Oct. 14, 1941. H. NELSON 2,258,791

IMAGE TRANSMITTING TUBE

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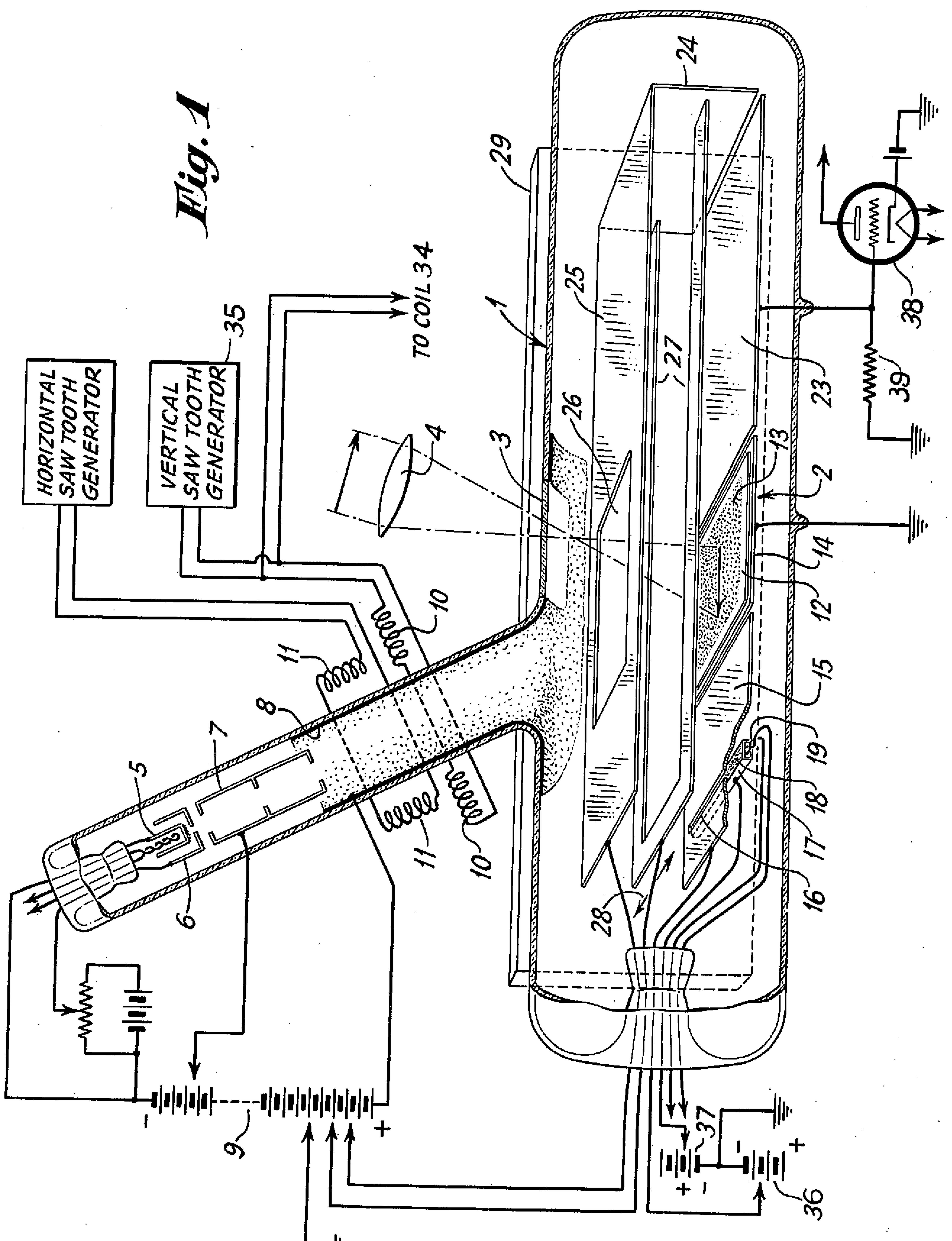

Fig. 1

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Fig. 2

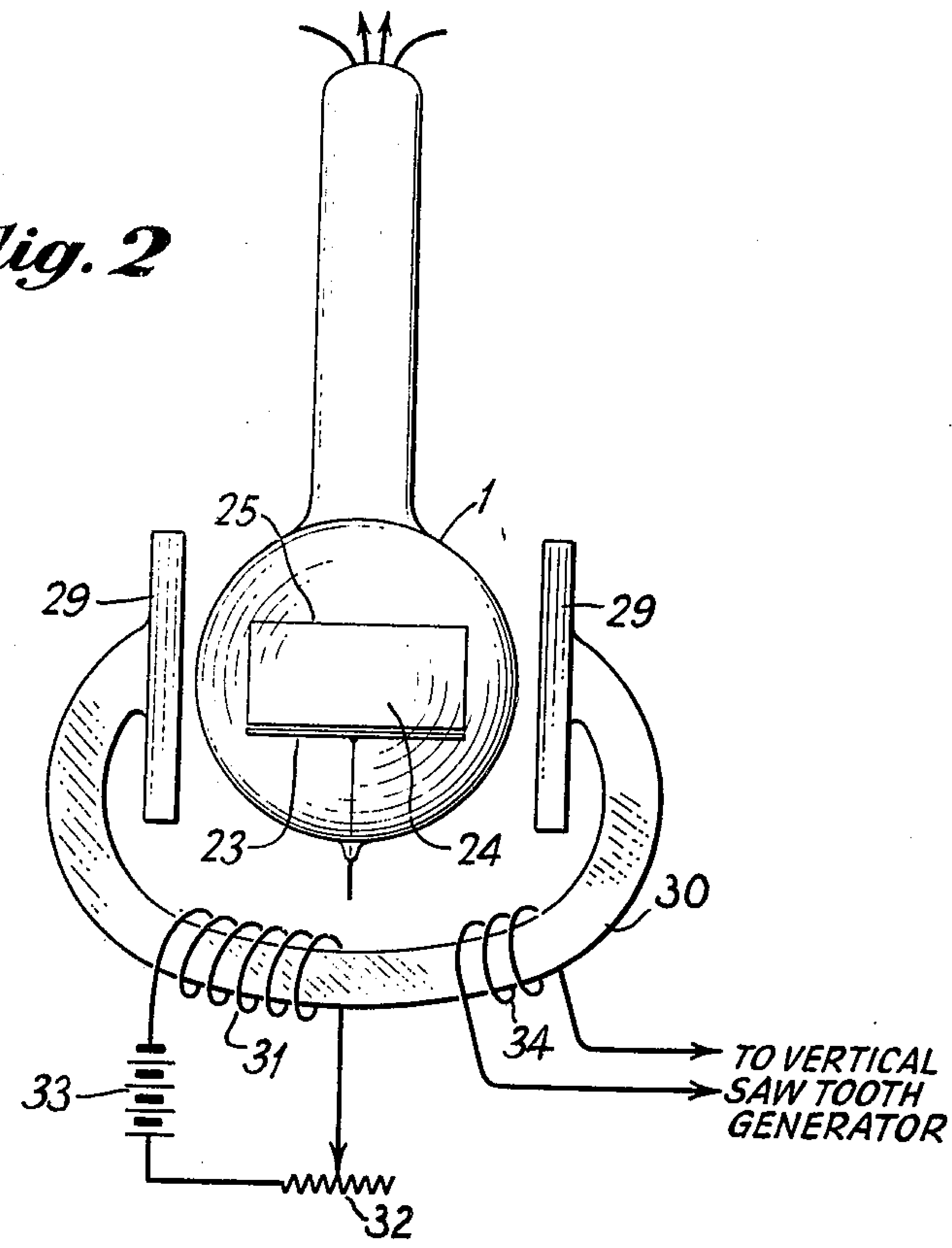
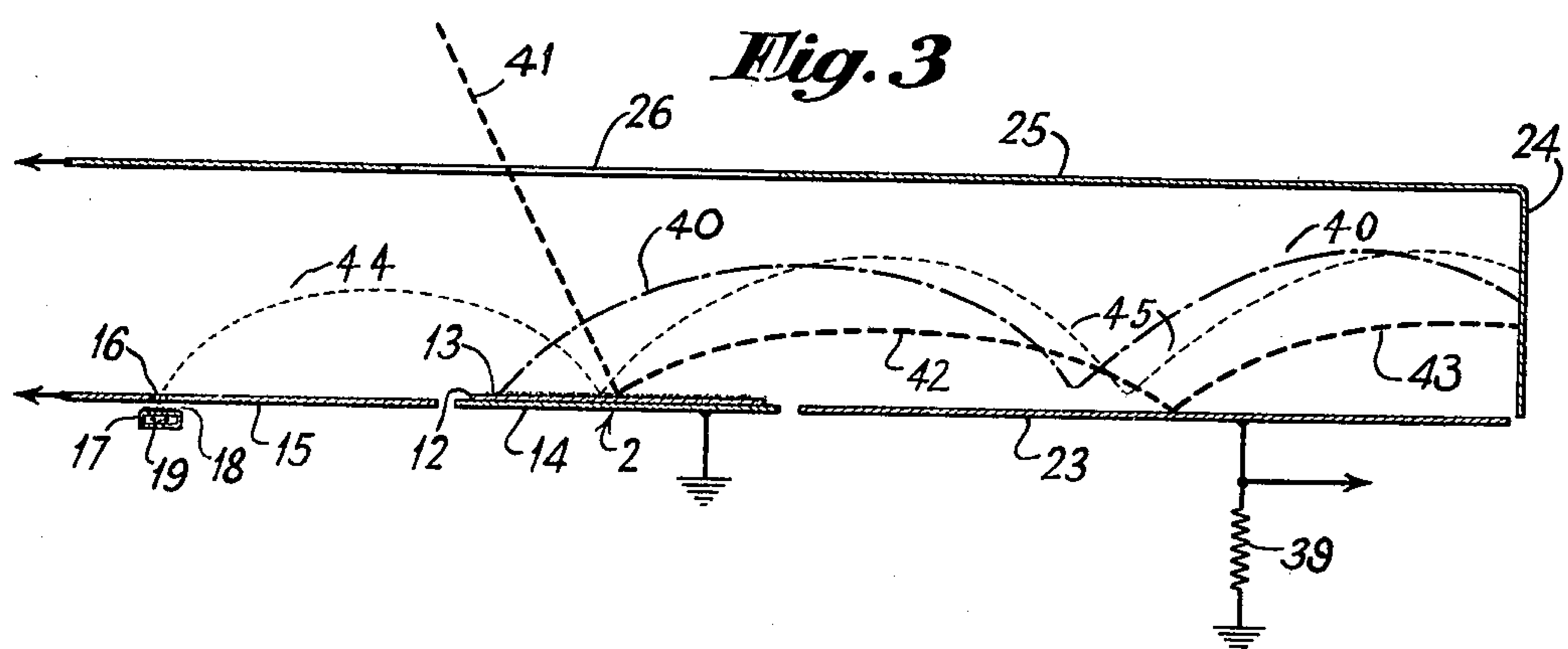


Fig. 3



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Patented Oct. 14, 1941 **2,258,791**

UNITED STATES PATENT OFFICE

2,258,791

IMAGE TRANSMITTING TUBE

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Application January 31, 1939, Serial No. 253,763

12 Claims. (Cl. 178—7.2)

My invention relates to electronic devices and is concerned primarily with television transmitting tubes and a new method for generating television signals representative of an optical image which may be recreated as a replica of the image at a distance.

In electronic image transmitting tubes of the storage type it has been found that in many instances the signal to noise ratio is not as high as might be desired for the transmission of images having low values of light intensity. It is well known that the effective sensitivity of such a tube with a mosaic type electrode is limited by the absence of a material electric field for drawing the emitted electrons away from the mosaic of photosensitive particles and by the fact that most of the secondary electrons produced by the impingement of the scanning beam on the surface of the mosaic return to the mosaic. Since the secondary electrons return to the mosaic at random, local potential distributions are formed on the mosaic which result in a spurious signal, usually referred to in the art as dark spot signal, which introduces distortion and dark spot effects in the recreated optical image.

It is an object of my invention to provide a light translating and scanning device which will convert optical effects into signalling impulses and simultaneously provide a response which is proportional to the optical effects for which translation is desired without the introduction of distortion such as dark spot effects. Another object of my invention is to provide selective means in and a method of operation of a television transmitting tube whereby only the energy representative of the signal energy is utilized and the non-signal energy is excluded.

It is a further object of my invention to provide an image translating device having a minimum of spurious effects which produce distortion of the recreated replica of an image to be transmitted, and a still further object to provide means whereby a more sensitive photoelectric structure may be utilized to the fullest extent and operated at its maximum efficiency.

In accordance with my invention, I provide an electronic device suitable for generating television signalling impulses wherein the optical image is focused directly upon a mosaic electrode to generate an electrostatic image corresponding in intensity and distribution to the optical image by the emission of photoelectrons of an intensity corresponding to the optical image intensity and distribution which electrostatic image is used to control the liberation of secondary electrons upon being scanned by an electron beam the said secondary electrons being diverted from the mosaic electrode along definite paths thereby preventing their return to the mosaic electrode, and neutralizing the residuary charge produced on the mosaic electrode in accordance with the scanning operation by subjecting the mosaic to electronic energy in a time and space sequence following that of the scanning operation. Further in accordance with my invention, I selectively collect the electrons, both primary photoelectrons and secondary electrons, in accordance with the potential at their points of origin and also in accordance with their relative initial velocities, by providing crossed electromagnetic and electrostatic fields whereby high velocity electrons will be collected in one circuit where they may be utilized to generate television signals and low velocity electrons will be rejected by that circuit. Still other objects, features and advantages of my invention will become apparent and will at once suggest themselves to those skilled in the art to which the invention is directed from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a longitudinal perspective view, partially in section, of an electron discharge device, embodying my invention, and a diagram of the associated circuits;

Figure 2 is a plan view of the device shown in Figure 1, showing the magnetic field generator used therewith; and,

Figure 3 is a schematic representation of a portion of the electrode structure shown in Figure 1 to show the operation of the device.

In the illustrative embodiment of my invention as shown in Figure 1, the discharge device or cathode ray tube comprises a highly evacuated glass envelope or bulb 1 of cylindrical shape with a tubular arm or neck section enclosing a conventional type electron gun. The bulb 1 encloses a flat target or mosaic electrode 2 opposite the junction of the neck section with the cylindrical section so that the surface of the mosaic electrode 2 may be scanned by an electron beam from the electron gun located in the neck section. Since the image projected on the mosaic electrode is produced by light from an object situated outside the tube, a portion of the tube such as the transparent window 3 which is optically uniform and preferably a continuation of the cylindrical portion of the envelope 1, is provided so that the image of which an electrical replica is to be transmitted may be projected upon the mosaic electrode 2 with a minimum of distortion by a lens system 4.

The electron gun assembly is of the conventional type and comprises a cathode 5 from which an electron stream may be drawn, a control electrode 6 connected to the usual biasing battery, and a first anode 7 maintained positive with respect to the cathode 5. The electron stream leaving the first anode 7 is accelerated and concentrated into an electron scanning beam focused on the surface of the target or mosaic electrode 2 facing the electron gun by a second anode 8 which is preferably a conductive coating on a portion of the inner surface of the neck section of the bulb 1. The beam is preferably focused to a small spot having a cross-section at the mosaic electrode equivalent to the elemental area of the image to be transmitted. The first anode 7 and the second anode 8 are maintained at the desired positive potentials with respect to the cathode by a potential source such as the battery 9. Conventional deflection means, such as the deflection coils 10 and 11, may be energized with saw-tooth currents to sweep the beam in mutually perpendicular directions to scan the mosaic electrode 2. Thus the coils 10 are designed to operate at relatively low frequency for frame scanning such as 30 cycles per second while the coils 11 are designed to operate at relatively high frequency for line scanning. The line scanning frequency for 30 frames per second and 441 lines would thus be 13,230 cycles per second. It is obvious that conventional electrostatic deflection plates or electrodes may be substituted for either one or both of the deflection coils if desired.

The mosaic electrode 2 is of the conventional type and comprises a layer 12 of insulating material having on the side facing the electron gun a mosaic consisting of a multiplicity of mutually separated silver particles 13 which are oxidized and coated with caesium or other alkali metal to provide a mosaic surface of high photosensitivity which exhibits high secondary electron emission when scanned by the electron beam from the electron gun. The insulating layer 12 may be deposited directly on a metal base 14 or it may be a sheet of insulation such as mica. I have found it desirable that the insulating layer 12 extend only over the central portion of the metal base 14 so that the base extends beyond the borders of the insulation and the mosaic of photosensitive particles thereon for a distance of approximately one quarter inch. The metal base 14 serves as a common condenser plate, the other plate being subdivided into a great number of individual plates and constituted by the particles 13. The construction and photosensitization of such electrodes is well known in the art and is more adequately described by S. F. Essig in U. S. Patent 2,065,570.

In accordance with my invention I project an optical image on the mosaic electrode to liberate photoelectrons and form thereby an electrostatic image of the optical image and scan the mosaic electrode with a beam of high velocity electrons to generate an electron flow representative of the optical image projected on the mosaic electrode and direct this electron flow away from the surface of the mosaic. During the scanning with high velocity electrons a residuary charge is formed on the mosaic particles which I neutralize by sweeping a broad sheet-like beam of electrons over the mosaic closely following the scanning beam. To sweep the sheet-like beam and remove the electron flow generated on the mosaic electrode from the surface of the electrode I provide adjacent the mosaic electrode crossed magnetic and electrostatic fields. Further in accordance with the invention I utilize the crossed magnetic and electrostatic fields to direct the signal electrons to a signal electrode where they may be utilized and the non-signal electrons to a position at which they may be rejected.

Referring again to Figure 1, I provide at one side of the mosaic electrode 2 and preferably in a plane coplanar therewith an apertured beam focusing electrode 15 which is preferably of somewhat greater length than the width of the mosaic along the tube axis. The electrode 15 is provided with an elongated aperture or slot 16 parallel with one edge of the mosaic electrode 2 and preferably coplanar with the mosaic electrode. On the side of the slot 16 opposite that facing the electron gun, I provide an electron source preferably of somewhat greater length than the length of the aperture 16. This electron source may take the form of a uni-potential cathode 17 having an electron emitting surface or coating 18 of alkaline earth oxides which when heated such as by the heater 19 emits a sheet-like beam of low velocity electrons. The sheet-like beam of electrons is directed toward and is collected in most part on the mosaic electrode by crossed magnetic and electrostatic fields generated in a manner as described below. It is obvious that the unipotential cathode may be replaced by any other electron source such as a directly heated cathode.

The low velocity electrons liberated by the high velocity beam impinging on the mosaic electrode, the electrons from the cathode 17 which are not collected by the mosaic and the photoelectrons liberated from the mosaic under the influence of the optical image may be collected immediately adjacent the edge of the mosaic electrode opposite the cathode 17 and utilized to produce picture signals without dark spot distortion but I prefer to increase the signal to noise ratio by collecting only the secondary electrons liberated from the mosaic surface under scansion by the high velocity beam which are liberated from the elemental areas in accordance with the intensity of the optical image on the respective areas. I therefore provide beyond the edge of the mosaic electrode opposite that edge which is adjacent the beam forming electrode 15 a signal electrode 23 preferably in the same plane as the electrode 15 and the mosaic electrode 2. The electrode 23 collects electrons originating from points which are negative with respect to it, such as the secondary electrons from the mosaic surface, but rejects electrons having low initial velocities which originate from points which are positive with respect to it, such as the photoelectrons and electrons from the cathode 17. The electrons rejected by the electrode 23 are collected by a collecting electrode 24 which is preferably perpendicular to the common plane of the electrode system 15, 2 and 23 and located near but slightly spaced from the end of the electrode 23 opposite the end adjoining the edge of the mosaic electrode 2. In addition to the above described system of electrodes I provide an electrostatic accelerating electrode 25 which is preferably in a plane parallel with the common planes of the electrodes 15, 2 and 23 but spaced a substantial distance therefrom. While I have shown the electrode 25 as being constructed from a single metal sheet it is obvious that several electrically connected electrodes having an equivalent area could be used so I prefer to refer to this or these electrodes as a second system of electrodes to differentiate over the first system which includes the electrodes 15, 2 and 23. Furthermore, while I have shown the electrode 25 as being formed integrally with the electrode 24 these electrodes may be separate and distinct and may be connected together outside of the bulb 1. Therefore, when I refer to the electron collecting electrode I mean to refer to an electrode having the property of collecting electrons and in a position where it will intercept the electrons to be collected such as the electrode 24 which is at the end of the two electrode systems opposite the end near the elongated cathode 17. A portion of this accelerating electrode 25 is between the mosaic electrode 2 and the electron gun in the neck section of the bulb so that I provide in the electrode 25 between the gun and the mosaic electrode an opening 26, preferably rectangular, through which the optical image to be transmitted may be projected on the mosaic electrode and the mosaic electrode scanned by the high velocity electron beam from the gun. Located in a plane substantially midway between the electrodes 15, 2 and 23 and the deflection electrode 25 I provide an equalizing electrode 27 which is for the purpose of equalizing and maintaining more uniform the electrostatic field between these electrodes during operation. The equalizing electrode 27 is preferably a U shaped metal plate, the central portion of which is open to allow unimpeded the electron flow along the length of the electrode structure.

To provide the crossed electrostatic-magnetic fields referred to above, I have found it convenient to provide magnetic means outside of the bulb 1 to produce a magnetic field having lines of force parallel with and transverse to the electrodes 2, 15, 23 and 25, in the direction shown by the arrow 28. For this purpose I have found suitable a magnetic yoke arrangement shown in Figure 2 including pole faces 29 and an interconnecting yoke 30. The yoke and pole faces are constructed of material such as Swedish iron or other material having high magnetic permeability and are energized by a coil 31 connected through a variable resistance 32 to a potential source 33 so that a uniform unidirectional magnetic field may be produced, the field extending over the length of the tube and preferably slightly beyond the above mentioned electrode structures. In addition to the coil 31 which produces uniform magnetic flux between the pole faces 29, I provide an auxiliary coil 34 likewise surrounding the yoke 30, the said coil being energized from a source 35 of sawtooth current, the frequency of which is determined by the number of frames which it is desired to scan per second. Thus, if the frame scanning coils 10 are supplied with 30 cycle per second sawtooth currents I likewise apply the same frequency of sawtooth currents to the coil 34. The purpose of the coil 34 is to produce a varying magnetic field to sweep the sheet-like beam from the cathode 17 over the mosaic electrode in a space and time sequence closely following the vertical scanning of the high velocity beam. I have found in practice that a constant and uniform magnetic field density between the pole faces 29 of 6.1 gauses is satisfactory for the voltage ratings of the tube to be disclosed below and that a variable magnetic field strength varying between 0 and 3 gauses added to the constant magnetic field is sufficient in following my method of operation. The value of the constant uniform field required and produced by the coil 31 may be expressed by the formula

$$\sqrt{\frac{K\pi\frac{V}{D}}{d}}$$

where:

K=11.3,
V=potential between electrodes 14 and 25 in volts,
D=distance between 14 and 25 in centimeters,
d=distance between aperture 16 and the more distant parallel edge of electrode 14 in centimeters.

The value of the varying uniform field required may be expressed as the constant field minus a quantity determined by the above formula but substituting d for d' where d'=distance between aperture 16 and the nearest parallel edge of electrode 14 in centimeters.

The tube shown in Figure 1 is made ready for operation by applying appropriate electron beam accelerating potentials to the electron gun anodes 7 and 8 with respect to the cathode 5 such as by the potential source or battery 9. The potential between the anode 8 and the cathode 5 is preferably approximately 1000 volts, the potential on the anode 7 being varied to produce an electron beam focused on the front surface of the mosaic electrode 2. The anode 8 is preferably operated at approximately 75 volts and the accelerating electrode 25 at approximately 50 volts both of these values being positive with respect to ground. The beam forming electrode 15 is connected to ground through the potential source or battery 36 so that it is maintained between 1 to 4 volts positive with respect to ground. The cathode 17 is also connected to ground through the potential source or battery 37 so that it is maintained between 0 to 3 volts positive with respect to ground. The mosaic electrode base 14 is connected directly to ground although I have found the tube to operate satisfactorily when this base was connected directly to the beam forming electrode 15. The signal electrode 23, which collects the secondary electrons to produce the signalling energy, is connected to the input circuit of a translating device such as the thermionic tube 38, and to ground through the output impedance 39. For these conditions the U shaped equalizing electrode 27 is operated at a potential between 50 volts and ground such as approximately 25 volts to maintain uniform the electrostatic field between the electrodes 2, 15 and 23 and the accelerating electrode 25. The above potentials have been found suitable for a tube wherein the combined length of the electrodes 15, 2 and 23 including the spacing therebetween is 12 inches, the distance between the plane of the electrodes 2, 15 and 23 and the plane of the electrode 25 being 1⅝ inches, the length of the beam forming electrode 15 being 3 inches, that of the signal electrode 23 being 6 inches, the width of the mosaic electrode base 14 being 2¾ inches, and the distance between the slot 16 and the nearest parallel edge of the base 14 being 2$\frac{1}{16}$ inches. The width of the electrodes and the length of the mosaic electrode, that is the dimension of the electrodes in the direction of the arrow 28, should be uniform but the above dimensions are not critical, although the ratio of dimensions of the electrodes to the other electrodes should be maintained. Thus the electrodes should be designed so as to meet the requirements entailed by the necessary paths of both the electrons flowing from the cathode 17 to the mosaic electrode and the electrons flowing from the mosaic electrode to the rejection electrode 23 and the collecting electrode 24.

After the tube is made ready for operation by the application of suitable operating potentials an optical image of an object of which a picture is to be transmitted is focused on the front surface of the mosaic electrode 2 to produce thereon an electrostatic image corresponding in elemental potential distribution to the optical image. This electrostatic image is formed by the liberation of photoelectrons from the front surface of the mosaic electrode in accordance with the intensity of the optical image. These photoelectrons have relatively low velocity and by their liberation from the mosaic surface produce an electrostatic image of positive electrostatic charges on the mosaic electrode. These photoelectrons are directed toward the signal electrode 23 and the collecting electrode 24 by the crossed magnetic and electrostatic fields generated by the potential differences between the accelerating electrode 25 and electrodes 15, 2 and 23 and by the coils 30 and 31. Due to the low velocity of these electrons they fail to impinge upon the signal electrode 23 but continue to and are collected by the collecting electrode 24. Simultaneously with the projection of the optical image upon the mosaic electrode, this electrode is scanned by the electron beam from the electron gun, the line scanning being made to follow paths substantially parallel with the aperture 16 and the cathode 17. The electrons of the beam are of high velocity and liberate secondary electrons from the particles 13 of the mosaic, the quantity of these electrons and the velocity thereof being proportional to the intensity of the electrostatic charge on the various particles. These secondary electrons are directed by the crossed magnetic and electrostatic fields toward the signal electrode 23, those having sufficient velocity being collected by the electrode 23, those having insufficient velocity being redirected and collected by the electrode 24. In this manner the quantity of electrons reaching the electrode 23 and consequently the signal produced across the output impedance 39 and applied to the translation device or tube 38 is proportional to the intensity of the optical image being projected on the mosaic electrode and is produced in a time sequence determined by the rate of scanning of the electron beam from the gun structure. Simultaneously with, but slightly following in time and space sequence the scanning of the mosaic electrode by the high velocity beam the electrons from the broad beam originating at the cathode 17 are swept in one direction only, that is, in a direction perpendicular to the longitudinal dimension of the slot 16 across the mosaic electrode by the varying magnetic field produced by the frame sawtooth currents applied to the coil 31. The electrons from the broad beam impinge on the mosaic electrode at a very low velocity since the only voltage difference between the electrode 23 and the mosaic electrode 2 is that occasioned by the positive charge or charges on the particles 13 as a result of secondary emission from these particles under bombardment by the high velocity beam. The electrons from the broad beam therefore neutralize these positive charges and charge the particles 13 negatively with respect to the base 14 on the opposite side of the mosaic electrode so that they are again in condition to liberate photoelectrons in response to the optical image focused thereon.

This mode of operation may be explained more fully by reference to Figure 3 which shows the approximate paths of the electrons during the operation of the device shown in Figure 1. Under the influence of the optical image, electrons are liberated from the particles 13 of the mosaic electrode and proceed toward the electrode 23 along a path such as represented by the dashed line 40 but are repelled due to their low velocity by the electrode 23 and continue to the electrode 24 where they are collected. The dashed line 41 represents the path of the electrons from the electron gun which impinge on the particles 13 of the mosaic liberating secondary electrons which follow the path shown by the dashed line 42 to the signal electrode 23. Certain of these secondary electrons following the path shown by the dashed line 40 may be repelled if they are of very low velocity whereupon they follow a path to the electrode 24 such as shown by the dashed line 43. The secondary electrons flowing along the path shown by the dashed line 42 and collected by the signal electrode 23 flow to ground through the impedance 39 thereby producing voltage variations in a time sequence determined by the scanning and representative of the intensity of the optical image from point to point over the area of the mosaic electrode. These voltage variations are applied to the input circuit of the translation device or tube 38 to produce the television signals which are further amplified and transmitted as well known in the art. The electrostatic residuary charge on the mosaic is neutralized by the electrons from the cathode 17 flowing along the path shown in Figure 3 by the dashed line 44, those which are not collected by the mosaic following the path 45 to the collector electrode 24, since they are of very low velocity. Since only the secondary electrons flowing along the path 42 are collected by the signal electrode the signal to noise ratio of the device is increased, the electrons which would tend to increase distortion and noise being collected by the electrode 24 where they are discarded.

It will be seen from the examination of the above description and described operation of my invention that I have provided a device and disclosed a method of generating television signals which will convert optical effects into signalling impulses and simultaneously provide a response which is proportional to the optical effects for which translation is desired and at the same time that I have provided means whereby the energy representative of the signal energy is utilized to the exclusion of non-signal energy. Since the secondary electrons liberated from the surface of the mosaic electrode are prevented from returning to this surface by the crossed magnetic and electrostatic fields, there is no possibility of spurious effects such as dark spot signals being produced which would distort the recreated replica of the image being transmitted

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

I claim:

1. A television transmitting tube comprising an evacuated envelope, a light sensitive mosaic electrode having the property of liberating electrons when scanned by a high velocity electron beam positioned in said envelope to have focused thereon an optical image, an electron gun exposed to said mosaic electrode to generate and direct a beam of electrons on said electrode, means to scan the beam from said gun over said mosaic in two mutually perpendicular directions, an elongated cathode parallel to one of said directions of scanning and having a length substantially equal to the dimension of said mosaic electrode in the direction of said one of said directions of scanning to generate a sheet-like beam of electrons said cathode lying in substantially the same plane as the plane of said mosaic electrode, magnetic means to sweep said sheet-like beam along arced paths of progressively increasing length over said mosaic electrode in a time and space sequence following the scanning of the beam of electrons from said gun and means to collect electrons liberated from the surface of said mosaic electrode.

2. A television transmitting tube comprising an electrode arrangement including two elongated systems of mutually parallel flat extended electrodes, a mosaic of mutually separated photosensitive particles substantially in the plane of one system and between two electrodes of that system to liberate primary electrons in response to an optical image focused thereon, an elongated cathode exposed to said mosaic, substantially perpendicular to the longitudinal dimension of said electrodes, and adjacent one end of the said one system of electrodes to generate a flat beam of primary electrons, an electron collecting electrode substantially closing the space between the two systems at the opposite end of said electrodes from said cathode, an electron gun exposed to said mosaic of photosensitive particles to generate and focus an electron beam of high velocity electrons thereon, means to scan said beam over said mosaic in two mutually perpendicular directions one of which is substantially parallel to said elongated cathode to liberate secondary electrons from the scanned area of said mosaic, and means to generate a magnetic field of varying intensity between the two systems of electrodes to direct the electrons from said elongated cathode and from said mosaic electrode along arced paths toward said collecting electrode and to separate said secondary electrons from said primary electrons.

3. A cathode ray television transmitting device having an evacuated envelope, a mosaic electrode within the envelope, elongated electrode means extending in planes parallel with and beyond two opposite edges of said mosaic electrode by an amount greater than the width of said mosaic electrode between the said two edges to generate a substantially uniform electrostatic field over the surface of said mosaic electrode and beyond the said two edges thereof, an elongated primary electron emitting cathode near one end of said electrode means having its longitudinal dimension parallel with said edges, an electron collecting electrode adjacent the opposite end of said electrode means, an electron gun exposed to said mosaic electrode to generate and focus an electron beam capable of emitting secondary electrons on said mosaic electrode, means to scan said beam over said mosaic electrode in two mutually perpendicular directions one of which is substantially parallel to said elongated cathode to liberate secondary electrons from said mosaic electrode, and means outside said envelope to generate a magnetic field of varying intensity between the elongated electrode means to direct electrons from said elongated cathode and said mosaic electrode along arced paths toward said collecting electrode and to separate said secondary electrons from said primary electrons.

4. A cathode ray television transmitting device comprising an envelope, a mosaic electrode of extended area in said envelope, a first electrode in the plane of said mosaic electrode and extending longitudinally of the envelope from adjacent one edge of the mosaic electrode, a second electrode in the plane of said mosaic electrode extending in the opposite direction from the edge of said mosaic electrode opposite the first mentioned edge, an electron source of extended length parallel with the said edges of said mosaic electrode to produce a flat beam of electrons, an electron gun to produce an electron beam and positioned to focus said beam on the mosaic electrode, means to sweep the beam from said gun over the mosaic electrode in a plurality of paths parallel with said electron source, an electron deflecting electrode parallel and substantially coextensive with said first and second electrodes and spaced therefrom, means to generate a substantially uniform magnetic field between said deflecting electrode and said other electrodes and means to generate a variable magnetic field to scan said broad beam of electrons in one direction over said mosaic electrode.

5. A cathode ray television transmitting device comprising an envelope, an elongated neck section joined to said envelope, a mosaic electrode in said envelope opposite said neck section, a pair of plate shaped electrodes in substantially the same plane as, and lying adjacent opposite edges of said mosaic electrode, an elongated source of electrons to generate a flat electron beam adjacent one of said plate shaped electrodes, an electron gun in said neck section to produce an electron beam of elemental cross-section, means to scan said beam of elemental section over said mosaic electrode in a series of lines substantially parallel to said elongated electron source and means to generate a crossed magnetic-electrostatic field having a varying magnetic component to scan said flat electron beam over said mosaic electrode.

6. A cathode ray television transmitting device comprising an evacuated envelope, an elongated neck section joined to said envelope, a mosaic electrode in said envelope opposite said neck section, a pair of plate shaped electrodes in substantially the same plane as, and lying adjacent opposite edges of said mosaic electrode, an elongated aperture in one of said plate sections said aperture being disposed in a direction normal to an axis through the center of said electrodes and said mosaic electrode, an elongated electron source adjacent said aperture to project a flat beam of electrons through said aperture and toward said mosaic electrode, an electron deflecting electrode parallel to but separated from said mosaic electrode and said pair of electrodes and having a surface coextensive with said mosaic electrode and said pair of electrodes for producing a substantially uniform electric

field, an electron collector electrode adjacent the end of said pair of electrodes furthest removed from said elongated electron source, an electron gun in said neck section to produce a high velocity electron beam of elemental cross-section, means to scan said beam from said electron gun over said mosaic electrode in a series of parallel lines parallel with said elongated aperture to liberate secondary electrons from said mosaic electrode, and means to generate a magnetic field transverse to said electrodes and parallel with said elongated slot to direct electrons from said elongated cathode to said mosaic electrode, electrons from said mosaic electrode other than said secondary electrons to said collector electrode, and said secondary electrons to one of said plate-shaped electrodes.

7. The method of generating signals for television transmission comprising the steps of projecting an optical image on a light sensitive mosaic surface, scanning the surface with a beam of electrons to liberate secondary electrons having a velocity distribution determined by the intensity of elemental areas of light and shade of the optical image projected on the mosaic surface, collecting at a surface other than said mosaic surface electrons liberated from said mosaic surface with relatively high velocities, simultaneously rejecting from said other surface electrons liberated from said mosaic surface having relatively low velocities, collecting the electrons rejected from said other surface at a position removed from said other surface and said mosaic surface and utilizing the electrons liberated from said mosaic surface with relatively high velocities to produce signalling impulses.

8. The method of geenrating signals for television transmission comprising the steps of projecting an optical image on a light sensitive mosaic surface, scanning the surface with an electron beam to liberate from each instantaneously scanned area of said surface electrons having a velocity distribution determined by the intensity of elemental areas of light and shade of the optical image projected on the areas of the mosaic surface, simultaneously removing the electrons liberated from the mosaic surface from the neighborhood of each area of the surface as scanned, directing the liberated electrons to areas remote from said mosaic surface along definite paths, collecting at a surface other than said mosaic surface electrons liberated from said mosaic surface with relatively high velocities, simultaneously rejecting from the collecting surface electrons liberated from said mosaic surface having relatively low velocities and utilizing only the electrons of relatively high velocity to produce signalling impulses.

9. The method of generating signals for television transmission comprising the steps of liberating photoelectrons from a surface in response to elemental areas of light and shade of an optical image focused thereon, generating an electron beam of elemental area, scanning said beam over said surface along a series of parallel lines to liberate from said surface secondary electrons having a velocity proportional to the intensity of the light on the elemental areas, scanning said surface with an elongated beam of electrons of a length equivalent to that of the said lines, selectively collecting the photoelectrons and secondary electrons on surfaces other than the mosaic surface in accordance with the velocity of said electrons and utilizing only the collected secondary electrons to produce signalling impulses.

10. The method of producing signal energy in a tube wherein is contained a capacitor having a multiplicity of light sensitive conductive elements spaced from a common electrode element by a dielectric and a signal collector electrode connected with a load circuit which includes the steps of illuminating the light sensitive elements of the capacitor to release from the individual discrete areas thereof a flow of photoelectrons proportional to the activating light and to simultaneously develop between the illuminated elements and the common electrode electrostatic charges, developing a concentrated beam of electrons, directing the concentrated beam of electrons to traverse the individual discrete light sensitive elements of the capacitor to release therefrom secondary electrons measurable in accordance with a magnitude of the developed electrostatic charges, collecting the photoelectrons released under activating light independently of the signal electrode and the connected load circuit, directing the released secondary electrons upon the signal electrode to energize the load circuit therefrom in accordance with the magnitude of the instantaneously released secondary electron flow, developing an elongated beam of electrons simultaneously with the development of the concentrated beam of electrons, directing the elongated beam of electrons upon the areas of the capacitor in time relationship and spacial positioning following the instantaneous area of impact of the concentrated electron beam to remove by impact upon the capacitor surface residual electrostatic charges resulting from the release of secondary electrons from the said surface, and collecting the electrons remaining subsequent to neutralization independently of the load circuit.

11. In a television system wherein is incorporated an electron tube having a photosensitive mosaic electrode, the method of signal generation which includes the steps of illuminating the mosaic electrode by the light of an optical image to produce electrostatic charges, scanning the mosaic electrode with a sharply focused high velocity electron beam to release from the mosaic electrode secondary electrons of a quantity substantially representative of the magnitude of the electrostatic charge at the area of the mosaic scanned, flooding predetermined areas of the mosaic electrode with low velocity electrons subsequent to the scanning thereof by the high velocity electrons to restore equilibrium potentials at scanned areas of the mosaic electrode, directing the released secondary electrons along a first predetermined path, directing both the excess of said low velocity electrons not collected by the mosaic and the photo-electrons released from the mosaic by the light of the optical image along a second path, collecting the electrons directed along each of said paths and generating wave trains of signalling energy solely in accordance with the secondary electrons collected at the termination of the first of said paths.

12. In a television system wherein is incorporated an electron tube having a photosensitive mosaic electrode, the method of signal generation which includes the steps of illuminating the mosaic electrode by the light of an optical image to produce electrostatic charges over the mosaic electrode, scanning the mosaic electrode with a sharply focused high velocity electron beam to release from the mosaic electrode secondary electrons in substantial proportion to the magnitude of the electrostatic charge at the scanned area

of the mosaic, flooding predetermined areas of the mosaic element with low velocity electrons subsequent to the scanning thereof by the high velocity electrons to restore equilibrium potentials at the scanned areas of the mosaic electrode, collecting the secondary electrons released from the mosaic due to high velocity scanning thereof and independently collecting both the low velocity electrons in excess of the electrons necessary to restore said equilibrium potentials and the photo-electrons released from the mosaic by the light of the optical image and generating wave trains of signalling energy solely in accordance with the collected secondary electrons.

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