March 7, 1944. A. V. LOUGHREN 2,343,561

TELEVISION BROADCASTING SYSTEM

Filed Nov. 6, 1940 3 Sheets-Sheet 1

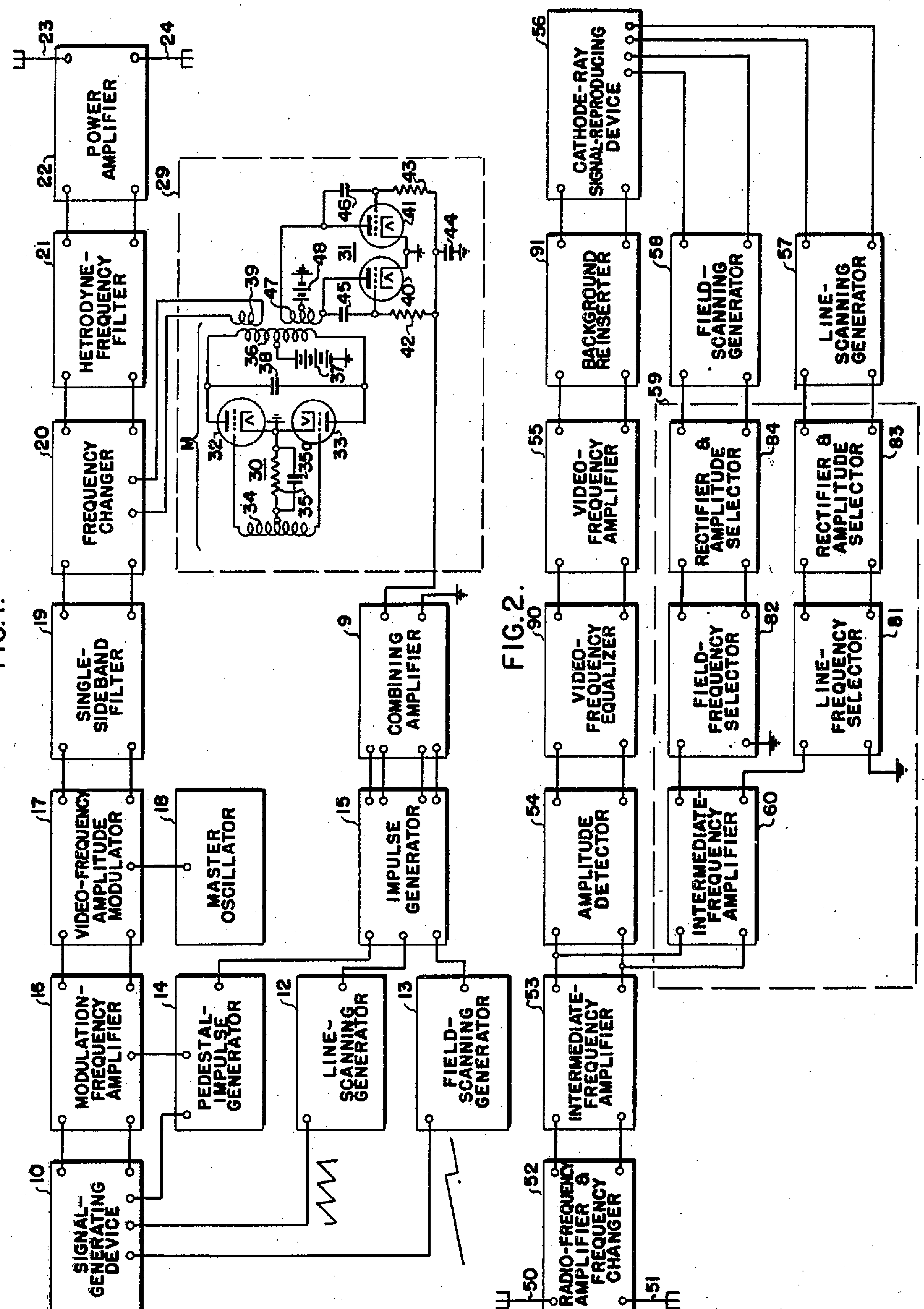

FIG. 1.

FIG. 2.

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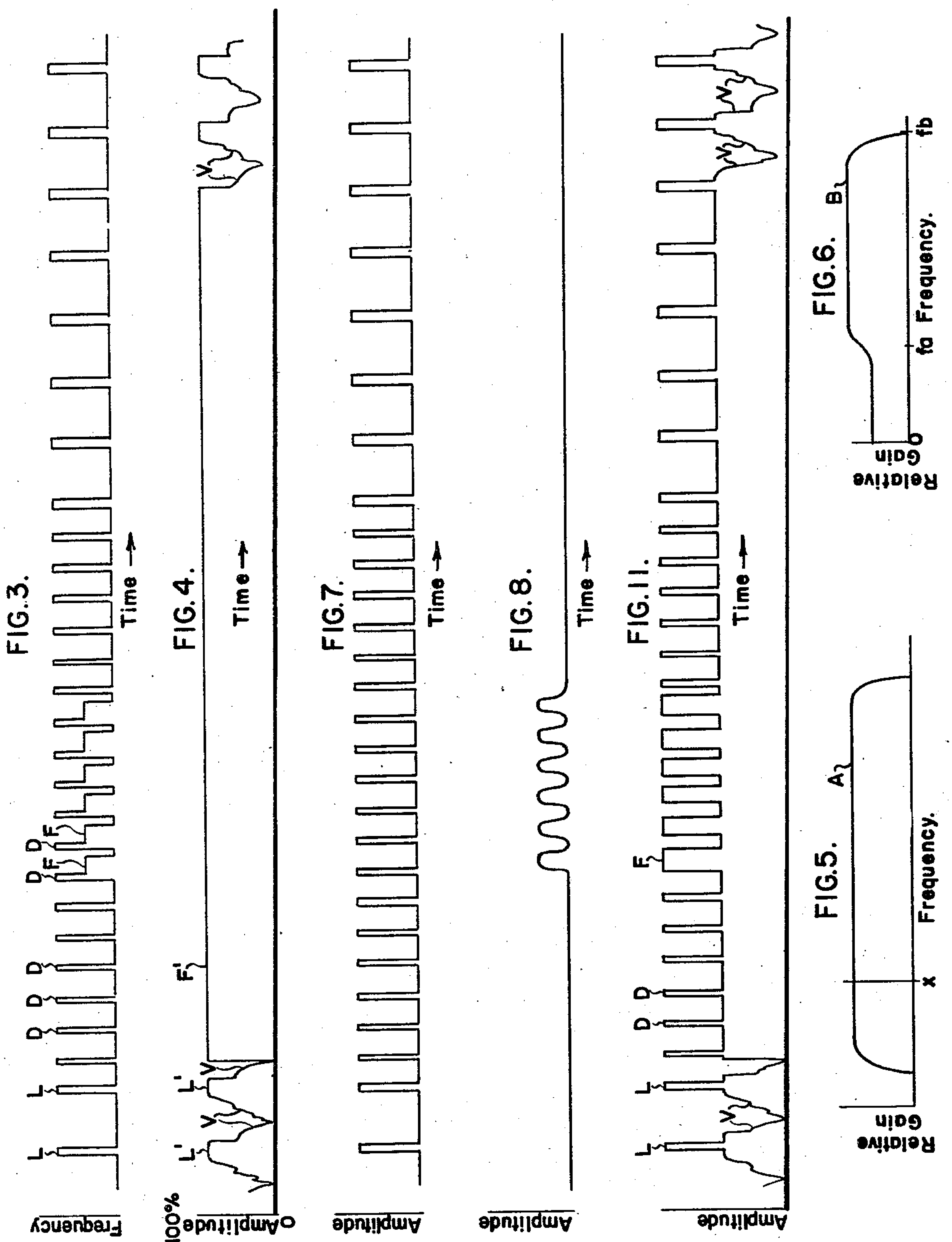
Filed Nov. 6, 1940 3 Sheets-Sheet 2



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TELEVISION BROADCASTING SYSTEM

Filed Nov. 6, 1940 3 Sheets-Sheet 3

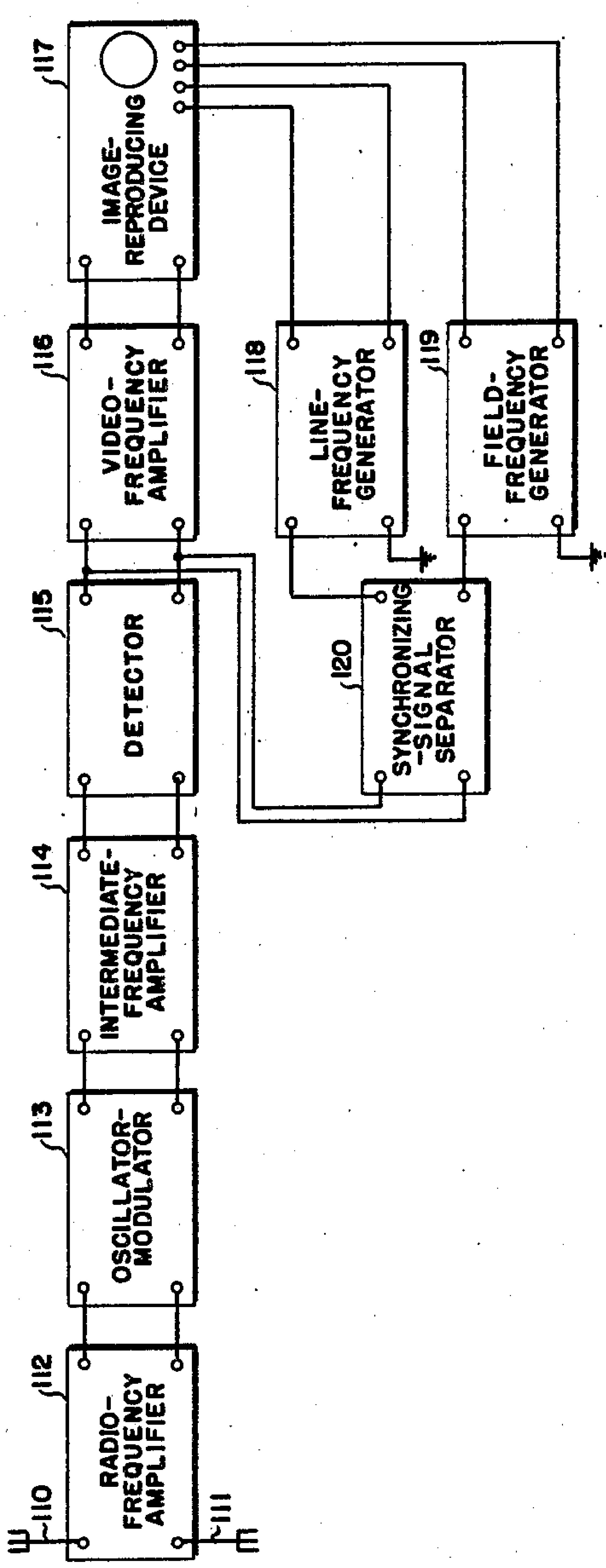

FIG. 9.

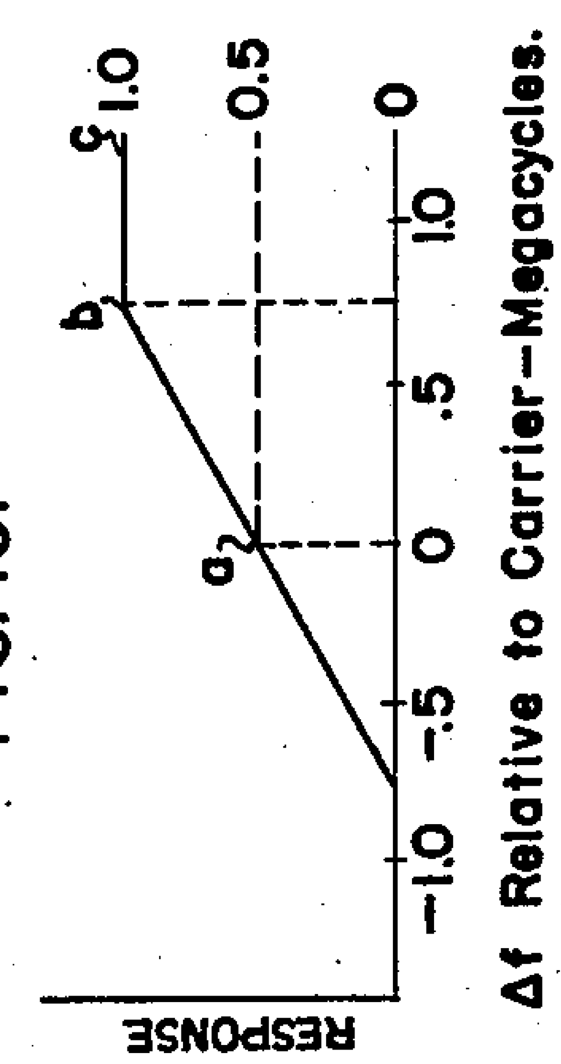

FIG. 10.

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UNITED STATES PATENT OFFICE

2,343,561

TELEVISION BROADCASTING SYSTEM

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Application November 6, 1940, Serial No. 364,499

10 Claims. (Cl. 178—6.8)

This invention relates to television broadcasting systems and is particularly concerned with broadcasting systems of the type comprising a receiver which includes signal-translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals.

It has been proposed to provide a television system including a transmitter adapted to generate and transmit, and a receiver adapted to receive, a carrier-signal wave amplitude-modulated in accordance with video-signal components and frequency-modulated in accordance with synchronizing-signal components. Applicant's United States Letters Patent No. 2,302,619, granted Nov. 17, 1942, and applicant's United States Letters Patent No. 2,254,435, granted September 2, 1941, relate to systems of the type mentioned. In systems of the type under consideration, the advantage of an increase in synchronizing-signal amplitude without any corresponding increase in power at the transmitter is obtained. However, many receivers of the prior art are of a type which comprises synchronizing-signal translating and utilizing apparatus designed to respond only to received carrier signals amplitude-modulated by synchronizing signals. It is, therefore, particularly desirable to provide a television broadcasting system which would retain the beneficial features inherent in arrangements of the type to which the above-mentioned applications relate, that is, of a type in which a carrier wave comprises video signals amplitude modulated thereon and synchronizing signals frequency-modulated thereon, the generated signal being of such a type that it is adapted also to be received on conventional television signal receivers of the type which comprises a synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals.

It is an object of the present invention, therefore, to provide an improved television broadcasting system not subject to the disadvantages of the prior art systems mentioned above.

It is still another object of the invention to provide a television broadcasting system adapted to generate and transmit a carrier signal, amplitude-modulated by video-signal components and frequency-modulated by synchronizing-signal components, which is adapted to be received by conventional television receivers designed to translate and utilize a received carrier signal amplitude-modulated by synchronizing signals.

In accordance with the invention, therefore, a television broadcasting system comprises a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals. A television transmitter is included in the system which comprises means for generating and transmitting to the receiver a modulated-carrier wave including means for generating video-signal components during trace periods and synchronizing-signal components during retrace periods and means for supplying a carrier wave having a predetermined frequency. Means are comprised in the transmitter for modulating the carrier wave in accordance with the video-signal components and means are also comprised in the transmitter for frequency-modulating the carrier wave with the synchronizing-signal components. Means are provided in the system having a frequency-response characteristic so related to the frequency- and frequency deviations of the carrier wave as to develop in the receiver, in response to the synchronizing-signal components, a carrier signal amplitude-modulated by the synchronizing-signal components.

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 accompanying drawings, Fig. 1 is a circuit diagram, partly schematic, of a complete television transmitting system utilized in the broadcasting system of the present invention; Fig. 2 is a schematic circuit diagram of a complete receiving system of a type which comprises synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals frequency-modulated by synchronizing signals; Figs. 3 and 4 are graphs illustrating the wave forms of signals developed by the transmitter of the present invention; Figs. 5–8, inclusive, are graphs illustrating certain operating characteristics of the receiver of Fig. 2; Fig. 9 is a schematic circuit diagram of a complete television receiving system comprising synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals; while Figs. 10 and 11 are graphs illustrating certain of the operating characteristics of the receiver of Fig. 9.

Referring now more particularly to Fig. 1 of the drawings, there is illustrated a television transmitting system which is generally similar to that of Fig. 1 of applicant's above-mentioned United States Letters Patent No. 2,302,619, granted Nov. 17, 1942, and circuit elements which are similar in the two figures have identical reference numerals. This television transmitting system comprises a signal-generating device 10 of any conventional design which may include a cathode-ray signal-generating tube having the usual electron gun, photosensitive target, and line-scanning and field-scanning elements. There are also provided a line-scanning generator 12 and a field-scanning generator 13 with their output circuits connected directly to the line-scanning and field-scanning elements, respectively, of signal-generating device 10. In order to provide pedestal impulses for blocking-out or for suppressing undesired impulses in, and ensuring the proper wave form of, the modulation signal developed by the generator 10, there is provided a pedestal-impulse generator 14 having its output circuit coupled to a control electrode of signal-generating device 10.

In order to synchronize the operations of the synchronizing-signal generating apparatus of the transmitter, and in order to provide periodic pulses of particular wave forms and frequencies as well as apparatus for keying the periodic pulses into the circuit of a combining amplifier to generate a composite synchronizing signal for transmission, there is provided an impulse generator 15. Generator 15 has a plurality of output circuits connected to the generators 12, 13, and 14, as well as a plurality of output circuits coupled to a combining amplifier 9 for combining periodic pulses generated in impulse generator 15 to develop a composite synchronizing signal for transmission.

A modulation-frequency combining amplifier 16 is coupled to the output circuits of signal-generating device 10 and pedestal-impulse generator 14. Connected in cascade to the output circuit of the amplifier 16, in the order named, are a video-frequency amplitude modulator 17 which is provided with a local or master oscillator 18, a single-sideband filter 19, a frequency changer 20, a heterodyne-frequency filter 21, a power amplifier 22, and an antenna system 23, 24.

Neglecting for the moment the details of the stages 19–21, inclusive, and the synchronizing-signal generating apparatus presently to be described, the system just described includes the apparatus of a television transmitting system of a conventional design, rendering a detailed description of its operation unnecessary herein. Briefly, however, the image of the scene to be transmitted is focused on the target of the cathode-ray tube of signal-generating device 10, in which a cathode ray is developed, accelerated, and focused on the target. Scanning or deflection waves developed by the generators 12 and 13 are supplied to the scanning elements of the signal-generating device 10 and serve to deflect the ray to scan successive series of fields of parallel lines on the target. Pedestal impulses developed by the generator 14 are applied to the control electrode of the tube of signal-generating device 10 to suppress or block-out the beam during retrace portions of the scanning cycle and are applied to the modulation-frequency amplifier 16 to suppress undesirable impulses or transients developed in the system during the retrace intervals to aid in obtaining the required wave form of the video-modulation signal. The photosensitive elements of the target of signal-generating device 10 being electrically affected to an extent dependent upon the varying values of light and shade at corresponding incremental areas of the image focused thereon as the cathode ray scans the target, a voltage of correspondingly varying amplitude is developed in the output circuit of the signal-generating tube and supplied to the amplifier 16.

Suitable timing or synchronizing impulses are applied from generator 15 to the generators 12, 13 and 14 to maintain these generators in synchronism with either the master frequency, in case of direct camera shots, or the motion picture film, in the case where such pictures are being transmitted. The video-frequency signal components applied to the amplifier 16 are amplified therein and thereupon supplied to the modulator 17, where they are impressed on the carrier wave generated by the oscillator 18. The signal is translated from modulator 17 to the power amplifier 22 by way of stages 19–21, inclusive, which will be described hereinafter in more detail, the signal input to frequency changer 20 from unit 19 being combined therein with the synchronizing-signal components of the transmitted signal. The heterodyne-frequency filter 21 may be of any suitable conventional type designed to pass either the sum or difference frequencies developed in frequency changer 20. The resulting modulated-carrier wave is amplified in the power amplifier 22 and is impressed upon the antenna system 23, 24 for radiation.

Coming now to the portion of the transmitter provided for adding synchronizing components to the transmitted carrier wave, it will first be noted that the generators 12 and 13 develop scanning waves of saw-tooth form, as indicated at the left of these generators, for application to signal-generating device 10 for effecting desired scanning thereof. Generator 15 is adapted to generate, in accordance with well-known practice, periodic waves of predetermined wave form and frequency, including rectangular-pulse keying waves for keying predetermined portions of other periodic waves into the circuit of combining amplifier 9. The output circuit of combining amplifier 9 is coupled to a control apparatus 29 which is provided for the purpose of shifting the frequency of the carrier wave derived from frequency changer 20 during the synchronizing pulses. Control apparatus 29 includes an oscillator indicated generally at 30 and a frequency-adjusting network indicated generally at 31. Preferably, the oscillator is of the push-pull type and comprises vacuum tubes 32 and 33 having their input circuits connected in push-pull relation by way of an inductance 34, a leak resistor 35 and a grid condenser 35a being connected in parallel between a mid-tap on inductance 34 and the cathodes of the tubes. The anode circuits of tubes 32 and 33 are also connected in push-pull relation by way of an inductance 36 coupled to the inductance 34, as indicated by bracket M, a mid-tap on the inductance 36 being connected to the cathodes of the tubes by way of a suitable anode-voltage supply, such as a battery 37. The inductance 36 is normally sharply-tuned to a fixed frequency by means of a condenser 38, or other suitable circuit arrangement such that the oscillations developed by the oscillator 30 when combined with the carrier wave developed by oscillator 18 produce a heterodyne component of the desired carrier frequency for transmission. An inductance 39 is coupled to inductance 36 and connected to the frequency changer 20 for the purpose of shifting the carrier frequency of the signal derived from frequency changer 20 in accordance with the frequency of the oscillations developed by the oscillator 30.

The frequency-adjusting network 31 preferably comprises a pair of vacuum tubes 40 and 41 having their control grids connected by way of resistors 42 and 43 to the output circuit of combining amplifier 9, condenser 44 being connected across the coupling circuit effectively to by-pass oscillation-frequency currents to ground. The control grids of tubes 40 and 41 are also connected by way of coupling condensers 45 and 46 to their respective anodes which, in turn, are connected to the terminals of an inductance 47. The inductance 47 is connected in push-pull relation in the anode circuits of the tubes, a midtap thereof being connected to the tube cathodes by way of a suitable anode-voltage supply source, indicated by battery 48. The inductance 47 is inductively coupled to the inductance 36 of the oscillator frequency-determining circuit.

In considering the operation of the transmitter just described and referring first to frequency-adjusting network 31 which, it will be assumed, is excited from oscillator 30, it will be seen that, if the impedances of condensers 45 and 46 are high compared with those of resistors 42 and 43, the voltages across the resistors lead the voltage across inductance 47 by a large angle. Therefore, the space current of the tubes, being in phase with the tube input voltage, also leads the voltage across inductance 47 in a corresponding degree. Hence, the system simulates an impedance having primarily capacitive reactance the value of which varies in accordance with the grid-bias voltage applied to the tubes. The adjustment of the grid-bias voltages on the tubes 40 and 41, therefore, varies the effective reactance of the circuit 31 and, hence, the natural frequency of the oscillation circuit 36, 38 to which it is coupled.

Normally the tubes 40 and 41 are biased beyond cutoff and remain so biased during the video signal or trace periods, being rendered operative only during synchronizing or retrace periods when impulses from the combining amplifier 9 are applied thereto. Since the tubes 40 and 41 are cut off during the video-signal periods, the oscillation circuit 36, 38 maintains its own natural frequency during these periods. During the occurrence of the synchronizing impulses, however, the impedance reflected into the oscillation circuit 36, 38 by the frequency-adjusting network 31 is varied in accordance with the line-frequency and field-frequency impulse voltages applied to the grids of the tubes 40 and 41 from the combining amplifier 9, so that the frequency of the oscillation circuit is shifted to a value dependent upon the amplitude of the line-frequency or field-frequency pulse applied to the input circuits of tubes 40 and 41.

The relationship of the line-synchronizing, equalizing, and field-synchronizing pulses of the composite synchronizing signal is preferably as shown in Fig. 3 of the drawings, in which the transmitted line-synchronizing signals are indicated at L, the transmitted equalizing pulses are indicated as D, and the transmitted field-synchronizing pulses are indicated as F. The field-synchronizing pulses are approximately of half the amplitude of the line-synchronizing pulses, but considerably longer in duration, and preferably bear such relationship to the line-synchronizing pulses that pulses of the two types are not transmitted during the same time interval. The field pulses F preferably initiate immediately after the occurrence of the equalizing pulses D and are of a duration somewhat less than one-half a line-scanning period. It will be understood that, in a double-interlace system, the field-synchronizing pulses of the succeeding field-retrace interval are displaced by one-half line, as is conventional practice.

Since the oscillator 30 is coupled to the frequency changer 20, its output is mixed with the video-modulated carrier signal from the filter 19 and the sum and difference heterodyne-frequency components are developed in the output circuit of the frequency changer 20 in a well-known manner. Either the sum-frequency or the difference-frequency components are selected by the filter 21 and delivered to power amplifier 22 to be broadcast. Therefore, the frequency of the selected heterodyne-carrier output of frequency changer 20 is maintained constant during the trace intervals, but is varied or shifted during the retrace intervals in accordance with the frequency variations of oscillator 30, as described above. In Fig. 4 there is illustrated half of the envelope of the resultant amplitude-modulated carrier wave developed by the transmitting system. The video-signal components are represented by the portion of the wave indicated at V, the portions representing the line-retrace and field-retrace periods during which the carrier is shifted or varied, as described with reference to Fig. 3, being indicated at L' and F', respectively, and the magnitudes of the frequency shifts of the carrier wave being represented by the pulses L, D, and F of Fig. 3, as explained above.

Thus, the carrier wave developed in the output circuit of modulator 17 is amplitude-modulated by the video-signal components during only the trace-scanning periods and during these periods the frequency of the wave generated by the generator 30 and supplied to the frequency changer 20 has its normal constant value, which may be of the order of 10—50 megacycles, so that the carrier frequency of the output of the frequency changer 20 is constant. During a portion of each line-retrace period an impulse from combining amplifier 9 is impressed on frequency-adjusting network 31, thereby to effect a predetermined deviation of the frequency developed by the generator 30 and, hence, in that of the signal developed in frequency changer 20, as indicated by the pulses L of Fig. 3. Preferably, this frequency deviation is many times the frequency of the line-synchronizing signals of the system and may be, for example, of the order of 2 megacycles for a carrier frequency of 50 megacycles. During a portion of each field-retrace period, on the other hand, impulses from the combining amplifier 9 are applied to network 31, thereby to effect a frequency deviation corresponding to the equalizing pulses D and also to effect a different and lesser predetermined frequency deviation in the frequency developed by oscillator 30 corresponding to the field-synchronizing pulses F. Preferably, the carrier-frequency deviation during the field-synchronizing pulses is about one-half that during the line-synchronizing pulses, for example, of the order of 1 megacycle for a 50-megacycle carrier wave. Line synchronization of the system, as will be seen by the curves of Fig. 3, is not interrupted during field-retrace periods. Preferably, the direction of the carrier-frequency deviations by the synchronizing pulses is such as to bring it within the frequency range of the transmitted sideband. In the signal of Fig. 3 it is seen that the total energy of the line pulses and equalizing pulses during one line-scanning period is constant.

Referring now to Fig. 2, the system there illustrated comprises a receiver of the superheterodyne type for receiving and utilizing the signal developed by the transmitter of Fig. 1. This receiver includes an antenna system 50, 51, to which are connected in cascade, in the order named, a radio-frequency amplifier and frequency changer 52, an intermediate-frequency amplifier 53, an amplitude detector 54, a video-frequency equalizer 90, a video-frequency amplifier 55, a unidirectional or background component reinserter 91, and a cathode-ray signal-reproducing device 56. Preferably, as explained below, the stages 52 and 53 are designed for single-sideband reception. A line-scanning generator 57 and a field-scanning generator 58 are coupled to the scanning elements of signal-reproducing device 56 in a conventional manner and preferably include conventional synchronizing circuits which are adapted to be controlled by synchronizing impulses developed by the apparatus 59.

The circuits 50–58, inclusive, may be of any conventional well-known construction, so that detailed illustrations and descriptions thereof are deemed unnecessary herein. Referring briefly to the general operation of the receiving system, however, television signals are selected and amplified and converted into intermediate-frequency signals in the radio-frequency amplifier and frequency changer 52, the intermediate-frequency signals being, in turn, selectively amplified in the intermediate-frequency amplifier 53 and delivered to the detector 54. The video-frequency amplitude-modulation components of the signal are derived by the detector 54 and are supplied through equalizer 90, the operation of which will be described hereinafter, to the video-frequency amplifier 55, wherein they are amplified and from which they are supplied in the usual manner to a brilliancy-control electrode of the signal-reproducing device 56, the signals being stabilized by background reinserter 91 in a manner to be hereinafter fully described.

The intermediate-frequency signal is also supplied from the amplifier 53 to the apparatus 59, wherein the synchronizing signals are derived, the line-synchronizing and field-synchronizing components being effectively separated from the video-frequency signal and from each other and supplied to the control circuits of generators 57 and 58, as will be hereinafter further explained. Saw-tooth current or voltage-scanning waves are developed in the line-scanning and field-scanning generators 57 and 58 and applied to the scanning elements of the signal-reproducing device 56 to produce electric scanning fields, thereby to deflect the intensity-modulated cathode ray in two directions normal to each other so as to trace successive series of fields of parallel lines on the target of the tube to reconstruct the transmitted image.

Referring now more particularly to the synchronizing-signal deriving apparatus 59, there is comprised therein an intermediate-frequency amplifier 60 to which line-scanning generator 57 is coupled through a line-frequency selector 81 and a rectifier and amplitude selector 83, and to which field-scanning generator 58 is coupled through a field-frequency selector 82 and a rectifier and amplitude selector 84. The line-frequency selector 81 may be constructed in accordance with the correspondingly numbered unit of Fig. 2 of applicant's United States Letters Patent No. 2,302,619 granted Nov. 17, 1942, and comprises a selector circuit effective to pass primarily the carrier wave when deviated by the line-synchronizing pulses L, or the equalizing pulses D of Fig. 3, which selected pulses of the carrier-frequency wave are rectified in the rectifier and amplitude selector 83, which may also be constructed in accordance with the teachings of the correspondingly numbered element of applicant's said United States Letters Patent. The selected line-synchronizing pulses and equalizing pulses as applied to the input circuit of generator 57 are of a wave form as represented by the curve of Fig. 7.

Similarly, field-frequency selector 82 is effective to pass primarily the carrier wave when deviated to a different frequency by the field-synchronizing pulses F of Fig. 3 and the selected wave pulses are rectified by rectifier and amplitude selector 84. Only the peaks of the rectified output of the amplitude selector unit 84 are utilized to synchronize field-canning generator 58 and such peaks comprise substantially only field-synchronizing information as illustrated by the wave form of Fig. 8.

In considering the operation of the system just described, it will be assumed that both the single-sideband filter 19 of Fig. 1 and the selector of intermediate-frequency amplifier 53 of Fig. 2, which may be of any suitable well-known design, have response-frequency characteristics such as that shown by curve A of Fig. 5, wherein relative gain is plotted against frequency. Each selector is designed to have a response characteristic which is substantially level or uniform over a wide frequency band and a mean frequency so related to the carrier frequency of the signal to be translated that this carrier frequency is located on the uniform portions thereof, as indicated by X in Fig. 5. The selectors thus pass the carrier wave, one complete sideband of its modulation components, the vestigial portion of the other sideband components not suppressed at the transmitter, and, in case the carrier-frequency is deviated within the normally transmitted sideband, such carrier-frequency deviations. It will be seen that, inasmuch as the carrier frequency of the system is at all times located upon the uniform-response portion of the characteristic, there is substantially no amplitude change in the intermediate-frequency signal output of amplifier 53 due to the frequency shift of the carrier wave by the line-synchronizing and field-synchronizing pulses of the system. Therefore, the video-frequency signal of the receiver of Fig. 2 is not subject to any spurious amplitude variation during the line-retrace or field-retrace periods of the signal and the background reinserter or stabilizing unit 91 is effective to stabilize the signal input to signal-reproducing device 56 at a predetermined shade value within the amplitude range of the actual transmitted signal, rather than on the peaks of synchronizing pulses which correspond to signal amplitudes outside of the range of the transmitted shade values as in conventional television systems. For example, in a receiver adapted to receive video-signal components which are negatively amplitude-modulated on the received carrier, back ground reinserter 91 may be effective to stabilize the signal input to signal-reproducing device 56 directly at an amplitude level thereof corresponding to the black level of the transmitted signal, rather than at some infra-black level, as in conventional television systems. On the other hand, if the received video-signal components are positively modulated on the received carrier, background reinserter 91 is effective to stablize the signal input to signal-reproducing device 56 at an amplitude level corresponding to the white shade value of the transmitted signal. If the receiver is adapted to receive such a positively modulated video signal, in some cases, it may be necessary that block-out pulses also be supplied to signal-reproducing device 56 for causing the scanning beam to be blocked-out during the retrace intervals of the system. Background reinserter 91 may be of the form disclosed in the correspondingly numbered unit of Fig. 2 of applicant's United States Letters Patent No. 2,302,619, granted Nov. 17, 1942.

Since, in the receiver of Fig. 2, both sideband components correspond to the lower modulation-frequency components and adjacent the carrier signal are translated with substantially the same gain as the pure single-sideband components, the detector output at the lower modulation frequencies is greater than that at the higher modulation frequencies. Therefore, it is preferable to provide an equalizer 90 having a band-pass characteristic substantially as represented by curve B of Fig. 6 which is effective relatively to equalize all reproduced video-signal components of the transmitted picture. For this purpose, the relative gain of equalizer 90 between zero frequency and a frequency f_a, corresponding to the video-signal range over which double-sideband components are transmitted and received, is one-half that over the video-signal range f_a to f_b, which corresponds to that over which only single-sideband components are transmitted and received. The equalizer 90 may, therefore, be constructed in accordance with the disclosure of applicant's United States Letters Patent No. 2,302,619, granted Nov. 17, 1942.

The signal generated and transmitted by the transmitter of Fig. 1 can also be received on a conventional type of television receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals. A receiver of this type is illustrated in Fig. 9 and includes an antenna system 110, 111 connected to a radio-frequency amplifier 112, to which are connected in cascade, in the order named, an oscillator-modulator 113, an intermediate-frequency amplifier 114, a detector 115, a video-frequency amplifier 116, and an image-reproducing device 117. A line-frequency generator 118 and a field-frequency generator 119 are coupled to the output circuit of the detector 115 through a synchronizing-signal separator 120 and to deflecting elements of image-reproducing device 117. The stages or units 110–120, 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 an antenna circuit 110, 111 are selected and amplified in radio-frequency amplifier 112 and coupled to the oscillator-modulator 113 where they are converted into intermediate-frequency signals which, in turn, are selectively amplified in the intermediate-frequency amplifier 114 and delivered to the detector 115. The modulation components of the signal are derived by the detector 115 and are supplied to the video-frequency amplifier 116 wherein they are amplified and from which they are supplied in the usual manner to a brilliancy-control electrode of the image-reproducing device 117. Detected modulation-signal components are also supplied to synchronizing-control elements of generators 118 and 119 through synchronizing-signal separator 120. The intensity of the scanning ray of device 117 is thus modulated or controlled in accordance with the video-frequency voltages impressed on the control electrode in the usual manner. Scanning waves are generated in the line-frequency and field-frequency generators 118, 119 and are controlled by synchronizing-voltage pulses supplied from detector 115 and supplied to the scanning elements of image-reproducing device 117 to produce deflecting fields, thereby to deflect the scanning 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.

Reference is made to the graphs of Figs. 10 and 11 for an explanation of the operation of the receiver of Fig. 9 when the signal transmitted by the transmitter of Fig. 1 is being received. In Fig. 10, there is shown a portion of the response-frequency characteristics of one of the band-pass circuits of the television receiver of Fig. 9. This may, for instance, be a portion of the characteristic of the intermediate-frequency amplifier 114. The received intermediate-frequency signal is applied to the selector having the characteristic of Fig. 10 so that the carrier frequency thereof, during the time when video signals are being translated, that is, during the time when the received carrier is only amplitude-modulated, falls at the point zero. The selector is so designed that equalization of single-sideband components and double-sideband components is obtained. Therefore, during intervals of reception of frequency-modulated synchronizing signals, the frequency deviation of the carrier signal shifts it beyond the sloping portion of the curve *a, b* and on the straight or uniform-response part *b, c* of the curve for all translated synchronizing signals; that is, even the translated field-synchronizing pulses F are effective to shift the carrier frequency to the point *b* of the curve *a, b*. Under these conditions, therefore, there is developed in the output of intermediate-frequency amplifier 114 during the synchronizing intervals and in response to the synchronizing signal components a carrier-frequency signal which is amplitude-modulated by the synchronizing-signal components. In this manner the selector comprises means having a frequency-response characteristic so related to the frequency and frequency variations of the carrier wave as to develop in the receiver in response to the synchronizing-signal components a carrier signal amplitude-modulated thereby. Such a signal may be translated and utilized by the receiver in the same manner that conventional amplitude-modulation signals are translated and utilized.

In Fig. 11, there is illustrated one-half of the modulation envelope of the carrier-frequency signal so produced in intermediate-frequency amplifier 114. It is thus seen that this carrier-frequency envelope comprises amplitude-modulated line-synchronizing pulses L, equalizing pulses D, and relatively broad field-synchronizing pulses F and so corresponds precisely to the standard composite television signal recommended by the Radio Manufacturers Association. However, it will be readily apparent that the invention is equally applicable to a television system utilizing a composite synchronizing signal of any other wave form. However, it is also seen that the synchronizing-signal components of the curve of Fig. 11 are of substantially the same amplitude as the video-frequency portions of the received signal, and this feature is an added advantage of applicant's improved television system in that it facilitates the separation of the synchronizing signal.

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 broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components during retrace periods, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said carrier wave with said synchronizing-signal components, and means in said system having a frequency-response characteristic so related to the frequency and frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier signal amplitude-modulated by said synchronizing-signal components.

2. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components of a predetermined wave form during retrace periods, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said carrier wave with said synchronizing-signal components, and means in said system having a frequency-response characteristic so related to the frequency and frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier signal amplitude-modulated in response to said synchronizing-signal components with amplitude-modulation components of a substantially similar wave form.

3. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for modulating and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and line-synchronizing signal components of a predetermined wave form during line-retrace periods and field-synchronizing components of a predetermined wave form during field-retrace periods, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said carrier wave with said synchronizing-signal components, and means in said system having a frequency-response characteristic so related to the frequency and frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier wave amplitude-modulated by said synchronizing-signal components and comprising amplitude-modulation components of wave forms similar to the wave forms of said synchronizing-signal components.

4. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components during retrace periods, means for supplying a carrier wave having a predetermined frequency, means for amplitude-modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said wave with said synchronizing-signal components, and means in said system having a frequency-response characteristic so related to the frequency and frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier signal amplitude-modulated by said synchronizing-signal components.

5. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and a composite synchronizing signal including line-synchronizing components and field-synchronizing components, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said wave with said composite synchronizing signal so that said line-synchronizing components and said field-synchronizing components effect different frequency deviations of said wave, and means in said system having a frequency-response characteristic so related to the frequency

and frequency deviations of said carrier wave as to develop in said receiver in response to said composite synchronizing-signal components a carrier signal amplitude-modulated by said composite synchronizing-signal components.

6. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a modulated-carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components during retrace periods, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said wave with said synchronizing signal components, and means in said receiver having a frequency-response characteristic so related to the frequency and frequency deviations of said carrier wave as to develop in response to said synchronizing-signal components a carrier signal amplitude-modulated by said synchronizing-signal components.

7. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components during retrace periods, means for supplying a carrier wave having a predetermined frequency, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said carrier wave with said synchronizing-signal components, and means in said receiver having a frequency-response characteristic with a sloping portion so related to the frequency and frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier signal amplitude-modulated by said synchronizing-signal components.

8. A television broadcasting system comprising, a receiver which includes synchronizing-signal translating and utilizing apparatus designed to respond to received carrier signals amplitude-modulated by synchronizing signals, a television transmitter including, means for developing and transmitting to said receiver a carrier wave including means for developing video-signal components during trace periods and synchronizing-signal components during retrace periods, means for modulating said carrier wave in accordance with said video-signal components, means for frequency-modulating said carrier wave with said synchronizing-signal components, and means in said receiver having a frequency-response characteristic with a sloping portion and a uniform-response portion so related to the frequency and the frequency deviations of said carrier wave as to develop in said receiver in response to said synchronizing-signal components a carrier signal amplitude-modulated to a substantially uniform degree by said synchronizing-signal components.

9. In a television system including a transmitter and a receiver designed to receive an amplitude-modulated carrier-frequency television signal, the method of operation of which comprises generating and transmitting a carrier-frequency signal which is modulated by video-frequency components and frequency-modulated by synchronizing-signal components, receiving the transmitted signal, translating the received carrier-frequency signal to develop a carrier-frequency signal having amplitude variations corresponding to the frequency variations of the received carrier signal, utilizing only said amplitude variations of said developed carrier-frequency signal to synchronize the operation of the receiver, and utilizing the developed carrier-frequency signal also to reproduce the transmitted picture.

10. In a television receiving system including a receiver designed to receive an amplitude-modulated carrier-frequency television signal, the method of operation of which comprises receiving a carrier-frequency signal which is modulated by video-frequency components and frequency-modulated by synchronizing-signal components, translating the received carrier-frequency signal to develop a carrier-frequency signal having amplitude variations corresponding to the frequency variations of the received carrier-frequency signal, utilizing only said amplitude variations of the developed carrier-frequency signal to synchronize the operation of the receiver, and utilizing the developed carrier-frequency signal also to reproduce the transmitted picture.

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