

Sept. 24, 1946.

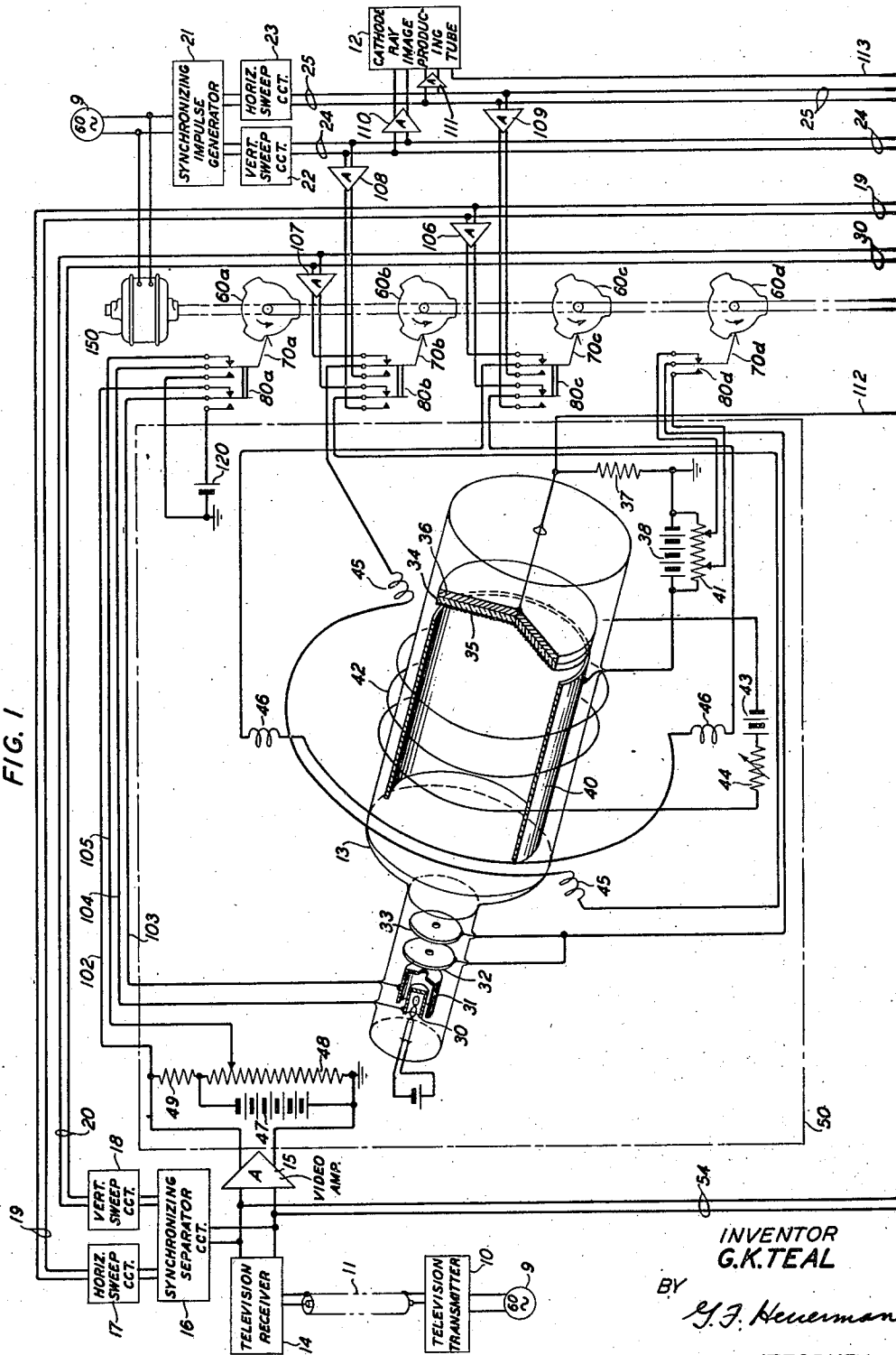
G. K. TEAL

2,408,108

TELEVISION IMAGE PRODUCTION

Filed May 11, 1943

4 Sheets-Sheet 1



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Sept. 24, 1946.

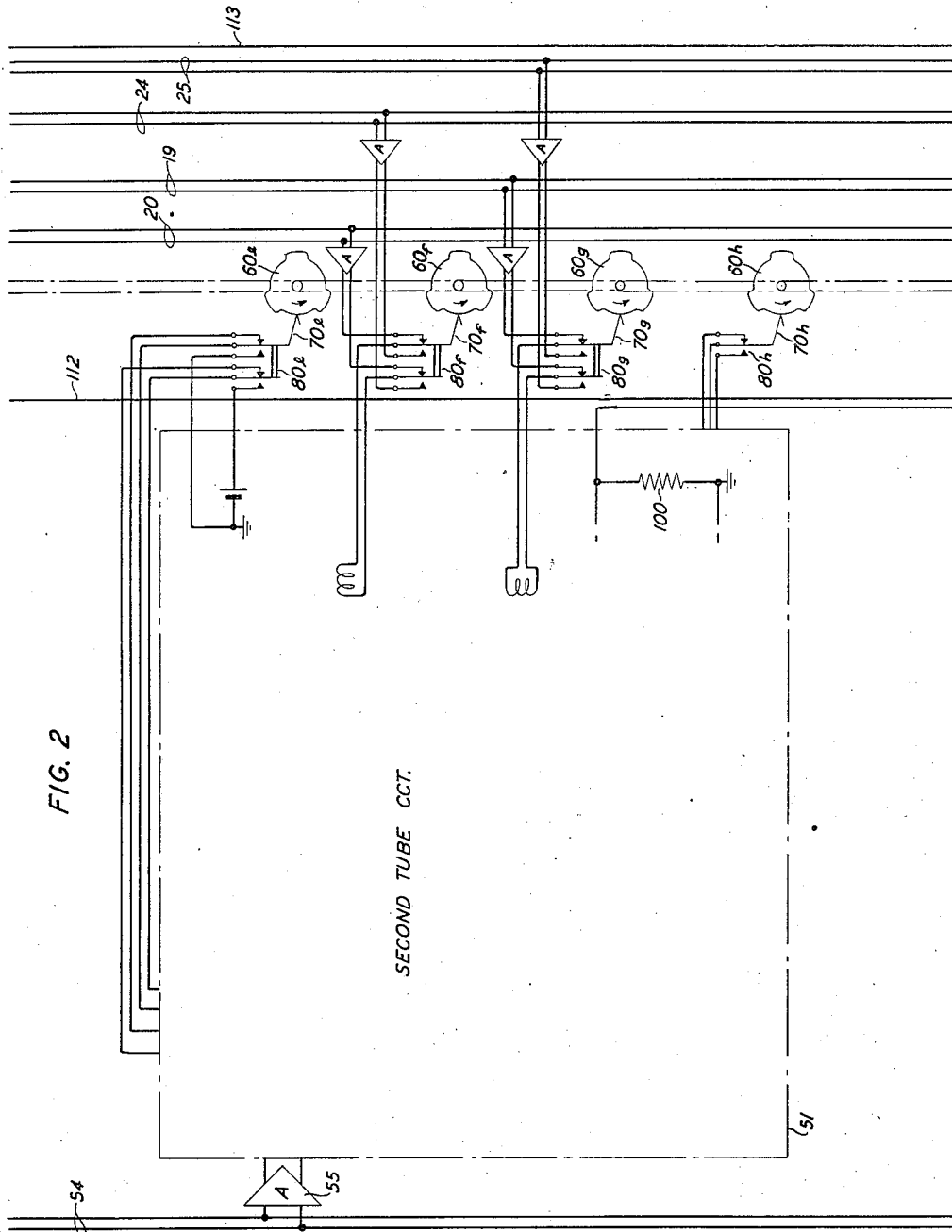
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4 Sheets-Sheet 2



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TELEVISION IMAGE PRODUCTION

4 Sheets-Sheet 3



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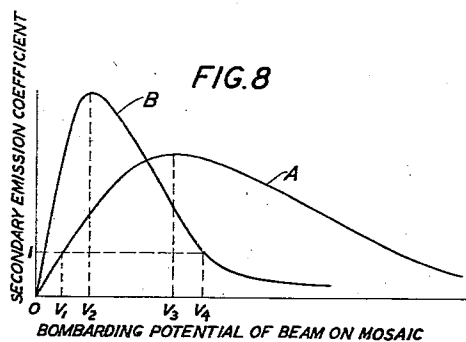
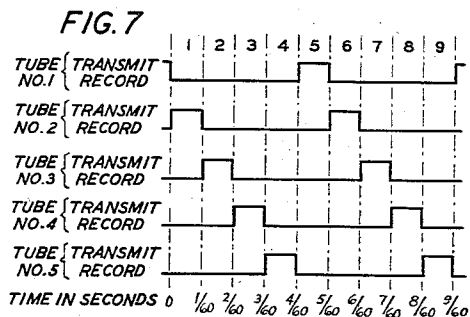
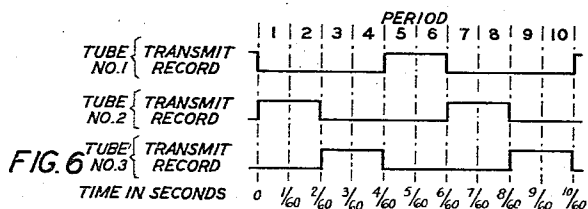
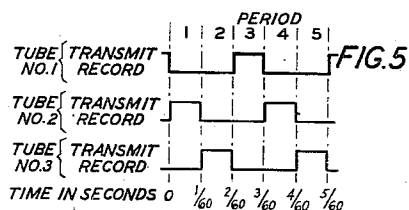
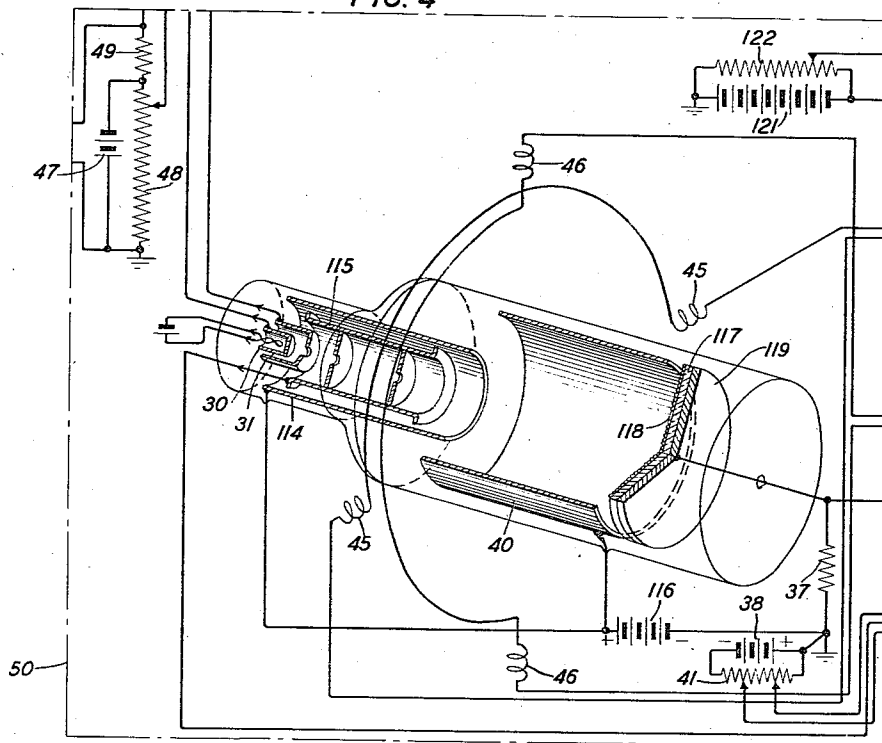
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TELEVISION IMAGE PRODUCTION

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4 Sheets-Sheet 4

FIG. 4



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TELEVISION IMAGE PRODUCTION

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Application May 11, 1943, Serial No. 486,533

20 Claims. (Cl. 178-6.8)

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This invention relates to electric signaling and particularly to a method of and apparatus for producing television images of a field of view at a rate higher than that of scanning the field of view.

In accordance with an embodiment of the invention herein shown and described for the purpose of illustration, there are provided at a television receiving station a plurality of cathode ray recorder-transmitter tubes each for alternately non-pictorially recording an image and controlling the production of the image from the record. Each recording of an image takes place in a period equal to a frame scanning period of the image signal generated at a television transmitting station, that is, the period required for scanning the entire field of view. The recordings are scanned in succession to produce electric signaling energy which is impressed upon an image producing device for controlling the production of television images, each recording being completely scanned and each television image being produced in a period less than the frame scanning period of the field of view so that the television images are produced at a frame frequency higher than the frame frequency of the scanning of the field of view and of the resulting television signal. If T represents the frame scanning period at the transmitter, t the frame scanning period of the image production at the receiver and n the number of recorder-transmitter devices, then

$$t = \frac{T}{n-1}$$

If, for example, $\frac{1}{15}$ second is required for completely scanning a field of view at the transmitter and three recorder-transmitter tubes are employed at the receiving station, then during a certain frame scanning period of the television signal one recorder-transmitter tube will record a complete image, a second recorder-transmitter will complete, during the first half of the frame scanning period, the recording of an image which was started during the preceding frame scanning period and will transmit to the image producing apparatus an image signal from the record during the second half of the frame scanning period, and a third recorder-transmitter will transmit to the image producing apparatus, during the first half of the frame scanning period, an image signal from the record which was completed during the preceding frame scanning period and will record, during the last half of the frame scanning period, the recording of an image being completed during the following frame scanning period. There

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will thus be produced television images having a frequency of repetition equal to twice the frame frequency of the image signal. Similarly if the frame frequency of the image signal is $\frac{1}{15}$ second and five recorder-transmitter tubes are used, images will be produced at the rate of 60 per second.

In accordance with a feature of the invention there is employed alternately for recording an image and for producing an image electromotive force from the record a cathode ray device having a mosaic electrode one side of which is scanned by a beam of electrons which, during the image recording, impinge upon the mosaic with a velocity such as to cause the emission of a larger number of secondary electrons than the number of primary electrons which impinge thereon and which, during the generation of the image electromotive force, impinge upon the mosaic with a velocity such that the number of secondary electrons emitted therefrom is less than the number of primary electrons impinging upon the mosaic surface, the beam being modulated with respect to intensity during the recording period and having a constant density during the period of generation of the image electromotive force.

As the bombarding potential of the electron beam which reaches the mosaic is increased from zero, the secondary emission coefficient rises rapidly until it has reached a maximum and then decreases slowly. Therefore, a secondary emission coefficient between zero and one may be obtained at a beam velocity below the velocity required for maximum secondary emission and also at a beam velocity above the velocity required for the maximum secondary emission and either the high or the low velocity beam may be employed for the generation of the image electromotive force which is to be used at the receiver for controlling the image production. However, magnetic focussing of the electron beam is required when a low velocity beam is used to prevent spreading of the beam at the mosaic and, to avoid the necessity of using a focussing coil, it is desirable to employ a high velocity beam both for the recording and for the generation of the image signal. The use of a beam having a very high velocity makes necessary the use of accelerating voltages and deflecting fields of high magnitude. It is therefore desirable to employ a secondary emitter mosaic having a secondary emission coefficient which has a high maximum value and which decreases rapidly from its maximum value to a value below one as the velocity of the bombarding electron beam is increased.

A mosaic electrode having this desirable characteristic comprises a discontinuous layer of secondary emitter material upon one side of a dielectric and a signal plate of electrical conducting material on the other side of the dielectric, the secondary emitter material being preferably a caesium carbon alloy or a film of magnesium oxide on carbon. Such a mosaic has a secondary emission coefficient less than one when the velocity of the electron beam bombarding the mosaic is sufficiently high to penetrate through the caesium carbon alloy or magnesium oxide to the carbon which has a secondary emission coefficient less than one.

The invention will now be described in detail with reference to the accompanying drawings in which:

Figs. 1, 2 and 3, with Fig. 1 placed above Fig. 2, and Fig. 3 placed below Fig. 2, are a diagrammatic view of a complete television system embodying the invention;

Fig. 4 is a diagrammatic view of a modification of a portion of the television system shown in Figs. 1, 2 and 3; and

Figs. 5 to 8 are diagrams to which reference will be made in describing the operation of the television system shown in the preceding figures.

Referring to Figs. 1, 2 and 3, there is disclosed a television system comprising a transmitter 10 of any well-known type for generating a carrier current modulated in accordance with a video signal produced as the result of scanning a field of view and having horizontal synchronizing impulses produced during intervals between successive scanning lines and vertical synchronizing impulses produced during intervals between successive scanings of the field of view, that is, at the end of each field and frame scanning period. The generator of the vertical and horizontal synchronizing impulses used in the transmitter 10 is connected to the 60-cycle power source 9 for maintaining the generation of the impulses in synchronism with the 60-cycle power source, as is well known. This current is transmitted over a coaxial conductor cable 11 or other suitable transmission medium to a receiving station for controlling the production of images of the field of view scanned at the transmitter upon the fluorescent screen of a cathode ray image producing tube 12, for example. Apparatus comprising a plurality of recorder-transmitter cathode ray tubes, each like tube 13 of Fig. 1, is provided for causing images to be produced upon the screen of cathode ray tube 12 in succession at a rate higher than the rate of repetition of scanning of the field of view at the transmitter. Assuming for the present that interlaced scanning is not used and that the scanning rate at the transmitter is 30 frames per second, then the images of the field of view will be produced at a rate which is an integral multiple of 30, say 60 frames per second.

The television current transmitted over the cable 11 is impressed upon a conventional television signal receiving apparatus 14 which demodulates and amplifies the received television signal. The output of the receiver 14 is connected to an amplifier 15 and to a separating circuit 16 which selects and separates the vertical and horizontal synchronizing impulses, the horizontal impulses being impressed upon a horizontal sweep circuit 17 and the vertical synchronizing impulses being impressed upon a vertical sweep circuit 18 in well-known manner. The saw-toothed wave generated in the horizontal sweep

circuit is impressed upon the conductors 19 and the saw-toothed wave generated in the vertical sweep circuit is impressed upon the conductors 20.

The cathode ray beam of the image producing tube 12, like the scanning beam used in the television transmitter 10, is deflected in synchronism with the 60-cycle power source 9 to which the synchronizing impulse generator 21 is connected. The vertical and horizontal scanning impulses derived from the generator 21 are supplied to the vertical and horizontal sweep circuits 22 and 23, respectively, the output circuits of which are connected to the lines 24 and 25, respectively, the output of the vertical sweep circuit 22 being connected through an amplifier 110 to the vertical deflecting coils, not shown, of the cathode ray tube 12 and the output of the horizontal sweep circuit 23 being connected through an amplifier 111 to the horizontal deflecting coils of the cathode ray tube 12.

The cathode ray recorder-transmitter tube 13 comprises an evacuated chamber or bulb having therein an indirectly heated cathode 30 for emitting electrons, a modulating or control electrode 31, accelerating anodes 32 and 33, a collector anode 40 and a mosaic electrode upon which the cathode ray beam impinges. The mosaic electrode comprises a sheet of dielectric material 34, glass, for example, a secondary electron emitting surface 35 and a signal plate 36 of a conducting material such as platinum or aluminum. The surface 35 is formed by insufflating silver oxide upon the dielectric sheet 34, reducing the oxide to silver, then oxidizing the silver and treating the surface with caesium or other secondary electron emitting material.

One terminal of an output resistor 37 is connected to the conducting plate 36 of the mosaic electrode, the other terminal being connected to ground. The positive terminal of battery 38 is connected to the collecting cylinder 40, the negative battery terminal being grounded. Accelerating potentials from a potentiometer 41 which is connected across battery 38 are applied through contacts of cam switch 80d to the electrodes 32 and 33. The electron beam is focussed upon the mosaic electrode due to the electromagnetic field set up by the winding 42 which is energized by direct current from battery 43 through a circuit including a variable resistor 44. The electron beam is deflected by the electromagnetic field which is set up due to the energization of the vertical deflecting coils 45 and the horizontal deflecting coils 46. The output circuit of video amplifier 15 is connected across a circuit comprising battery 47, having a potentiometer 48 connected across its terminals, and a resistor 49 in series with battery 47.

There are provided a plurality of recorder-transmitter tubes, each like tube 13, together with the associated circuit elements and connections as shown within the area defined by the dash-dot line 50 of Fig. 1. This additional apparatus is not shown in detail, but, for purpose of simplification, is indicated by the dash-dot lines 51 and 52 of Figs. 2 and 3, respectively, the area defined by each of these lines including a recorder-transmitter tube like tube 13 and the associated circuit elements and connections as shown within the area defined by the line 50 of Fig. 1. Video signal voltage from the television receiver 14 is supplied to circuits 51 and 52, respectively, through line 54 and amplifiers 55 and 56, like amplifier 15.

In each of the diagrams shown in Figs. 5, 6 and 7 the abscissa is divided into periods each of $\frac{1}{60}$ second duration. Referring briefly to Fig. 5, it is indicated that the first recorder-transmitter tube is in the recording condition during the first two periods and in the transmitting condition during the third period. The second tube records during periods two and three and transmits during period four. The third tube records during periods three and four and transmits during period five.

For the purpose of causing each of the recorder-transmitter tubes like 13 alternately to non-pictorially record an image under control of a received video signal and to transmit from the record for controlling the production of an image upon the cathode ray image producing tube 12, during time periods as indicated in Fig. 4, for example, there are provided a plurality of cam switches comprising cams 60a to 60l, inclusive, and a commutator switch having a brush arm 69, the cams and brush arm being driven at the rate of 400 revolutions per minute by means of synchronous motor 159, energized from 60-cycle power source 9, and suitable gearing not shown. The cam followers 70a to 70l, inclusive, for cams 60a to 60l, respectively, operate the cam switches 80a to 80l, respectively. The commutator has a brush 79 which rides on the conducting ring 89 and nine conducting segments 91 to 99, inclusive, of equal length. As the brush arm rotates a circuit is completed from the output resistors 37, 100 and 101 in succession to the control circuit of the cathode ray image producing tube 12. For the conditions specifically depicted in Figs. 1, 2 and 3, the switches 80a to 80h, inclusive, are closed to the right-hand contact as viewed in Figs. 1 and 2, and the recorder-transmitter devices 50 and 51 are in the recording condition. At the same time the switches 80i to 80l are closed to the left-hand contacts as viewed in Fig. 3 so that the recorder-transmitter 52 is in the transmitting condition. It will be noted that any instant during the operation, one of the three recorder-transmitter devices will be set to transmit while the remaining two devices are simultaneously set to record.

The ungrounded side of amplifier 15 is connected through a circuit comprising leads 102 and 103 to the control element or modulating cylinder 31 of the recorder-transmitter tube 13 and the cathode 30 of this tube is connected through a circuit comprising leads 104 and 105 to a contact on potentiometer 48 which is highly negative with respect to ground. Under this condition, the target 34, 35, 36 of recorder-transmitter tube 13 is sufficiently positive with respect to the cathode to cause the cathode ray beam to impinge with a high velocity upon the sensitized surface 35 of the target or mosaic electrode 34, 35, 36. Secondary electrons are therefore emitted from the surface 35 of the mosaic electrode and each elemental area of the recording mosaic is thus charged to a potential which is proportional to the instantaneous amplitude of the video signal from amplifier 15. The horizontal deflecting voltage from the saw-toothed wave generator 17 is impressed through conductor 19 upon the input circuit of amplifier 106 to produce a saw-toothed unidirectional current wave in the amplifier output circuit which is connected through switch 80c to horizontal sweep coils 46. Similarly the vertical sweep circuit 18 is connected through line 20, amplifier 107 and switch 80b to vertical sweep coils 45 to produce a saw-toothed current

wave therein. The cathode ray beam in tube 13 is thus deflected in synchronism with the cathode ray beam of the cathode ray device which scans the field of view at the transmitter 14. There are thus stored upon the elemental areas of the mosaic electrode 34, 35, 36 charges corresponding to the tone values of the corresponding elemental areas of the field of view which is being scanned at the transmitting station.

Assume now that the cams 60a to 60l have been rotated sufficiently to bring the apparatus 53 of Fig. 1 to the transmitting condition and the apparatus 51 and 52 to the recording condition. The cathode 30 is then connected through lead 104 and switch 80a to the grounded negative terminal of battery 120 and the modulating cylinder or control electrode 31 is connected through lead 103 and switch 80a to the positive terminal of battery 120. Under these conditions the mosaic electrode is at substantially the same potential as the cathode and the cathode ray beam impinging upon the mosaic electrode 34, 35, 36 is unmodulated and has a relatively low velocity such that the secondary emission coefficient of the mosaic electrode is less than unity, that is, the number of primary electrons reaching the mosaic electrode is greater than the number of secondary electrons emitted from the electrode. Each element of the mosaic surface 35 is thus brought to the equilibrium value of potential, that is, zero volts. The relatively few secondary electrons ejected from the mosaic surface and the excess electrons in the beam are accelerated toward the collector cylinder 40 which is at a high positive potential with respect to the potential of the mosaic surface. Saw-toothed wave deflecting current is applied to the vertical deflecting coils 45 from a source 22 through amplifier 106 and switch 80b and the horizontal deflecting coils 46 are energized from source 23 through amplifier 109 and switch 80c. Since the vertical and horizontal sweep coils of the image producing tube 12 are energized at all times from source 22 through amplifier 110 and from source 23 through amplifier 111, respectively, the mosaic 35 and the screen of the image producing tube 12 are scanned in synchronism by the respective cathode ray beams. As the electron beam scans the mosaic electrode, a video signal is generated in the resistor 37 and the voltage generated across this resistor is impressed upon the modulating electrode of the image producing tube 12 through a circuit comprising lead 112, one of commutator segments 91, 94 or 97, brush 79, conducting ring 89 and lead 113 to the cathode ray tube 12.

Since the mosaic surface is scanned at a higher rate during the transmitting condition than it is during the recording condition, successive images are produced by the cathode ray tube 12 at a higher rate than the frame scanning rate of the field of view at the transmitter 10. As mentioned above with reference to Fig. 5, if three recorder-transmitter tubes are used and if the scanning rate at the transmitter is 30 frames per second, images will be produced by tube 12 at the rate of 60 frames per second. If five tubes are used and the scanning rate at the transmitter is 15 frames per second, images will be produced at the rate of 60 frames per second as depicted in Fig. 7. The invention is also of use in a system employing interlaced scanning. Referring to Fig. 6, if the first recorder-transmitter tube records the even lines of an image during periods one and two and the odd lines during periods three and four, the even lines of the recorded image will be

produced by tube 12 during period five and the odd lines will be produced during period six. The second tube will similarly record during periods three, four, five and six and transmit during periods seven and eight while the third tube will record during periods five, six, seven and eight and transmit during periods nine and ten.

Fig. 4 depicts a modification of the recorder-transmitter tube 13 and the associated circuit arrangement within the dot-dash line 50 of Fig. 1, the corresponding parts being similarly designated. This recorder-transmitter tube comprises a cathode 30, a modulator electrode 31, accelerating electrodes 114 and 115, a collector anode 40 and a mosaic electrode. The mosaic electrode comprises a surface 118 of secondary emitter material which may be a caesium carbon alloy or a film of magnesium oxide on carbon, this secondary emitter material being discontinuous to provide sufficient surface resistance to allow a charge to be stored on the mosaic. This mosaic surface is supported upon a dielectric sheet 117 of titanium oxide, mica, aluminum oxide or quartz. The mosaic electrode is also provided with a metal signal plate 119 of platinum or aluminum.

When in the transmitting condition, the negative terminal of battery 121 is connected through switch 80a to the control electrode 31, the positive battery terminal being grounded, and a potentiometer 122, which is connected across battery 121, has a variable tap connected to the cathode 30 to make the cathode potential more negative with respect to ground than it is during the recording portion of the cycle. Electrodes 114 and 40 are connected to the positive side of battery 116, the negative side being grounded. Accelerating electrode 115 is made negative by connection to potentiometer 41 across battery 38 since, in this case, the positive terminal of battery 38 is grounded. The position of the potentiometer connection is controlled through cam switch 82a to give good focus, whatever the potential of the cathode 30 may be at the moment.

The recorder-transmitter tube of Fig. 4 employs a high velocity scanning beam during both the recording and transmitting periods of its operation and it is therefore not necessary to employ a magnetic field for focussing the electron beam.

Curve A of Fig. 8 shows the relationship between the bombarding potential of the cathode ray beam on the mosaic electrode and the secondary emission coefficient for the recorder-transmitter tube of Fig. 1, while curve B shows this relationship for the recorder-transmitter tube of Fig. 4. It is important that the beam current shall never become sufficiently great to charge an element of the mosaic to a potential greater than that for which the secondary emission coefficient is greater than unity. If this rule is not observed the surface of the mosaic tends to become positive relative to the collector cylinder and it no longer will be possible for the secondary electrons ejected from the mosaic electrode to be accelerated toward the collector cylinder. It is preferable that the maximum value of the beam current should be sufficiently low that the value of secondary emission coefficient is not greatly changed during the recording operation. Referring to curve A, the electron beam impinging on the mosaic has a bombarding potential V_3 during the recording cycle and this bombarding potential is reduced during the transmitting cycle to a value between 0 and V_1 such

that the secondary emission coefficient is less than unity. In the case of curve B the bombarding potential is V_2 during the recording operation and it is subsequently increased to a value above V_4 during the transmitting operation so that the secondary emission coefficient will be less than unity. The rapid decrease in secondary emission coefficient of the tube of Fig. 4 when the bombarding potential is increased from V_2 to V_4 may be explained by the fact that the carbon of the mosaic electrode always has a secondary emission coefficient less than unity and therefore the secondary emission coefficient must fall to a value below unity when the bombarding potential is increased sufficiently for the electrons to penetrate the caesium carbon alloy or the magnesium oxide with which the carbon is coated.

In addition to recording and retransmitting television signals, the recorder-transmitter devices disclosed obviously may be used for recording and retransmitting other signals, telephone or telegraph signals, for example, in a system of time division multiplex telephony or telegraphy. The devices may also be used as a means for delaying electric signals. It is particularly useful when the applied signals have a wide band of frequency components but may be used with a single sinusoidal or other pulse. In a broader aspect of the invention scanning of the target may be omitted and the electron emitting material on the target may be in the form of a single element rather than a mosaic of elements.

What is claimed is:

1. In a television system, the combination with means for repeatedly scanning an object field in parallel elemental lines to produce an image current, of three separate beams at a receiving point for making separate records of variations of said current and for later reading the records at twice the speed of recording, and means for causing two of said last-mentioned means to record the same variations during half of a field scanning period while the third means reads a record which was previously made by it and for causing said third one of said means to record and one of the two others to change from recording to reading at the beginning of the second half of the field scanning period.

2. In a television system, the combination with means for repeatedly scanning a field of view along parallel lines to produce an image current, the entire field of view being scanned in a certain frame scanning period, of a plurality of separate means at a receiving point for making separate records of variations of said current and for later reading the records at a speed equal to an integral multiple of the recording speed, and means for causing one of said recording and reading means to record during an entire frame scanning period and each of the other of said recording and reading means to record for a portion of that frame scanning period and to read a record made by it for the remainder of that frame scanning period, said means being so constructed and arranged that the reading of said records by said different recording and reading means occurs successively.

3. In a television system, the combination with means for repeatedly scanning a field of view along parallel lines to produce an image current, the entire field of view being scanned in a certain frame scanning period, of a plurality of separate means at a receiving point for making separate records of variations of said current and for later reading the records at a speed equal

to an integral multiple of the recording speed, and means for causing one of said recording and reading means to record during an entire frame scanning period and each of the other of said recording and reading means to record for a portion of that frame scanning period and to read a record made by it for the remainder of that frame scanning period, said means being so constructed and arranged that the reading of said records by said different recording and reading means occurs successively and that one of said others of said recording and reading means reads a record which was completed by it prior to the beginning of said frame scanning period and the remaining of said others of said recording and reading means reads a record which is completed during said frame scanning period.

4. In a television system, the combination with means for repeatedly scanning a field of view to produce an image electromotive force, each scanning of the field of view taking place in a certain frame scanning period, of n separate recording and reading means each for alternately making a separate non-pictorial record in a period equal to said frame scanning period under control of said image electromotive force and for reading the record made by it when completed, said recording and reading means being so constructed and arranged that said records are read in succession at a rate equal to $n-1$ times the frame scanning rate.

5. The method of recording electric signals and retransmitting signals from the record, comprising the steps of modulating a cathode ray beam from a source of cathode rays under control of a signaling electromotive force, utilizing said modulated cathode ray beam to scan a recording surface to produce a record corresponding to said signaling electromotive force, interrupting the modulation of the cathode ray beam from said source and utilizing the unmodulated cathode ray beam from said source for scanning said recording surface to produce a signaling electromotive force.

6. In the method of producing television images under control of a television image electromotive force, the steps of modulating a cathode ray beam from a source of cathode rays under control of said television image electromotive force, scanning a recording surface with said modulated beam to produce a record of an image, interrupting the modulation of the beam from said source and scanning said recording surface with said unmodulated beam to generate an electromotive force for controlling the production of an image.

7. In the method of producing television images under control of a television image electromotive force, the steps of modulating a cathode ray beam from a source of cathode rays under control of said television image electromotive force, causing the electrons of said modulated beam to impinge upon a recording surface with a certain velocity to produce secondary electron emission therefrom in accordance with the number of primary electrons reaching said surface, scanning said recording surface with said modulated beam to produce a record of the image, interrupting the modulation of said beam and simultaneously producing a change in the velocity with which the primary electrons impinge upon said surface, and scanning said recording surface with said unmodulated beam to generate an electromotive force for controlling the production of an image.

8. In the method of producing television images under control of a television image electromotive force, the steps of modulating a cathode ray beam from a source of cathode rays under control of said television image electromotive force, causing the electrons of said beam to impinge upon a recording surface with a certain velocity to cause the emission therefrom of a larger number of secondary electrons than the number of primary electrons reaching said surface, scanning said recording surface with said modulated beam to produce a record of the image, interrupting the modulation of said beam and simultaneously causing the velocity with which the primary electrons of said beam impinge upon said surface to increase to a value such that the ratio of secondary electrons emitted to the primary electrons reaching the surface is less than unity, and scanning said recording surface with said unmodulated beam of increased electron velocity to cause the generation of an electromotive force for controlling the production of an image.

9. The method of signaling, comprising modulating a cathode ray beam from a source of cathode rays under control of an electromotive force having variations corresponding to signals, causing the electrons of said beam to impinge upon a recording surface with a certain velocity to cause the emission therefrom of a larger number of secondary electrons than the number of primary electrons reaching said surface, interrupting the modulation of said beam and simultaneously causing the velocity with which the primary electrons of said beam impinge upon said surface to increase to cause the ratio of the secondary electrons emitted from said surface to the primary electrons reaching the surface to be reduced to a value less than unity, and scanning said recording surface alternately with said modulated beam at a certain rate to produce a record corresponding to said signals and with said unmodulated beam at an increased rate to generate an electromotive force for controlling the reproduction of said signals.

10. Cathode ray apparatus for alternately producing under control of a source of signaling electromotive force an electrical record corresponding to signals and transmitting from said record to generate a signaling electromotive force, which comprises a mosaic electrode having an electrically conducting signal plate on one side of a sheet of dielectric material and a discontinuous surface of secondary emitter material on the opposite side, said secondary emitter material comprising a first layer adjacent said dielectric of a material having a secondary emission coefficient which is always less than unity and a second layer on said first of a material which has a secondary emission coefficient greater than unity when the velocity of electrons bombarding the material is within a certain range, means for scanning said secondary emitter mosaic with a signal modulated cathode ray beam having a certain velocity for producing a signal record, and means for subsequently scanning the secondary emitter mosaic with an unmodulated cathode ray beam having a higher velocity such that the primary electrons penetrate said second layer and reach said first layer for causing a signaling electromotive force to be generated.

11. Cathode ray apparatus in accordance with claim 10 in which said first layer of said secondary emitter material is carbon.

12. Cathode ray apparatus in accordance with

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claim 10 in which said first layer of said secondary emitter material is carbon and said second layer is magnesium oxide.

13. Cathode ray apparatus in accordance with claim 10 in which said first layer of said secondary emitter material is carbon and said second layer is an alloy of caesium and carbon.

14. A television system comprising means for scanning a field of view line by line at a certain rate to produce a television image electromotive force, a cathode ray recorder-transmitter tube comprising means for producing a cathode ray beam, means for modulating said beam, a storage electrode having a secondary electron emitting surface, a collector electrode for said secondary electrons and means for deflecting said cathode ray beam, a cathode ray image producing device having means for producing a cathode ray beam and means for deflecting said beam, means for modulating the cathode ray beam of said recorder-transmitter tube, means for causing said modulated beam to scan said storage electrode in synchronism with the scanning of said field of view to record an image upon said storage electrode, means for interrupting the modulation of said cathode ray beam, means for simultaneously changing the velocity with which the electrons of said beam impinge upon said storage electrode, means for causing said unmodulated beam to scan said storage electrode at a rate greater than a rate of scanning said field of view to produce an electromotive force for controlling the modulation of the cathode ray beam produced in said image producing device, and means for causing the cathode ray beam of said image producing device to scan the image field in synchronism with the scanning of said storage electrode by said unmodulated cathode ray beam thereby producing television images at a higher rate than the rate at which said field of view is scanned.

15. A television system comprising means for repeatedly scanning a field of view line by line at a certain rate to produce a television image electromotive force, a plurality of cathode ray recorder-transmitter tubes each comprising a storage electrode, means for producing a cathode ray beam, means for modulating said cathode ray beam, and means for deflecting said cathode ray beam, said storage electrode comprising a secondary electron emitting means and an electrically conducting signal plate separated by a dielectric, means for impressing said television image electromotive force upon the means for modulating a plurality of said cathode ray beams simultaneously, means for impressing electrical energy upon said deflecting means to cause a plurality of said cathode ray beams to scan the secondary electron emitting means of a plurality of said storage electrodes in synchronism with the scanning of the field of view thereby producing simultaneously a plurality of electrical records corresponding to the field of view, means for reading said records in succession to produce an electromotive force for controlling the image production, said means comprising means for interrupting the modulation of said cathode ray beam, and means for simultaneously changing the velocity of the electrons of said beam, a cathode ray image producing device having means for producing an electron beam, means for modulating said beam under control of said last-mentioned electromotive force, and means for deflecting said cathode ray beam, and means

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for energizing the deflecting means of said image producing device and for energizing the deflecting means of said recorder-transmitter tubes in succession during the periods of reading said records respectively to cause said records to be read and the corresponding images to be produced in succession at a rate higher than the rate of scanning said field of view.

16. The combination with an electron beam target having a front conducting layer and a rear conducting layer with a layer of insulation therebetween, means for generating and directing to said target a beam of electrons which when it reaches said target has successively a velocity within one range and a velocity within a different range, said two ranges being such that the front conducting layer of said target which receives the beam has a secondary electron emitting ratio greater than one for one of said ranges and less than one for the other of said ranges, said beam generating means comprising a cathode and an anode, means for placing said conducting layer at a potential higher than said anode, and an electrode for collecting electrons emitted from said front layer whereby when the beam velocity is within one of said ranges the potential of said front layer is raised by reason of the large emission of electrons therefrom and when the beam velocity is within the other of said ranges the potential of said front layer is lowered until an equilibrium value is reached.

17. The combination of claim 16 in which said front layer consists of a plurality of layers of different materials respectively and the beam velocities are such that the one of said last-mentioned layers most remote from said cathode is reached by said beam only when it has a velocity within the higher of said ranges.

18. The combination of claim 16 in which said front layer comprises a layer of carbon adjacent said layer of insulation and a coating of material on said carbon layer having a higher maximum secondary electron emitting ratio than carbon, the beam velocities being such that the beam reaches said carbon layer only when it has a velocity within the higher of said ranges.

19. The method of television image synthesizing which comprises scanning elemental areas of a field of view in succession at a certain frame of frequency rate to produce an image signal, simultaneously producing two similar recordings with two of a larger number of scanning beams under the control of said image signal, and subsequently during the same frame scanning period continuing the recording with a different pair of scanning beams.

20. The method of television image synthesizing which comprises scanning elemental areas of a field of view in succession at a certain frame frequency rate to produce an image electromotive force simultaneously modulating a plurality of scanning cathode ray beams under control of said image electromotive force, simultaneously producing under control of said cathode ray beams and causing to be completed in succession at a rate greater than said frame scanning rate a plurality of similar recordings each corresponding to said field of view, and producing under control of said recordings in succession as they are completed television images of said field of view at a rate greater than said frame scanning rate.

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