

April 26, 1949.

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2,468,256

TELEVISION RECEIVER INCLUDING A HORIZONTAL OSCILLATOR
RESPONSIVE TO A PREDETERMINED FRACTION OF
TRANSMITTED SYNCHRONIZING PULSES

Filed June 22, 1945

3 Sheets-Sheet 1

FIG. 1

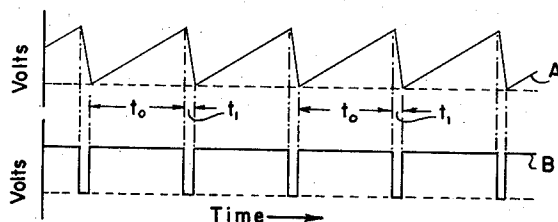


FIG. 2

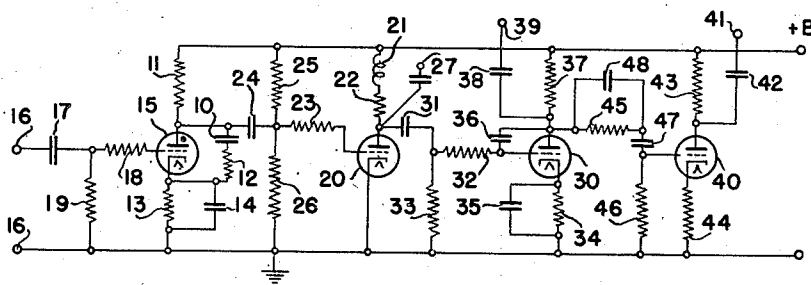
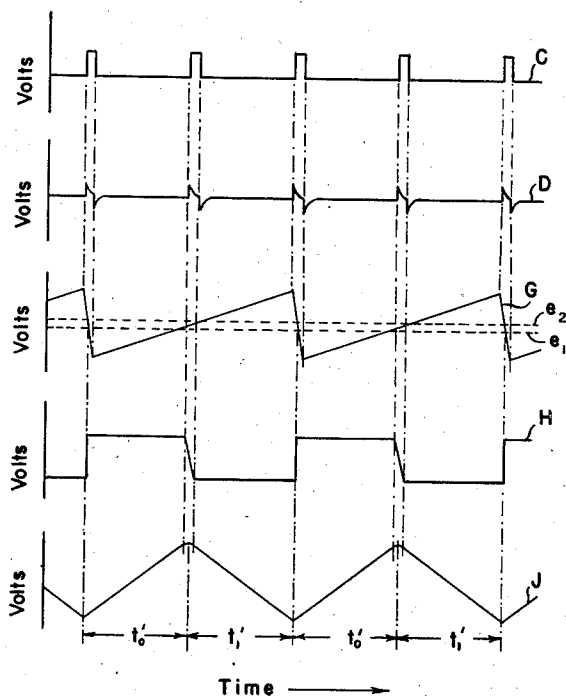


FIG. 3

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3 Sheets-Sheet 2

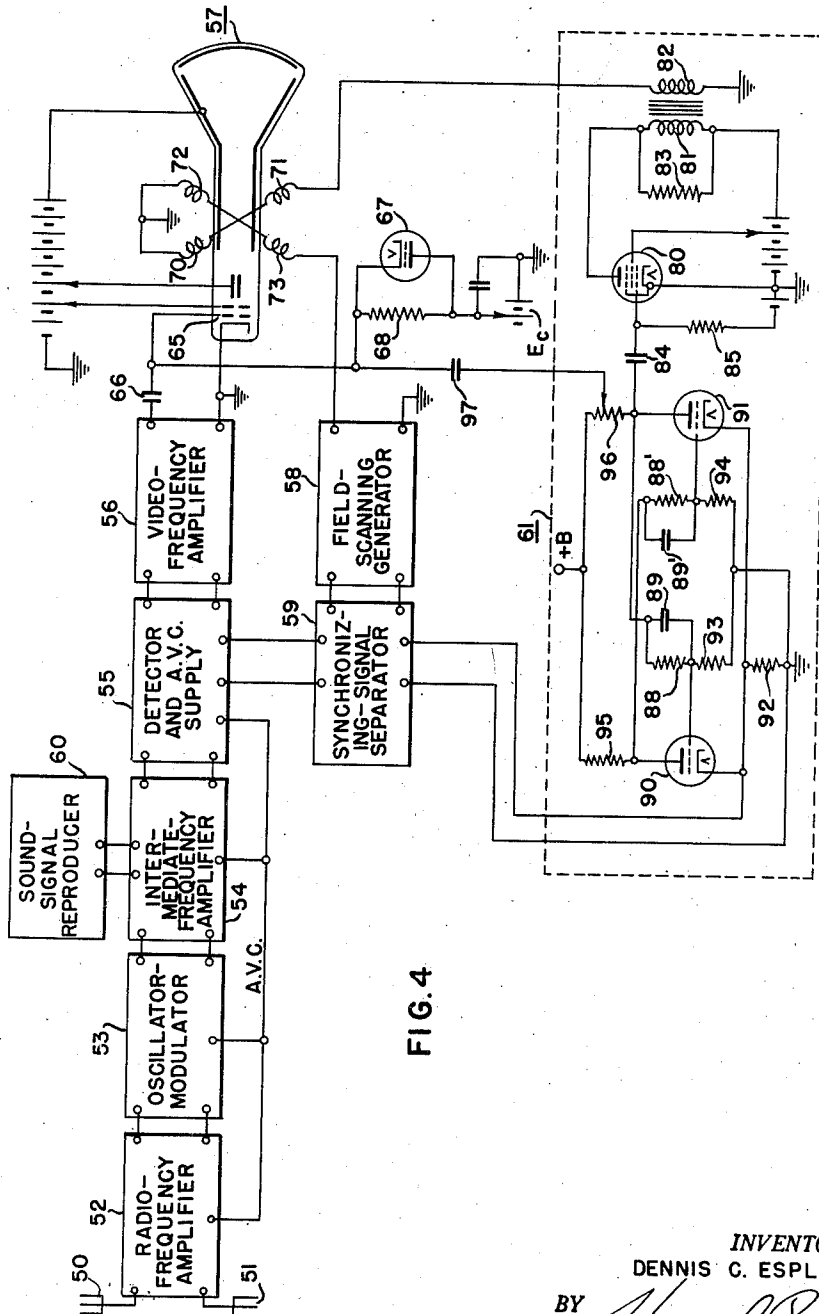


FIG. 4

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3 Sheets-Sheet 3

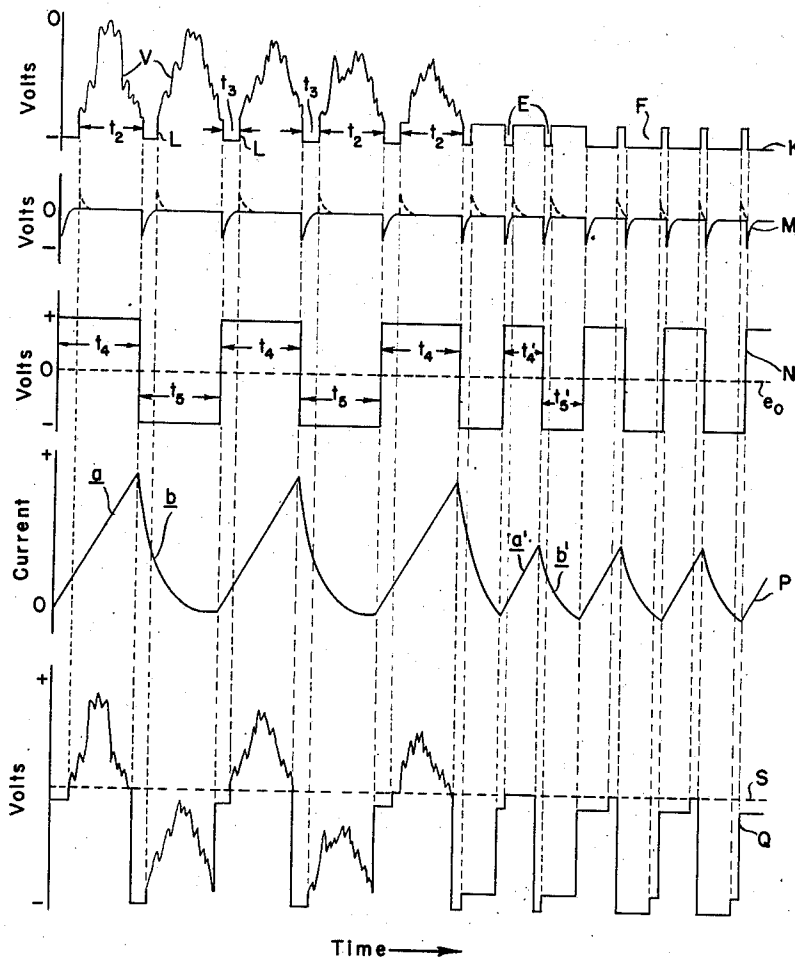


FIG. 5

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TELEVISION RECEIVER INCLUDING A HORIZONTAL OSCILLATOR RESPONSIVE TO A PREDETERMINED FRACTION OF TRANSMITTED SYNCHRONIZING PULSES

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Application June 22, 1945, Serial No. 600,868
In Great Britain October 6, 1943

10 Claims. (Cl. 178—7.5)

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This invention relates to television receivers for utilizing the video components of a received signal during only certain ones, rather than during all, of the line-trace intervals in which video components are available for reproduction. The present application is a continuation-in-part of application Serial No. 557,325, filed on October 5, 1944, now abandoned, in the name of Dennis C. Espley.

One form of television receiver well known to the art utilized a 441-line picture signal, that is, a signal including 441 line-trace intervals per frame. Others of more recent design use a 551-line picture signal. Such receivers comprise an image-reproducing device, such as a cathode-ray tube including line-scanning and field-scanning elements, for utilizing video-frequency signal components. Line-scanning and field-scanning generators, responsive to synchronizing-signal components usually received along with the video-frequency signal components in the retrace intervals of a composite television signal, provide scanning signals for controlling the scanning elements. The scanning signals generated have trace and contiguous retrace portions which produce corresponding trace- and retrace-scanning effects within the reproducing device. These effects cause an image-reproducing area to be scanned in synchronism with the scanning of an image to be translated at the transmitter. In such a system the video-frequency signal components contained in each line-trace interval of the received signal are utilized in synthesizing the image at the receiver.

While television systems utilizing the described prior art receivers have proved to be generally satisfactory, other systems have been proposed which improve the detail of the reproduced image. Since the image definition is a function of the number of picture elements translated which, in turn, is dependent upon the number of line scansions per frame, these other systems utilize an increased line-scanning frequency both at the receiver and transmitter. For example, systems using approximately 800 and 1000 line scansions per frame have been suggested. These higher definition systems include television receivers which are generally similar to that described above, but which differ materially therefrom in the line-scanning generator. It has been found desirable in receiver systems which utilize the video-frequency signal content of each line-trace interval of a received signal, to maintain a given relationship of line-trace to line-retrace scanning intervals. Usually the retrace-scanning

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time is approximately equal to ten per cent. of the line-trace scanning interval. At high line-scanning frequencies this ratio may be established only through the use of costly line-scanning generators of rather intricate construction which may constitute an undesirable limitation in some applications.

Even though it may ultimately be determined that the fidelity of the reproduced image warrants extensive use of systems of 800 or 1000 lines per frame, or systems having a still greater number of line scansions per frame, there will remain installations in which the detail of a lower order line system is adequate. In these installations line-scanning generators of simplified construction may be used, materially reducing the equipment cost. However, the first-described prior art receivers designed for use in present day 441-line or 525-line systems and including comparatively inexpensive line-scanning arrangements are not adapted to translate the television signal utilized in higher definition systems. Hence, these prior art receivers cannot readily be employed in such remaining installations.

It is an object of the invention, therefore, to provide a television receiver which avoids the aforementioned limitations of prior art arrangements.

It is another object of the invention to provide a simplified television receiver for utilizing the video components of a received signal during only certain ones, rather than during all, of the line-trace intervals in which video components are available for reproduction.

It is a specific object of the invention to provide an improved television receiver featuring a simplified and inexpensive line-scanning arrangement and adapted to utilize a television signal including well over 400 line-trace intervals per frame.

In accordance with the invention, a television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprises an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements. The receiver also comprises a signal generator for controlling the line-scanning elements of the reproducing device to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of the plurality of line-trace intervals of the received

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signal. The generator further controls the line-scanning elements to produce line-retrace scanning effects having a duration several times that of the line-retrace intervals of the received signal. The line-trace scanning effects individually have a duration equal to, and a time coincidence with, a substantial portion of one of the line-trace intervals and means are provided for applying the video-frequency signal to the reproducing device to effect image reproduction during the aforesaid separated time intervals and for preventing image reproduction throughout the periods between such separated time intervals.

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

In the drawings, Figs. 1 and 2 comprise curves used in explaining the present invention; Fig. 3 is a schematic circuit diagram of a signal generator for inclusion in a television receiver in accordance with the invention; Fig. 4 represents a complete television receiver embodying the invention in modified form; and Fig. 5 comprises graphs used in explaining the operation of the Fig. 4 arrangement.

In Fig. 1, curve A indicates the line-scanning signal of potential or current conventionally supplied by the line-scanning signal generator of a television receiver. Where, as in the usual case, the receiver is to utilize the video components of each line-trace interval of a received composite television signal, the line-scanning signal of curve A has a frequency corresponding to the repetition frequency of the line-trace intervals of the received signal. Assuming the receiver to be designed for operation in an 800 or 1,000-line system, the line-scanning signal of curve A has a corresponding frequency of 800 or 1,000 cycles for each frame period which means an operating frequency of 20,000 or 25,000 cycles per second where the frame frequency is taken as 25 per second. Curve B of Fig. 1 shows a synchronizing signal of negative polarity and pulse wave form used to synchronize the line-scanning generator of the receiver and to paralyze or block the cathode-ray image-reproducing tube in conventional manner during the line-retrace intervals. For the 800-line system the rise or trace portion t_0 of the line-scanning signal has a duration of approximately 45 microseconds while the fly-back or retrace portion t_1 has a duration approximately of only 5 microseconds. As mentioned above, where the fly-back or retrace interval is of such a short duration, the line-scanning signal generator is both complicated and expensive.

In one embodiment of the invention, the complexity of the line-scanning signal generator is reduced by having the fly-back or retrace intervals of the line-scanning signal correspond substantially with those intervals occupied by alternate line-scanning periods of the received signal. This will be apparent from Fig. 2 in which curve J shows the wave form of the desired line-scanning signal. It includes a trace portion t'_0 and a fly-back or retrace portion t'_1 each of which has a duration of approximately 50 microseconds corresponding to the line-scanning interval of the received 800-line signal. The remaining curves of Fig. 2 are to be identified and explained in connection with the signal-generating arrangement of Fig. 3.

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The arrangement of Fig. 3 includes a primary line-scanning generator for producing a signal of saw-tooth wave form. This generator comprises a condenser 10 having one terminal connected through a charging resistor 11 to a unidirectional potential source +B. The other terminal of condenser 10 is connected to ground to complete a charging circuit. This connection is provided by a resistor 12 in series with a resistor-condenser combination of elements 13 and 14. The parameters of the charging circuit are selected to obtain a linear variation of potential between the high-potential terminal of condenser 10 and ground during the charging interval.

The anode electrode of a gas-filled triode 15 is connected to the junction of condenser 10 and resistor 11. The cathode is connected to the junction of resistor 12 and the resistor-condenser combination 13, 14 to complete a discharging circuit for condenser 10. The discharging circuit is proportioned to have a time constant which is short with reference to that of the charging circuit. Tube 15 is controlled in order to time the generation of the primary line-scanning signal by means of synchronizing pulses applied to terminals 13, 16. The synchronizing terminals are coupled to the input circuit of tube 15 through a condenser 17, a resistor 18 connected in series therewith to the control electrode of tube 15 and an additional resistor 19 connected in shunt relation thereto. Condenser 17 and resistor 19 have such values as to provide a differentiating circuit in the input circuit of tube 15.

A wave-shaping stage, including an amplifying triode 20, has an input circuit coupled across the high-potential terminal of condenser 10 and ground. The potential source +B is connected to the anode electrode of tube 20 through a series peaking coil 21 and a resistor 22. The cathode of tube 20 is grounded while its control electrode is coupled through a resistor 23 and coupling condenser 24 to the high-potential terminal of condenser 10. Resistors 25 and 26 in conjunction with potential source +B constitute a biasing circuit for establishing an operating bias for tube 20. The operating potentials applied to this tube are selected to obtain symmetrical limiting of the signal applied thereto from condenser 10, in a manner described more fully hereinafter. An output terminal 27 is coupled to the anode of tube 20 for deriving an output signal therefrom.

The output signal of the wave-shaping stage is also applied to the input circuit of an integrating and amplifying unit, including a triode tube 30. The coupling between the input circuit of tube 30 and the output circuit of the preceding tube is provided by a condenser 31, a series resistor 32 and a shunt resistor 33. A cathode resistor 34 and a by-pass condenser 35 constitute a self-biasing arrangement for tube 30, and a condenser 36 is coupled from the anode to the control electrode thereof for a purpose to be made clear presently. An anode resistor 37 couples the potential source +B with the anode of tube 30 and a condenser 38 supplies the signal translated therethrough to an output terminal 39. The signal from tube 30, after translation through a triode vacuum-tube repeater 40, is also supplied to a second output terminal 41 coupled through a condenser 42 to the anode of tube 40. Potential source +B is also coupled to the anode through a resistor 43. Cathode resistor 44 provides a self-biasing arrangement. The output circuit of tube 30 is coupled to the input circuit of tube 40 through a voltage-dividing arrangement includ-

ing resistors 45 and 46 and coupling condenser 47. A condenser 48, arranged in parallel with the resistor 45, is provided to compensate the capacitance to ground of the control electrode of tube 40.

The generating arrangement of Fig. 3 includes three output terminals designated 27, 39, and 41. The first of these supplies a control voltage from tube 20 which may be utilized to suppress the cathode-ray beam of the image-reproducing tube of the receiver during fly-back or retrace intervals of the line-scanning operation. The remaining terminals 39 and 41 provide balanced line-scanning signals which may be applied to electrostatic deflecting plates to control the line-scanning operation in the receiver.

In considering the operation of the generating arrangement of Fig. 3, reference is made to the curves of Fig. 2. Curve C represents a synchronizing signal applied to terminals 16, 16. It includes spaced line-synchronizing pulses of positive polarity derived from a received composite television signal having approximately 800 line intervals per frame. These pulses individually correspond with the line-retrace portion of the received signal and are separated by the line-trace portion. The synchronizing signal of curve C, after differentiation in the input circuit of tube 15, is applied to the control electrode thereof with the wave form of curve D. Assume that upon the arrival of the first differentiated line-synchronizing pulse condenser 10 is fully charged. At this instant, the positive component occurring at the leading edge of the differentiated synchronizing pulse initiates an electron discharge in tube 15, rapidly discharging condenser 10 there-through. As a consequence, the potential across condenser 10 and tube 15 falls rapidly, in the manner indicated in curve G. The slow charging time constant of condenser 10 permits deionization to take place, extinguishing the electron discharge in tube 15. Thereafter, condenser 10 is recharged from the source +B, increasing the anode voltage of tube 15 in a positive direction and in a linear manner as shown in curve G.

The second differentiated line-synchronizing pulse is applied to the control electrode of tube 15 when the charging process of condenser 10 is approximately half completed. At this instant, the anode potential of tube 15 has a relatively low value. Also, the charging current for condenser 10, in traversing resistor 13, establishes a bias potential which tends to maintain the tube in a nonconductive state. These effects of anode potential and bias potential are such that the second differentiated line-synchronizing pulse is ineffective and tube 15 remains in its nonconductive state so that the recharging of condenser 10 continues uninterruptedly.

When the third differentiated line-synchronizing pulse arrives, condenser 10 is charged to the extent desired, the anode of tube 15 has a relatively high value, and the charging current and resulting biasing potential developed thereby across resistor 13 are much reduced. Consequently, the third differentiated line-synchronizing pulse initiates an electrode discharge in tube 15, discharging condenser 10 and completing a cycle of the primary saw-tooth line-scanning signal generator. The line-scanning signal thus produced by the primary generator has the wave form of curve G. It has a frequency equal to half that of the line-scanning synchronizing pulses of curve C.

The saw-tooth line-scanning signal of curve G is applied to the input circuit of the wave shap-

ing or limiting stage. The potentials applied to tube 20 of this stage establish two critical potential levels. The first, designated by horizontal broken-line curve e_1 , corresponds with a condition of anode current cutoff. The other, represented by broken-line curve e_2 , designates a condition of anode current maximum. In view of these critical potential levels, the portion of the applied signal of curve G below line e_1 is eliminated in the translation through tube 20 by way of anode current cutoff phenomenon. The portion of curve G which lies above line e_2 is also eliminated but through anode current limiting phenomenon. As a consequence, the output signal of the limiter has the wave form of curve H. This signal of approximately rectangular wave form is available at output terminal 27 and is also supplied to the input circuit of tube 30.

The condenser 36, bridged between the anode and control electrodes of tube 30, causes the impedance measured between its control electrode and cathode terminals to be highly capacitive. This capacitive reactance, in junction with the preceding series resistor 32, constitutes an integrating circuit in the input of tube 30. Therefore, the input signal of curve H is first integrated then, after amplification in tube 30, appears at output terminal 39 with the wave form of curve J. This output signal of tube 30 is repeated by tube 40 and also appears at the remaining output terminal 41 with the same wave form but opposite polarity.

From a comparison of curves C and J of Fig. 2, it is apparent that the generating arrangement of Fig. 3 produces line-scanning signals for controlling a television receiver to utilize only a portion of the video components contained in a received composite television signal. More particularly, the trace portions t'_0 of the line-scanning signals are effective to produce line-scanning effects only during separated time intervals corresponding in total time to approximately half of the line-trace intervals of the received signal. Each trace portion t'_0 of the line-scanning signal will be seen to have a duration at least equal to and a time coincidence with one of the line-trace intervals of the received signal. The fly-back or retrace portion t'_1 of the line-scanning signal is substantially equal to the trace portion t'_0 . Hence, the line-trace scanning effect occurs during alternate line-trace intervals of the received signal while the retrace scanning effect occupies the intervening line-trace intervals of the received signal. The signal of curve H, which is available at output terminal 27, may be utilized to suppress the image-reproducing device of the receiver during line-retrace scanning intervals t'_1 . It will be noted that for the duration of such intervals, the control signal has negative polarity.

While the invention as described in connection with the arrangement of Fig. 3 is particularly suited for obtaining line-scanning signals to control electrostatic deflections of the image-reproducing tube, it has equal application to arrangements employing electromagnetic deflections. Such an arrangement is disclosed in Fig. 4 and the invention will be more fully described with reference thereto.

Referring now more particularly to Fig. 4, the television receiver there represented is of the superheterodyne type and is adapted to utilize a received signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals and separated by line-retrace intervals. This receiver in-

cludes an antenna system 50, 51 connected to a radio-frequency amplifier 52 of one or more stages. There are connected to amplifier 52 in cascade and in the order named an oscillator-modulator 53, an intermediate-frequency amplifier 54 of one or more stages, a detector and automatic volume control or A. V. C. supply 55, a video-frequency amplifier 56 of one or more stages, and a cathode-ray type image-reproducing device 57. The image-reproducing device is provided with a conventional electron-gun structure and accelerating electrodes for forming an electron beam and for focusing the beam on an image-reproducing area. The input circuit of tube 57, including a brilliancy-control electrode 65, is coupled through a condenser 66 to the output circuit of video-frequency amplifier 56, thereby providing means for applying video-frequency signals to the image-reproducing device for utilization. A stabilizing diode 67 having a load resistor 68 is associated with the input circuit of tube 57 for the purpose of stabilizing applied television signals in well-known manner. A source of bias potential, indicated E_c, is coupled to control electrode 65, establishing a predetermined cutoff amplitude level, defined more particularly hereinafter, and rendering tube 57 responsive only to applied video-frequency signal components having an amplitude exceeding its cutoff level. The image-reproducing device also includes the usual line-scanning elements 70, 71 and field-scanning elements 72, 73.

A line-scanning generator arrangement 61, particularly described hereinafter, and a field-scanning generator 58 are coupled to an output circuit of detector 55 through a synchronizing-signal separator 59. They have output circuits coupled, respectively, to line-scanning elements 70, 71 and field-scanning elements 72, 73 of tube 57. A conductor labelled "A. V. C." applies a unidirectional voltage derived from detector and A. V. C. supply 55 to one or more of the tubes of radio-frequency amplifier 52, oscillator-modulator 53, and intermediate-frequency amplifier 54 to control the amplification of the signal-translating channel of the receiver. A sound-signal reproducer 60 is coupled to an output circuit of intermediate-frequency amplifier 54 for translating and reproducing sound signals accompanying the received television program. The stages or units 50-60, inclusive, may all be of conventional well-known construction so that a detailed illustration and description thereof are unnecessary herein.

Referring briefly, however, to the operation of the described receiver and momentarily assuming unit 61 to be a conventional line-scanning arrangement, television signals intercepted by antenna system 50, 51 are selected and amplified in radio-frequency amplifier 52 and applied to oscillator-modulator 53 wherein they are converted into intermediate-frequency signals. The intermediate-frequency signals, in turn, are selectively amplified in intermediate-frequency amplifier 54 and delivered to detector 55. The modulation components of the signal are derived by detector 55 and supplied to video-frequency amplifier 56, wherein they are amplified and from which they are supplied in the usual manner to the brilliancy-control electrode 65 of image-reproducing device 57. The intensity of the electron beam of device 57 is thus modulated or controlled in accordance with the video-frequency voltages impressed upon its control electrode. Line and field synchronizing-signal components derived in de-

tor 55 are separated from the video-frequency components of the detected signal and from one another in synchronizing-signal separator 59 and are applied to synchronizing-control elements of units 61 and 58, respectively. Scanning signals are generated in units 58 and 61 under the control of the applied synchronizing-signal components and are supplied to the scanning elements of tube 57 to produce scanning fields, thereby to deflect the electron beam in two directions normal to each other so as to trace a rectilinear scanning pattern and reconstruct the reproduced image. A unidirectional control potential, derived from unit 55 and applied to one or more tubes of the preceding stages, serves to maintain the amplitude of the signal input to detector 55 within a relatively narrow amplitude range for a wide range of received signal intensities. Sound signals accompanying the received television program are reproduced in sound-signal reproducer 60 in conventional fashion.

Returning now to a consideration of unit 61, this unit of the receiver is a modification of the generator arrangement of Fig. 3. It constitutes means for controlling the line-scanning elements 70, 71 of the image-reproducing device to produce line-trace scanning effects only during separated time intervals which correspond in total time to a preselected fractional portion of the plurality of line-trace intervals included in the received television signal. Further, the line-trace scanning effects produced under the control of this unit individually have a duration equal to, and a time coincidence with, at least a substantial portion of one of the line-trace intervals of the received signal, as will be made clear in the following description.

Unit 61 includes a line-scanning signal generator for generating line-scanning signals having trace portions and contiguous retrace portions for controlling the line-scanning elements of tube 57 to produce line-trace and line-retrace scanning effects, respectively. This generator includes a pentode-type vacuum tube 80 having an output circuit which includes the primary winding 81 of a transformer 81, 82. Winding 81 is shunted by a resistor 83, while winding 82 is directly coupled to the line-scanning elements of tube 57. Tube 80 has an input circuit including a coupling condenser 84 and grid resistor 85 for coupling the described generator to a trigger circuit through the agency of which the scanning generator is controlled or synchronized by at least predetermined ones, but preferably by all, of the synchronizing-signal components customarily received along with the video-frequency signals during the line-retrace intervals. The trigger circuit is provided by a pair of cathode-driven electron-discharge devices 90 and 91 having a common cathode impedance 92. These devices are cross-coupled by means of a pair of resistor-condenser circuits individually coupling the control electrode of one such device to the anode of the other. One resistor-condenser circuit includes a resistor 88 and a condenser 89 and the other includes a resistor 88' and condenser 89'. Grid resistors 93 and 94, as well as plate resistors 95 and 96, are provided for tubes 90 and 91, respectively. A suitable source of space current, indicated +B, is coupled to the anode electrode of each tube, as illustrated. Cathode impedance 92 is coupled to an output circuit of synchronizing-signal separator 59 so that synchronizing-signal components supplied therefrom may excite the trigger circuit. A control effect or control signal

is derived in the anode-cathode circuit of tube 91 for application to the input circuit of tube 80. This control signal is also applied from a tap on anode resistor 96 through a condenser 97 to the control electrode of image-reproducing device 57 for a purpose to be stated hereinafter.

In considering the operation of unit 61 and its effect on the described operation of the receiver of Fig. 4, reference is made to the curves of Fig. 5. Curve K represents one-half the modulation envelope of a fragmentary portion of a received composite television signal of familiar wave form, this signal appearing in the output circuit of detector 55. This signal includes video-frequency signal components having a maximum amplitude limited to a predetermined percentage of the peak amplitude of the carrier signal, occurring during a plurality of substantially identical line-trace intervals t_2 , t_2 and separated by line-scanning synchronizing-signals L occurring during line-retrace intervals t_3 , t_3 . The signal also includes double line-frequency equalizing pulses E and serrated field pulses F, occurring during field-retrace intervals. Let it be assumed that the received signal is generated in a high definition television transmitter and that approximately 1000-line scansions take place in a given field-trace interval. In other words, 1000 line-trace intervals, each including the video-frequency signal components V, intervene between succeeding field pulses F. The signal of curve K is applied directly to control electrode 65 of tube 57 and to the input circuit of synchronizing-signal separator 59, as already indicated. Unit 59 derives and applies to cathode impedance 92 of the trigger circuit line-scanning synchronizing-signal components, equalizing pulses and serrated field pulses, represented by the full-line curve M. In deriving such signals, unit 59 removes the video-frequency signal components V of the signal input thereto through an amplitude-limiting process. The limited signal is then differentiated and the resulting amplitude variations of positive polarity, shown in broken-line construction in curve M, are removed through a second amplitude-limiting step. Thus, only signal variations of negative polarity, representing the line-scanning synchronizing-signal components, equalizing pulses and serrated field pulses of the received signal, are applied to unit 61. The response of the trigger circuit to this applied signal of curve M is represented by curve N and will be clear from the following consideration.

The trigger circuit is a modified form of a well-known circuit. Assume an instantaneous operating condition in which tubes 90 and 91 are equally conductive. If, for any reason, one of the tubes, say tube 90, should be rendered even slightly more conductive, the potential at its anode electrode decreases, applying a negative potential to the control electrode of the opposite tube, tube 91 for the assumed case, to decrease the conductivity thereof. As the conductivity of the second tube decreases, a positive signal variation is applied from its anode circuit to the control electrode of the first tube, increasing the conductivity of the latter still further. This regenerative effect endures until the first tube is rendered fully conductive, while the alternate one is biased to anode current cutoff by the combination of grid and cathode potentials. Thus, the normal condition of the tubes is such that one operates at a condition of anode current saturation, while the other is cut off.

When a synchronizing signal of negative po-

larity is applied to the common cathode impedance 92, it has substantially no effect on the tube operating at anode current saturation. However, the applied pulse renders the alternate tube conductive, thereby to apply a negative potential to the control electrode of the first-mentioned tube. A regenerative cycle, similar to that already described, follows and reverses the conductive states of the tubes. Thus, it will be seen that the succeeding synchronizing-signal components of curve M produce a so-called "flip-flop" action in the trigger circuit, first rendering tube 90 conductive and biasing tube 91 to anode current cutoff, and then reversing their conductive states. The resulting control effect or control signal of curve N derived from the anode-cathode circuit of tube 91 by means of condenser 84 is an alternating current signal of substantially rectangular wave form having a reference amplitude level corresponding to its alternating current axis e_0 . This control signal has amplitude variations in a given direction from its reference amplitude level, or of positive polarity, and alternate amplitude variations in an opposite direction, or of negative polarity, and has a peak-to-peak amplitude value which is at least equal to, but preferably greater than, the maximum amplitude value of the video-frequency signal components V of the received signal.

From a comparison of curves K and N, it will be evident that the amplitude variations of positive polarity of the control signal produced during any given field-trace interval of the received signal occur only during separated time intervals t_4 , t_4 corresponding in total time to a pre-selected fractional portion of the plurality of line-trace intervals t_2 , t_2 include within the particular field-trace interval. More specifically, for the illustrated arrangement such positive polarity amplitude variations of the control signal occur during alternate line-trace intervals of the received signal or, expressed differently, occur only during uniformly separated time intervals corresponding in total time to approximately one-half of the plurality of line-trace intervals of the received signal. It will also be evident from a comparison of curves K and N that these positive polarity amplitude variations of the control signal individually have a duration at least equal to, and a time coincidence with, one of the line-trace intervals t_2 , while the negative polarity amplitude variations have a duration t_5 which is equal to the separation of the above-mentioned uniformly separated time intervals t_4 . The portion of the control signal generated by the double-line-frequency pulses E and the serrated field pulse F is generally similar to that described, except that the durations t'_4 and t'_5 of its positive and negative polarity amplitude variations are approximately half of the corresponding portions of the control signal obtained during field-trace intervals of the received signal.

The positive and negative polarity amplitude variations of the control signal are effective to render tube 80 of the line-scanning generator alternately conductive and nonconductive, in order to generate line-scanning signals. When tube 80 is energized, its anode-cathode circuit has a time constant proportional to

$$\frac{L}{R_p}$$

where L is the effective inductance of winding 81 and R_p is the plate-cathode resistance of tube 80 plus the resistance of winding 81. When tube

80 is biased to cutoff, the current through winding 81 decays in accordance with a time constant proportional to

$$\frac{L}{R}$$

where R is the value of resistor 83 which is selected to be much larger than the resistance R_p . The parameters of the generator are so selected that the described time constants result in the generation of line-scanning signals having a sawtooth wave form, as represented by curve P. The scanning signals generated during field-trace intervals of the received signal have substantially linear trace portions *a* and contiguous retrace portions *b* for controlling the line-scanning elements 70, 71 of tube 57 to produce corresponding line-trace and line-retrace scanning effects, respectively. It will be clear from a comparison of curves N and P that the control signal so controls the line-scanning generator during field-trace intervals that the line-trace and the line-retrace scanning effects produced in image-reproducing device 57 have the same occurrence and duration as those positive and negative amplitude variations of the control signal, respectively, obtained in the same intervals. In particular, the line-trace scanning effects occur during every other line-trace interval of the received signal and the retrace scanning effects occur during equal intervals that separate succeeding line-trace scanning effects.

For the particular arrangement illustrated, the line-scanning effect endures not only during a given line-trace interval of the received signal but also during the preceding line-retrace interval thereof. This causes a dark band to border one side of the reproduced image which may be obviated through the use of a suitable picture-centering device (not shown).

During field-retrace intervals of the received signal, the control of the line-scanning generator 80 by the control signal of curve N continues to maintain line synchronization. However, the line-scanning signals obtained, having trace portions *a'* and retrace portions *b'*, produce no scanning effects within tube 57 since the tube is biased to cutoff during such intervals.

Since the line-retrace time of tube 57 occupies at least a full line-trace interval of the received signal, it is necessary to render the image-reproducing device unresponsive to video-signal components occurring during such line-retrace scanning intervals. To this end, the control signal of curve N is combined in the input circuit of tube 57 with the received video-frequency signal components, establishing a resultant signal in the input circuit of tube 57 having a wave form represented by curve Q. This signal is stabilized by diode 67 on its negative peaks and the value of bias potential E_b is adjusted to set the cutoff level of tube 57 at a value indicated by broken-line curve S. The resultant stabilized signal includes video-signal components having an amplitude exceeding the cutoff amplitude level of tube 57, but occurring only during the above-mentioned separated time intervals in which line-trace scanning effects are produced by scanning elements 70, 71. Thus, the circuit arrangement including condenser 97 comprises means for utilizing the control signal of curve N effectively to apply received video-frequency signals to reproducing device 57 only during the aforescribed separated time intervals. Therefore, in reconstructing the transmitted image, reproducing device 57 utilizes

only the video-frequency signal components included in alternate line-trace intervals of the received signal.

By way of summary, it may be pointed out that a television receiver including the generator of Fig. 3 or the modified unit 61 of Fig. 4 is adapted to utilize a television signal transmitted by a high definition television transmitter. In order to realize an economy in construction, the receiver includes a simplified line-scanning generator arrangement synchronized by line-scanning synchronizing-signal components of the received signal, but effective to control the line-scanning elements of the image-reproducing device to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of the line-trace intervals included in the received signal. The line-trace scanning effects individually have a duration and a time coincidence corresponding to at least one of the line-trace intervals of the received signal and the image-reproducing device is controlled to respond only to such of the video-frequency signal components as occur during its line-trace scanning intervals.

While for the assumed received signal of curve K, the receiver is arranged effectively to respond to alternate line-trace intervals of the received signal, it will be apparent that other division ratios may be utilized, if desired. For example, if the received signal has an unusually large number of line scans in each field-trace interval, a division ratio of one-third or one-fourth may be utilized.

While curve K indicates a received signal including line-scanning synchronizing-signal components, it will be appreciated that such line-scanning signals need not be received as modulation of a single carrier-wave signal along with the video-frequency signal components.

The receiver of the invention is equally useful for receiving interlaced television signals. As is well understood in the art, in interlaced systems the received signal includes a plurality of field-trace intervals for each frame of the translated image. In a progressive line-scanning system, however, the field intervals are identical with the frame intervals and, therefore, the term "field interval" has been used throughout the description. It will be apparent that in an interlaced system embodying the invention, the receiver is controlled during each field period of the received signal in the manner described above.

While there have been described what are at present considered to be the preferred embodiments of this 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. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals, and

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to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

2. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time to approximately one-half of said plurality of line-trace intervals and to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

3. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and to produce contiguous line-retrace scanning effects, said line-trace scanning effects individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals and said line-retrace scanning effects individually having a duration corresponding substantially to the separation of said separated time intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

4. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects individually having a duration equal to and a time co-

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incidence with a substantial portion of one of said line-trace intervals, and means responsive to said last-named means for effectively applying said video-frequency signal to said reproducing device only during said separated time intervals.

5. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-scanning synchronizing-signal components occurring during line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator responsive to said synchronizing-signal components for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

6. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-scanning synchronizing-signal components occurring during line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for generating line-scanning signals having trace portions for controlling said line-scanning elements to produce line-trace scanning effects and having retrace portions for controlling said elements to produce line-retrace scanning effects of a duration several times that of said line-retrace intervals, means responsive to said synchronizing-signal components for deriving a control effect, means for utilizing said control effect to control said generator so that said line-trace scanning effects occur only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and so that said line-trace scanning effects individually have a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

7. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-scanning synchronizing-signal components occurring during line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for generating line-scanning signals having trace portions for controlling said line-scanning elements to produce line-trace scanning effects and having retrace portions for controlling said elements to

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produce line-retrace scanning effects of a duration several times that of said line-retrace intervals, means including a pair of cross-coupled electron-discharge devices responsive to said synchronizing-signal components for deriving a control effect, means for utilizing said control effect to control said generator so that said line-trace scanning effects occur only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and so that said line-trace scanning effects individually have a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

8. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-scanning synchronizing-signal components occurring during line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for generating line-scanning signals having trace portions and contiguous retrace portions for controlling said line-scanning elements to produce line-trace and line-retrace scanning effects, respectively, means responsive to said synchronizing-signal components for deriving a control signal of substantially rectangular wave form having a reference amplitude level, predetermined amplitude variations in a given direction therefrom, and alternate predetermined amplitude variations in an opposite direction therefrom, said amplitude variations of said given direction occurring only during separated time intervals corresponding in total time to a preselected fractional portion of said plurality of line-trace intervals and individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals and said amplitude variations of said opposite direction having a duration substantially equal to the separation of said separated time intervals, means for utilizing said control signal to control said generating means so that said line-trace and line-retrace scanning effects have substantially the same occurrence and duration as said amplitude variations of said given and opposite directions, respectively, and means for applying said video-frequency signal to said reproducing device to effect image reproduction during said separated time intervals and for preventing image reproduction throughout the periods between said separated time intervals.

9. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time with a preselected fractional portion of said plurality of line-trace intervals and to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects indi-

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vidually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, means for deriving a control signal of substantially rectangular wave form having a reference amplitude level, amplitude variations in a given direction therefrom, and alternate amplitude variations in an opposite direction therefrom, at least certain of said amplitude variations of said given direction having substantially the same occurrence and duration as said separated time intervals, means for applying said video-frequency signal components to said reproducing device, and means for utilizing said control signal effectively to render said reproducing device responsive only to those of said video-frequency signal components which occur during said separated time intervals.

10. A television receiver for utilizing a signal including video-frequency signal components occurring during a plurality of substantially identical line-trace intervals separated by line-retrace intervals comprising, an image-reproducing device for utilizing video-frequency signal components having an amplitude level exceeding a predetermined cutoff amplitude level and including line-scanning elements, a signal generator for controlling said line-scanning elements to produce line-trace scanning effects only during separated time intervals corresponding in total time with a preselected fractional portion of said plurality of line-trace intervals and to produce line-retrace scanning effects having a duration several times that of said line-retrace intervals, said line-trace scanning effects individually having a duration equal to and a time coincidence with a substantial portion of one of said line-trace intervals, means for deriving a control signal of substantially rectangular wave form having a reference amplitude level, amplitude variations in a given direction therefrom, and alternate amplitude variations in an opposite direction therefrom, at least certain of said amplitude variations of said given direction having substantially the same occurrence and duration as said separated time intervals, and means for combining said video-frequency signal components and said control signal to derive a resultant signal including video-frequency signal components having an amplitude exceeding said cutoff amplitude level but occurring substantially only during said separated time intervals and for applying said resultant signal to said reproducing device.

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