Feb. 24, 1948. C. C. LARSON ET AL 2,436,516

TELEVISION RELIEF PICTURE SYSTEM

Filed March 29, 1945 2 Sheets-Sheet 1

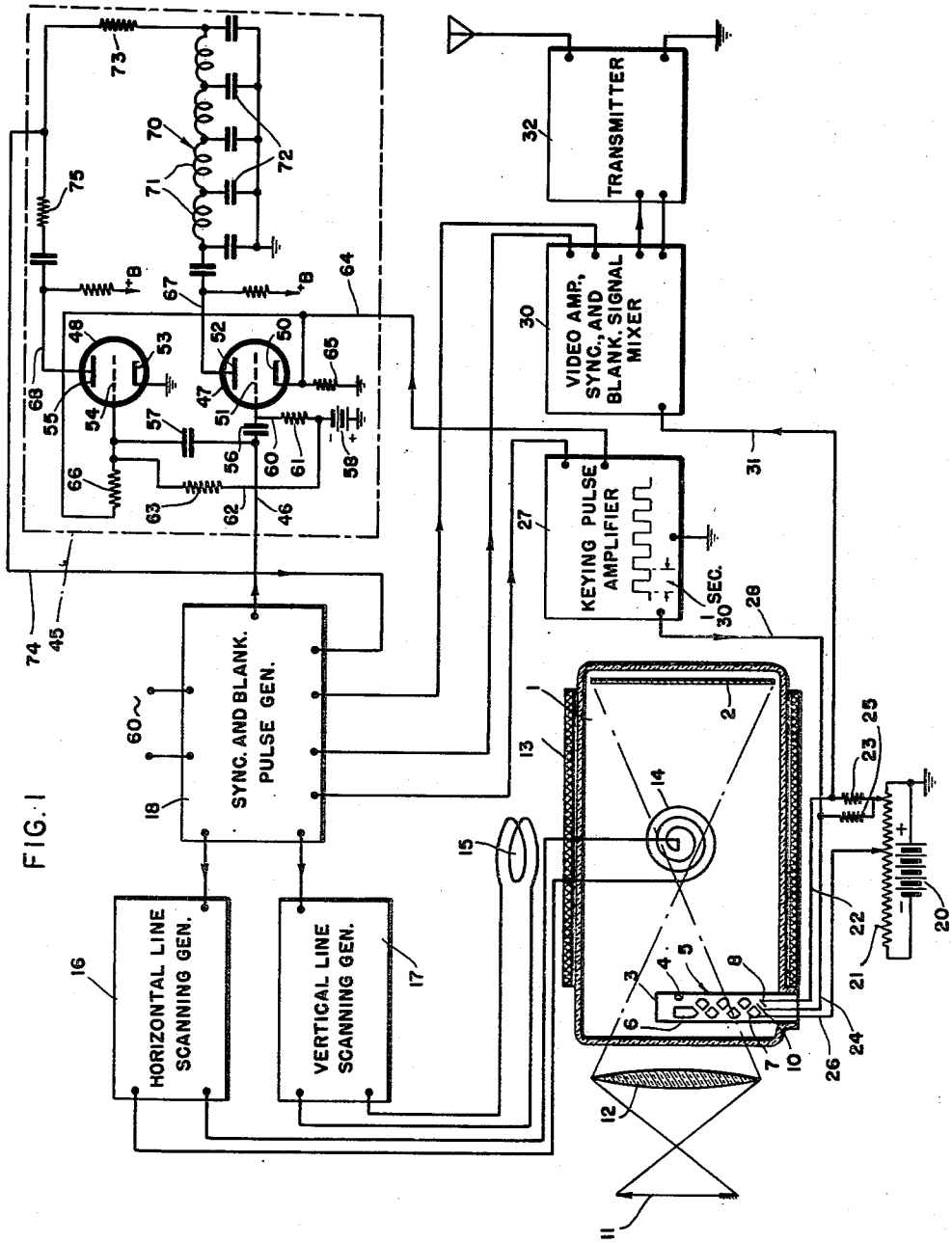


FIG. 1

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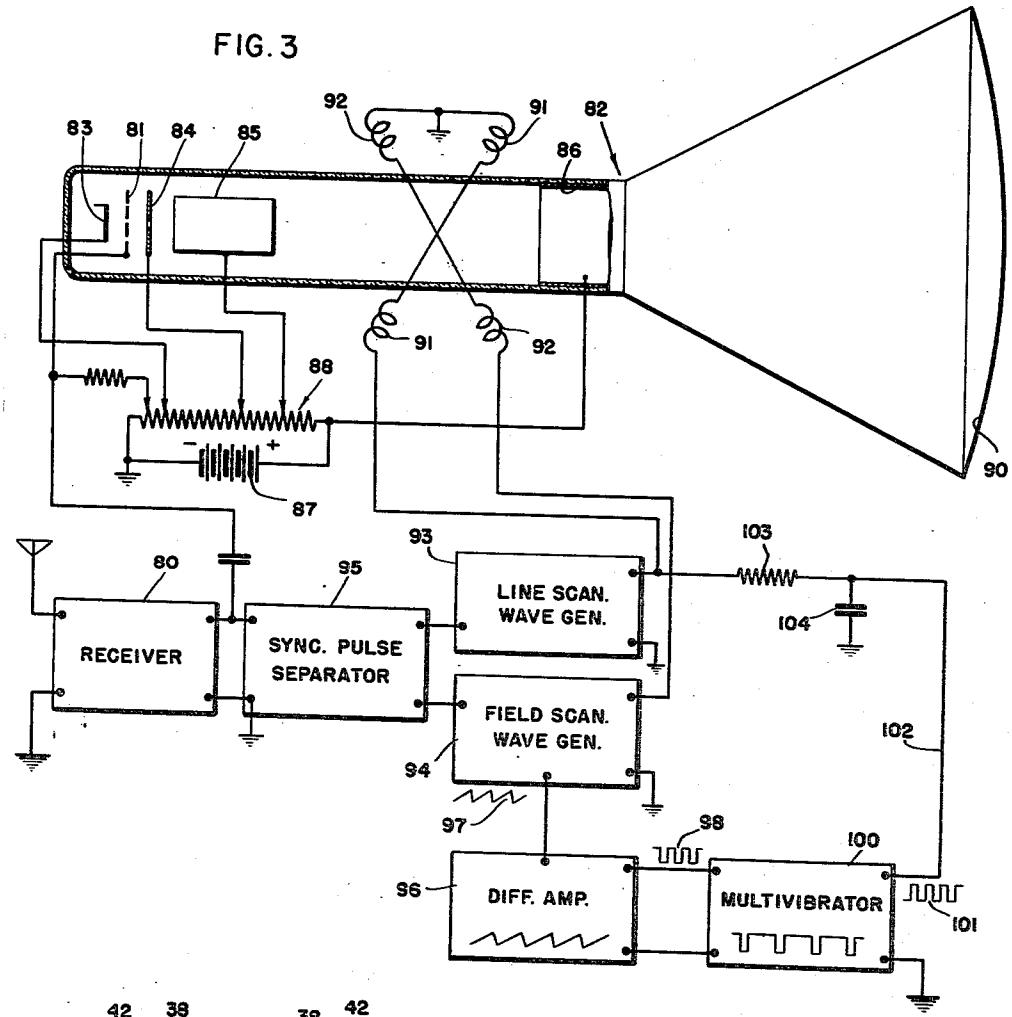
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FIG. 3



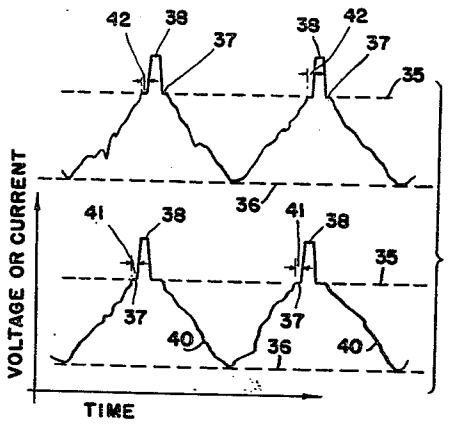


FIG. 2

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UNITED STATES PATENT OFFICE

2,436,516

TELEVISION RELIEF PICTURE SYSTEM

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Application March 29, 1945, Serial No. 585,538

23 Claims. (Cl. 178—6.5)

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This invention relates to a method of and means for transmitting and receiving television pictures, and particularly relates to a television system for reproducing an object in relief.

Various television systems have been devised for obtaining stereoscopic pictures. To this end it is customary to provide two picture signal generating tubes to transmit picture signals representative of the object to be transmitted. At the television receiver the images must be reproduced so that picture signals from each of the two picture signal generating tubes are presented to one eye of the observer only. Stereoscopic television picture systems of this type are complicated because they require two picture signal generating tubes for supplying picture signals which can be converted into images giving a plastic impression of the object. Also, auxiliary means must be provided the observer of the received television image to segregate the reproduced video signals in such a manner that each eye of the observer receives light information from one of the picture signal generating tubes only. It has, for instance, been suggested to provide two picture signal generating tubes arranged in such a manner that alternate lines of the object are scanned in succession by the two tubes. The picture signal reproducing tube comprises a special viewing screen arranged so that each eye of the observer sees one set of reconstructed image lines corresponding to the picture signals developed by one of the picture signal generating tubes. An arrangement of this type is subject to the same criticism of utilizing complicated apparatus for effecting a stereoscopic reproduction of the object. Furthermore, the special viewing screen required for the television reproducing tube does not permit the reproduction of standard television images.

It is an object of the present invention, therefore, to provide a novel method of and system for transmitting and receiving television pictures in relief.

Another object of the invention is to provide a novel system for transmitting and receiving an object or scene whereby images representative of the object are alternately reproduced in opposite transparencies, the images having a positive transparency being displaced with respect to the images having a negative transparency.

A further object of the invention is to provide novel means in a television transmitting system for deriving groups of picture signals of alternate positive and negative polarity representative of the object to be reproduced.

In accordance with the present invention there is provided in a television system a picture signal generating tube having a photosensitive cathode. The object to be transmitted is projected upon the cathode, and means are provided cooperating

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with the cathode for deriving picture signals representative of the object. Further means are provided for reversing the polarity of successive groups of picture signals at a predetermined frequency.

In accordance with a preferred embodiment of the invention a television system for transmitting relief pictures comprises a picture signal generating tube having an electron multiplier including a plurality of multiplier stages. Means are provided for passing at any instant an electron stream into the multiplier representative of the instantaneous brightness of a selected elemental area of an object. An electrode is arranged to receive secondary electrons from the last stage of the multiplier. Apparatus is provided for periodically reversing the polarity of the output signal which includes means for alternately driving the electrode to a potential so that secondary electrons from the last multiplier stage are collected thereby and to a potential so that secondary electrons from the last stage are repelled thereby. Thus, either the last stage of the electron multiplier or the electrode is made a collector of electrons. In this manner the signal polarity derived from the last multiplier stage is periodically reversed in synchronism with the rate of change of the potential on the electrode, and successive groups of picture signals of different polarity may be derived from the last electron multiplier stage.

In accordance with the invention there is further provided a television system for transmitting and receiving relief pictures comprising a picture signal generating tube having means for deriving picture signals representative of an object. Means are provided for reversing the polarity of successive groups of signals at a predetermined frequency as well as means for transmitting the picture signals and for receiving the same. Further means are provided for reproducing the television picture in accordance with the groups of picture signals, thereby to obtain a picture with positive transparency when a group of signals of one polarity is reproduced and a succeeding picture with negative transparency when the succeeding groups of signals having an opposite polarity from that of the first group is reproduced. Finally, means are provided for displacing the television pictures with positive transparency with respect to the television pictures with negative transparency. Hence, the reproduced pictures exhibit a relief effect.

For a better understanding of the invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings:

Fig. 1 illustrates a television transmitting apparatus including circuit connections shown mainly in block form and embodying the present invention;

Fig. 2 is a representation of two different composite video signals referred to in explaining the operation of the invention; and

Fig. 3 illustrates a television receiving apparatus including circuit connections shown in block form and embodying an alternate form of the invention.

Referring now more particularly to Fig. 1 of the drawings, there is shown a television transmitting apparatus comprising picture signal generating tube 1, generally known as an image dissector tube, having a photoelectric cathode 2 and an anode shield 3 provided with a scanning aperture 4. Electron multiplier 5 is located in shield 3 and includes a plurality of multiplier stages such as first stage 6 arranged to receive photoelectrons passing through aperture 4, penultimate stage 7 and last multiplier stage 8. Electrode 10 is arranged between penultimate stage 7 and last stage 8 for a purpose to be explained hereinafter.

For the purpose of projecting an optical image of the object to be transmitted, schematically indicated by arrow 11 on photoelectrode cathode 2, there is provided optical system 12. For developing in the plane of scanning aperture 4 an electron image of the emission from cathode 2, there is provided cylindrical coil 13 surrounding tube 1 and energized by means of a suitable current source such as a battery, not shown in the drawing to avoid confusion. Operating voltage between cathode 2 and anode 3 is provided by a battery or other suitable voltage source not illustrated.

For deflecting the electron image in two directions across scanning aperture 4 in anode shield 3, there are provided line deflecting coil 14 and field deflecting coil 15. Deflecting coils 14 and 15 are energized by horizontal line scanning generator 16 and vertical line scanning generator 17, respectively, both synchronized by synchronizing pulses developed in synchronizing and blanking pulse generator 18 which may be connected to a 60-cycle alternating current source as indicated. Horizontal line scanning generator 16 develops saw-tooth current waves at a frequency of, for example, 15,750 cycles per second, while vertical line scanning generator 17 develops similar waves at a field frequency of, for example, 60 cycles per second, thereby to produce a 525-line interlaced scanning pattern at a frame frequency of 30 cycles per second and an interlace ratio of 2:1.

The component parts of the television transmitter described up to now are all conventional and of well known construction so that detailed explanation of the operation thereof is deemed to be unnecessary.

In accordance with the present invention the polarity of the output signal is periodically reversed in accordance with the field frequency of 60 cycles per second. By reproducing groups of picture signals of alternate positive and negative polarity in a television picture reproducing tube in such a manner that the images having a positive transparency are displaced with respect to images having a negative transparency, a relief effect may be obtained. This is accomplished in accordance with the present invention by alternately reversing or keying the potential supplied to electrode 10.

For the purpose of providing operating potentials to the multiplier stages of electron multiplier 5 there is provided battery 20 connected to voltage divider 21 and having its positive terminal grounded as shown. Each of the stages of electron multiplier 5 is supplied with a potential that may, for instance, be 100 volts more positive than that of the preceding stage. The last multiplier stage 8 is kept at ground potential by lead 22 connected to a tap of potentiometer 21 through resistor 23. Lead 24 is connected to the same tap of potentiometer 21 through resistor 25 for normally keeping electrode 10 at the same potential as stage 8. Multiplier stage 7, being the penultimate stage, may be kept at a potential of 100 volts negative against ground by lead 26 connected to a tap of voltage divider 21.

In accordance with the invention electrode 10 is keyed in such a manner that its potential is alternately maintained at an intermediate value between that of penultimate stage 7 and last stage 8 or made positive with respect to last multiplier stage 8. To this end there is provided keying pulse amplifier 27 connected to synchronizing and blanking pulse generator 18. Keying pulse amplifier 27 receives pulses of a frequency of 30 cycles per second from synchronizing and pulse generator 18. Usually, there is included a generator for generating pulses such as blanking pulses at a frequency of 30 cycles per second in synchronizing pulse generator 18, or else a blocking oscillator may be provided for that purpose. Pulses derived from synchronizing generator 18 at a frequency of 30 cycles per second are delivered to keying pulse amplifier 27 where they are amplified and then impressed by leads 28 and 22 on electrode 10. We may, for instance, assume that the pulses amplified by keying pulse amplifier 27 and impressed upon electrode 10 have a maximum potential of 50 volts positive against ground for 1/60 of a second and then a minimum potential of 50 volts negative against ground for a duration of 1/60 of a second. Thus, electrode 10 will alternately assume a potential of +50 volts and −50 volts.

Multiplier stage 8 alternately acts as an electron multiplier and an electron collector as will be more fully explained; for convenience, however, electrode 8 will be referred to as last multiplier stage 8. When electrode 10 has a voltage of 50 volts positive against ground, it will attract secondary electrons liberated from last multiplier stage 8. At this instant last multiplier stage 8 is an electron source, while electrode 10 acts as a collector of electrons and hence is an electron sink. When the potential of electrode 10 is now reduced to −50 volts, no electrons are collected by electrode 10. All the secondary electrons liberated from penultimate stage 7 are collected by multiplier stage 8 which, therefore, now acts as a collector of electrons. It is well known that the signal polarity obtained from the last multiplying stage of an electron multiplier is opposite from that obtained from the electron collector thereof. As will be evident from the above explanation, multiplier stage 8 alternately acts as the last multiplier stage and as the electron collector, and hence the output signal obtained from multiplier stage 8 will have a polarity that is periodically reversed in synchronism with the rate of change of the keying pulses supplied to electrode 10. Therefore, the polarity of the output signal will change at a rate of 60 cycles per second.

The video signal of a periodically reversed signal polarity is derived from multiplier stage 8 across load resistor 23 and applied by lead 31 to video amplifier and synchronizing and blanking signal mixer 30. Blanking and synchronizing pulses are also applied from synchronizing and blanking pulse generator 18 to amplifier and mixer 30 to develop in amplifier 30 the conventional composite television signal comprising picture signals as well as blanking and synchronizing signals. To the output of amplifier and mixer 30 there is coupled transmitter 32 for transmitting the composite television signal modulated on a carrier wave.

The television transmitting system as described provides means for periodically reversing the signal polarity of the picture signals. However, in order to obtain television relief pictures it is also necessary to displace the reproduced television images of positive transparency with respect to the images of negative transparency. This can be effected in different ways. It is, for instance, possible to key the horizontal synchronizing pulses so that the time delay between the beginning of each blanking pulse and the beginning of each synchronizing pulse changes at a predetermined frequency, such as the field frequency of 60 cycles. Thus, a displacement of images of opposite transparencies may be effected. An arrangement of this kind may advantageously be incorporated into the television transmitter.

To explain more clearly this change of the time delay between the beginning of the blanking signal and the beginning of the horizontal synchronizing signal, reference is made to Fig. 2 illustrating a composite television signal at two different times. The composite television signal shown in the bottom portion of Fig. 2 complies with the standards adopted by the Radio Manufacturers Association. The abscissa in Fig. 2 indicates the time as illustrated, while the ordinate is representative of the voltage or current of the signal. The black level is shown by dotted line 35, while the white level is represented by dotted line 36. Blanking signal 37 coincides with the black level, while the horizontal sychronizing signal 38 extends beyond the black level into a region commonly referred to as blacker-than-black. The video signal proper is indicated at 40 and represents the instantaneous brightness values of a horizontal strip of the object to be transmitted which at that instant is under scansion.

The distance or time delay 41 between the beginning of blanking signal 37 and the beginning of horizontal sychronizing signal 38 is equal to 1% of the line scanning frequency of 15,750 cycles per second. In accordance with the invention the distance between the beginning of blanking signal 37 and the beginning of horizontal synchronizing signal 38 is made larger during predetermined intervals as shown at 42 in the upper curve of Fig. 2. An increase of time delay 41 as shown at 42 has the effect that the scanning beam in the picture reproducing tube begins its scanning motion after a longer time interval than when the scanning beam is controlled according to the standard horizontal synchronizing pulses illustrated in the bottom section of Fig. 2. The result is that when the image is reproduced under the control of horizontal synchronizing signal 38 having a time delay 42, the image is displaced with respect to an image reproduced under the control of a synchronizing signal with the normal time delay 41.

Apparatus for alternately changing the time delay of the horizontal sychronizing signal with respect to the blanking signal referred to hereinabove is illustrated in Fig. 1. To this end time delay mechanism shown enclosed in dotted lines 45 is connected to synchronizing and blanking pulse generator 18 as well as to keying pulse generator 27. The horizontal synchronizing signal derived from generator 18 is connected by lead 46 to three-element vacuum tubes 47 and 48. Vacuum tube 46 includes cathode 50, grid 51 and anode 52, while tube 48 is provided with cathode 53, grid 54 and anode 55. The horizontal synchronizing signal is applied by lead 46 through coupling condensers 56 and 57 to the grids 51 and 54 of tubes 47 and 48, respectively. Battery 58, having its positive terminal grounded, is provided for supplying a biasing voltage to grids 51 and 54 which may, for instance, amount to 60 volts negative against ground. To this end battery 58 is connected by lead 60 through resistor 61 to grid 51, while lead 62 connects grid 54 through resistor 63 to battery 58.

Vacuum tubes 47 and 48 are alternately blocked by means of a keying pulse derived from generator 27 through lead 64. Lead 64 is connected to cathode 50 of tube 47 which in turn is grounded through resistor 65 as shown. The keying pulses derived from generator 27 are also connected through lead 64 and resistor 66 to grid 54 of tube 48. We may assume that generator 27 delivers a pulse of an amplitude of 50 volts positive for a duration of 1/60 of a second and another pulse of equal duration having an amplitude of −50 volts. When a pulse of +50 volts is applied to grid 54, it will reduce the normal grid bias of −60 volts to −10 volts which will permit current to flow through tube 48. The same pulse of +50 volts applied to cathode 50 will increase the effective grid bias of tube 47 to −110 volts, thus blocking tube 47. On the other hand, if a negative pulse of 50 volts is impressed upon grid 54, the grid bias of tube 48 now amounts to −110 volts which will block tube 48. The same pulse of +50 volts is also applied to cathode 50 of tube 47 which reduces the grid bias of that tube to −10 volts, thus making the tube conductive. It is assumed, of course, that both tubes 47 and 48 are able to conduct space current when their grid bias voltage is 10 volts negative against the cathode.

Hence, the signal impressed upon tubes 47 and 48 from lead 46 is alternately conducted through tube 47 or tube 48, each tube being conductive for a duration of 1/60 of a second corresponding to the field frequency whereafter each tube is blocked for the same length of time. The output of tube 47 is derived from lead 67 connected to anode 52, and the output of tube 48 is obtained from lead 68 connected to anode 55. Lead 67 is coupled to time delay network 70 consisting of a plurality of coils 71 connected in series and condensers 72 connected between coils 71 and ground. The output signal of time delay network 70 is derived across resistor 73 connected to lead 74 which in turn is connected to synchronizing pulse generator 18. The output of tube 48 is derived across resistor 75 also connected to lead 74.

Thus, time delay network 70 alternately imparts a predetermined time delay to the horizontal line synchronizing pulses at a frequency of 60 cycles per second. It may be mentioned that while keying generator 27 is synchronized by the blanking pulses from generator 18, the signals

controlled by time delay mechanism 45 are the horizontal synchronizing pulses derived from generator 18. As explained hereinabove in connection with Fig. 2, the periodic time delay of horizontal synchronizing signal 38 may be used for displacing the images reproduced during alternate fields. The television transmitter illustrated in Fig. 1 may be used in connection with a conventional television receiver, the operation of which is well known to those skilled in the art.

The apparatus for displacing a reproduced television image of positive transparency with respect to the succeeding image of negative transparency, which has been described hereinabove, will effect a horizontal displacement of the positive and negative images with respect to each other. It is to be understood that alternate images corresponding to groups of picture signals of opposite polarity may also be displaced in other directions. Thus, it is obvious that alternate images may be displaced in a vertical direction by keying the vertical line synchronizing pulses instead of keying the horizontal line synchronizing pulses by means of time delay mechanism 45.

The images of opposite transparency reproduced during alternate field cycles may also be displaced in another manner. This may be accomplished by keying the deflecting coil of a television picture reproducing tube in such a manner that the images of alternate fields are displaced with respect to each other. An arrangement of this kind is illustrated in Fig. 3 showing a television receiving station.

At the receiving station, receiver 80 amplifies and demodulates the received modulated carrier waves whereby the composite television signal containing groups of picture signals of opposite polarity is developed at the output terminals of receiver 80. This composite television signal is applied to control electrode 81 of cathode ray reproducing tube 82 to control the emission from cathode 83. Electrodes 84, 85 and 86, held at suitable operating potentials by battery 87 connected to voltage divider 88, develop an electron beam directed at fluorescent screen 90. This electron beam is scanned across fluorescent screen 90 in accordance with the 525-line interlaced scanning pattern by means of the magnetic fields developed by deflecting coils 91 and 92 energized by line scanning wave generator 93 and field scanning wave generator 94, respectively. Scanning wave generators 93 and 94 are synchronized by scanning pulses obtained from synchronizing pulse separator 95 to the input of which the composite television signal is applied from receiver 80. Synchronizing pulse separator 95 is of conventional design and adapted to separate synchronizing signals from picture signals. The operation of the television receiver described is conventional and, therefore, no further explanation is deemed necessary here.

In accordance with the invention, horizontal deflecting coils 91, connected to line scanning wave generator 93, are keyed at a frequency of 60 cycles per second corresponding to the field frequency and deflect the electron beam periodically over fluorescent screen 40. To this end differentiating amplifier 96 is connected to field scanning wave generator 94 which delivers a saw-tooth wave 97 at a frequency of 30 cycles per second to amplifier 96. Amplifier 96 differentiates saw-tooth wave 97 obtained from generator 94 and generates rectangular pulses 98 which are utilized for driving multivibrator 100. Multivibrator 100 develops symmetrical square wave pulses 101 which are fed through lead 102 and resistor 103 to deflecting coils 91. Condenser 104, connected between line 102 and ground as shown, provides a low impedance path to ground for the high frequency waves developed by generator 93.

By means of multivibrator 100 and lead 102 horizontal deflecting coils 91 are periodically supplied with a current pulse which develops a constant magnetic deflecting field which changes its strength during alternate field scanning cycles. The current pulses supplied by lead 102 to deflecting coils 91 are superimposed upon the current waves developed by line scanning wave generator 93 which cause the electron beam to sweep horizontally across fluorescent screen 90. Thus, images reproduced during alternate field scanning cycles are displaced with respect to each other because all horizontal lines of one field are displaced with respect to the horizontal lines of the succeeding field. We may assume that receiver 80 receives successive groups of picture signals of opposite polarity, as explained in connection with Fig. 1. Thus, the images reproduced during alternate field scanning cycles are displaced with respect to each other and are of opposite polarities to effect reproduction of television pictures in relief.

It is to be understood that the television receiver illustrated in Fig. 3 will operate in conjunction with a television transmitter such as illustrated in Fig. 1 providing time delay mechanism 45 is omitted. On the other hand, if a television transmitter is provided which includes time delay mechanism such as illustrated at 45 in Fig. 1, no special keying means is required at the television receiver. In that case differentiating amplifier 96, multivibrator 100 and their associated networks may be omitted, and the television receiver will operate in the conventional manner.

The preferred way of reversing the signal polarity of alternate groups of picture signals is effected by means of an electron multiplier in the manner set forth hereinabove. A preferred apparatus for reversing the signal polarity has been illustrated in Fig. 1 in connection with an image dissector tube. However, the signal polarity may also be reversed in substantially the same manner as described herein by using any picture signal generating tube of the light storage type which utilizes an electron multiplier for amplifying the signal output. Pickup tubes of this type which employ electron multipliers are well known in the art and include, for instance, the orthicon where a low velocity electron beam is used for scanning a mosaic electrode.

It is further to be understood that the reversal of the signal polarity of alternate groups of picture signals may also be effected in various ways other than by the utilization of an electron multiplier. For instance, it is feasible to derive video signals in any conventional manner, and to reverse the signal polarity periodically by alternately switching in and out a reversing amplifier. Switching of this nature may, for instance, be effected by a keying mechanism similar to that shown enclosed by box 45. The reversing amplifier that is switched in and out at a predetermined frequency may add one more amplifier stage to the normally operative video amplifier chain. Since each amplifier stage reverses the signal polarity such an arrangement would have the desired effect of alternately reversing the output signal polarity.

While there has been described what are at

present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a television system, a picture signal generating tube having a photosensitive cathode, means for projecting an object to the transmitted upon said cathode, an electron multiplier, means for scanning said cathode to pass at any instant an electron stream into said multiplier representative of the instantaneous brightness of a selected elemental area of said object, said multiplier including a plurality of multiplier stages, and means for deriving successive groups of picture signals from the last stage of said multiplier, said groups of picture signals being representative of said object and of a polarity that is periodically reversed at a predetermined frequency.

2. In a television system, a picture signal generating tube having an electron multiplier including a plurality of multiplier stages, means for passing at any instant an electron stream into said multiplier representative of the instantaneous brightness of a selected elemental area of an object, an electrode arranged to receive secondary electrons from the last stage of said multiplier, apparatus for periodically reversing the polarity of the output signal including means for alternately driving said electrode to a potential so that secondary electrons from said last stage are collected thereby and to a potential so that secondary electrons from said last stage are repelled thereby, and means for deriving successive groups of picture signals from said last stage of a polarity that is periodically reversed in synchronism with the rate of change of the potential on said electrode.

3. In a television system, a picture signal generating tube having an electron multiplier including a plurality of multiplier stages, means for passing at any instant an electron stream into said multiplier representative of the instantaneous brightness of a selected elemental area of an object, means for supplying each of said stages with a potential that is positive with respect to that of the preceding stage, an electrode arranged to receive secondary electrons from the last stage of said multiplier, apparatus for periodically reversing the polarity of the output signal including means for alternately driving said electrode to a potential that is between that of said last stage and that of the penultimate stage to repel secondary electrons from said last stage by said electrode and to a potential that is more positive than that of said last stage to collect secondary electrons from said last stage by said electrode, and means for deriving successive groups of picture signals from said last stage of a polarity that is periodically reversed in synchronism with the rate of change of the potential on said electrode.

4. A television system for transmitting and receiving relief pictures comprising a picture signal generating tube having means for deriving picture signals representative of an object, means for reversing the polarity of successive groups of said picture signals at a predetermined frequency, means for transmitting said picture signals, means for receiving said picture signals, means for reproducing the television picture in accordance with said groups of picture signals thereby to obtain a picture with positive transparency when a group of signals of one polarity is reproduced and a succeeding picture with negative transparency when the succeeding group of signals having the opposite polarity from that of said first group is reproduced, and means for displacing said television pictures with positive transparency with respect to said television pictures with negative transparency, thereby to obtain a relief effect of the reproduced picture.

5. In a television system for transmitting and receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce a luminous image, and means for displacing the image representative of a group of picture signals of one polarity with respect to the image representative of the succeeding group of picture signals of opposite polarity, thereby to obtain a relief effect of the reproduced picture.

6. In a television system for transmitting and receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce a luminous image, said field patterns being synchronized with said groups of picture signals, and means for displacing an image representative of a group of picture signals of one polarity with respect to an image representative of the succeeding group of picture signals of opposite polarity, thereby to obtain a relief effect of the reproduced picture.

7. In a television system for transmitting and receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce a luminous image, said field patterns being synchronized with said groups of picture signals, and means associated with said deflecting means for periodically displacing an image representative of a group of picture signals of one polarity with respect to an image representative of the succeeding group of picture signals of opposite polarity, thereby to obtain a relief effect of the reproduced picture.

8. In a television system for transmitting and receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be

scanned by said beam, means for controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, means including a keying device for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce a luminous image representative of a group of picture signals of one polarity that is displaced with respect to an image representative of the succeeding group of picture signals of opposite polarity, said field patterns being synchronized with said group of picture signals, thereby to obtain a relief effect of the reproduced picture.

9. In a television system for transmitting and receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce a luminous image, and means including a keying device cooperating with said deflecting means for laterally shifting said beam in synchronism with the rate of change of said signal polarity, thereby to displace the image representative of a group of picture signals of one polarity with respect to the image representative of the succeeding group of picture signals of opposite polarity.

10. A television system for transmitting relief pictures including a picture signal generating tube having means for deriving picture signals representative of an object, means for reversing the polarity of successive groups of said picture signals at a predetermined frequency, means for developing synchronizing signals including pulses, means for developing a blanking signal including pulses, means for cyclically changing the time delay between the beginning of each pulse of said blanking signal and the beginning of each pulse of a selected one of said synchronizing signals in such a manner that said time delay changes in synchronism with the reversal of the polarity of said groups of picture signals, and means for mixing said blanking and synchronizing signals with said groups of picture signals, thereby to derive a composite video signal output adapted for the reproduction of television pictures having a relief effect representative of said object to be transmitted.

11. A television system for transmitting relief pictures including a picture signal generating tube having means for deriving picture signals representative of an object, means for reversing the polarity of successive groups of said picture signals at a predetermined frequency, means for developing a line synchronizing signal including pulses, means for developing a field synchronizing signal including pulses and having a lower frequency than said line synchronizing signal, means for developing a blanking signal including pulses of the same frequency as that of said line synchronizing signal, means for cyclically changing the time delay between the beginning of each pulse of said blanking signal and the beginning of each pulse of said line synchronizing signal in such a manner that said time delay remains unchanged during the transmission of each of said groups of picture signals and changes when the polarity of said groups of picture signals is reversed, and means for mixing said blanking and synchronizing signals with said groups of picture signals, thereby to derive a composite video signal output adapted for the reproduction of television pictures having a relief effect representative of said object to be transmitted.

12. In a television system including a picture signal generating tube having a photosensitive member, an electron multiplier having a plurality of multiplier stages and an electrode arranged to receive secondary electrons from the last stage of said multiplier, the method of transmitting television pictures which comprises the steps of projecting an optical image of the object to be transmitted on said photosensitive member, deriving an electron image representative of said object from said member, scanning said electron image to direct at any instant an electron stream into said multiplier representative of the instantaneous brightness of a selected elemental area of said image, alternately attracting secondary electrons from the last stage of said multiplier toward said electrode and repelling secondary electrons from said electrode, and deriving from said last stage successive groups of picture signals of a polarity that is periodically reversed in synchronism with the rate of change of the potential supplied to said electrode.

13. The method of transmitting and receiving television pictures in relief comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, deriving picture signals representative of said object from said member, reversing the polarity of successive groups of said picture signals at a predetermined frequency, transmitting said picture signals, receiving said picture signals, reproducing the television picture in accordance with said groups of picture signals in such a manner to obtain a picture with positive transparency when a group of signals of one polarity is reproduced and a succeeding picture with negative transparency when the succeeding group of signals having the opposite polarity from that of said first group is reproduced, and displacing said television pictures with positive transparency with respect to said television pictures with negative transparency, thereby to obtain a relief effect of the reproduced picture.

14. The method of transmitting and receiving relief pictures comprising the steps of developing an electron beam, controlling said beam in accordance with received groups of picture signals representative of the object to be reproduced, each of said groups having a signal polarity that is opposite from that of the succeeding group, deflecting said beam across a target in accordance with cyclically recurring scanning field patterns to produce a luminous image, and displacing the image representative of a group of picture signals of one polarity with respect to the image representative of the succeeding group of picture signals of opposite polarity, thereby to obtain a relief effect of the reproduced picture.

15. The method of transmitting television pictures in relief comprising the steps of projecting an optical image of the object to be transmitted on a photosensitive member, deriving picture signals representative of said object from said member, reversing the polarity of successive groups of said picture signals at a predetermined frequency, developing a line synchronizing signal including

pulses, developing a field synchronizing signal including pulses of a frequency that is lower than that of said line synchronizing signal, developing a blanking signal including pulses of the same frequency as that of said line synchronizing signal, cyclically changing the time delay between the beginning of each pulse of said blanking signal and the beginning of each pulse of said line synchronizing signal so that said time delay changes in synchronism with the reversal of the polarity of said groups of picture signals, and mixing said blanking and synchronizing signals with said groups of picture signals, thereby to derive a composite video signal output adapted for the reproduction of television pictures having a relief effect representative of said object.

16. A television system for transmitting and receiving relief pictures comprising a picture signal generating tube having means for deriving successive groups of picture signals representative of an object, means for transmitting said groups of picture signals, means for receiving said groups of picture signals, means for reproducing successive complete television images in accordance with said successive groups of picture signals, and means for periodically displacing one of said television images with respect to another one of said television images.

17. In a television system for receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received successive groups of picture signals, each group being representative of a complete image of the object to be reproduced, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce successive complete luminous images, and means for periodically displacing one of said images representative of a group of said picture signals with respect to a succeeding image representative of another group of picture signals.

18. In a television system for receiving relief pictures, a cathode ray picture reproducing tube including means for developing an electron beam and a target adapted to be scanned by said beam, means for controlling said beam in accordance with received successive groups of picture signals representative of the object to be reproduced, means for deflecting said beam across said target in accordance with cyclically recurring scanning field patterns to produce successive complete luminous images, said field patterns being synchronized with successive groups of picture signals, and means associated with said deflecting means for periodically displacing an image representative of a group of said picture signals with respect to the succeeding image representative of the succeeding group of said picture signals.

19. A television system for transmitting relief pictures including a picture signal generating tube having means for deriving successive groups of picture signals representative of an object, means for developing a synchronizing signal including pulses, means for developing a blanking signal including pulses, means for cyclically changing the time delay between the beginning of each pulse of said blanking signal and the beginning of each pulse of said synchronizing signal, and means for mixing said blanking and synchronizing signals having their time delay changed with said successive groups of picture signals to derive a composite video signal.

20. The method of transmitting and receiving television pictures in relief comprising the steps of deriving successive groups of picture signals representative of an object to be transmitted, transmitting said groups of picture signals, receiving said groups of picture signals, reproducing said successive groups of picture signals to obtain successive complete television images, and periodically displacing one of said television images with respect to another one of said television images.

21. The method of receiving and reproducing relief pictures comprising the steps of developing an electron beam, controlling said beam in accordance with received successive groups of picture signals, each group being representative of a complete image of the object to be reproduced, deflecting said beam across a target in accordance with cyclically recurring scanning field patterns to produce successive complete luminous images, and periodically displacing one of said images representative of a group of picture signals with respect to a succeeding image representative of another group of picture signals.

22. The method of transmitting television pictures in relief comprising the steps of deriving successive groups of picture signals representative of the object to be transmitted, developing a line synchronizing signal including pulses, developing a field synchronizing signal including pulses of a frequency that is lower than that of said line synchronizing signal, developing a blanking signal including pulses of the same frequency as that of said line synchronizing signal, cyclically changing the time delay between the beginning of each pulse of said blanking signal and the beginning of each pulse of said line synchronizing signal, and mixing said blanking and synchronizing signals having their time delay changed with said groups of picture signals to derive a composite video signal.

23. The method of receiving and reproducing relief pictures comprising the steps of developing an electron beam, controlling said beam in accordance with received successive groups of picture signals representative of the object to be reproduced, deflecting said beam across a target in accordance with cyclically recurring scanning field patterns to produce successive complete luminous images, and periodically displacing one of said images representative of a group of picture signals with respect to a succeeding image representative of another group of picture signals.

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