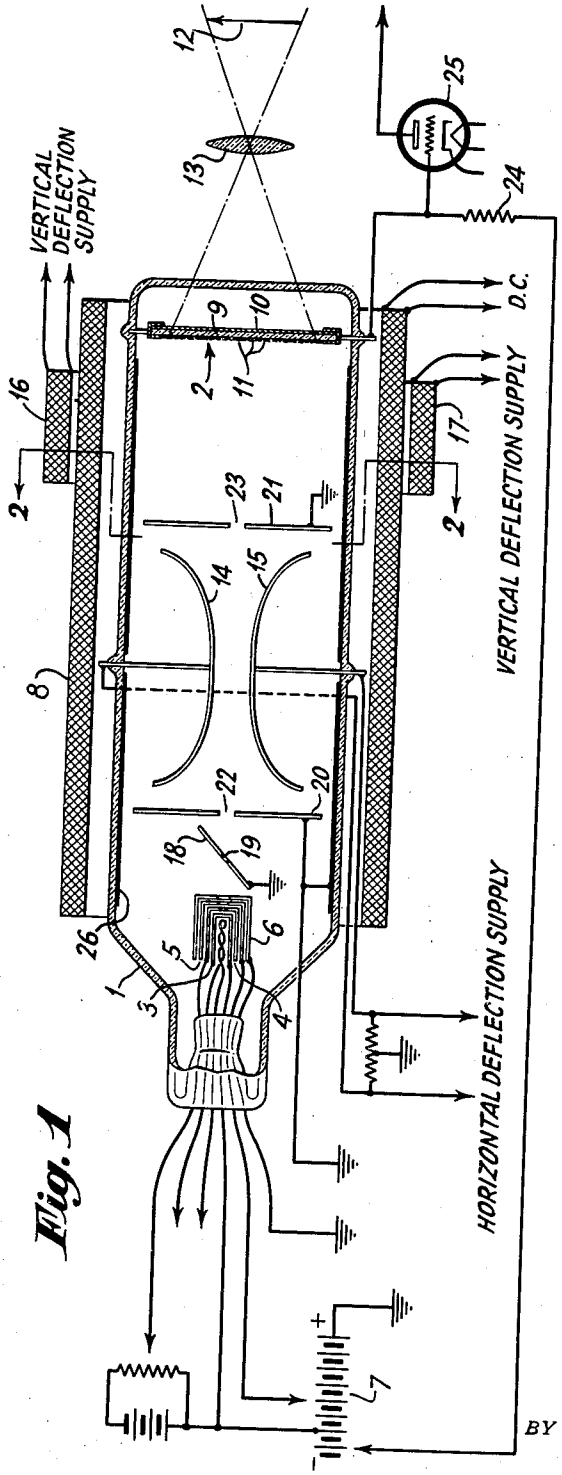

Fig. 1

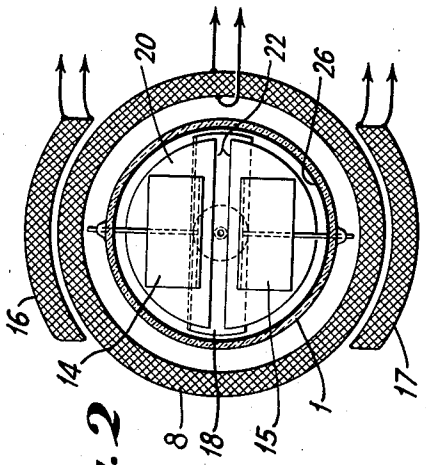

Fig. 2

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TELEVISION TRANSMITTING TUBE

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5 Claims. (Cl. 250—153)

My invention relates to television transmitting tubes and is more particularly directed to tubes utilizing low velocity electron scanning beams.

In the operation of a television transmitting tube of the low velocity electron beam scanning type including a target or mosaic electrode with an oppositely disposed electron gun and a combination magnetic-electrostatic deflection system including electrostatic plates wholly immersed in a uniform axial magnetic field, the electrons of the scanning beam which do not reach the target or mosaic electrode because of their low velocity return to a collecting electrode at the surface of which they may produce secondary electrons which travel toward the target. These secondary electrons modify the charges on the target or mosaic electrode thereby producing distortional effects.

The principal object of my invention is to provide such a television transmitting tube which will generate signals representative of an optical image without the production of distortional effects due to secondary electrons returning to the target electrode. It is a further object of my invention to provide such a tube by which a television image can be transmitted with equal fidelity over its entire area without distortional effects being produced.

In accordance with my invention, an electrostatic image corresponding in electrostatic energy distribution to an optical image is formed on a target or mosaic electrode which is scanned by a low velocity electron beam from an electron gun, the scanning of the beam over the target being accomplished in a combination magnetic-electrostatic field. A portion of the low velocity electron beam neutralizes the electrostatic image, and the remainder of the beam returns from the target to a collecting electrode which is so constructed and positioned that most of the secondary electrons liberated from it by the electrons returning from the target are prevented from reaching the target. Further in accordance with my invention, I also provide means for intercepting the few secondary electrons which otherwise might reach the target electrode.

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

Fig. 1 is a longitudinal sectional view of a television transmitting tube embodying my invention and Fig. 2 is a cross section of the tube shown in Fig. 1 taken along the lines 2—2.

In general, the tube incorporating my invention comprises an evacuated envelope having a target preferably of the photosensitive mosaic type at one end and an electron gun and an electron collecting electrode at the opposite end of the tube. The target, if of the mosaic type, is provided on its front surface with an extremely large number of mutually insulated photosensitive particles and is so positioned that it may be scanned by an electron beam from the gun and may also have focused upon it an optical image of the object of which a picture is to be transmitted. Intermediate the collecting electrode and the target I provide two or more electrostatic deflection plates wholly immersed in a magnetic field coaxial with the center line of the gun and the target to scan the electrons from the gun over the mosaic electrode. The potentials between the electron gun and target are so adjusted that the electron beam is projected at relatively low velocity and impinges upon the target at extremely low or substantially zero velocity, that is, with a velocity approaching zero at the point of impact. In operation, the electrostatic image consisting of charges proportional to the intensity of the incident light, is neutralized by the low velocity beam to generate electrical signals representative of the optical image.

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

The electron gun assembly is of the conventional type and comprises a cathode 3 from which electrons may be drawn, a control electrode 4 connected to the usual bias battery and a first anode 5 maintained positive with respect to the cathode 3. The electron stream leaving the cathode 3 is accelerated by the first anode 5 and further accelerated at relatively low velocity and concentrated into an electron scanning beam focusing on the front surface of the mosaic electrode by a second anode 6 which is preferably an apertured tubular member partially surrounding the first anode 5. The first anode 5 and second anode 6 are maintained at the desired positive potentials with respect to the cathode by a battery 7.

The mosaic electrode 2 which faces the electron gun preferably comprises a substantially transparent sheet of insulation such as the mica sheet 9 having on its rear surface a translucent or semitransparent electrically conducting film

10, the opposite or front surface of the mica sheet facing the electron gun being provided with an exceedingly great number of mutually separated photosensitive particles 11. In making the mosaic electrode I select a mica sheet 9 of the desired area having a uniform thickness of approximately .002 inch and as a first step coat one side of the sheet with a film of metal of sufficient thinness as to be substantially transparent so that an optical image such as represented by the arrow 12 may be focused on the photosensitive particles 11 by a lens system 13. The mosaic of mutually separated particles may be made by depositing on the front surface of the mica sheet 9 finely divided silver oxide which is reduced to provide a surface of individually separated silver particles or globules 11 which are subsequently oxidized and sensitized with caesium or other alkali metal during the evacuation process. Such an electrode structure and a method of sensitization is disclosed by S. F. Essig in U. S. Patents 2,020,305 and 2,065,570.

Intermediate the electron gun assembly and the mosaic electrode I provide deflection plates 14—15 which are curved to provide a uniformly increasing and decreasing electrostatic deflection field. The plates 14—15 are connected to ground through a center-tapped resistance of one to ten megohms and to a source of deflection potential. To produce the desired deflection of the electron beam I provide means to wholly immerse the deflection platse in a uniform magnetic field which is preferably generated by a magnetic coil 8 of slightly larger diameter than the envelope 1 extending over and beyond the space between the electron gun and the mosaic electrode 2. The plates 14—15 in combination with the field produced by the coil 8 deflect the beam in a plane midway between the plates and through the center line of the gun and target. Deflection of the electron beam in a direction normal to that produced by the plates 14—15 is accomplished by a pair of deflection coils 16—17. This deflection is preferably the frame or vertical deflection, and since in standard television systems the frame deflection is of lower frequency than the horizontal line deflection the magnetic deflection coils 16—17 should preferably be operated at the lower of the two frequencies. The deflection coils 16—17 may, of course, be replaced by a second pair of deflection plates. However, a substitution of magnetic means for the electrostatic deflection means, such as the plates 14—15, does not render the device operative as envisaged by my invention because if this undesired structure is used the electrons returning from the mosaic electrode are directed along the same approximate paths over the entire trajectory between the mosaic electrode and the electron gun, and many of these returning electrons are directed toward the cathode which is at a negative potential and incapable of collecting them, whereupon they return to the mosaic electrode and produce a spurious signal effective over the entire picture area.

In accordance with my invention I provide between the electron gun and the deflection plates 14—15 an electron collecting electrode so constructed and positioned as to intercept electrons returning from the mosaic electrode. Referring to the drawing, the collecting electrode 18 is so positioned with respect to the center line of the electron gun and mosaic electrode that few, if any, secondary electrons emitted from the collecting electrode by impact of the impinging electrons returning from the mosaic electrode are redirected toward the mosaic electrode.

More specifically, the electrode 18 comprises an apertured metal sheet of extended surface having low secondary electron emitting properties, the aperture 19 being axially aligned with the longitudinal axis of the tube and the axis of the electron gun, the electrode 18 being located in a plane which is inclined at an oblique angle with respect to the longitudinal axis. The electrode 18 may be of nickel or other metal coated on its surface facing the mosaic electrode with carbon or other material having low secondary emission properties. Further in accordance with my invention I provide between the collecting electrode 18 and the mosaic electrode 2, two slotted electron intercepting electrodes 20—21, one on either side of the deflection plates 14—15 in a direction along the tube axis, to intercept secondary electrons which may be emitted by the collecting electrode 18 notwithstanding its low secondary emission properties and its positioning with respect to the tube axis. The intercepting electrode 20 is connected to ground and is provided with an elongated slot 22 in axial alignment with the aperture 19 in the collecting electrode 18, the length of the slot 22 being parallel with a plane through the tube axis and midway between the deflection plates 14—15. The intercepting electrode 21 is located near the ends of the deflection plates opposite the electrode 20 and is likewise connected to ground and is provided with an elongated slot 23 parallel with the slot 22 in the intercepting electrode 20.

The collector electrode 18 may be operated at second anode or ground potential and the signal representative of the optical image focused on the mosaic electrode may be taken from the semitransparent electrically conducting film 10. With this arrangement I prefer to connect the film 10 to the battery 7 at a point close to cathode potential through an output impedance 24 and to a translating device 25 which amplifies the signals, whereupon after further amplification, the signals may be applied to a transmitting network as well known in the art. If desired, however, the output impedance 24 and the translating device 25 may be connected in the circuit of the collecting electrode to ground, although it has been found that with this arrangement somewhat greater distortion is produced than with the connections shown in the drawing.

I have found that electrons liberated from the cathode 3, when accelerated and projected toward the mosaic electrode 2, follow a spiral path while under the influence of the axial magnetic field generated by the coil 15. The amplitude of these spiral paths is relatively small and is apparently due to the initial transverse velocities with which the electrons are emitted at the cathode. A portion of the electron beam will neutralize the electrostatic charge of the particles on the mosaic electrode at which the beam is directed during the scanning cycle, and the remainder of the electron beam is reflected from the mosaic and directed toward the electron gun. If the electrons are not collected by the mosaic they return toward the electron gun end of the tube, following similar spiral paths of small amplitude occasioned by their transverse emission velocities from the cathode. Since the amplitude of these spiral paths is low, the electrons pass unimpeded through the elongated slots 22—23 in the intercepting electrodes 20—21 and

are collected over the length of the collecting electrode 18. These electrons while approaching the mosaic electrode 2 lost their velocity by reason of the low electrostatic potential on the particles with respect to the cathode 3, but upon returning toward the collecting electrode 18, these electrons receive energy from the deflection plates 14—15 and other electrode structure so that they impinge upon the collecting electrode with a velocity sufficient to liberate secondary electrons from the collecting electrode 18. Most of the secondary electrons emitted by the collecting electrode 18 will be emitted normal to the plane of the collecting electrode, and since, in accordance with my invention, the collecting electrode 18 is positioned in a plane at an oblique angle with respect to the tube axis and is consequently at an oblique angle with respect to the helical paths of the returning electrons, the secondary electrons will have large components of velocity transverse to the tube axis and transverse to the axial magnetic field. Because of their large transverse velocities these secondary electrons follow helical paths of great amplitude. These electrons starting on what might be another round trip between the collecting electrode and the mosaic electrode are intercepted by the intercepting electrode 20, while those which may have somewhat lower transverse velocity and therefore less helical amplitude pass through the slot 22 and are collected by the intercepting electrode 21. It is therefore impossible for these electrons to again approach the mosaic electrode and possible impinge thereon, thereby causing distortion in the signal representative of the light intensity on the various mosaic elements.

In addition to intercepting electrons the electrodes 20—21 maintain a substantially field-free space within the electrostatic deflection region of the plates 14—15 and at the same time prevent fringing of the electrostatic field between the plates. Thus any variations in electrostatic potential distribution on the mosaic electrode or any slight potential variations applied to the electron gun electrodes produce little or no distortion in the deflection space. In order to further insure a field-free space between the deflection plates 14—15, I have found it desirable to coat the inner wall of the envelope 1 with a film 26 of electrically conductive material so that electrons are prevented from collecting on the bulb wall, thereby introducing an electrostatic field within the space separating the intercepting electrodes 20—21.

In the operation of tubes made in accordance with my invention I have found that the operating parameters such as the size of the electrodes, the separation of electrodes and operating potentials, may be varied over wide limits. However, to limit the structure to practical proportions I have found that the potential applied between the cathode 3 and the anode 6 is preferably between 50 and 250 volts. Tubes operating with a potential below 50 volts have shown decreased beam focusing properties, and the use of potentials below this value necessitates greater accuracy in the alignment of the electron gun electrodes and the deflection plates. Certain tubes operating with potentials above 250 volts have given unstable operation. The axial magnetic field is preferably between 50 and 150 gausses. Below 50 gausses some distortion due to stray electrostatic fields may be produced, and the use of a field stronger than 150 gausses necessitates increased deflecting power and use of heavier coils and results in poorer focus of the electron beam near the edges of the target electrode. The width of the target or mosaic electrode is preferable made between 5 and 7 centimeters, since the width of the plates must be of the same or greater width, and greater width of the target would necessitate a tube of larger overall diameter. The length of the deflection plates is preferably between 10 and 20 centimeters, for when using a length less than 10 centimeters, some distortion and defocusing of the beam is produced. Lengths of the deflection plates above 20 centimeters unduly increase the tube length and the length of the focusing coil.

While I have indicated the preferred embodiments of my invention of which I am now aware and have indicated the specific application as directed to cathode ray transmitting tubes having target electrodes of the photosensitive mosaic type, it will be apparent that my invention is by no means limited to the purpose of television transmission, to the exact forms illustrated, or to its use in cathode ray tubes incorporating target electrodes of the mosaic type, but that many variations may be made in the particular structure used, such as by replacing the mosaic electrode with target electrodes of the fluorescent, photoconductive, or photovoltatic type, without departing from the scope of the invention as set forth in the appended claims.

I claim:

1. A cathode ray tube having an electron source, an oppositely disposed electron receiving target, an anode adjacent said source to form and direct an electron beam toward said target, means to generate a magnetic field having lines of force parallel with the center line between said anode and said target, means to generate electron beam deflection fields at least one of which is an electrostatic field to deflect the beam over said target in mutually perpendicular directions, and apertured means adjacent said anode and interposed between said anode and said means to generate beam deflection fields to collect electrons not reaching said target between said anode and said deflection means, said apertured means lying in a plane oblique to the center line of said anode and said target and surrounded by said first-mentioned means.

2. A cathode ray tube having a cathode to emit electrons, an anode adjacent said cathode to form the emitted electrons into a beam, a target electrode in the path of said beam, means to generate a magnetic field having lines of force which are substantially parallel with the center line between said anode and said target and extending over the space between said anode and said target, means wholly immersed in said magnetic field and between said anode and said target for electrostatically deflecting the beam over said target, two electron intercepting electrodes, one on either side of said deflection means, and an electron collecting electrode between said anode and the intercepting electrode nearer said anode to collect electrons returning from said target electrode in the direction of said anode, said collecting electrode having an extended surface which is oblique to said axis and said intercepting electrodes intercepting the secondary electrons emitted by said electron collecting electrode.

3. A cathode ray tube having a target, an oppositely disposed electron gun including an anode to direct a beam of electrons toward said target, an electron focusing coil surrounding the space

between said gun and said target to generate a magnetic field having lines of force extending from said gun to said target, a pair of oppositely disposed beam deflection plates between said gun and said target to deflect, in combination with the magnetic field, the electron beam over said target, two slotted electron intercepting electrodes positioned with their slotted portions parallel one to the other and parallel with the plane of deflection of said beam within said deflection plates, and an apertured electron collecting electrode aligned coaxially with said intercepting electrodes and said electron gun inclined at an oblique angle to the center line of said electron gun and target to collect electrons of said beam not reaching said target and said intercepting electrodes intercepting secondary electrons emitted by said collecting electrode.

4. In combination with a cathode ray tube having means to generate a uniform magnetic field, an electron receiving target, and an electron gun having a center line to said target parallel with the lines of force of said field, said gun being adapted to generate an electron beam and direct said beam along the lines of force of said magnetic field toward said target, an electrostatic electron beam deflection structure comprising a pair of plates on opposite sides of the path between said gun and target and wholly immersed in said field, an electron collecting electrode adjacent the electron gun and between said gun and said deflection structure to collect electrons of said beam not reaching said target, and a pair of slotted electron intercepting electrodes to intercept secondary electrons emitted by said collecting electrode, one on either side of the said deflection structure in the direction between said gun and target aligned with their slotted portions in the plane of deflection of the electron beam between said deflection structure, and in planes substantially perpendicular to the direct path between said gun and target.

5. In combination with a cathode ray tube having means to generate a uniform magnetic field, an electron gun to generate an electron beam, an electron receiving target of the mosaic type in the path of the electrons from said gun, an electrostatic electron beam deflection structure wholly immersed in said field comprising a pair of plates on opposite sides of the path between said gun and target, a pair of electron intercepting electrodes having slots aligned in the plane of deflection of the electron beam between said plates and in planes substantially perpendicular to the direct path between said gun and target, one on either side of the said plates in the direction between said gun and said target, and an electron collecting electrode having an extended surface lying in a plane at an oblique angle with the plane of deflection to collect electrons which return from said target, said intercepting electrodes intercepting secondary electrons emitted by said collecting electrode.

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