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TELEVISION SYNCHRONIZING AND
CONTROL SYSTEM

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This invention relates to television receiving apparatus and more particularly to synchronizing and control systems for such apparatus. The invention is especially directed to the provision of a combined synchronizing-signal-separating and automatic amplification control system for television receivers.

In accordance with present television practice, a transmitted signal comprises a carrier wave modulated by light-modulation components representative of varying light values in successive incremental areas of an image being transmitted and of its average background illumination, and synchronizing-modulation components which correspond to initiations of successive lines and fields in the scanning of the image. In signals generally referred to as negatively modulated signals, decreases in carrier amplitude correspond to increases in light values. The synchronizing components extend in the black direction; that is, they are represented by increases in carrier amplitude and they have amplitude values which extend outside of the amplitude range of the light-modulation components.

At the receiver, a beam is so deflected as to scan and illuminate a target in a series of fields of parallel lines. The synchronizing-modulation components of the received signal are utilized to control the scanning apparatus so as to synchronize its operation with that of similar apparatus utilized at the transmitter in developing the signal. The intensity of the cathode ray is controlled by the video-frequency components of the signal, as well as by the unidirectional background illumination voltage developed in the receiver, thereby to reconstruct the transmitted image.

Essential functions which must be performed in a television receiving system of the type described include deriving from the signal-carrier wave the line-frequency and field-frequency-synchronizing components or pulses separate from the other or light-modulation components. Also, certain operating characteristics of the receiver, for example, the amplification or gain, must be controlled automatically in accordance with the intensity of the received carrier wave and independent of its light-modulation components, that is, as determined by the power of its transmitting station, its distance, fading, etc. For this purpose there is usually developed a control effect, for example, a unidirectional bias voltage, which is proportional to the average carrier intensity and independent of light-mod-

ulation components, which control effect is utilized to produce the desired control of the operating characteristics of the receiver. Various methods have heretofore been devised for performing these functions but, in general, they have involved relatively complicated and/or unstable apparatus, or otherwise have not been entirely satisfactory.

It is an object of the present invention to provide, in a television signal-reproducing system wherein the received carrier wave is modulated by light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of the light components, improved means for deriving from the received signal-carrier wave the synchronizing components separate from the other modulation components.

It is a further object of the invention to provide, in a system of the character described, combined means for developing both a unidirectional control-bias voltage representative of the average intensity of the received signal and independent of the light-modulation components and the separated synchronizing-modulation components themselves.

In accordance with the present invention, there is provided a television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of the light-modulation components. The receiver includes means including a modulated-carrier signal detector for deriving the modulation components from the signal-carrier wave, means for controlling the detector in accordance with the amplitude of the signal input to the detector to limit detection thereby to said modulation components outside the amplitude range of the light-modulation components regardless of variations of the signal-input amplitude to the detector and means for utilizing these detected components for controlling the operation of the receiver, for example, synchronizing the receiver.

In accordance with one embodiment of the invention, a rectifier is provided for developing from the carrier wave a control effect, such as a unidirectional bias voltage, proportional to the intensity of the received signal and independent of light-modulation components. There is also provided a detector for deriving modulation components from the carrier wave and a portion of the control effect or unidirectional bias voltage

is utilized to control the detector to effect detection only of the desired portion of the amplitude range of the received carrier wave. The total control effect or bias voltage is preferably utilized to control an operating characteristic of the receiver, for example, to effect automatic amplification control.

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

In the accompanying drawing, Fig. 1 is a circuit diagram, partially schematic, of a television receiver or reproducing system including circuits embodying the present invention, while Fig. 2 is a graph representing certain operating characteristics of the system of Fig. 1 to aid in the understanding of the invention.

Referring now more particularly to the drawing, the system there illustrated comprises a receiver of the superheterodyne type including an antenna system 10—11 connected to a radio-frequency amplifier 12 to which is connected, in cascade in the order named, an oscillator-modulator 13, an intermediate-frequency amplifier 14, a detector 15, a video-frequency amplifier 16 and an image-reproducing device 17 which may, for example, be a cathode-ray signal-reproducing tube, these stages or units constituting the main signal-translating channel of the receiver. A line-frequency generator 18 and a field-frequency generator 19 are also coupled to the output circuit of the amplifier 14, by way of synchronizing-signal-separating apparatus presently to be described, and to the scanning elements of the image-reproducing device 17, in the conventional manner. The stages or units 10—19 may all be of conventional well-known construction, so that detailed illustrations and descriptions thereof are deemed unnecessary herein.

Referring briefly, however, to the operation of the system described above, television signals intercepted by the antenna circuit 10—11 are selected and amplified in the radio-frequency amplifier 12 and supplied to the oscillator-modulator 13, where they are converted to intermediate-frequency signals which, in turn, are selectively amplified in the intermediate-frequency amplifier 14 and delivered to the detector 15. The modulation components of the signal are derived by the detector 15 and are supplied to the video-frequency amplifier 16 wherein they are amplified and from which they are supplied in the usual manner to a brilliancy-control element of the image-reproducing device 17.

The intensity of the scanning beam of the device 17 is thus modulated or controlled in accordance with the light-modulation voltages impressed upon the control element of the device in the usual manner. Saw-tooth current waves generated in the line-frequency and field-frequency generators 18 and 19, respectively, which are controlled by synchronizing-voltage pulses supplied from the apparatus of this invention, as presently to be explained, are applied to the scanning elements of the device 17 to produce electric scanning fields, thereby to deflect the scanning ray in directions normal to each other so as to trace a rectilinear scanning pattern on the screen of the tube and thereby to reconstruct the transmitted image.

Referring now more particularly to the portion of the system of Fig. 1 embodying the present in-

vention, for the purpose of deriving from the received carrier wave the synchronizing components separate from the other modulation components, as well as a unidirectional control-bias voltage, there is provided a control signal-translating channel comprising a vacuum-tube amplifier 20, a rectifier 21, and a detector 22. The tube 20 may be of any suitable type having an input circuit, comprising a coupling condenser 23 and leak resistor 24, connected to the output circuit of the amplifier 14. A suitable biasing battery 25a is included in the cathode circuit of this tube. The output circuit of the tube 20 includes the primary winding 25 of an intermediate-frequency transformer, the secondary winding 26 of which is coupled to rectifier 21 and detector 22, as shown. The windings 25 and 26 are each tuned to the intermediate frequency by condensers 25a and 26a, respectively, and suitable shunt resistors 25b and 26b are connected across these tuned circuits, as shown.

The rectifier 21 is provided for developing the control-bias voltage and includes a load circuit comprising a parallel-connected voltage divider resistor 27 and condenser 28 having a large time constant. This time constant should be considerably greater than the period of the line-synchronizing pulses. For conventional systems utilizing, for example, 30 frames (60 fields) of 441 lines per second, the resistor 27 may be of the order of 0.5 megohm and the condenser 28 of the order of 500 micro-microfarads, providing a time constant of 250 microseconds. The negative terminal of the resistor 27 is connected, by way of a suitable filter including series resistor 31 and shunt condenser 32 and suitable conductors indicated as A. V. C., to the control electrodes of one or more vacuum tubes included in the amplifier 12, oscillator-modulator 13, and amplifier 14, as shown.

The detector 22 is provided for the purpose of deriving the synchronizing pulses separate from the other modulation components, and to this end is designed to detect the modulation envelope of the received carrier wave and includes a load circuit comprising a parallel-connected resistor 29 and condenser 30. The time constant of this circuit is considerably less than that of the load circuit 27, 28 and short compared to the duration of the line-synchronizing pulses so that the modulation voltages are developed thereacross. The load circuit of detector 22 is completed through a resistor 33 and a portion of voltage divider 27 determined by an adjustable tap 35, both by-passed by a condenser 34, resistor 33 and condenser 34 also serving as a filter for the bias voltage derived from rectifier 21. Thus, a predetermined portion of the unidirectional bias voltage developed by the rectifier is applied as a negative delay bias to the anode of detector 22, so that the latter is effective to detect only a portion of the amplitude range of the carrier, more particularly, only the synchronizing-modulation components. The input circuits of the line-frequency and field-frequency generators 18 and 19 are connected across the load circuit of the detector 22 by way of suitable leads 36 and condenser 34. Conventional circuits may be included in the generators 18 and 19 for separating the line-synchronizing and field-synchronizing pulses from each other.

The operation of the system in accordance with the present invention may best be explained with reference to the graph of Fig. 2, in which curve A illustrates the characteristic of the detector 22, the abscissae representing applied alternat-

ing voltage and the ordinates representing the load current of the detector 22. The applied voltage is illustrated by curve C which shows the envelope of the negatively modulated-carrier wave the amplitude of which may vary at the receiver, as developed in the output circuit of the intermediate-frequency amplifier 14 and applied by way of the tube 20 and transformer 25, 26 to the diodes 21 and 22. For the purpose of simplicity, only a few line-frequency cycles are shown. The light-modulation components and synchronizing-modulation components are indicated at L and S, respectively, the latter, it will be noted, extending beyond the amplitude range of the former. Signal levels corresponding to white and black are indicated at W and B, respectively, in the figure.

The diode 21 operates as a conventional peak rectifier, passing current only during the occurrence of synchronizing pulses, which represent the peak values of the modulated-carrier wave, this being determined by the large time constant circuit provided by the resistor 27 and condenser 28. There is thus built up across the load circuit 27, 28 a unidirectional voltage of a value such as indicated by the arrow labeled A. V. C. in Fig. 2, which is the peak rectified applied signal. That is, the average value of this voltage is proportional to the maximum amplitude of the carrier wave and independent of light-modulation components. The filter comprising the resistor 31 and condenser 32 serves to remove residual fluctuations from the rectified voltage and the resultant steady unidirectional bias voltage is impressed negatively on the control grids of one or more of the tubes in the stages 12, 13 and 14 to control the amplification of these stages inversely in accordance with the maximum values of the carrier-wave amplitude and independent of light-modulation components. Thus, the output signal intensity of the main signal-translating channel is maintained within a relatively narrow range for a wide range of received signal intensities due to the effect of the control-bias voltage developed by rectifier 21, the bias voltage being variable in accordance with the intensity of the received carrier wave and independent of its light-modulation components.

The detector 22 constitutes a modulated-carrier signal-detecting means and operates similarly to the rectifier 21, as just described, except that the time constant of its load circuit is such that the modulation envelope of the signal is detected. Further, in this case, a part of the unidirectional voltage developed by the rectifier 21 is applied to the anode of diode 22 as a negative bias to limit detection thereby, the applied bias being variable in accordance with the amplitude of the signal input to the detector. Referring again to Fig. 2, it will be seen that the synchronizing components S represent a certain percentage of the modulation amplitude range of the carrier wave, for example, 25 per cent. The tap 35, therefore, is adjusted so that a delay bias voltage corresponding to at least a portion and preferably approximately 75 per cent of the total voltage developed by the rectifier 21 is applied negatively to the anode of the detector 22, this negative bias, as indicated in Fig. 2, serving to delay the detector 22 so that it is operative to detect, that is to pass current representative of, only the portion of the amplitude range of the carrier constituting the synchronizing-modulation components or pulses and its output is thus limited to modulation components outside the amplitude range of the light-

modulation components of the received signal regardless of variations of the signal-input amplitude to the detector. There is thus developed across the load circuit of the detector 22 the synchronizing-modulation components or pulses free from the light-modulation components of the carrier, as illustrated by curve e of Fig. 2. These pulses are applied to the generators 18 and 19, in which conventional separating apparatus serves to separate the line-synchronizing and field-synchronizing pulses and these pulses are utilized to maintain the generators 18 and 19, respectively, in synchronism with the corresponding apparatus at the transmitter, in the usual manner. It is, therefore, seen that the arrangement of Fig. 1 comprises a television receiver adapted to reproduce a signal-carrier wave, the amplitude of which may vary at the receiver, and which has light-modulation components and synchronizing-signal components having amplitude values outside the amplitude range of the light-modulation components. The arrangement comprises means including a modulated-carrier signal detector 22 for deriving modulation components of the received carrier wave, as well as means for developing a bias across resistor 27 for controlling the detector 22 in accordance with the amplitude of the signal input to the detector to limit detection thereby to the modulation components outside the amplitude range of the light-modulation components regardless of variations of the signal-input amplitude to the detector. Furthermore, means are provided including the conductor 36 for utilizing the detected components for controlling an operation of the receiver, specifically for controlling the synchronization of the receiver.

The system of the present invention thus serves to derive from the signal carrier both the unidirectional bias voltage proportional to the intensity of the modulated-signal carrier and independent of its light-modulation components and the synchronizing-modulation components separate from the other modulation components.

While there has been described what is at present considered to be the preferred embodiment 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 adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for controlling said detector in accordance with the amplitude of the signal input to said detector to limit detection thereby to said modulation components outside said amplitude range of said light-modulation components regardless of variations of the signal-input amplitude to said detector, and means for utilizing said detected components for controlling the operation of said receiver.

2. A television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having light-modulation

components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, a means for deriving from said signal a control-bias voltage variable in accordance with the intensity of the carrier wave and independent of its light-modulation components, a vacuum-tube repeater for translating the signal, means for applying said bias voltage to said repeater to limit the translation of the signal thereby to the portion of the signal including said modulation components outside said range of said light-modulation components, and means for utilizing the signal components translated by said repeater for synchronizing the operation of said receiver.

3. A television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for biasing said detector in accordance with the amplitude of the signal input to said detector to limit detection thereby to said modulation components outside said amplitude range of said light-modulation components regardless of variations of the signal-input amplitude to said detector, and means for utilizing said detected components for synchronizing the operation of said receiver.

4. A television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having a portion of its amplitude range modulated by light-modulation components and another portion of its amplitude range modulated by synchronizing-modulation components comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for controlling said detector in accordance with the amplitude of the signal input to said detector to limit detection thereby to said portion of said amplitude range of said carrier wave modulated by said synchronizing-modulation components regardless of variations of the signal-input amplitude to said detector, and means for utilizing said detected components for synchronizing the operation of said receiver.

5. A television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for deriving a control effect proportional to the intensity of said carrier wave and independent of its light-modulation components, means for utilizing said control effect for controlling said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, and means for utilizing said detected components for synchronizing the operation of said receiver.

6. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation com-

ponents comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for deriving a unidirectional control-bias voltage proportional to the intensity of said carrier wave and independent of its light-modulation components, means for applying at least a portion of said bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, and means for utilizing said detected components for synchronizing the operation of said receiver.

7. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, means for deriving from a received signal-carrier wave a control effect proportional to the intensity of the carrier wave and independent of its light-modulation components, means for detecting said carrier wave to derive its modulation components, means for utilizing said control effect for controlling said detecting means to limit detection thereby to said modulation components outside said range of said light-modulation components, means for utilizing said control effect for controlling an operating characteristic of the receiver, and means for utilizing said detected components for synchronizing the operation of said receiver.

8. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components, said carrier wave having a wide range of signal-input intensities comprising, a modulated-carrier signal-detecting and -reproducing means, means for deriving from a received signal-carrier wave a control-bias voltage proportional to the intensity of said carrier wave and independent of its light-modulation components, means for detecting said carrier wave to derive its modulation components, means for applying at least a portion of said bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, means for utilizing said control-bias voltage for maintaining the average amplitude, independent of light modulation, of the carrier input to said signal-detecting and -reproducing means within a relatively narrow range for a wide range of received signal-input intensities, and means for utilizing said limited detected components for synchronizing the operation of said receiver.

9. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and line-synchronizing and field-synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components, said carrier having a wide range of signal-input intensities comprising, a modulated-carrier signal-detecting and -reproducing means, a rectifier having a load circuit with a time constant long compared to the period of said line-frequency synchronizing components for deriving from said signal a control-bias voltage variable in accordance with the intensity of the carrier wave independent of its light-modulation components, means including a modulated-carrier signal detector having a load circuit with a time constant short

compared with the duration of said line-frequency pulses for deriving from said carrier wave its modulation components, means for applying at least a portion of said bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, means for utilizing said control-bias voltage for maintaining the average amplitude, independent of light modulation, of the carrier input to said signal-detecting and -reproducing means within a relatively narrow range for a wide range of received signal-input intensities, and means for utilizing said limited-detected components for synchronizing the operation of said receiver.

10. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, a rectifier having a load circuit including a voltage divider resistor for deriving from said signal a control-bias voltage proportional to the intensity of the received carrier wave and independent of its light-modulation components, means including a modulated-carrier signal detector for deriving modulation components from said carrier wave, a connection between said voltage divider and said detector for applying at least a portion of said bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, and means for utilizing said detected components for synchronizing the operation of said receiver.

11. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components comprising, a rectifier having a load circuit including a voltage divider resistor for deriving from said signal a control-bias voltage proportional to the intensity of the received carrier wave and independent of its light-modulation components, means including a modulated-carrier signal detector for deriving modulation components from said carrier wave, a connection between said voltage divider and said detector for applying at least a portion of said

5 bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, means for utilizing said control-bias voltage for controlling an operating characteristic of the receiver, and means for utilizing said detected components for synchronizing the operation of said receiver.

12. A television receiver adapted to reproduce a signal-carrier wave having light-modulation components and synchronizing-modulation components having amplitude values outside the amplitude range of said light-modulation components, said carrier wave having a wide range of signal-input intensities comprising, a rectifier having a load circuit including a voltage divider resistor for deriving from a received signal-carrier wave a control-bias voltage proportional to the intensity of said carrier wave and independent of its light-modulation components, means including a modulated-carrier signal detector for deriving modulation components from said carrier wave, a connection between said voltage divider and said detector for applying a portion of said bias voltage negatively to said detector to limit detection thereby to said modulation components outside said range of said light-modulation components, means for utilizing all of said control-bias voltage for maintaining the average signal-output intensity independent of light modulation within a relatively narrow range for said wide range of signal-input intensities, and means for utilizing said detected components for synchronizing the operation of said receiver.

13. A television receiver adapted to reproduce a signal-carrier wave the amplitude of which may vary at the receiver and comprising, means including a modulated-carrier signal detector for deriving modulation components from a received signal-carrier wave, means for deriving a control effect proportional to the intensity of said carrier wave, means for utilizing a predetermined portion of said control effect for controlling said detector to limit detection thereby to a related predetermined portion of the amplitude range of said modulation components regardless of variations of the signal-input amplitude to said detector, and means for utilizing said detected modulation components.

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