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TELEVISION SYNCHRONIZING AND CONTROL SYSTEM

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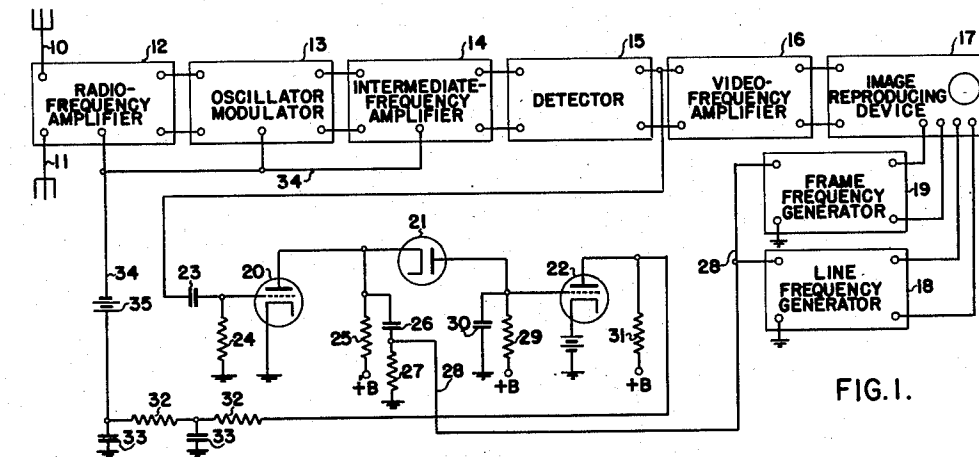
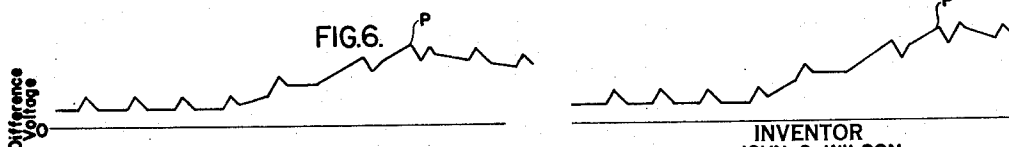
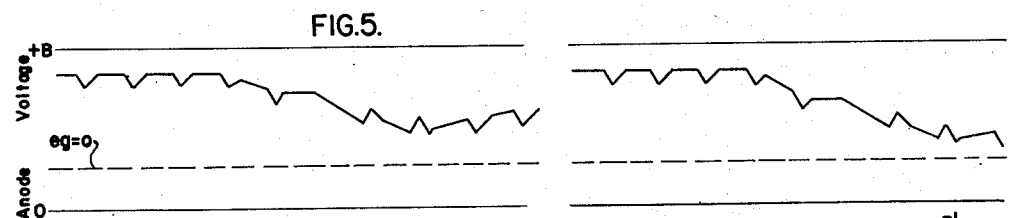
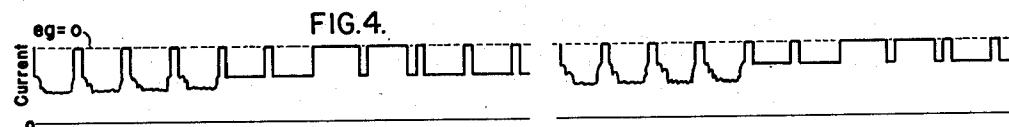
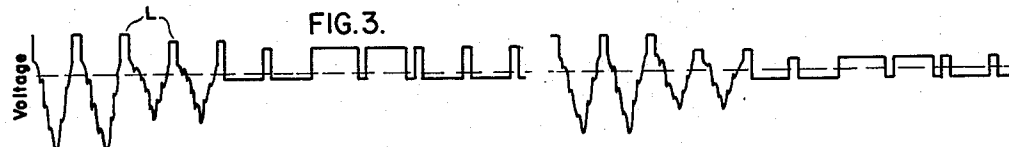
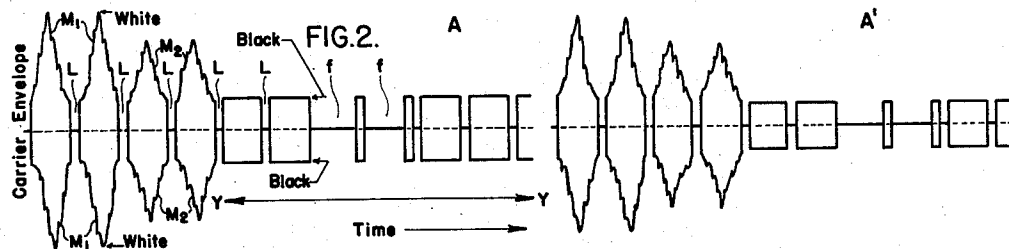


FIG. 1.



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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, modulated during successive intervals or trace periods by high-frequency and unidirectional components representative of an image being transmitted and of its average background illumination, respectively, and modulated between the trace periods, that is, during retrace intervals, by synchronizing components which correspond to initiations of successive lines and fields in the scanning of the image.

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 components of the received signal must be separated from the other modulation signal components of the received signal and utilized to control the scanning apparatus of the receiver so as to synchronize its operation with that of similar apparatus utilized at the transmitter in developing the signal, such separation ordinarily requiring special separating circuits. The intensity of the beam, as it is deflected, is controlled by the light-modulation components, thereby to reconstruct the image.

As is well known, it is frequently desirable to provide automatic control of certain operating characteristics of a television receiving system in accordance with the average received carrier amplitude and independent of light modulation, for example, automatic amplification control. Since the average intensity of the carrier is varied at the transmitter in accordance with background light-modulation components, such average intensity cannot be utilized to effect satisfactory automatic amplification control in the conventional manner, which requires some controlling effect dependent solely upon the average carrier intensity, as determined by the power of the transmitting station, its distance, fading, etc., and independent of the degree of modulation. Further, the amplitude of the synchronizing pulses cannot be utilized in positive modulation systems, in which they are ordinarily transmitted on inward peaks of modulation, corresponding substantially to zero amplitude of the carrier wave. Special arrangements, therefore, are usually required for providing automatic control of

an operating characteristic of a television receiver in accordance with the average amplitude of the received carrier wave and independent of light-modulation components.

5 It is an object of the present invention, therefore, to provide a television receiver including improved means for separating the synchronizing components from the other modulation components of a received signal and for automatically controlling the amplification of the receiver in accordance with the average intensity of the received modulated-carrier signals and independent of the light-modulation components.

10 In accordance with the present invention, a television signal receiver, adapted for the reception of a television signal carrier modulated by light and synchronizing components and having a wide range of signal-input intensities, comprises signal-reproducing means included in a main signal-translating channel and a separate control signal-translating channel. Means are included in the control channel for deriving from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave an automatic amplification control effect variable in accordance with the intensity of the received carrier and independent of light-modulation components. There are also included in said control channel means for separating the synchronizing components from the other modulation components, means for utilizing the control effect inversely to control the gain of the main signal-translating channel in accordance therewith, and means for utilizing the separated synchronizing components for synchronizing the operation of the signal-reproducing means.

25 In accordance with another feature of the invention, a single means is included in a signal-translating channel of the receiver for deriving a control voltage including a component variable in accordance with variations in a predetermined level of a signal translated by said channel and independent of variations corresponding to light modulation and for separating said synchronizing components from the other modulation components. Separate circuits are provided for utilizing the variable component of the derived control voltage and the synchronizing components.

50 For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description taken in connection with the accom-

panying 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 cathode-ray tube television receiving system including circuits embodying the present invention; Fig. 2 is a diagrammatic illustration of the envelope of a positively modulated television carrier wave to aid in the understanding of the invention; while Figs. 3-6, inclusive, are groups of wave forms representing the derived signal developed at different points in the receiver of Fig. 1.

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 a cathode-ray image-reproducing tube 17. A line-frequency generator 18 and a field-frequency generator 19 are also coupled to the output circuit of the detector 15 by way of synchronizing-signal-separating apparatus presently to be described and are connected to the scanning elements of the cathode-ray tube 17 in a conventional manner. The stages or units 10-19, inclusive, 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, wherein they are converted into 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 electrode of the cathode-ray tube 17 and to the synchronizing-control elements of the generators 18 and 19. The intensity of the electron beam of the tube 17 is thus modulated or controlled in accordance with the video-frequency voltages impressed upon the control electrode of the tube in the usual manner. Saw-tooth current or voltage-scanning waves are generated in the line-frequency and field-frequency generators 18 and 19, which are controlled by synchronizing-voltage pulses supplied from the apparatus of this invention, as presently to be explained, and applied to the scanning elements of the cathode-ray tube 17 to produce electric scanning fields, thereby to deflect the ray in two directions normal to each other so as to trace a rectilinear scanning pattern on the screen of the tube and thereby reconstruct the transmitted image.

Referring now more particularly to the portion of the system of Fig. 1 embodying the present invention, for the purpose of separating the synchronizing pulses or components from the other components of the modulation signal and for developing an automatic amplification control-bias voltage, there is provided an auxiliary control signal-translating channel at least in part separate from the main signal-translating channel including the signal-translating means 10-19. The control channel comprises a vacuum-

tube repeater or stabilizer 20, a rectifier 21 and a direct current reversing amplifier 22 connected as shown, in the order mentioned. 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 detector 15. An output circuit is provided for the tube 20, comprising a resistor 25 and a condenser 26 in parallel and having a predetermined time constant which is long compared to the duration of the line-synchronizing pulses but short compared to the field-blanking intervals. For conventional systems utilizing 30 frames (60 fields) of 441 lines per second interlaced, the resistor 25 may be of the order of 100,000 ohms and the condenser 26 of the order of 0.006 microfarad, providing a time constant of 0.0006 second. A resistor 27 of low value relative to the impedance of the condenser 26 at the line-scanning frequency is included in series with the condenser 26, as shown. The input circuits of the line-frequency and frame-frequency generators 18 and 19 are connected across the resistor 27 by way of a suitable lead 28. Conventional circuits may be included in the generators 18 and 19 for separating the line-synchronizing and field-synchronizing pulses from each other, as in usual practice.

The diode rectifier 21 is coupled across the output circuit of the tube 20 and is provided with a load circuit comprising a parallel-connected resistor 29 and condenser 30 having a large time constant. This time constant should be considerably greater than the field-scanning period, for example, of the order of $\frac{1}{60}$ second. The input electrodes of the reversing amplifier are connected across the resistor 29 while its anode circuit includes a load resistor 31. Operating potentials are applied to the anodes of the tubes 20 and 22 by way of their respective load resistors 25 and 31 from suitable sources, indicated at +B. The anode of tube 22 is connected, by way of a suitable filter, including series resistors 32 and shunt condensers 33, and conductors 34 to the control electrodes of one or more vacuum tubes included in the amplifier 12, oscillator-modulator 13, and amplifier 14, as shown. The conductor 34 may include a negative-biasing battery 35 to compensate for the high potential of the anode of the tube 22 from which the automatic amplification control potential is derived. However, if the cathodes of the tubes in the stages 12, 13 and 14 are properly biased, the battery 35 may be omitted.

The operation and results obtained by the system of Fig. 1 may best be understood by reference to Figs. 2-6, inclusive. In Fig. 2 there are illustrated the wave forms of portions of the complete modulation envelopes of television carrier waves of the positively modulated type. The portion shown at A represents a wave of relatively large amplitude while that at A' represents a similar wave differing only in that it is of smaller amplitude, as might be caused by occasional fading, in each case the signal having components representing the blanking level at a level constantly related to the unmodulated peak level of the carrier wave. In Figs. 3-6 corresponding wave portions are shown, illustrating the form of the signal derived at different parts of the system for the assumed signal inputs of different amplitudes.

The portions of the wave of Fig. 2 at which the carrier amplitude is reduced to zero, certain of which are indicated at L and F, represent

the line-synchronizing and field-synchronizing pulses, respectively, which occur during the retrace periods. The portions between the pulses L, which represent trace portions of successive lines, are modulated, as indicated at M₁ and M₂, by the high-frequency and background light components. During the field-retrace periods, part of one of which is indicated at Y—Y, the amplitude of the wave is independent of light-modulation components.

It is well known that, with the positive type of modulation such as is represented in Fig. 2, transitions of the scanning beam from a darker to a lighter part of the image are represented by increases in the amplitude of the carrier amplitude, and the average intensity of the carrier wave is varied in accordance with the low-frequency or unidirectional background-illumination components of the image. Thus, in the particular portions of the wave shown, during the line-trace modulation periods represented at M₁, the amplitude of the carrier is such that it reaches the white level, whereas this does not occur during the modulation periods represented at M₂. Since the average intensity of the carrier is thus varied in accordance with background illumination variations, these carrier variations cannot be used for the purpose of amplification control. Nor, as stated above, are there in this type of wave any synchronizing pulses which could be utilized directly for the purpose in question, since the signal is reduced to zero during the duration of the line-synchronizing pulses. However, the modulation envelope includes a certain representative level, for example, the blanking level, at which the signal may represent black or blacker than black and which appears in the signal not only for black pictures but also during the frame-retrace periods. This level, indicated as black in Fig. 2, affords a measure of the intensity of the carrier wave which is independent of light-modulation components and of other signal characteristics. This level may, therefore, be utilized automatically to control a characteristic of the receiver, such as its amplification.

In the operation of the present invention, therefore, the modulated-carrier wave is detected by the detector 15 to derive a voltage wave corresponding to the modulation envelope of Fig. 2, which voltage is impressed upon the input circuit of the amplifier 16 in the main channel as well as on the input electrodes of the stabilizing tube 20 in the control channel 20, 21, 22 by way of the grid condenser 23 and leak resistor 24. The grid condenser and leak serve automatically to vary the bias of the control grid which, in the absence of a signal, is provided with zero bias, so that the signal is stabilized; that is, the inward peaks of modulation representing the synchronizing pulses are established at a substantially fixed level as they appear on the control grid. Where the connection between the control circuit and the detector is substantially a direct one, so that the unidirectional component of the signal is not lost, the signal may be sufficiently stabilized without the use of the stabilizing tube 20. However, where a non-conductive coupling intervenes between the detector and the control circuit, as the condenser 23 of Fig. 1, the unidirectional component is suppressed and the signal tends to center itself about the zero axis and to appear as illustrated by the curves of Fig. 3. In this case, therefore, it must be stabilized as explained. Moreover, the circuit constants and

operating voltages of the tube 20 are such that the tube is biased beyond cutoff for signal levels beyond a predetermined value so that the signal is effectively limited.

The wave form of the current in the anode circuit of the tube 20 is, therefore, stabilized and limited as illustrated by the wave forms of Fig. 4. Due to the time constant provided by the anode load circuit comprising resistor 25 and condenser 26, which is long compared with the duration of the line-synchronizing pulses but short compared with the duration of the field-retrace periods, the voltage developed between the anode of the tube 20 and ground is not of the same form as the anode current, but is of the form shown by the idealized curves in Fig. 5. In other words, the output circuit time constant may be said to cause the system to ignore the line-synchronizing pulses because of their short duration; that is, the condenser 26 may be considered as by-passing the line-synchronizing pulses or components.

The difference voltage between the anode voltage shown in Fig. 5 and the operating or +B voltage is thus developed across the resistor 25 with a wave form such as shown by the idealized curves of Fig. 6. This voltage, therefore, provides a control signal which has a peak amplitude corresponding to the average intensity of the received carrier and independent of its light-modulation components, such peak amplitude being indicated at *p* and *p'* in Fig. 6 for the signals of different intensities. Moreover, the control signal is derived in response to a predetermined level of the modulation envelope, and independently of other characteristics thereof and particularly independently of whether the receiver is in synchronism or not and is, therefore, independent of the timing characteristics of the received signal.

The control signal developed across the resistor 25 is thereupon rectified by the peak rectifier or diode 21, thereby developing across its load resistor 29 a control-bias voltage dependent solely upon the portions *p* and *p'* of the waves of Fig. 5. This control-bias voltage is applied negatively to the grid of tube 22, wherein it is amplified with a reversal in polarity. This rectified and amplified automatic amplification control-bias voltage developed across the load resistor 31 of tube 22 varies in accordance with a predetermined level of the received signal, specifically in accordance with the blanking level thereof, or with the average intensity of the carrier and independent of light-modulation components. The filter comprising the resistors 32 and condensers 33 serves to remove residual fluctuations from the bias voltage. The resultant automatic amplification control unidirectional-bias voltage is impressed negatively on the control electrodes of one or more of the tubes in the stages 12, 13 and 14 to control the amplification or gain of these stages inversely in accordance with variations of the average carrier intensity and independently of light-modulation components. Thus, the output signal intensity of the channel including the stages 12, 13 and 14 is maintained within a relatively narrow range for a wide range of received signal intensities.

As explained above, the amplifier 22 simply serves to reverse the polarity of the unidirectional-bias voltage developed by the rectifier 21 to develop a voltage which increases negatively with increasing carrier amplitude and independent of light-modulation components. This is, of

course, the required polarity for effecting automatic amplification control. Various other embodiments of the invention will be readily apparent to those skilled in the art, in some of which a reversing amplifier will be unnecessary. For example, the tubes 20 and 21 may be so connected that the voltage developed in the output circuit of the tube 21 increases negatively with increasing carrier amplitude, as by including a resistor equivalent to resistor 25 in the cathode circuit instead of the anode circuit of tube 20. It will be appreciated that, while the present invention has been illustrated as embodied in a receiver adapted to receive television signals of the positively modulated type, and with the A. V. C. system especially constructed for this type of signal, the invention may also be utilized to provide improved synchronizing-signal-separation and automatic control of a received characteristic in receivers adapted for negatively-modulated signals.

The resistor 27 constitutes an impedance through which flow the charging and discharging currents of condenser 26, including the synchronizing components, so that a voltage wave of the same wave form as illustrated in Fig. 4, including pulses corresponding to the synchronizing components in the received signal, is built up across this resistor. As stated above, this voltage is impressed on the input circuits of the generators 18 and 19 for the purpose of synchronizing their operation with the operations of the corresponding apparatus at the transmitter.

It will be appreciated that the condenser 26 in parallel with the resistor 25, fed from the tube 20, provide an integrating circuit whereby the control signal is derived from the detected signal. The resistor 27 in series with the condenser 26, on the other hand, provide a differentiating circuit whereby the original detected signal is restored, or is derived from the control signal, to make available the effectively separated synchronizing components.

It is to be noted that, since the cutoff effected by the tube 20 must be an appreciable distance below the blanking level in order that a suitable control signal may be obtained, the separation of the synchronizing-modulation components from the light-modulation components will not be perfect, and for dark signals the light-modulation components may indeed all be in the signal in the output circuit of the limiter tube. However, such a signal is suitable for use in effecting synchronization, it being essential that the light-modulation components be actually cut off only for strong signals representing white images.

It will also be noted that where the expression "wide range of signal-input intensities" is employed herein and in the appended claims it refers to such intensity variations of the received carrier as are due to fading, to the different field strengths of different signals and the like, and are independent of light-modulation components and not to the relatively smaller average carrier intensity variations which are caused by variation of the average background illumination.

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 for the reception of a television signal-carrier wave modulated by light and synchronizing components, comprising a main signal-translating channel including signal-reproducing means, a separate control signal-translating channel, means included in said control channel for deriving from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave an automatic amplification control effect variable in accordance with the intensity of said carrier wave and independent of its light-modulation components, means included in said control channel for separating said synchronizing components from said other modulation components, means for utilizing said automatic amplification control effect inversely to control the gain of said main channel in accordance therewith, and means for utilizing said separated synchronizing components for synchronizing the operation of said signal-reproducing means.

2. A television receiver adapted for the reception of a television signal-carrier wave modulated by light and synchronizing components and having a wide range of signal-input intensities, comprising a main signal-translating channel including signal-reproducing means, a separate control signal-translating channel, means included in said control channel for deriving from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave an automatic amplification control effect variable in accordance with the average intensity of said carrier wave and independent of its light-modulation components, means included in said control channel for separating said synchronizing components from said other modulation components, means for utilizing said automatic amplification control effect to maintain the intensity of the signal output of said main channel within a relatively narrow range, and means for utilizing said separated synchronizing components for synchronizing the operation of said reproducing means.

3. A television receiver adapted for the reception of a television signal-carrier wave modulated by light-modulation and synchronizing-modulation components, comprising a main signal-translating channel including signal-reproducing means, a separate control signal-translating channel, means included in said control channel for separating said synchronizing components from the other components of said modulation envelope, means included in said control channel for developing from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave an automatic amplification control effect variable in accordance with variations in a predetermined level thereof and independent of its light-modulation components, means for utilizing said separated synchronizing-modulation components to synchronize the operation of said reproducing means, and means for utilizing said automatic amplification control effect inversely to adjust the gain of said signal-translating channel in accordance therewith.

4. A television receiver adapted for the reception of a television signal-carrier wave modu-

lated by light-modulation and synchronizing-modulation components and having a predetermined blanking level, comprising a main signal-translating channel including signal-reproducing means, a control channel, means for applying said derived modulation envelope to both said channels, said control channel including means for separating said synchronizing components from the other components of said stabilized detected signal, means for developing an automatic amplification control effect from said stabilized detected signal variable in accordance with variations in the blanking level and independent of timing characteristics thereof, means for utilizing said separated synchronizing components for synchronizing the operation of said signal-reproducing means, and means for utilizing said automatic amplification control effect inversely to adjust the gain of said main signal-translating channel in accordance therewith.

5. A television receiver adapted for the reception of a television signal-carrier wave modulated by light-modulation components and by synchronizing-modulation components and having a predetermined blanking level, comprising a main signal-translating channel including signal-reproducing means, a control channel, means included in said control channel for separating said synchronizing components from the other components of said signal, means for developing from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave a control signal variable in amplitude in accordance with variations in the blanking level thereof from a fixed level, means for developing a unidirectional-bias automatic amplification control voltage proportional to the peak amplitude of said control signal, means for utilizing said synchronizing components to synchronize the operation of said signal-reproducing means, and means for utilizing said bias voltage inversely to adjust the gain of the main signal-translating channel in accordance therewith.

6. A television receiver comprising a signal-translating channel adapted to translate a television signal including light-modulation components and synchronizing-modulation components, a single means included in said channel for deriving from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier

wave an automatic amplification control voltage including a component variable in accordance with variations in a predetermined level of a signal translated by said channel and independent of variations corresponding to light modulation and for separating said synchronizing components from the other modulation components, separate circuits for utilizing said variable component voltage to control the gain of the receiver inversely in accordance therewith and said synchronizing components for synchronizing the operation of the receiver.

7. A television receiver comprising a signal-translating channel adapted to translate a television signal including light-modulation components and synchronizing-modulation components, a single means included in said channel developing from a signal having predetermined signal components at a level constantly related to the unmodulated peak level of said carrier wave a control voltage having a peak amplitude varying in accordance with the intensity of the signal independent of its light-modulation components and for effectively separating said synchronizing-modulation components from the other modulation components, means for deriving from said control voltage an automatic amplification unidirectional-bias voltage, means for utilizing said bias voltage to control the gain of the receiver inversely in accordance therewith, and means for utilizing said separate synchronizing components to synchronize the operation of the receiver.

8. A television receiver adapted for the reception of a television signal-carrier wave modulated by light and synchronizing components, comprising means for deriving a signal from a received carrier comprising at least the part of its modulation envelope including said synchronizing components stabilized with respect to the peaks thereof, means for integrating said derived signal to derive an automatic amplification control signal, means for utilizing said control signal for controlling the gain of the receiver inversely in accordance therewith, means for differentiating said integrated signal to derive said synchronizing-modulation components, and means for utilizing said synchronizing-modulation components to synchronize the operation of said receiver.

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