

March 30, 1943.

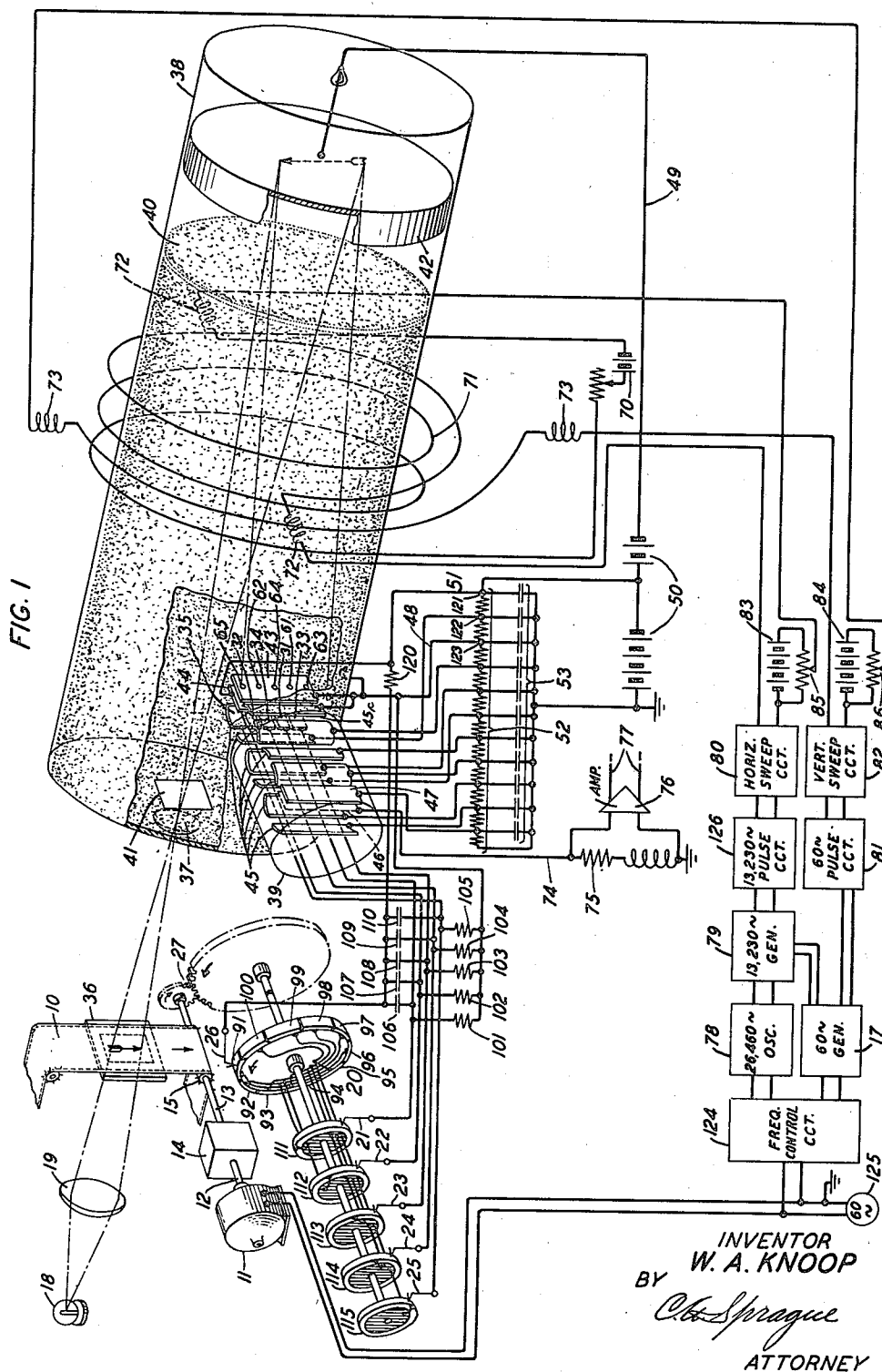
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2,315,288

APPARATUS FOR AND METHOD OF GENERATING TELEVISION SIGNALS

Filed Feb. 27, 1941

3 Sheets-Sheet 1



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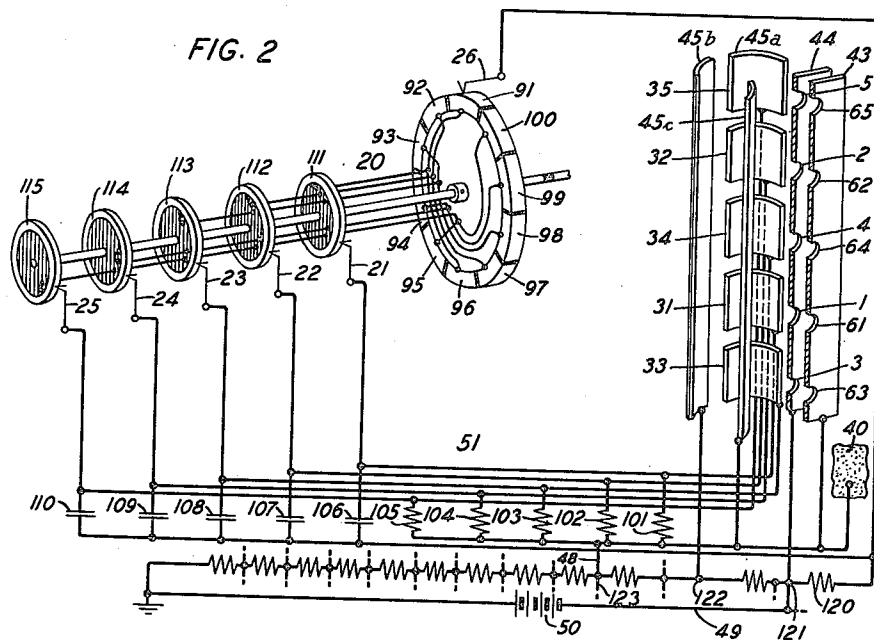


FIG. 3

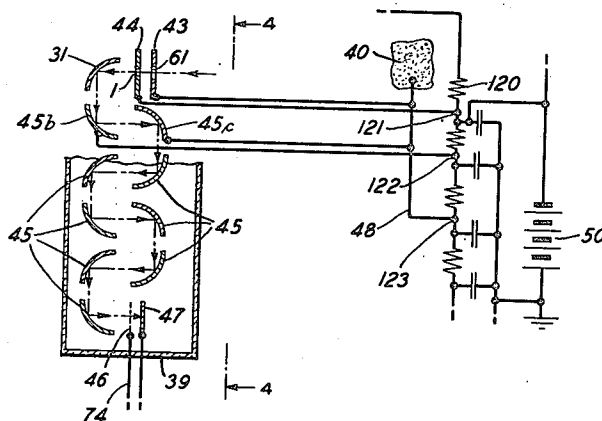
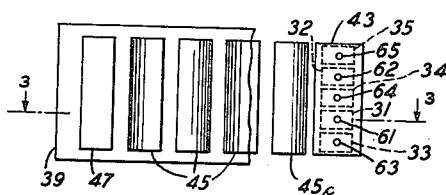


FIG. 4



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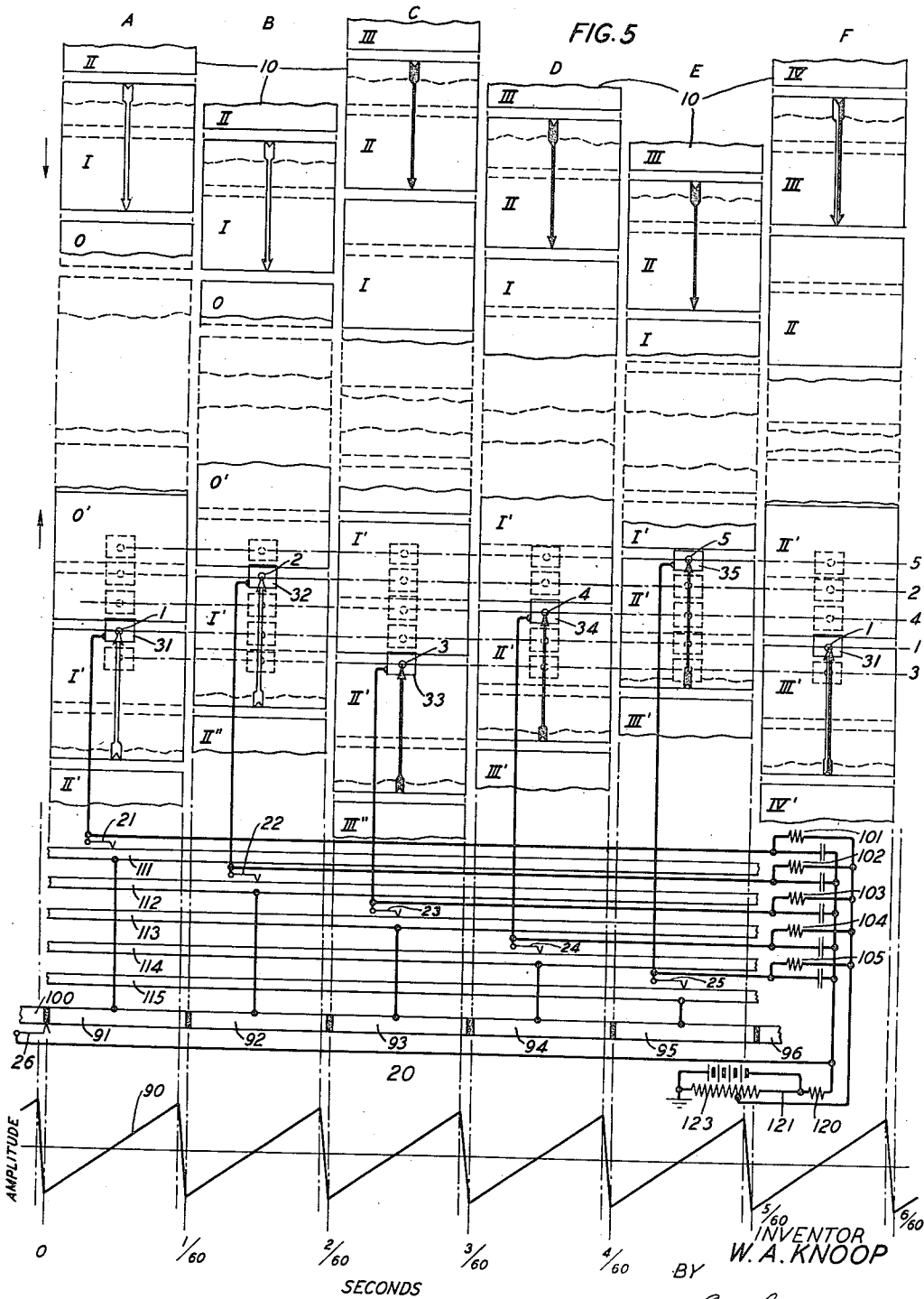
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APPARATUS FOR AND METHOD OF GENERATING TELEVISION SIGNALS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,315,288

APPARATUS FOR AND METHOD OF GENERATING TELEVISION SIGNALS

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Application February 27, 1941, Serial No. 380,756

15 Claims. (Cl. 178-7.2)

This invention relates to signaling and particularly to a method of and apparatus for scanning motion picture film for generating television signals.

An object of the invention is to provide an improved apparatus for scanning motion picture film for television transmission.

Another object is to provide an improved cathode ray scanning device.

In accordance with standard motion picture practice a motion picture film is exposed at the rate of 24 film frames per second and pictures are projected from the film at the same rate. However, in transmitting television images in accordance with the standards adopted by Radio Manufacturers Association, a field of view is scanned at the rate of 60 field scans of $220\frac{1}{2}$ lines each per second with the lines of one field scan interlaced with the lines of the preceding and following field scans so that 30 complete frame scanings of 441 lines each take place in one second. Therefore, in scanning for television transmission a motion picture film which is moved continuously at the rate of 24 film frames per second it is desirable to scan the odd film frames, for example, twice and the even frames three times so that there are five field scans of $220\frac{1}{2}$ lines each in $\frac{1}{30}$ second, that is, 60 field scans or 30 complete frame scanings of 441 lines each interlaced per second.

In accordance with a preferred embodiment of the invention herein shown and described for the purpose of illustration, there is employed for generating a television image current an image dissector tube of special construction, upon the cathode of which are projected images from a continuously moving motion picture film. The image dissector tube is provided with an electrode having five scanning apertures therein through a plurality of which electrons emitted from the cathode may pass simultaneously. The image dissector tube comprises an electron multiplier, the first multiplier plate or target of which is divided into five sections or targets, one for each aperture, so that electrons passing through different apertures bombard different targets or plate sections respectively. In order to render effective the scanning apertures one at a time in succession in the production of an image current, there is employed a commutator which causes to be impressed upon the sections of the first multiplier plate one at a time in succession in a desired order a potential which is negative with respect to the potential of the second multiplier plate. At any instant four of the sections

of the first multiplier plate are at the same potential as the third multiplier plate and electrons from these four sections are repelled by the second multiplier plate the potential of which is negative with respect to the potential of the four sections of the first multiplier plate. Thus electrons from different sections or targets of the first multiplier plate in succession are accelerated to the second multiplier plate and the electrons from the second multiplier plate and from other plates in turn are likewise accelerated to cause the production of a television image electromotive force at the output of the electron multiplier of the image dissector tube.

The centers of the scanning apertures lie on a line substantially parallel to the direction of vertical deflection of the electron image which is focussed upon the plane of the aperture plate containing the scanning apertures. The usual horizontal and vertical deflecting coils and the usual sources of current for energizing the deflecting coils are provided but, since the motion picture film, and therefore the image projected upon the cathode of the image dissector tube, is moved continuously at a constant rate, the amplitude of the current supplied to the vertical deflecting coils is correspondingly reduced. Movement of the film, the rotation of the commutator and the deflecting fields for controlling the deflection of the electron image are all maintained in synchronism so that the pictures recorded on the film are scanned at a desired rate different from the rate at which the successive pictures recorded on the film are projected.

The invention will now be described with reference to the accompanying drawings in which: Fig. 1 is a diagrammatic view of a motion picture film scanning apparatus in accordance with the present invention;

Fig. 2 is a diagrammatic view of a portion of the apparatus shown in Fig. 1;

Fig. 3 is a diagrammatic view of a portion of the apparatus shown in Fig. 1 including a view in horizontal section of the electron multiplier of the image dissector tube;

Fig. 4 is a view in side elevation of the electron multiplier shown in Figs. 1 and 3 as viewed from the line 4-4 of Fig. 3; and

Fig. 5 is a diagram to which reference will be made in explaining the operation of the apparatus shown in Figs. 1 to 4.

Referring now to the drawings, a modified motion picture projector projects the successive images recorded on the motion picture film 10 upon the cathode of a cathode ray image dissector tube.

The motion picture film 10 is driven by synchronous motor 11 through shafts 12 and 13, gear box 14 and film sprocket 15. The motor 11 is energized by current from the 60 cycle power source 125 for controlling the motor speed, the motor speed and the gearing in gear box 14 being such that the film is driven continuously at the rate of 24 film frames per second. Light from source 18 is directed through condenser lens 19 and through the opening in framing aperture plate 36 to illuminate a portion of the film 10 while it is in motion. A lens 37 focusses an image of the illuminated portion of the film 10 upon the cathode of an image dissector tube comprising an evacuated glass housing 38 of substantially cylindrical shape from which extends a side tube 39 of smaller diameter.

The inner surface of the housing 38 has a metallic coating or anode 40 in which is formed a window 41 through which the light beam from the illuminated portion of film 10 is projected to the cup-shaped light sensitive cathode 42, the cathode 42 being positioned near the end of the cylinder 38 opposite the end having the window 41 and beyond the coating 40. The remaining electrodes within the housing 38, 39 constitute an electron multiplier comprising a shield 43, aperture plate 44, multiplier plates 45, grid 46 and anode 47, the first, second and third multiplier plates being more definitely designated as 45a, 45b and 45c, respectively (see Fig. 2). The aperture plate 44 has five small equally spaced scanning apertures 1, 2, 3, 4 and 5 therein and the shield 43 has five larger apertures 61, 62, 63, 64 and 65. The first multiplier plate or target 45a is divided into five sections 31, 32, 33, 34 and 35. The apertures in the shield 43, the apertures in aperture plate 44 and the sections of target 45a are in proper alignment such that electrons from cathode 42 passing through apertures 61 and 1 reach electrode section 31 of target 45a, that electrons from cathode 42 passing through apertures 62 and 2 reach electrode section 32, etc. An electromotive force is applied between the cathode 42 and anode 40 through leads 48 and 49 from a circuit comprising battery 50, the positive terminal of which is grounded, and a network 51 made up of voltage dividing resistors 52 and condensers 53 as shown. Leads from the circuit 51 are connected to the electrodes 43, 44, 45 and 47 of the electron multiplier as shown for applying suitable potentials thereto. The electrons emitted from cathode 42 due to the light activation thereof are focussed to form an electron image in the plane of the aperture plate 44, the electron image being focussed by means of an axial magnetic field set up due to the current from source 10 flowing through the coil 71 surrounding the glass envelope 38 and extending substantially the full length of the tube.

There are provided two pairs of deflecting coils the horizontal or high frequency deflecting coils 72 and the vertical or low frequency deflecting coils 73. The magnetic fields set up when these deflecting coils are suitably energized cause the beam of electrons emitted from the cathode 42, and therefore the electron image focussed in the plane of the scanning apertures 1 to 5, inclusive, to be deflected along both horizontal and vertical coordinates.

The electron beam reaching the apertured shield 43 is of such size that electrons may pass through a plurality of apertures 61 to 65, inclusive, and through a plurality of apertures 1 to 5, inclusive, simultaneously, and the electrons

passing through these apertures simultaneously reach a plurality of sections 31 to 35, inclusive, of the first multiplier plate or target 45a. As will be further explained below, only electrons passing through one of the apertures 1 to 5 and reaching one of the electrode sections 31 to 35 are effective in controlling the television image current which is set up in the output circuit of the electron multiplier, the electrons passing through different apertures 1 to 5, inclusive, and reaching different electrode sections 31 to 35, inclusive, being effective in succession. The motion of the electron image with respect to the scanning apertures results in progressively selecting elemental areas of the image. Due to the bombardment of the target or first multiplier plate 45a by electrons from different portions of the cathode 42 in succession, an image current is set up in the circuit including lead 74 connected to the collector grid 46, terminating impedance element 75 and ground. This image current may be amplified by the vacuum tube amplifier 76 if desired and transmitted over a suitable transmission medium such as the balanced line 77.

Any suitable means may be employed for supplying deflecting currents of saw-toothed wave form to the deflecting coils 72 and 73. As shown diagrammatically in Fig. 1 of the drawings, there are provided a 26,460 cycle controlled oscillator 78 from which is derived by successive steps the submultiple frequency sources 79 and 17 of 13,230 cycle and 60 cycle waves, respectively, of rectangular wave form. The 60 cycle wave from the power source 125 and the 60 cycle wave from the submultiple frequency generator 17 are impressed upon the frequency regulating circuit 124. There is produced by the circuit 124 as the result of beating together the waves from sources 125 and 17, a control current which is impressed upon the oscillator 78 for maintaining the frequency of the wave produced by the oscillator 78 in step with the frequency of the 60 cycle power source 125, that is, for maintaining the frequency of source 78 at the 441st multiple of the frequency of power source 125. Of course, a line frequency scanning rate, other than 441 lines per frame scanning period may be used in which case the frequency of source 78 would be maintained at some harmonic of the 60 cycle power source other than the 441st harmonic. An arrangement of the type described for generating waves for controlling the sweep circuits which, in turn, control the deflection of a cathode ray beam and for maintaining the waves in synchronism with an alternating current power source is disclosed in an article by A. V. Bedford and John Paul Smith on page 51 of "RCA Review" for July 1940, published by RCA Institute Technical Press, 75 Varick Street, New York, New York. The 13,230 cycle source 79 controls a 13,230 cycle impulse generating circuit which, in turn, controls the horizontal sweep circuit 80 for supplying a 13,230 cycle saw-toothed current wave to the horizontal deflecting coils 72. Sixty cycle pulses produced by the generator 81 under control of the sub-harmonic generator 17 control the vertical sweep circuit 82 which in turn supplies a 60 cycle saw-toothed current wave to the vertical deflecting coils 73. In order that the electron image produced in the plane of the aperture plate 44 may be brought into correct vertical and horizontal alignment there are provided batteries 83 and 84 from which direct current is supplied through the potentiometers 85 and 86 to the horizontal

and vertical deflecting coils 72 and 73 respectively.

For the purpose of rendering effective scanning apertures 1 to 5 successively in order in the scanning process for controlling the production of an image current, there are provided a commutator 20 which is driven from the film driving shaft 13 through gears 27 and a circuit comprising resistive elements 101 to 105, condensers 106 to 110 and a resistive element 120. The resistance of the element 120 is small with respect to that of the elements 101 to 105. As depicted in Fig. 2, the commutator 20 comprises the conducting segments 91 to 100 embedded in insulating material, diametrically opposed segments being conductively connected, a brush 26 which makes contact with the conducting segments in order, slip rings 111 to 115, conductively connected with the segments 91 to 95 and 96 to 100, respectively, and brushes 21 to 25 in contact with the slip rings 111 to 115, respectively. The brushes 21 to 25 are conductively connected to the electrodes 31 to 35, respectively, to one set of terminals of resistive elements 101 to 105, respectively, and to one set of plates of condensers 106 to 110, respectively. The other set of terminals of resistors 101 to 105 is connected to point 123 of the voltage dividing resistors 52 and the other set of plates of condensers 106 to 110 is connected through resistor 120 to point 121 of the voltage dividing resistors. The condensers 106 to 110 are provided to prevent sparking at the brush 26. The anode 40, shield 43 and the third multiplier plate 45c are also connected to point 123, the second multiplier plate 45b is connected to point 122 and the aperture electrode 44 connected to point 121 of the voltage dividing resistors 52.

The point 121 of the voltage dividing resistors is negative with respect to point 122 which, in turn, is negative with respect to point 123. Therefore, when commutator 20 is in the position shown in Fig. 2, a circuit is completed from point 123 through resistor 101, brush 21, slip ring 111, commutator segment 91, brush 26 and resistor 120 to point 121 of the voltage dividing resistors 52. The voltage drop across resistor 101 being relatively large and that across resistor 120 being small, the potential of section 31 of the first multiplier electrode 45a and that of the aperture electrode 44 is substantially the potential of point 121, the second multiplier electrode 45b is at the potential of point 122 and the third multiplier electrode 45c is at the potential of point 123 of the voltage dividing resistors. Electrode 45b being positive with respect to target section 31 and electrode 45c, being positive with respect to electrode 45b, electrons from cathode 42 passing through apertures 61 and 1 bombard the target section 31, electrons from target section 31 are accelerated to electrode 45b and electrons from electrode 45b are accelerated to electrode 45c.

The remaining electrodes 45 of the electron multiplier function similarly in the manner known to those skilled in the art to cause an image current to be set up. When a circuit is completed through resistive element 101 as described above and as shown in Fig. 2, no circuit is completed from resistive elements 102 to 105 through commutator 20 and resistor 120 to point 121 but target sections 32 to 35 are at the potential of point 123 to which these sections are connected through resistors 102 to 105 respectively. Therefore, target sections 32 to 35 are each positive with respect to multiplier electrode 45b and 75

electrons from these target sections are not accelerated to electrode 45b but are repelled because electrode 45b is negative with respect to target sections 32 to 35 of electrode 45a. The resistive elements 101 to 105 are successively connected in the circuit through resistor 120 to point 121 to cause the potential of the target sections 31 to 35 in succession to be changed from a positive to a negative potential with respect to the potential of the second multiplier electrode 45b, thus rendering effective successively in order the scanning apertures 1, 2, 3, 4, and 5 in the transmission of electrons for controlling the production of a television image current, the apertures 1 to 5, respectively, being effective during successive field scanning periods.

Referring to Fig. 5, the film 10 is moved downwardly as viewed in the figure, at the rate of 24 film frames per second so that, at the beginning of successive equal periods of $1/60$ second the film is in the positions designated A, B, C, D, E and F, respectively. The time periods are indicated at the lower portion of the figure. The size of the image projected from the motion picture film on to the cathode 42 at any instant is somewhat larger than the image of a single film frame in the direction of movement of the film, the size of the projected image corresponding to about $1\frac{2}{5}$ film frames. Obviously, however, during any one field scanning period use is made only of electrons emitted from a portion of cathode 42 which receives light from a single film frame of the motion picture film.

At zero time the projection of an optical image of film frame I upon cathode 42 causes an electron image I' corresponding to film frame I to be focussed in the plane of aperture plate 44 which has therein the scanning apertures 1, 2, 3, 4 and 5 lying on the lines so numbered in Fig. 5. It will be noted that while the optical system inverts the optical image projected on cathode 42, the electron image produced in the plane of aperture plate 44 is not inverted with respect to the optical image on cathode 42. Due to the downward motion of film 10 from position A to position B the optical image focussed on cathode 42 and the electron image focussed in the plane of electrode 44 will move upwardly by a corresponding amount, that is, an amount corresponding to $2\frac{2}{5}$ film frame in $1/60$ second, or one field scanning period. This vertical motion of the electron image is supplemented by deflecting the cathode ray beam through a distance corresponding to $3\frac{2}{5}$ film frame by applying to the deflecting coil 73 a regular saw-toothed wave 90 from source 82. Of the apertures 1, 2, 3, 4 and 5 in the aperture plate 44 one only is effective in the process of scanning the image to generate an image current during a certain field scanning period, the apertures becoming effective successively during successive field scanning periods. The apertures 1, 2, 3, 4 and 5 are rendered effective periodically in succession by impressing upon the sections 31, 32, 33, 34 and 35 of the first multiplier plate or target periodically in succession a potential which is negative with respect to that of the second multiplier plate of the electron multiplier. For this purpose there is provided a commutator 20 shown in developed view in Fig. 5 having conducting segments 91 to 95 which come in contact with brush 26 in succession and which are connected to slip rings 111 to 115, respectively, making contact with brushes 21 to 25, respectively.

During the first field scanning of frame I,

brush 26 is in contact with segment 91 and, as a result, section 31 of the first multiplier plate or target 45a is connected through the low resistance 120 to point 121 of the voltage dividing resistors 52. The electrode section 31 is thus brought to a potential which is negative with respect to the potential of the second multiplier electrode 45b and electrons are accelerated from section 31 of electrode 45a to electrode 45b. Thus during this first field scanning period of frame I only aperture 1 is effective for scanning. During this period the electron image of frame I moves vertically with respect to aperture 1 through a distance corresponding to a film frame. While the electron image is thus moved along a vertical component, it is also moved horizontally in the usual manner at the rate of 441 lines per frame scanning period of $\frac{1}{60}$ second or $220\frac{1}{2}$ lines per field scanning period of $\frac{1}{60}$ second, by applying a saw-toothed wave current from the horizontal sweep circuit 80 to the horizontal sweep coil 72.

At the start of the second field scanning period the film and the electron image are in the position shown at B in Fig. 5. Aperture 2 is now effective and due to the continuous movement of the film 10 and the deflection of the electron beam from cathode 42, film frame I is scanned a second time. At the beginning of the third field scanning period aperture 3 becomes effective in the process of scanning film frame I. Aperture 4 next becomes effective in the scanning of film frame II a third time. At the beginning of the sixth field scanning period as shown by F in Fig. 5, film frame III occupies the position which was occupied by frame I and electron image III' occupies the same position which was occupied by electron image I' at the beginning of the first field scanning period A. At this time brush 26 makes contact with conducting segment 96 which is conductively connected to segment 91. Thus alternate film frames are scanned twice and the remaining film frames are scanned three times along 441 lines per field scanning period, the lines of one field scanning being interlaced with those of the preceding or following field scanning period. The film moving continuously at 24 film frames per second is thus scanned at the rate of 60 field scans per second.

In accordance with the standards adopted by Radio Manufacturers Association there is an interval, about 7 per cent of the field scanning period, at the end of each field scanning period, during which the electron beam of the image producing cathode ray tube at the receiving station is reduced in intensity and returns to its initial scanning position. During this interval frame synchronizing impulses are transmitted and no image production takes place. This 7 per cent of the field scanning period is also required for the return sweep of the cathode ray beam emitted from the cathode 42 of the image dissector tube. Moreover, the switching operations of commutator 20 which render apertures 1 to 5 effective in succession occur during the 7 per cent intervals at the ends of the field scanning periods. In standard motion picture film the dimension along the length of the film of the frame line between two successive picture portions is about 15 per cent of the length of an entire film frame consisting of a picture portion and a frame line. In order to avoid waste of transmission time it is desirable to scan the picture portion only of a film frame during 93 per cent of a field scanning period, thus allowing 7 per cent of the field scanning period between the time of scanning the last

scanned elemental area of one field scanning period and the first scanned elemental area of the succeeding field scanning period. In order that picture portion only of the motion picture film may be scanned during 93 per cent of the field scanning period of $\frac{1}{60}$ second the amplitude of the vertical deflecting current from source 82 may be reduced so that the electron image will be deflected along the vertical coordinate by an amount corresponding to somewhat less than $\frac{1}{2}$ of a complete film frame which includes both a picture portion and a frame line.

The subject-matter of this application is related to that of applications Serial No. 380,773 and Serial No. 380,774 of C. F. Mattke, filed concurrently herewith.

What is claimed is:

1. Photoelectric apparatus comprising a light sensitive cathode for emitting electrons to form an electron beam, an electrode in the path of the electrons emitted from said cathode for intercepting the major portion of said beam and having therein a plurality of scanning apertures which are widely spaced with respect to a dimension of an aperture and through which said electrons may pass from a space on one side of said electrode to a space on the opposite side thereof, and a plurality of targets one for each of said apertures upon which the electrons passing through said apertures respectively impinge to cause said targets simultaneously to emit electrons, and means for setting up a current under control of electron emission from said targets one at a time in a desired sequence.

2. Image dissecting apparatus comprising a light sensitive cathode for emitting a beam of electrons, an electrode in the path of the electrons emitted from said cathode for intercepting the major portion of said electron beam and having therein a plurality of apertures through which said electrons may pass, a plurality of targets upon which electrons passing through said apertures respectively impinge to cause secondary electrons to be emitted therefrom, and means for accelerating the secondary electrons emitted from one of said targets at a time and from different targets in succession.

3. Electronic apparatus comprising means for producing an electron beam, an electrode for intercepting the major portion of said electron beam and having therein a plurality of spaced apertures simultaneously in the path of said electron beam through which apertures electrons are simultaneously transmitted from a space on one side of said electrode to a space on the opposite side thereof, and means for producing a current under control of electrons transmitted through said apertures one at a time in succession, said means comprising electrode means for accelerating the electrons transmitted through said apertures simultaneously.

4. Electronic apparatus comprising means for producing an electron beam, a plurality of target electrodes, an aperture electrode for intercepting the major portion of said electron beam and having therein a plurality of spaced apertures for simultaneously transmitting electrons of said electron beam for bombarding said targets, respectively, and thereby causing the emission of electrons from said targets simultaneously, and means for accelerating the electrons emitted from said targets one at a time in succession.

5. Electronic apparatus comprising means for producing an electron beam, a plurality of target electrodes for simultaneously intercepting elec-

trons of said beam, a multiplier electrode, a source of electromotive force, means for applying an electromotive force from said source to said target electrodes to make a plurality of said target electrodes positive with respect to said multiplier electrode simultaneously, and means for reducing the electromotive force supplied to said target electrodes one at a time in succession to make said target electrodes in succession negative with respect to said multiplier electrode.

6. An electron multiplier apparatus comprising a plurality of multiplier electrodes the first of which is divided into a plurality of spaced sections, a source of electromotive force, means for connecting the second multiplier electrode to the positive terminal of said source, and means for connecting the sections of said first electrode in succession to the negative terminal of said source for producing an accelerating field between the second multiplier electrode and the sections cyclically in succession of the first multiplier electrode.

7. Electronic apparatus comprising a plurality of target electrodes, an aperture electrode having therein a plurality of scanning apertures which are widely spaced with respect to a dimension of said apertures, a source of electrons, means for directing electrons from said source through said apertures simultaneously to cause the electrons passing through different apertures to bombard different target electrodes, respectively, thereby causing said target electrodes simultaneously to emit electrons, and means for setting up a current corresponding to the electron emission from said target electrodes repeatedly in succession.

8. An image dissector tube comprising a light sensitive cathode for emitting electrons in accordance with the light activation of elemental areas thereof, means for accelerating the electrons emitted by said cathode, means for focussing in a plane an electron image corresponding to an optical image focussed on said cathode, means for simultaneously selecting for transmission electron beams of said electron image corresponding to a plurality of spaced elemental areas of said optical image, a plurality of spaced target electrodes for intercepting said beams, respectively, means for deflecting said electron image, and means for producing an image current under control of the electron beams intercepted by different target electrodes cyclically in succession.

9. Electronic apparatus comprising an electrode having a plurality of spaced apertures therein for transmitting electrons, a plurality of target or first multiplier electrodes in the paths of electrons transmitted through said apertures, respectively, a second multiplier electrode in position to be bombarded by electrons from said target electrodes, a third multiplier electrode in position to be bombarded by electrons from said second multiplier electrode, means for applying a certain potential to said second multiplier electrode, means for applying to a plurality of said target electrodes simultaneously and to said third multiplier electrode a potential which is positive with respect to the potential of said second multiplier electrode, and means for changing the potential applied to said target electrodes to cause to be applied to said electrodes periodically in succession a potential which is negative with respect to the potential applied to said second multiplier electrode.

10. Electron multiplier apparatus comprising a first, a second and a third electrode, means for applying a certain potential to said second electrode and a higher potential to said third elec-

trode, resistive means for connecting said first and third electrodes to bring said first electrode to the potential of said third electrode, and means for intermittently causing current to flow through said resistive means to bring said first electrode to a potential which is negative with respect to said second electrode.

11. Electron multiplier apparatus comprising an aperture electrode having therein a plurality of spaced apertures, a plurality of target or first multiplier electrodes in position to be bombarded by electrons transmitted through said apertures, respectively, a second and a third multiplier electrode, means for applying a certain potential to said aperture electrode, a higher potential to said second multiplier electrode, and a still higher potential to said third multiplier electrode, a plurality of resistors connected between said third multiplier electrode and said targets, respectively, for normally bringing said targets to a potential which is positive with respect to the potential of said second multiplier electrode, and means for applying to said targets successively and periodically a potential which is negative with respect to the potential of said second multiplier electrode.

12. The method of scanning to produce a television image current which comprises projecting an optical image, producing in a certain plane an electron image under control of said optical image, selecting and accelerating electrons from said electron image at spaced elemental areas in said plane simultaneously, deflecting said electron image to cause different apertures to scan simultaneously different portions respectively of the electron image and utilizing electrons selected at said spaced elemental areas in succession and repeatedly for controlling the production of an image current.

13. The method of scanning to produce a television image current which comprises projecting an optical image, producing in a certain plane an electron image corresponding to said optical image, selecting and accelerating electrons from said electron image at a plurality of spaced elemental areas in said plane simultaneously, moving said electron image to cause elemental portions of said electron image to be selected in succession at each of said spaced elemental areas in said plane, and producing an image current under control of electrons of said electron image selected at said spaced elemental areas cyclically in succession.

14. Electron multiplier apparatus comprising a plurality of target electrodes, a multiplier electrode, a plurality of resistive elements, means for connecting said resistive elements in circuit between said multiplier electrode and said target electrodes, respectively, a commutator having a plurality of conducting segments connected to said target electrodes, respectively, a brush for engaging said conducting segments in succession, a source of electromotive force, and means for connecting one terminal of said source to said multiplier electrode and the other terminal of said source to said brush.

15. Apparatus for scanning motion picture film comprising means for moving said film continuously at a substantially constant rate, a light sensitive electron emitting cathode, means for projecting from said film upon said cathode an image which is continuously changing due to the motion of said film, means for focussing the electrons emitted from said cathode to form an electron image, an electrode having a plurality of spaced apertures therein for transmitting elec-

trons from a plurality of spaced elemental areas of said electron image simultaneously, means for deflecting the electron beam from said cathode to cause electrons from elemental areas in succession of said electron image to pass through said apertures, a plurality of target electrodes for intercepting electrons transmitted through said apertures, respectively, a multiplier electrode for intercepting electrons emitted from said target elec-

trodes, and means for setting up an accelerating field between said multiplier electrode and said target electrodes cyclically in succession thereby controlling the production of an image current for controlling the production of television images corresponding to the images recorded on said motion picture film.

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