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AUTOMATIC GAIN CONTROL FOR TELEVISION RECEIVERS

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FIG. 1.

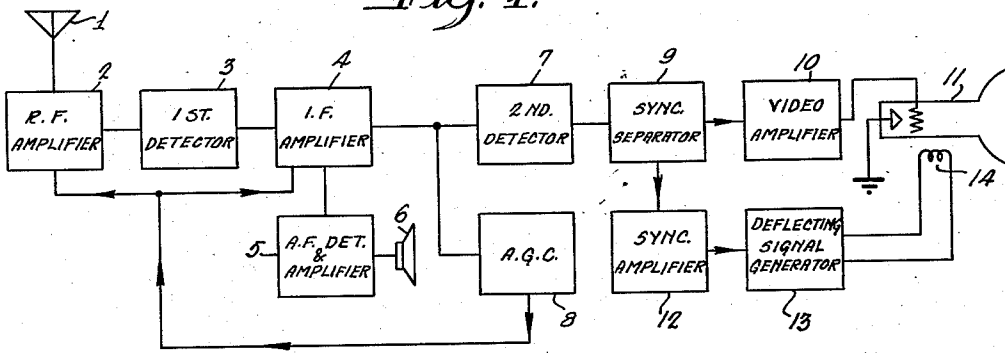


FIG. 2.

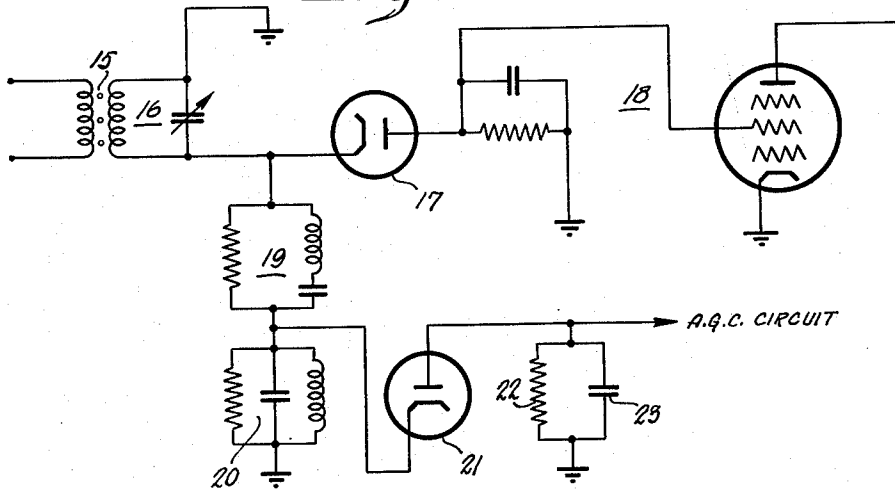
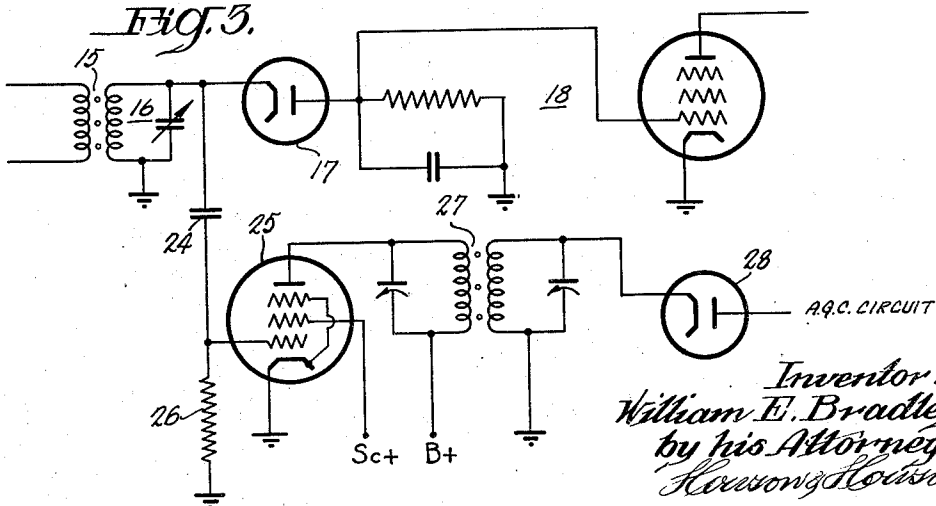


FIG. 3.



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AUTOMATIC GAIN CONTROL FOR
TELEVISION RECEIVERS

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14 Claims. (Cl. 178—7.5)

This application relates to an automatic gain control system for a television receiver and more particularly to an automatic gain control system which operates from the black level of the incoming carrier and is independent of the synchronizing pulses.

In the conventional type of television receiver used in the past, the synchronizing pulses have been transmitted at the same carrier frequency as the blanking pulses, but at a higher amplitude level.

As described, for example, in the copending application of F. J. Bingley, Serial No. 401,533, filed July 8, 1941, there has been introduced a new system of synchronizing known as the alternate carrier system in which the carrier wave, during the synchronizing pulse intervals, is shifted in frequency within the assigned television channel. In the particular system shown in the Bingley application, the carrier wave is also shifted in amplitude during the synchronizing intervals. This alternate carrier system provides greatly improved synchronizing performance on weak signals at the receiver.

It has been the usual arrangement to operate automatic gain control (hereinafter referred to as AGC) from the detected signal which includes the synchronizing pulses. In the older type of television signal the presence of the synchronizing pulse in the signal from which AGC voltage was directly derived was undesirable, but it is more so in the alternate carrier system because the shift in frequency is to a point of much higher receiver sensitivity. The effect of this frequency shift is to cause the synchronizing pulse to effectively take control of the AGC circuit. It is found, however, that the synchronizing pulses are not suitable for determining AGC voltage, for synchronizing pulse strength varies at different locations and with different transmitters, and are therefore unreliable as a base for AGC.

It is desirable to determine the automatic gain control voltage of the receiver by the black level rather than by the synchronizing pulses since the black level is a fixed picture level and a true base from which to obtain AGC.

It is one object of this invention to control the automatic gain control circuit from the black level of the signal.

It is another object of the invention to provide an automatic gain control system which is entirely independent of the synchronizing pulses.

It is still another object of the invention to provide an automatic gain control system which

utilizes the entire period of the black level rather than a portion of this period.

It is another object of the invention to substantially eliminate the effect of noise on the automatic gain control circuit.

Other objects of the invention will be apparent to those skilled in the art from the following specification and the accompanying drawing, the figures of which are intended to be merely illustrative of one form of the invention and not limiting thereof.

In the drawing,

Fig. 1 is a block diagram of a television receiver embodying a gain control system in accordance with the invention;

Fig. 2 is a circuit diagram of one embodiment of the invention which may be employed in the television receiver of Fig. 1; and

Fig. 3 is a circuit diagram of another embodiment of the invention which may be employed in the television receiver of Fig. 1.

Referring first to Fig. 1, there is shown a television receiver having an antenna 1, a radio frequency amplifier 2, a first detector 3 for converting to a fixed intermediate frequency, and an intermediate frequency amplifier 4 from which is derived directly the signal for the audio detector and amplifier unit 5 and the loudspeaker 6. The output of the I. F. amplifier is also fed to a video second detector 7 and to the automatic gain control circuit 8 which will be described in detail presently. The A. G. C. voltage developed in the device 8 is utilized to control the gain of the R. F. and I. F. stages in known manner. The output of the second detector 7 is fed to the synchronizing signal separator 9 from which is derived the video signal for the video amplifier 10 and the picture tube 11, and also the synchronizing signal for the synchronizing signal amplifier 12, which controls the deflecting signal generator 13 and the deflecting means 14 of the picture tube.

The automatic gain control circuit shown at 8 in Fig. 1 is shown in detail in Fig. 2. The signal from the intermediate frequency amplifier is transferred through the final I. F. transformer 15 to the tuned circuit 16, and in known manner is applied to the cathode of the detector diode 17 in the second detector 7. From the anode circuit of the diode 17 there is obtained the combined video and synchronizing signal, and this signal is then applied to the input circuit 18 of the synchronizing signal separator 9. This arrangement is conventional in most television receivers. Also connected to the tuned circuit

16 are constant resistance networks 19 and 20, both of which may be tuned to the intermediate video carrier frequency. The first of these networks 19 comprises a series-tuned circuit in parallel with a resistance, while the second network 20 comprises a parallel-tuned circuit in parallel with a second resistance. Both of these networks should advantageously be resonant to the same frequency, said frequency being such that the overall frequency response characteristic of the receiver, up to the cathode of the A. V. C. diode 21 is a maximum at the picture carrier frequency. For this condition of response it will be found that the tuned circuits 19 and 20 will be approximately, but not exactly, tuned to the carrier frequency in the I. F. amplifier. For any incoming signal in the I. F. band there will be a voltage drop developed across the combined circuits 19 and 20 which will be approximately the same irrespective of frequency, since the networks 19 and 20 in series form a constant resistance network. These networks will therefore act to attenuate all signals in the tuned circuit 16 to the same degree and will not cause different attenuation at different frequencies. When the incoming signal is at normal I. F. carrier frequency there will be a voltage produced across the parallel-tuned circuit 20, while there will be practically no voltage across the series-tuned circuit 19. Connected across the tuned circuit 20 is the diode 21 in series with a diode load circuit which comprises resistor 22 and condenser 23. The anode of the diode 21 is connected, in known manner, to a network of suitable time constant to supply the automatic gain control voltage to the preceding intermediate and radio frequency amplifying tubes.

In alternate carrier television transmission practice, the video carrier frequency may differ from the synchronizing carrier frequency by something in the order of a megacycle. In the operation of this receiver on an alternate carrier signal, when the set is properly tuned, the carrier frequency in the intermediate frequency stages of the receiver will be, as described above, near but slightly different from the frequency to which the circuits 19 and 20 are tuned. During the entire signal, but particularly during the blanking pulses, when the video carrier is at maximum amplitude, there will appear across the circuit 20 a voltage due to this circuit being in resonance with the I. F. carrier frequency. Mainly from the blanking pulses there will appear across the diode 21 and the resistance 22 a voltage of carrier frequency which will be rectified by the diode and will supply a voltage of proper magnitude to the automatic gain control circuit. As previously explained the synchronizing carrier is shifted in frequency as well as being of greater magnitude than the blanking pulses, and since the circuit 20 has a Q which is relatively high as compared with the circuits of the intermediate frequency amplifier, that is, of the order of 20 or 30, its resonant response to the frequency of the synchronizing carrier will be relatively low. The synchronizing signal, while of high magnitude, will, therefore, produce very little voltage across the tuned circuit 20. Thus it may be seen that the synchronizing pulses will have practically no effect on the automatic gain control circuit and the automatic gain control circuit will be materially affected only by the actual blanking pulses of the received signal.

Since the networks 19 and 20 are designed so

as to form together a constant resistance circuit, the effect of these circuits on the tuned circuit 16 will be merely that of a pure resistance, and there will be no tuning or distortion effects on the signal applied to the second detector; and therefore the broad band employed for the reception of the combination of the video signal and the synchronizing pulses will be passed without distortion.

Fig. 3 shows a modification of the invention in which the signal from the tuned circuit 16 is supplied through the condenser 24 to the control grid of the pentode tube 25, instead of to a constant resistance network. The output of the tube 25 is supplied to the tuned primary circuit of the transformer 27. The secondary circuit of this transformer is connected to the automatic gain control diode 28 which acts in the same manner as the automatic gain control diode 21 of Fig. 2. In this embodiment the transformer 27 may have a Q which is relatively high as compared to the Q of the I. F. transformer 15, and the coils of the transformer 27 may be critically coupled so as to give a sharp point of resonance. In the operation of the embodiment shown in Fig. 3, it is obvious that the signal applied to the cathode of the detector diode 17 is also applied to the control grid of the pentode amplifier tube 25. The amplified signal from the plate of this tube is fed to the sharply tuned transformer 27. This transformer is tuned to the frequency of the video carrier but is substantially off tune for the synchronizing carrier. The output of this transformer is fed to the automatic gain control diode. As explained in connection with Fig. 2, signals of video carrier frequency will be amplified by the tube 25 and will appear in the cathode circuit of the diode 28 and will accordingly affect the automatic gain control of the receiver. Synchronizing pulse signals on the other hand, which are materially shifted in frequency, will cause little voltage across the output of the transformer 27 due to the substantial mistune, and will therefore cause practically no effect on the automatic gain control circuit, even though such pulses are of considerably greater amplitude than either the video signal itself or the blanking pulses.

It is to be understood that the above-described embodiments are illustrative only and are not to be construed as limiting the invention. Other tube combinations, for example a pentode and a triode, and other circuits, e. g. the combination of a constant resistance network and a triode, will be obvious to those skilled in the art, as well as numerous other modifications and variations.

I claim:

1. In a television receiver adapted for reception of video and synchronizing signals transmitted at different carrier frequencies, the method of controlling the gain of said receiver which comprises deriving a portion of the signal energy from the signal channel of the receiver, selecting the video carrier from said derived signal, producing from the selected carrier a gain control voltage whose magnitude is determined substantially in accordance with the blanking level of the video carrier, and utilizing said voltage to control the gain of the receiver.

2. In a television receiver adapted for reception of video and synchronizing signals transmitted at different carrier frequencies, an automatic gain control system comprising means for deriving a portion of the signal energy from the signal channel of the receiver, means for selecting the video carrier from said derived signal and for

producing a gain control voltage whose magnitude is determined substantially in accordance with the blanking level of the video carrier, and means for utilizing said voltage to control the gain of the receiver.

3. In a television receiver of the superheterodyne type having a fixed intermediate frequency broad band amplifier and adapted to receive alternate carrier television signals by which the video and blanking impulses are transmitted at one carrier frequency and the synchronizing pulses are transmitted at a second carrier frequency, an automatic gain control system comprising at least one circuit tuned approximately to the first carrier frequency and being substantially non-responsive to said second carrier frequency, means for deriving an automatic gain control voltage from said circuit, and means for utilizing said voltage to control the gain of the receiver.

4. In a television receiver including an amplifier adapted for reception of video and synchronizing signals transmitted at different carrier frequencies, an automatic gain control system, comprising constant impedance means connected to said amplifier, said impedance means including a parallel-tuned circuit resonant approximately at the video carrier frequency, means for rectifying the voltage across said resonant circuit, and means for utilizing the rectified voltage to control the gain of the receiver.

5. In a television receiver of the superheterodyne type adapted for reception of video and synchronizing signals transmitted at different carrier frequencies, an automatic gain control system, comprising constant impedance means connected to the receiver's intermediate frequency amplifier, said impedance means including a parallel-tuned circuit resonant approximately at the video intermediate frequency, means for rectifying the voltage across said resonant circuit, and means for utilizing the rectified voltage to control the gain of the receiver.

6. In a television receiver of the superheterodyne type adapted to receive alternate carrier signals, an automatic gain control system comprising a constant impedance network connected to the receiver's intermediate frequency amplifier, said constant impedance network including a series-tuned circuit and a parallel-tuned circuit connected in series, each of the tuned circuits being resonant substantially to the receiver's video intermediate frequency, and said parallel-tuned circuit being relatively sharply tuned so as to be relatively unaffected by signals of other than the said video intermediate frequency, and rectifier means connected across said parallel-tuned circuit for generating an automatic gain control voltage.

7. In a television receiver of the superheterodyne type adapted for use in the reception of alternate carrier television signals, an intermediate frequency amplifier having a pass-band of sufficient width to pass the video carrier, the desired video side-band frequencies, and the synchronizing carrier, a second detector circuit responsive to both said carriers and to said side-band frequencies, and an automatic gain control circuit responsive primarily to said video carrier and constructed and arranged to discriminate against said synchronizing carrier, thereby to provide an automatic gain control voltage whose magnitude is substantially independent of synchronizing signal energy.

8. A television receiver as claimed in claim 7,

wherein said automatic gain control circuit includes a constant resistance network which comprises a first resonant circuit and a second resonant circuit in series, said first resonant circuit comprising at least a resistance, a capacitance and an inductance in parallel, and said second resonant circuit comprising at least a resistance in parallel with a series inductance-capacitance arm, said first and second resonant circuits being tuned approximately to said video carrier frequency, and rectifying means for obtaining an automatic gain control voltage from the signal appearing across said first resonant circuit.

9. A television receiver as claimed in claim 7, wherein said video and synchronizing carriers differ in frequency by approximately one megacycle.

10. In a television receiver of the superheterodyne type adapted to receive alternate carrier television signals and including means to convert the incoming carrier to a desired intermediate frequency, an automatic gain control system comprising a circuit arranged to receive said signals and presenting a substantially constant impedance for a substantial frequency deviation from said carrier frequency, said circuit comprising two networks in series, the first of said networks including at least a resistance, an inductance and a condenser all in parallel, and the second network including a resistance in parallel with an arm having a condenser and an inductance in series, each of said networks being resonant approximately to the converted video carrier frequency, and means for developing an automatic gain control voltage from said first network.

11. In a television receiver of the superheterodyne type having a fixed intermediate frequency broad band amplifier and adapted to receive different video and synchronizing signal carriers, an automatic gain control system comprising an amplifier tube connected to said intermediate frequency amplifier and adapted to receive a signal from said amplifier, a narrow band network tuned to the video intermediate frequency and connected in the output of said amplifier tube, said narrow band network causing substantial attenuation of the synchronizing signal carrier, rectifier means coupled to the output of said narrow band network, and means for deriving an automatic gain control voltage from the output of said rectifier means.

12. In a television receiver of the superheterodyne type adapted to receive alternate carrier television signals, an automatic gain control system comprising a pentode amplifier having its control grid coupled to the intermediate frequency amplifier of said receiver, a narrow-band filter connected to the output of said pentode, and tuned to the video intermediate frequency, a diode rectifier connected to said filter, and gain control means connected to said rectifier.

13. In a television system wherein a transmitted composite signal wave comprises periodically recurrent video portions alternating with periodically recurrent synchronizing portions, said portions being transmitted respectively by means of carrier frequency waves of substantially different frequency, said synchronizing portions being of substantially greater amplitude than said video portions, a receiver responsive to said transmitted composite signal wave for reconstructing the transmitted image, said receiver including an amplifier designed to pass the entire signal wave

including both the video portions and the synchronizing portions, and an automatic gain control system having means operative to select from the output of said amplifier energy derived from the video carrier largely to the exclusion of said synchronizing portions and to convert the selected energy into a gain control voltage whose magnitude is determined substantially in accordance with the blanking level of the video carrier, said gain control system including connections for applying said control voltage to said receiver for regulating its amplification.

14. In a television receiver capable of receiving a television signal in which the synchroniz-

ing and video components differ in carrier frequency and the synchronizing components are of higher amplitude than the video components, a gain control system comprising means for deriving signal energy from the signal transfer channel of the receiver, frequency-responsive means arranged to receive the derived signal and operable to produce from the video carrier a control signal whose magnitude is determined substantially in accordance with the blanking level of the received signal, and means for utilizing said control signal to control the gain of the receiver.

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