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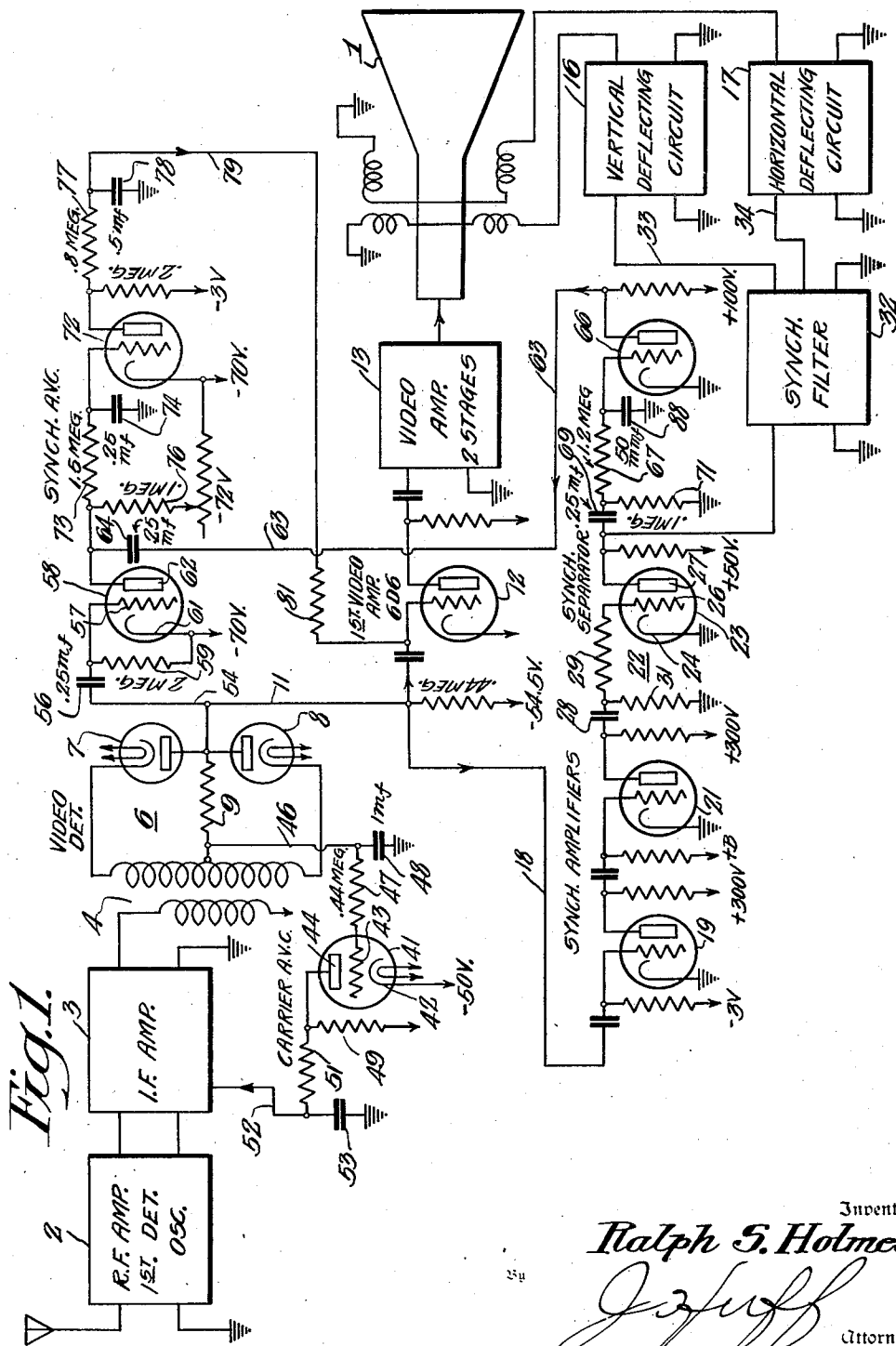
R. S. HOLMES

2,230,295

TELEVISION RECEIVER

Filed Aug. 31, 1938

3 Sheets-Sheet 1



Inventor  
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 Attorney

Feb. 4, 1941.

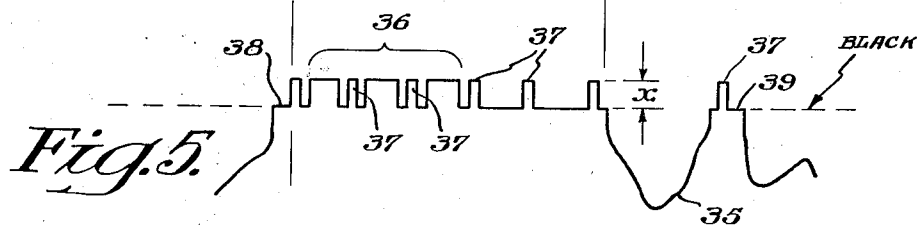
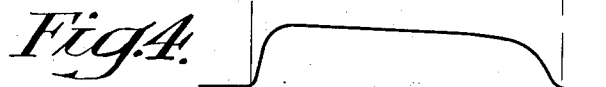
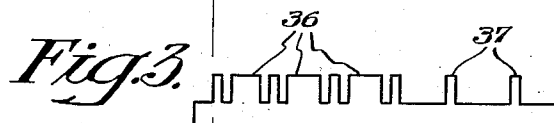
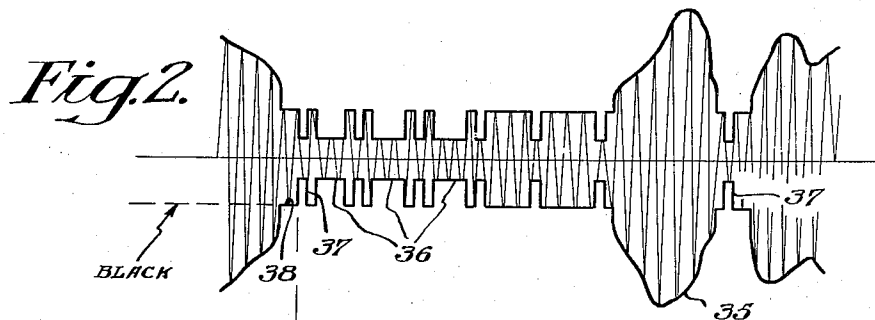
R. S. HOLMES

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TELEVISION RECEIVER

Filed Aug. 31, 1938

3 Sheets-Sheet 2



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Feb. 4, 1941.

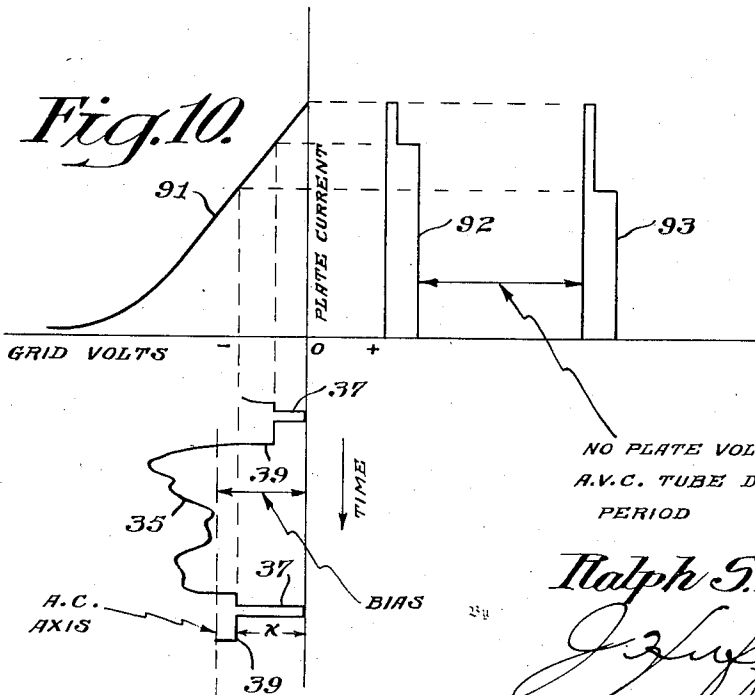
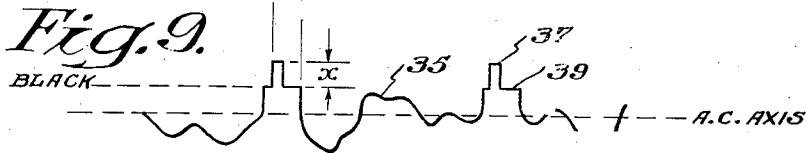
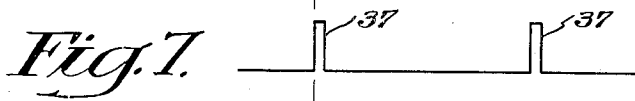
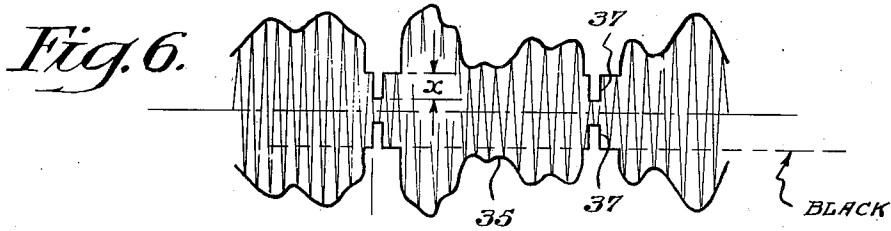
R. S. HOLMES

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TELEVISION RECEIVER

Filed Aug. 31, 1938

3 Sheets-Sheet 3



NO PLATE VOLTAGE ON SYNC.  
A.V.C. TUBE DURING THIS  
PERIOD

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## UNITED STATES PATENT OFFICE

2,230,295

## TELEVISION RECEIVER

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Delaware

Application August 31, 1938, Serial No. 227,789

8 Claims. (Cl. 178—7.5)

My invention relates to television receivers or the like and particularly to automatic volume control systems for such receivers for use in television systems employing "positive modulation."

5 The term "positive modulation" is used to describe the type of transmission wherein the synchronizing impulses (which are in the direction of "black") cause a decrease in the carrier strength. The invention will be described in connection with a television system wherein horizontal synchronizing impulses are transmitted at the end of each scanning line and wherein vertical synchronizing or framing impulses are transmitted at the end of each picture frame.

15 The conventional method of providing A. V. C. in either a broadcast receiver or in a television receiver is to derive a gain control voltage from the carrier wave of the incoming signal. However, in television transmission, it has been found desirable to transmit the direct current component of the picture signal. A television transmitter of this type is described and claimed in application Serial No. 203,015 filed April 20, 1938, in the name of A. V. Bedford, and assigned to the Radio Corporation of America.

25 When the D. C. component of the picture signal is transmitted, the average carrier no longer is a true measure of the signal strength, it being a measure of both the signal strength and the D. C. component of the picture signal.

30 In systems employing "negative modulation," this difficulty may be overcome by deriving a gain control signal from the synchronizing signals, since their height is a measure of the signal strength. A system of this character is described and claimed in my copending application Serial No. 210,611, filed May 28, 1938, entitled "Television receivers" and assigned to the Radio Corporation of America.

40 In systems employing "positive modulation" and D. C. transmission, however, the problem of obtaining A. V. C. is more difficult. For such systems it has been proposed to utilize what may be referred to as "synchronized A. V. C." wherein a gain control circuit is keyed or rendered responsive only during the occurrence of the synchronizing impulses, or more specifically, only during the occurrence of the signals commonly referred to as "super-sync" and "pedestal." In this way, the A. V. C. circuit measures the height of the "super sync" impulse itself, this height being a true measure of the signal strength. An A. V. C. system of this character is described in Blumlein British Patent 458,585.

55 The difficulty with a plain "synchronized

A. V. C." circuit such as described by Blumlein is that it is difficult to obtain sufficient control voltage to provide the desired gain control when there is a large change in signal strength as when tuning from one transmitter station to another.

5 It is, accordingly, an object of my invention to provide an improved A. V. C. or gain control system for television systems or the like.

More specifically, it is an object of my invention to provide an improved A. V. C. system for television systems of the type employing "positive modulation" and D. C. transmission.

10 In practicing my invention, I utilize two types of A. V. C. circuits in combination, one A. V. C. circuit being designed to correct for large changes in signal strength and the other A. V. C. circuit being designed to give a final and accurate control of the receiver's gain. In a preferred embodiment of my invention, the first-mentioned circuit is a conventional A. V. C. circuit which controls the gain of the receiver in accordance with the average carrier strength. Since the carrier wave is modulated by the D. C. component, this conventional circuit is controlled both by carrier strength and by the D. C. component. However, since the change in the carrier amplitude when tuning from one station to another is much greater than the change in the carrier amplitude produced by the D. C. component, this conventional A. V. C. circuit holds the amplitude of the incoming signal within limits such that a "synchronized A. V. C." circuit can complete the work of holding the receiver output at a constant level.

25 As indicated above, the second-mentioned circuit is a "synchronized A. V. C." circuit of the type referred to in connection with the Blumlein British patent. This circuit gives a final and accurate adjustment of the receiver gain. One way of describing the function of this second A. V. C. circuit is to say that it removes the inaccuracy in the gain control introduced by the conventional A. V. C. circuit because of the presence of D. C. modulation on the carrier.

40 The invention will be better understood by referring to the following description taken in connection with the accompanying drawings in which

Figure 1 is a circuit diagram of one embodiment of my invention,

Figures 2, 3, 4, and 5 are curves which are referred to in explaining the operation of my invention for the case where the synchronized A. V. C. is operated by the vertical synchronizing impulses,

Figures 6, 7, 8 and 9 are curves which are re-

ferred to in explaining the operation of my invention for the case where the synchronized A. V. C. is operated by the horizontal synchronizing impulses, and

5 Figure 10 is a diagram which is referred to in explaining the operation of the synchronized A. V. C.

Referring to Fig. 1, I have shown my invention applied to a television receiver comprising the usual cathode ray tube 1 connected to the receiver output circuit and comprising a radio receiver at the input end which, as indicated by the block 2, may be the input end of a super-heterodyne receiver comprising a radio frequency amplifier, a first detector and a tunable oscillator. The intermediate frequency signal supplied from the first detector is amplified by a suitable I. F. amplifier indicated by the block 3 and impressed through suitable coupling means such as a transformer 4 upon a second detector 6, which, in the example illustrated, is of the push-pull type comprising diodes 7 and 8.

The second detector circuit 6 includes an output resistor 9 across which appears the video signal such as shown in Figs. 5 and 9. This video signal is supplied through a conductor 11 to the first video amplifier indicated at 12 and through additional video amplifier stages indicated by the block 13, if desired, to the input electrodes of the cathode ray tube 1 whereby the received picture appears on the fluorescent screen of the cathode ray tube.

While the video signal is being supplied to the input electrodes of the cathode ray tube 1, the cathode ray is being deflected vertically and horizontally in the usual way to scan the fluorescent screen. The vertical and horizontal deflecting circuits indicated by the blocks 16 and 17, respectively, may be of any suitable design, but preferably are saw-tooth wave generators of the type including blocking oscillators.

In order to synchronize the deflecting circuits, the video signal is supplied through conductors 11 and 18 and through resistance coupled amplifiers 19 and 21 to a suitable separating circuit 22 for removing the picture signal from the synchronizing signals. In the receiver illustrated, the separating circuit 22 comprises a vacuum tube 23 having a cathode 24, a control grid 26 and a plate 27. The synchronizing impulses are impressed upon the grid 26 of the separating tube with a positive polarity through a coupling condenser 28 and, if desired, through a resistor 29. In some instances, it is desirable to omit the resistor 29. A grid leak resistor 31 is connected between the grid 26 and the cathode 24, this resistor having such resistance and the coupling condenser 28 having such capacity that the grid is maintained so negatively biased by a grid leak biasing action that the tube is biased beyond cut-off for picture signals whereby it passes only the positive synchronizing impulses, these being of greater amplitude than the picture signals of like polarity. It will be understood that any other synchronizing signal separator may be employed if desired.

The synchronizing signals which appear in the plate circuit of the separating tube 23, which are of the character illustrated in Figs. 3 and 7, are supplied to a suitable filter circuit indicated by the block 32 for separating vertical synchronizing and horizontal synchronizing signals from each other. Such a filter circuit preferably comprises two resistance-capacity networks, one of which passes only the horizontal synchronizing impulses due to a differentiating action and the other of

which passes only the vertical synchronizing impulses, which are of longer duration than the horizontal synchronizing impulses, due to an integrating action. The horizontal and vertical synchronizing impulses appearing in the filter output circuit are supplied over the conductors 33 and 34 to the deflecting circuits 16 and 17, respectively.

At this point, the character of the incoming signal will be considered more in detail. The modulated carrier wave which is supplied to the second detector is of the character illustrated in Figs. 2 and 6. It will be seen that this is a carrier wave which in Fig. 2 has been modulated by the video signal shown in Fig. 5 and in Fig. 6 has been modulated by the video signal shown in Fig. 9 with the polarity of modulation "positive" whereby the synchronizing impulses, which are in the black direction, reduce the amplitude of the carrier. It may be noted that the synchronizing signals shown in these figures are of the character described in Patent No. 2,192,121, issued Feb. 27, 1940, in the name of A. V. Bedford and assigned to the Radio Corporation of America. As described in this Bedford patent, the vertical synchronizing impulse indicated at 36 in Fig. 5 is slotted whereby horizontal synchronizing impulses 37, preferably of double frequency in the region of the vertical impulse, may be set in the slots. As also described in this Bedford patent, the synchronizing impulses 37 are added to set upon blanking impulses which are referred to as pedestals, these pedestals being held at a fixed level such as "black" in the picture. Thus the vertical synchronizing impulse 36 and the double frequency horizontal synchronizing impulses 37 are set upon a blanking impulse or pedestal 38 as shown in Fig. 5, while the horizontal synchronizing impulses 37 occurring at the line frequency are set upon horizontal blanking impulses or pedestals 39 as shown in Figs. 5 and 9. The picture signal is indicated at 35.

As previously pointed out, the incoming modulated carrier wave illustrated in Fig. 2 is modulated by the D. C. component of the picture being transmitted whereby the average carrier strength is not a true measure of the signal strength. Except for this fact, the first A. V. C. circuit which is of conventional design and which will now be described, would be satisfactory when used by itself for controlling the receiver gain.

This first A. V. C. circuit, which is operated by the average carrier, may comprise a vacuum tube 41 having a cathode 42, a control grid 43 and a plate 44. As is well known, there appears across the output resistor 9 of the push-pull detector 6 a D. C. voltage which is a measure of the average carrier. This D. C. voltage is impressed upon the grid of the A. V. C. tube 41 through a conductor 46 and a resistor 47. A by-pass condenser 48 is provided to hold the cathode end of resistor 9 at A. C. ground potential.

It will be noted that the A. V. C. tube 41 is connected to function as a direct current amplifier, the cathode 42 being connected to a negative potential to bias the control grid 43 the proper amount with respect to the cathode. The A. V. C. voltage appearing across the plate resistor 49 of the tube 41 is supplied to the desired number of I. F. amplifier stages and to the R. F. amplifier, if desired, through a filter resistor 51 and a conductor 52. A filter condenser 53 is provided which has the proper capacity with respect to the resistance of the resistor 51 to give the proper

time constant for A. V. C. action, as is well known in the art.

The carrier A. V. C. circuit described above will prevent large variations in signal strength from appearing in the output circuit of the second detector 6, substantially the only variations in signal strength appearing at this point being those introduced by the direct component of the transmitted picture signals.

10 The "synchronized" A. V. C. circuit which follows the "average carrier" A. V. C. circuit and which gives a final and accurate control of the receiver gain will now be described. The video signal appearing across the output resistor 9 of the second detector 6 is supplied through a conductor 54 and through a grid condenser 56 to the grid 57 of a vacuum tube 58. A grid resistor 59 is connected between the grid 57 and the cathode 61 of the tube 58. As in the case of the automatic background control circuit invented by Waldemar J. Poch and described and claimed in application Serial No. 718,192, filed March 30, 1934, and assigned to the Radio Corporation of America, the capacity of the grid condenser and the resistance of the grid resistor are such that due to a grid leak biasing action the grid 57 is so biased with respect to the cathode 61 that only the positive peaks of the synchronizing impulses produce a flow of grid current. Unlike the automatic background control circuit, however, the tube 58 is rendered operative to pass plate current only during the occurrence of a synchronizing impulse and its pedestal. This may be done by applying plate voltage through a conductor 63 and a coupling condenser 64 to the plate 62 of the tube 58 during this period. This plate voltage may be derived as follows:

The synchronizing impulses which appear in the output circuit of the separating tube 23 are impressed upon the input electrodes of an amplifier tube 66 through an integrating circuit comprising a series resistor 67 and a shunt condenser 88. The synchronizing impulses are supplied to the integrating circuit through a coupling condenser 69. A grid resistor 71 is connected between ground and the junction point of the coupling condenser 69 and resistor 67.

The capacity of the condenser 88 is made so large with respect to the other circuit constants that each synchronizing impulse is widened to produce an impulse having a duration which is greater than that of the synchronizing impulse but, preferably, not of sufficiently greater duration to last longer than the pedestal. For example, if the vertical synchronizing impulses are being utilized for operation of the synchronized A. V. C., the signal appearing in the plate circuit of the amplifier tube 66 and being supplied through the conductor 63 to the A. V. C. tube 58 may be substantially as illustrated in Fig. 4. The various circuit constants indicated on the drawings in microfarads, micro-microfarads and megohms are for an adjustment of the circuit where the vertical synchronizing impulses are being utilized for keying the synchronized A. V. C., these impulses occurring at the rate of 60 per second.

The current impulses supplied by the A. V. C. tube 58 during the occurrence of each vertical synchronizing impulse and its blanking impulse or pedestal are supplied through a filter or smoothing circuit to an amplifier tube 72, the filter circuit comprising a series resistor 73 and a shunt condenser 74. A suitable bias is applied to the grid of the amplifier tube 72 through a grid resistor 76. Further filtering may be provided in the plate circuit of the amplifier tube 72 as illustrated, this filter comprising a series resistor 77 and a shunt condenser 78. The resulting voltage appearing across the filter condenser 78 is a measure of the strength of the incoming signal and is supplied through a conductor 79 and a grid resistor 81 to the grid of the first video amplifier tube 12 for automatically controlling its gain. The tube 12 preferably is of the exponential type, such as the 606, which has a gradual cut-off whereby the gain may be varied about 5 to 1 without introducing noticeable distortion.

It will be apparent that the synchronized A. V. C. circuit may be adjusted to operate on the horizontal synchronizing impulses rather than on the vertical synchronizing impulses alone. To obtain this operation, it is required only that certain constants of the circuit be changed. For example, the integrating circuit comprising the resistor 67 and the condenser 88 should be given a shorter time constant to produce a keying voltage of the character illustrated in Fig. 8.

The operation of the synchronized A. V. C. circuit will be better understood by referring to Fig. 10. In this figure, in order to simplify the illustration, it is assumed that the synchronized A. V. C. is being obtained from the horizontal synchronizing impulses. The explanation for this operation, of course, applies equally well to the operation where the vertical synchronizing impulses are utilized.

Referring to Fig. 10, the video signal which is impressed upon the grid of the A. V. C. tube 58 is illustrated as comprising picture signal 35, the horizontal synchronizing impulses 37 and the horizontal blanking impulses or pedestals 39. The biasing voltage which is produced by the synchronizing impulses driving the grid slightly positive causes the peaks of the synchronizing impulses always to reach zero grid volts as a reference level. For example, if the video signal increases in amplitude, the grid leak bias increases and the A. C. axis of the video signal is moved away from the zero grid volts axis as illustrated.

The grid voltage-plate current characteristic of the A. V. C. tube 58 is indicated at 91. It will be apparent, remembering that plate voltage is applied to this A. V. C. tube only from the beginning of a synchronizing impulse to a time at or before the end of the pedestal, that the plate current resulting from this input signal will be as indicated at 92 and 93.

It has been assumed in Fig. 10 that the amplitude of the incoming signal has suddenly increased whereby the second synchronizing impulse or "super-sync" impulse 37 is of greater amplitude than the first one, as indicated on the drawings. As a result, the plate current produced by this second synchronizing impulse and by its pedestal will be less than the plate current produced by the first synchronizing impulse and its pedestal. In other words, it will be apparent that since the width of the blanking impulses or pedestals is constant, an increase in the height of the synchronizing impulse itself (i. e., of the "super-sync" impulse) will cause a decrease in the energy content of the impulse produced by it in the plate circuit of the A. V. C. tube 58. Obviously, therefore, the voltage supplied to the grid of the amplifier tube 72 and then to the grid of the first video amplifier 12 is a measure of the height  $x$  of the super-sync impulse which varies only with a variation in the strength of the incoming signal.

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It is, of course, desired that when the strength of the incoming signal increases, the gain of the video amplifier be reduced by applying to it a more negative bias. That this result is obtained will be seen from the following consideration of the circuit operation. Since the synchronizing impulses modulate the carrier positively, there is minimum current flow through the output resistor 9 of the second detector 6 during their occurrence and the plate end of this resistor, to which the grid of the A. V. C. tube 58 is connected, is the most positive. Thus, the synchronizing impulses are being applied to the grid of the A. V. C. tube 58 in the positive direction as required. If the super-sync impulses increase in amplitude due to an increase in signal strength, there will be a decrease in the plate current or energy supplied to the smoothing filter 73-74 and a corresponding decrease in the negative voltage applied to the grid of the amplifier tube 72. Thus, there is more current flow through the plate resistor 70 of the amplifier tube 72 whereby the plate end of this resistor 70 becomes more negative and whereby a more negative bias is applied to the grid of the first video amplifier 12.

Various modifications may be made in my invention without departing from the spirit and scope thereof. For example, the synchronizing impulses which are utilized to "key" the synchronized A. V. C. circuit may be obtained from one or both of the deflecting circuits. Also, instead of applying these "keying" impulses to the plate of the tube 58, they may be applied to an auxiliary grid such as a screen grid in this tube. My invention may be applied to a combined picture and sound receiver as follows:

It is customary to use an automatic volume control operated by average carrier on the sound side of a television receiver of the combined picture and sound type such as shown in Carlson Reissue Patent 20,700. Since the sound and picture carriers are adjacent to each other in frequency, their transmission characteristics are closely alike. Therefore, in every location the signals on a combined receiver from the sound and video transmitters will bear approximately the same ratio. Then if the automatic volume control voltage for the sound portion of the receiver is used also to control the gain of the picture side, the signal on the picture second detector will remain approximately constant, provided the ratio of sound and video transmitter powers for the various stations it is desired to receive is maintained approximately constant. In this case the average carrier A. V. C. on the picture side can be dispensed with and the synchronous A. V. C. will have to operate over only a limited range to make up for the unavoidable variations in ratio of sound and picture carrier strength.

It may be noted that the synchronizing voltage supplied to the sync, separating tube 23 may be maintained constant by applying the synchronized A. V. C. voltage to the grid of one of the amplifier tubes 19 or 21.

It should be understood that the point of separation of the two types of A. V. C. circuits need not be at the second detector. For example, it may be at one of the I. F. amplifier stages. To be specific, the signal for operating an average carrier A. V. C. circuit may be supplied from the third I. F. stage and the gain control voltage from this circuit applied to the preceding I. F. stages, while the signal for the synchronized A. V. C. circuit may be obtained from the second detec-

tor as illustrated in Fig. 1, its gain control output being applied to the fourth I. F. stage rather than to a video amplifier.

Although my improved receiver is most useful in connection with a system where the carrier wave is modulated by direct current and also "positively" modulated by the synchronizing impulses, it will operate satisfactorily for the reception of either a "negatively" or "positively" modulated carrier wave which may or may not be modulated by direct current. If the carrier wave is "negatively" modulated, a different type of system will generally be preferred.

It should be noted, however, that my combination A. V. C. system will correct for a difference in the percentage of modulation at different transmitter stations, and that for this reason its use may be desirable even though the carrier wave is not modulated by direct current.

While I have illustrated an incoming signal in which the pedestal is held at the "black" level, it should be understood that it may be held at a different fixed level if preferred.

I claim as my invention:

1. In a television receiver for the reception of a carrier wave modulated by picture signals and synchronizing signals, each of said synchronizing signals comprising a pedestal which goes to a fixed level such as "black" and which has a super-sync impulse thereon, the combination of means for intercepting at least one carrier wave radiated from a transmitting station and modulated by said signals, at least two amplifiers connected in cascade, means for controlling automatically the gain of the first of said amplifiers in accordance with the average amplitude of one of said intercepted carrier waves, and means for controlling the gain of the second of said amplifiers in accordance with the height of said super-sync impulses as measured from said pedestals.

2. In a television receiver for the reception of a carrier wave modulated by picture signals and synchronizing signals, each of said synchronizing signals comprising a pedestal which goes to a fixed level such as "black" and which has a super-sync impulse thereon, the combination of at least two amplifiers connected in cascade, means for controlling automatically the gain of the first of said amplifiers in accordance with the average amplitude of said modulated carrier wave, and means for controlling the gain of the second of said amplifiers in accordance with the height of said super-sync impulses as measured from said pedestals.

3. In a television receiver for receiving at least one carrier wave radiated from a transmitter station which wave is modulated by the direct current component of a picture being transmitted and modulated by synchronizing signals in the direction to decrease the amplitude thereof, each of said synchronizing signals consisting of a pedestal having a super-sync impulse thereon, the combination of means for amplifying the intercepted carrier wave modulated by synchronizing signals, means for next demodulating said carrier to produce a video signal, means for controlling automatically the amount of said amplification in accordance with the average amplitude of an intercepted carrier wave radiated from said station, means for supplying said video signals to an output device, and means for next controlling the amplitude of the video signals supplied to said output device in accordance with the

height of said super-sync impulses as measured from said pedestals.

4. In a television receiver for the reception of a carrier wave modulated by the direct current component of the picture being transmitted and modulated in the direction to reduce the amplitude of the carrier wave by synchronizing signals each comprising a pedestal having a super-sync impulse thereon, the combination of means for amplifying said modulated carrier wave, means for demodulating said carrier wave to produce video signals, means for amplifying said video signals, means for controlling the gain of said first amplifying means in accordance with the direct current output of said demodulating means, and means for controlling the gain of said second amplifying means in accordance with the height of said super-sync impulses as measured from said pedestals.

5. In a television receiver comprising means for intercepting at least one carrier wave radiated from a transmitting station and modulated by a video signal, the combination of means for amplifying said modulated wave, means for demodulating said amplified wave to produce video signals which include pedestals having super-sync signals thereon, means for controlling the gain of said amplifying means in accordance with the average carrier amplitude of a carrier wave radiated from said station, means for supplying said video signals to an output device, and means for controlling the amplitude of the video signals supplied to said output device in accordance with the amplitude of super-sync signals as measured from said pedestals.

6. A television receiver comprising means for intercepting at least one carrier wave radiated from a transmitting station and modulated by a video signal which includes blanking impulses and synchronizing signals, means for amplifying said modulated carrier wave, means for demodulating said carrier wave to produce video signals, means for supplying said video signals to an output device, means for controlling the gain of said first amplifying means in accordance with the average carrier amplitude of a carrier wave radiated from said station, an A. V. C. circuit comprising a grid leak biased vacuum tube, means for impressing said synchronizing signals supplied from said demodulating means upon the input electrodes of said tube with said signals of positive polarity, means for rendering said tube active to pass plate current only upon the occurrence of said blanking and synchronizing impulses to produce current pulses, means for

smoothing out said pulses to produce a gain control voltage, and means for controlling the amplitude of the video signals supplied to said output device in accordance with said gain control voltage.

7. A television receiver comprising means for intercepting at least one carrier wave radiated from a transmitting station and modulated by a video signal which includes blanking impulses and synchronizing signals, means for amplifying said modulated carrier wave, means for demodulating said carrier wave to produce video signals, means for supplying said video signals to an output device, an A. V. C. circuit comprising a grid leak biased vacuum tube, means for impressing said synchronizing signals supplied from said demodulating means upon the input electrodes of said tube with said signals of positive polarity, means for rendering said tube active to pass plate current only upon the occurrence of said blanking and synchronizing impulses to produce current pulses, means for smoothing out said pulses to produce a gain control voltage, and means for controlling the amplitude of the video signals supplied to said output device in accordance with said gain control voltage.

8. In a television receiver for the reception of a carrier wave modulated by synchronizing signals each comprising a pedestal which goes to a fixed level such as "black" and which has a super-sync impulse thereon, the combination of means for intercepting and amplifying said modulated carrier wave, means for demodulating said carrier wave to produce video signals, means for supplying said video signals to an output device, and means for controlling the amplitude of the video signals supplied to said output device in accordance with the height of said super-sync impulses, said last means comprising in one channel an electric discharge tube having an input circuit and an output circuit, means for supplying said synchronizing signals to said input circuit, means for holding the peaks of the super-sync impulses at a fixed reference level as they appear in said output circuit, means for widening said super-sync impulses in a second channel and then supplying them to said tube to make it active to pass plate current for the duration of the widened impulse only whereby pulses of plate current are produced, and means for smoothing said current pulses to produce a gain control voltage which varies in accordance with the height of said super-sync impulses.

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