

Sept. 22, 1942.

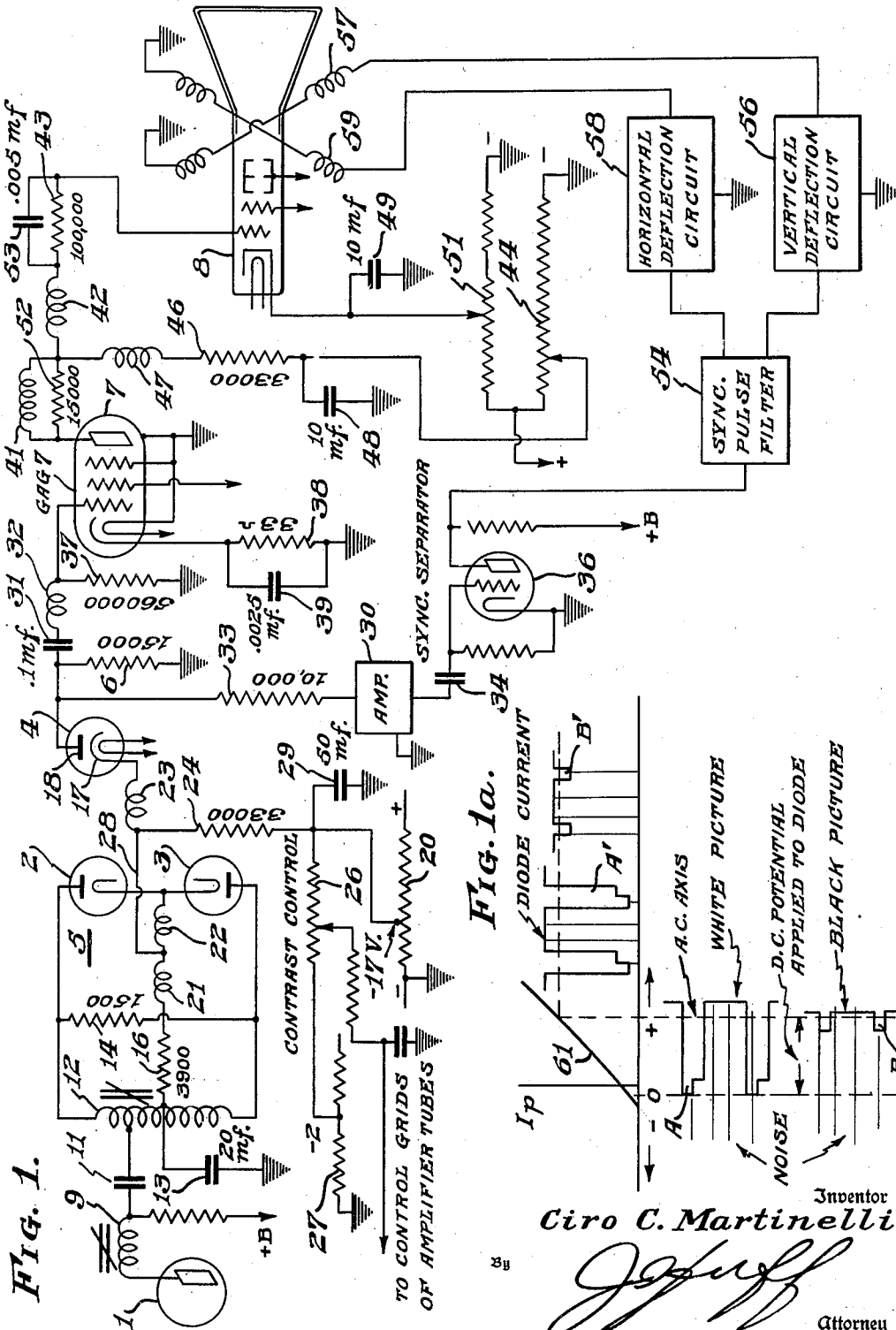
C. C. MARTINELLI

2,296,393

NOISE LIMITER

Filed March 16, 1940

4 Sheets-Sheet 1



Sept. 22, 1942.

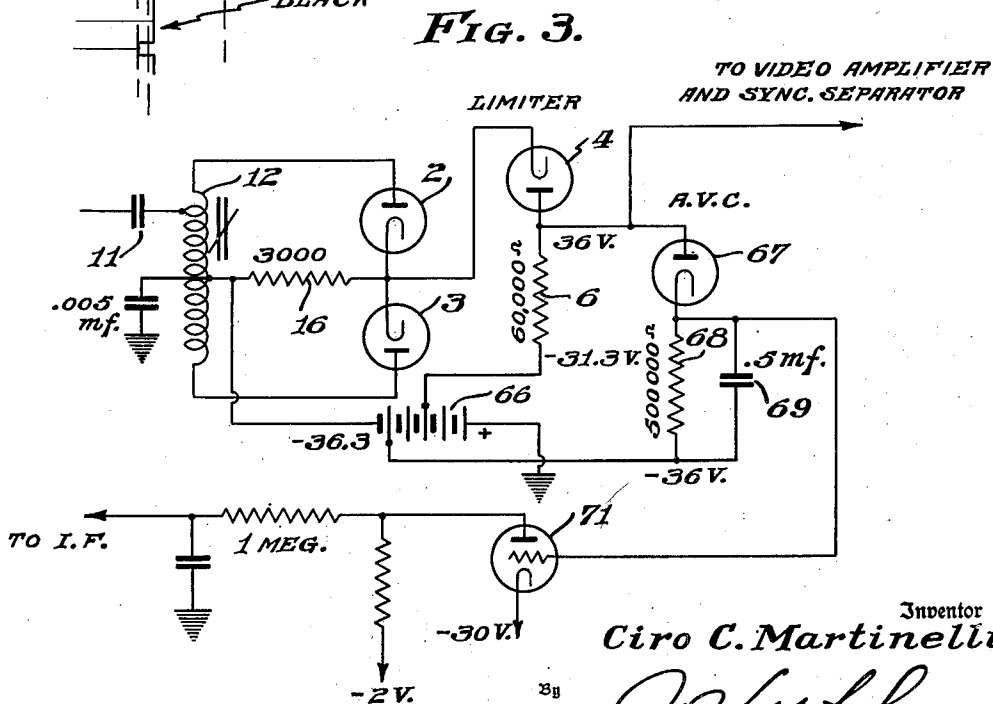
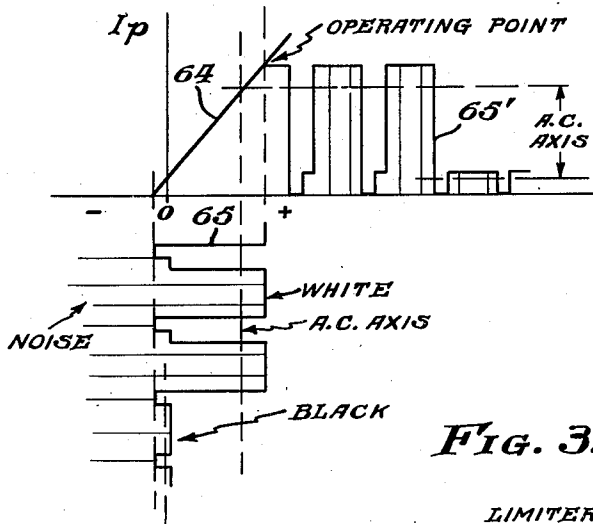
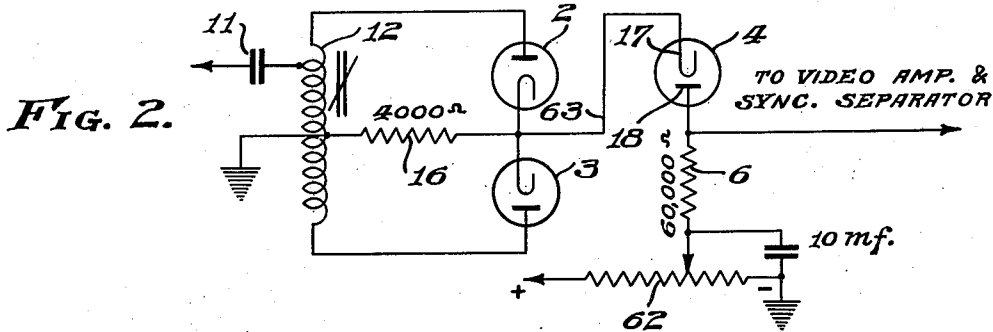
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NOISE LIMITER

Filed March 16, 1940

4 Sheets-Sheet 2



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NOISE LIMITER

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4 Sheets-Sheet 4

FIG. 7.

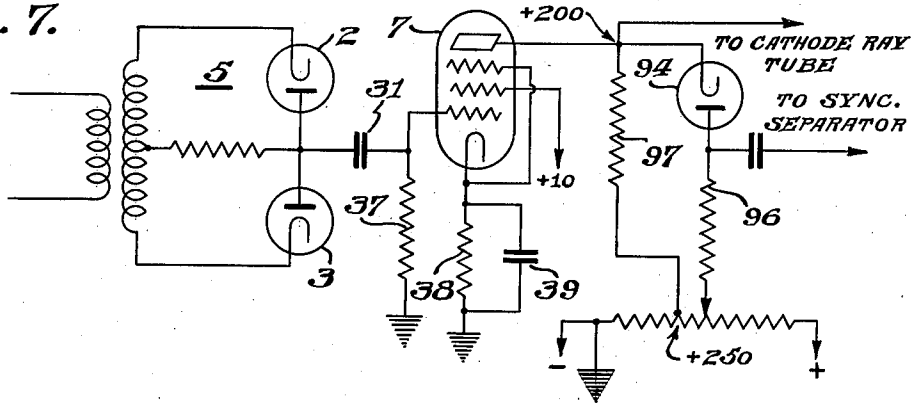


FIG. 8.

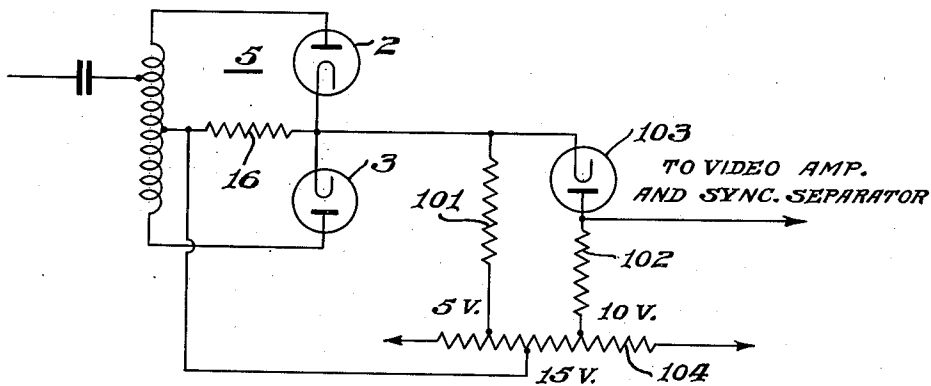
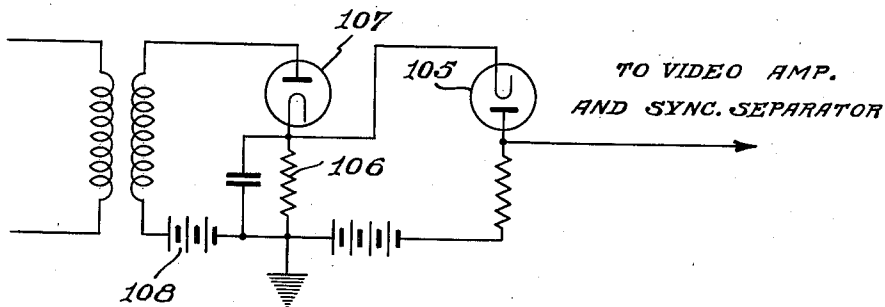


FIG. 9.



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By

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UNITED STATES PATENT OFFICE

2,296,393

NOISE LIMITER

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Application March 16, 1940, Serial No. 324,239

4 Claims. (Cl. 178—7.5)

My invention relates to limiting or clipping circuits for radio receivers and, in its preferred form, particularly to noise limiters for television receivers.

In television receivers it may be desirable to employ limiting circuits for various purposes, such as for example, leveling synchronizing pulses before they are impressed upon the deflecting circuits, or reducing the amount of noise in the received signal. Different circuits are known at the present time which will perform these functions, but many of them are not altogether satisfactory for one reason or another.

It is, accordingly, an object of my invention to provide an improved limiting circuit which will be effective in operation and simple in design and adjustment.

A further object of my invention is to provide an improved means for and method of limiting noise in a radio receiver, either for sound or picture reception.

A further object of my invention is to provide an improved means for and method of leveling synchronizing pulses in a television receiver.

A still further object of my invention is to provide an improved means for and method of effecting gain control in a television receiver.

In a preferred embodiment of my invention the limiter circuit comprises a diode and an output resistor in series with each other and also in series with a direct current voltage which normally maintains a flow of current through said diode and resistor. The picture signal, synchronizing pulses, or the like, are impressed upon the limiter circuit whereby they cause a variation in the diode current to produce a signal voltage across the output resistor, and they are impressed upon this circuit with such polarity that an increase in signal amplitude beyond a certain limit causes the flow of diode current to stop. Thus, any signal, such as noise or synchronizing pulses, exceeding this limit will produce no signal across the output resistor.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which:

Figure 1 is a circuit diagram of a portion of a television receiver embodying my invention where it is utilized as a noise limiter,

Figure 1a is a group of curves which are referred to in explaining the operation of the circuit of Fig. 1,

Figure 2 is a circuit diagram illustrating another embodiment of my invention,

Figure 2a is a group of curves which are referred to in explaining the operation of the circuit of Fig. 2,

Figure 3 is a circuit diagram of an embodiment of my invention as applied to an automatic volume control circuit of the type operating on the peaks of synchronizing pulses,

Figure 4 is a circuit diagram of an embodiment of my invention as utilized to clip or level synchronizing pulses,

Figure 4a is a group of curves that are referred to in explaining the operation of the circuit of Fig. 4,

Figures 5 and 6 are circuit diagrams of other embodiments of my invention as utilized to level synchronizing pulses,

Figure 7 is a circuit diagram of an embodiment of my invention in which the noise suppressor is applied to the synchronizing channel only and

Figures 8 and 9 are embodiments of the invention in which the limiter diode current is prevented from flowing through the output resistor of the detector.

Referring to Fig. 1 the invention is shown applied to a television receiver of the superheterodyne type comprising the usual radio frequency and intermediate frequency amplifier portions (not shown except for the last I. F. amplifier stage indicated at 1), a second detector 5 comprising diodes 2 and 3 connected to form a full wave rectifier and supplying signal through a noise suppressor diode 4 and its output resistor 6, a video amplifier tube 7 and a cathode ray tube 8.

The part of the receiver which precedes the second detector 5 preferably is designed in accordance with the teachings of my copending application Serial No. 287,027, filed July 28, 1939, and assigned to the Radio Corporation of America. Specifically, the time constants of the voltage supply filters are made either very short or very long in order to prevent a noise pulse from affecting the receiver for a period longer than that of the noise pulse itself.

The particular coupling between the last I. F. amplifier tube 1 and the second detector 5, in the example illustrated, is of the type described in the Grundmann and Allen Patent No. 2,157,170, issued May 9, 1939, and assigned to the Radio Corporation of America. The primary circuit, which includes a tunable primary coil 9, may be traced from the plate of the amplifier tube 1 through the primary coil 9, a blocking condenser 11, and through a portion of the secondary coil 12 and the large capacity condenser 13

to ground. The secondary circuit comprises the secondary coil 12 and the capacity of the diodes 2 and 3, this circuit being tunable like the primary circuit by means of an iron core as indicated. A suitable damping resistor 14 preferably is connected across the secondary coil 12.

The detector output resistor 16 is connected between the mid-point of the secondary coil 12 and, in this example, the cathodes of the diodes 2 and 3.

Instead of applying the picture signal and synchronizing pulses which appear across the output resistor 16 directly to the video amplifier 7, they are first passed through the limiter circuit comprising the diode 4 and the output resistor 6. The diode 4 may be of the usual type having an indirectly heated cathode 17 and a plate 18. In order to hold up the high frequency response the three inductance coils 21, 22 and 23 may be employed. The inductance coil 21 corresponds to the usual peaking coil employed in video amplifiers in series with the plate resistor while the coils 22 and 23 may be referred to as series resonating coils since they are caused to resonate with the capacities of the second detector diodes 2 and 3 and the limiter diode 4, respectively.

In accordance with the invention a flow of current is normally maintained through the limiter diode 4 by applying a certain direct current potential thereacross. In the example illustrated in Fig. 1, the plate 18 of the diode 4 is connected to ground through the output resistor 6, while the cathode 17 is connected through a resonating coil 23 and a resistor 24 to a direct current voltage of negative polarity, this voltage being indicated on the drawings as the -17 volt point on a voltage divider 20. Thus, the plate 18 of the limiter diode 4 is positive a certain amount with respect to its cathode 17, and in the absence of incoming signal there is a flow of current which may be traced from the plate 18 through the diode 4, the coil 23, the resistor 24, the voltage divider 20 to ground, and through ground to the output resistor 6 and back to the diode plate 18.

It will be evident that the picture signal output of the second detector 5 is impressed across the resistor 24 of the noise suppressor circuit, and, therefore, across the series combination of diode 4 and resistor 6, since the upper end of this resistor 24 is connected through a conductor 28 to the cathode end of the second detector output resistor 16 while the lower end of the resistor 24 is connected through a bypass condenser 29 and the condenser 13 to the other end of the output resistor 16. It follows that the second detector output will cause variations in the current flowing through the limiter diode 4 whereby there will be variations in the current flow to the limiter output resistor 6. Since the diode 4 has a substantially linear characteristic, the current variations through the output resistor 6 produce voltage variations thereacross which are faithful reproductions of the second detector output.

In Fig. 1 the signal appearing across the limiter output resistor 6 is applied through a blocking condenser 31 and a series resonating coil 32 to the video amplifier 7. It is also applied through a resistor 33, a direct current amplifier 30, and grid condenser 34 to a synchronizing separator tube 36.

The input circuit of the video amplifier 7 includes a grid leak resistor 37. The value of this

resistor and the value of the grid condenser 31 are made such that the periodically recurring synchronizing pulses, which drive the control grid of the amplifier tube 7 positive periodically, produce a grid leak biasing action such that the direct current component of the picture is reinserted as described and claimed in the copending Willans application Serial No. 720,205, filed April 12, 1934, and assigned to Radio Corporation of America.

In addition to employing the previously mentioned peaking and resonating coils for holding up the high frequency response, the amplifier tube 7 may be provided with a cathode resistor 38 and a bypass condenser 39, their relative values being such that the amplitude of the lower frequency components of the signal is reduced somewhat by degeneration.

The plate of the video amplifier 7 is connected through resonating coils 41 and 42 and a protective resistor 43 to the control grid of the cathode ray tube 8. Operating voltage is applied to the plate of the video amplifier tube 7 from a suitable voltage divider 44 through a plate resistor 46 and a peaking coil 47, the usual filter or bypass condenser 48 being provided in the plate circuit. The cathode of the cathode ray tube 8 is effectively connected to ground for alternating current signals by means of a large capacity condenser 49, while it is direct current connected, in the example illustrated, to a suitable voltage divider 51 connected in parallel with the voltage divider 44.

The series resonating coil 41 adjacent to the plate of the video amplifier 7 is preferably shunted by a damping resistor 52. The protective resistor 43 is shunted by a condenser 53 of sufficient capacity to permit all the frequency components of the signal to be applied to the control grid of the cathode ray tube 8. As described and claimed in the copending Tolson application Serial No. 315,312, filed January 24, 1940, and assigned to Radio Corporation of America, the r-c combination 43-53 functions both to protect the cathode ray tube 8 from the effects of driving its control grid too far positive and to reduce defocusing or "blooming" of the cathode ray.

The synchronizing pulse separator 36 is provided for the purpose of separating the synchronizing pulses from the picture signals, after suitable amplification by an amplifier 30, in accordance with the usual practice whereby only the horizontal and vertical synchronizing pulses are supplied to a suitable synchronizing pulse filter indicated at 54 for separating the horizontal and vertical synchronizing pulses from each other. The vertical synchronizing pulses are supplied to a suitable vertical deflection circuit 56 which causes saw-tooth current to flow through the vertical deflecting coils 57, while the horizontal synchronizing pulses are supplied to a suitable horizontal deflection circuit 58 which causes saw-tooth current to pass through the horizontal deflecting coils 59.

The synchronizing pulse separator, as shown in Fig. 1, may be of the grid-leak biased type described and claimed in Tolson Patent 2,207,839, issued July 16, 1940. The synchronizing pulse filter 54 may be of a type disclosed in this Tolson application or any suitable combination of capacitors and resistors for effecting frequency discrimination between the horizontal synchronizing pulses and the vertical synchronizing pulses which recur at comparatively low fre-

quency and which are of greater duration than the horizontal synchronizing pulses.

Referring now to the operation of the noise-limiter circuit, it will be apparent that, so long as the limiter diode 4 is conducting, there will be a signal voltage appearing across the output resistor 6 if a signal is being supplied from the second detector 5. However, if the signal impressed upon the cathode 17 of the limiter diode 4 has sufficient amplitude to raise the cathode 17 to the potential of the diode plate 18, or if it has still greater amplitude whereby the cathode becomes more positive than the plate, the limiter circuit is effectively open-circuited and no signal will appear across the output resistor 6 until the cathode 17 again becomes negative with respect to the plate 18 to permit the flow of current through the limiter diode.

The action of the noise-limiter circuit is illustrated in Fig. 1a, where the curve 61 represents the current flow through the limiter diode 4 plotted against voltage impressed across the diode electrodes 17 and 18. The curves A and B represent the signal impressed across the limiter input resistor 24 for the conditions of a "white" picture and a "black" picture, respectively. Since the synchronizing pulses are applied with positive polarity to the cathode 17 of the limiter diode 4, any signals such as noise signals of the same polarity as the synchronizing pulses will raise the cathode 17 to the same potential as that of the diode plate 18 when their amplitude reaches 17 volts in the specific example illustrated. Therefore, as shown by the curves A' and B' in Fig. 1a, any noise signal in excess of 17 volts (or any other predetermined limit) will not appear across the output resistor 6 of the limiter circuit.

It may be noted that, since the limiter circuit is A.-C. coupled to the second detector 5 rather than D.-C. coupled, a smaller percentage of the noise will be removed for a "black" picture than for a "white" picture, as is evident from a comparison of the curves A' and B'.

It will be evident from the foregoing that, by employing the limiter circuit at a point preceding the video amplifier 7 and its associated direct current reinserting circuit, I have substantially eliminated the previously encountered difficulty of noise pulses interfering with the D.-C. reinserting action. Such noise interference previously produced on the control grid on the video amplifier tube a greater negative bias than that required for the proper picture background. It will also be apparent that I have avoided a similar difficulty in the operation of the synchronizing pulse separator 36. Also, I have substantially eliminated the possibility of noise pulses feeding through into the deflection circuits where they may disturb the deflection circuit operation.

In Fig. 2, I have shown a noise limiter similar to that previously described, but which is direct current coupled to the second detector instead of A.-C. coupled, as in the circuit shown in Fig. 1. In Figs. 1 and 2, like parts are indicated by the same reference characters. In order to simplify the drawings, the peaking and resonating coils have been omitted in Fig. 2.

It will be noted that, in Fig. 2, the plate 18 of the limiter diode 4 is connected through the limiter output resistor 6 to a positive point on a voltage divider 62, and that the limiter circuit is completed through the voltage divider 62 to ground, through ground to the midpoint of the secondary winding 12 and through the detector

output resistor 16 and a conductor 63 to the cathode 17 of the limiter diode.

The action of this circuit is substantially the same as previously described, the voltage applied to the plate of the limiter diode being sufficient to maintain a flow of current therethrough until the signal impressed upon the cathode of the limiter tube exceeds a predetermined voltage. If the detector output voltage is in excess of this limiting voltage, it effectively opens the limiter circuit by making the diode non-conducting and no signal appears across the output resistor 6 for the duration of a noise pulse exceeding this voltage limit.

The operation of the circuit of Fig. 2 is illustrated by the curves in Fig. 2a, where the curve 64 represents the limiter-diode characteristic and where the signal impressed upon the limiter circuit is indicated at 65. It is assumed that the D.-C. component of the picture signal has been transmitted. It will be apparent that the signal appearing across the limiter output resistor 6, represented by the curve 65', contains substantially no noise having an amplitude in excess of the synchronizing pulses. The curve 65' also shows that, as a result of the direct current connection, this is true for all the picture signal regardless of whether it represents a "white" picture or a "black" picture.

Referring to Fig. 3, the invention is shown applied to an automatic volume control circuit of the synchronizing pulse operated type covered broadly by Holmes Patent No. 2,109,618, issued March 1, 1938, and assigned to Radio Corporation of America. In this figure, the limiter circuit is direct current connected and is otherwise substantially the same as the limiter circuit shown in Fig. 2. However, a battery 66 rather than a voltage divider has been indicated as the voltage source. Like parts in Figs. 2 and 3 are indicated by the same reference numerals.

The automatic volume control circuit, in the example illustrated, comprises a diode 67 connected in series with the parallel combination of a resistor 68 and a condenser 69, this parallel combination having a time constant such that the diode 67 is caused to function substantially as a peak rectifier. As explained in the above-mentioned Holmes A. V. C. patent, such a peak rectifier circuit, when connected to measure the peaks of the synchronizing pulses, will produce a voltage which is a measure of the fading or other change in the signal strength of an incoming signal. A circuit of this character is especially useful in television systems employing direct current transmission, since, in such systems, an average carrier A. V. C. system will not operate properly because of the fact that the carrier amplitude is being varied by the direct current component. It may be noted that in the Holmes patent the A. V. C. peak rectifier is a triode. The D.-C. connected A. V. C. diode circuit is described and claimed in my copending application Serial No. 210,614, filed May 28, 1938, and assigned to the Radio Corporation of America.

It has been found, however, that a peak rectifier type of A. V. C. system, such as shown in Fig. 3, may not operate properly in noisy locations unless suitable precautions are taken, because large amplitude noise pulses may control the A. V. C. action and thus reduce the gain of the receiver at times when the gain should not be reduced. However, if the A. V. C. circuit is preceded by my limiter circuit, as shown in Fig. 3, the A. V. C. voltage which appears across the resistor-conden-

ser combination 68—69 will be a true measure of the height of the synchronizing pulses and, therefore, of the amount of gain desired in the receiver. This A. V. C. voltage is applied in the usual manner to a direct current amplifier 71 and from this amplifier through suitable filter means to the control grids of the IF amplifier tubes.

Referring to Fig. 4, my limiter circuit is shown applied to a television receiver for the purpose of making all synchronizing pulses of the same amplitude before they are impressed upon the deflecting circuits. In the circuit shown in Fig. 4, a synchronizing pulse separator circuit comprising a diode 72 is connected to the output of the second detector 73 of a television receiver. In the example illustrated, the second detector comprises a diode 74 and the usual output resistor 76 shunted by a condenser 77.

The output of the second detector is impressed across the electrodes of the separator diode 72 through a condenser 78 and through a separator output resistor 79. There is also provided a comparatively high resistance resistor 81 connected between the plate of the diode 72 and ground. The positive synchronizing pulses which are applied through the condenser 78 to the plate of the diode 72 cause a biasing voltage to be maintained across the resistor 81, this bias being of such value that only the synchronizing pulses cause a flow of diode current whereby only the synchronizing pulses appear across the output resistor 79.

Since, for various reasons, these synchronizing pulses may be of uneven amplitude at this point, it has been found desirable to level them; that is, make them all of like amplitude by means of a limiter circuit similar to that previously described. As applied in Fig. 4, this leveling or limiting circuit comprises a limiter diode 82 and a resistor 83 which are connected across the output resistor 79 of the separating circuit and in series with a source of D.-C. voltage for maintaining normally a flow of current through the limiter diode.

In this application of the invention, the D.-C. voltage is set at such a value that each synchronizing pulse drives the cathode of the limiter diode 82 to a potential at least as great as the potential of the plate of the diode 82. As a result, the tops of all synchronizing pulses are clipped off to the same level, this clipping or leveling action being illustrated in Fig. 4a, where the limiter diode characteristic is represented at 84. The synchronizing pulses appearing across the separator output resistor 79 are indicated by the curve 86, while the leveled synchronizing pulses appearing across the limiter output resistor are indicated by the curve 86'.

In Fig. 5, I have shown a leveling circuit for synchronizing pulses, which is similar to that shown in Fig. 4, like parts in Figs. 4 and 5 being indicated by the same reference characters. The circuits of Figs. 4 and 5 differ in that the separating circuit is connected to different points in the receiver in the two figures. In Fig. 5, the separator tube 72 is connected to the output circuit of a video amplifier 87 rather than to the output of the second detector, as in Fig. 4.

In Fig. 6, there is shown another circuit in which my invention is utilized for leveling synchronizing pulses, where the limiting circuit is shown applied to the output circuit of a synchronizing pulse separator tube 88 of the type illustrated in Fig. 1. The limiter diode 89 and its output resistor 91 are connected across the plate resistor 92 of the separator tube, a suitable

positive voltage being applied to the plate of the limiter tube 89 by means of a battery 93 whereby the diode 89 is conducting until the signal impressed upon its plate exceeds a predetermined limit.

In Fig. 7, the invention is shown applied to a television receiver in such a way as to function as a noise limiter for the synchronizing channel. In this figure and in Fig. 1, like parts are indicated by the same reference numerals. In this particular application of the invention, the noise-limiter diode 94 and its output resistor 96 are connected across the plate resistor 97 of the video amplifier 7 with the plate of the diode 94 maintained normally at a certain D.-C. potential. It will be noted that a substantially noise-free signal is applied to the synchronizing separator tube, as in the case of Fig. 1, whereby the synchronizing action of the receiver is improved.

In Figs. 8 and 9, there are shown embodiments of the invention in which the current flowing through the limiter diode is prevented from flowing through the output resistor of the second detector, even though the limiter circuit is direct current connected to the detector. In Fig. 8, where parts corresponding to those in Fig. 1 are indicated by like reference numerals, this is accomplished by means of a balanced circuit, a resistor 101 which may have the same resistance as that of the limiter output resistor 102 being connected between the cathode of the limiter diode 103 and a point on the voltage divider 104 such that any flow of current through the resistor 101 and the output resistor 16 of the second detector balances out any flow of limiter diode current through the detector output resistor 16.

In Fig. 9, the current flow of the limiter diode 105 through the output resistor 106 of the second detector 107 is prevented by means of a battery 108 which is connected in the detector circuit to oppose the flow of such current. By means of arrangements, such as shown in Figs. 8 and 9, it is possible to avoid having the quality of the detector output impaired by the flow of an undesired direct current component through the detector output resistor. The circuits of Figures 8 and 9 are described and claimed in co-pending application Serial No. 436,559, filed March 28, 1942, in the name of Ralph S. Holmes.

In the drawings, the values of certain circuit elements have been indicated, by way of example, in ohms, megohms, and microfarads. Also, in certain figures, the voltages at different parts of the circuit have been indicated by way of example.

From the foregoing description, it will be apparent that various modifications may be made in my invention without departing from the spirit and scope thereof.

What I claim as my invention:

1. A television receiver for the reception of a carrier wave negatively modulated by a composite signal consisting of picture signals and synchronizing pulses and also modulated by the direct current component of the transmitted picture, said receiver comprising a diode detector for demodulating said received signal to produce picture signals and synchronizing pulses, said detector including an output resistor, and an amplitude limiter circuit comprising a diode, an output resistor and a source of direct-current potential connected in series with each other and direct current connected across the output re-

sistor of said detector, said diode being connected in such a direction in the circuit that the synchronizing pulses appearing across the detector output resistor and supplied to the diode through said direct current connection oppose 5 current flow through the diode, and said source of direct-current potential being connected in the circuit with the proper polarity to maintain a flow of current through the diode so long as the signal appearing across the detector output resistor of the polarity of the synchronizing pulses does not exceed a predetermined amplitude, the resistance of the limiter output resistor being at least several times the resistance of the detector output resistor.

2. In a television system of the type in which the direct current component of the picture is transmitted whereby the carrier varies in accordance with the changes in background of the transmitted picture, a receiver comprising a diode detector for demodulating said transmitted picture signals, said detector having an output resistor, a utilization circuit, and a signal amplitude limiter through which the output of said detector is fed to said utilization circuit, said 20 limiter comprising a diode and an output resistor connected in series, means for inserting a direct current voltage in series with said series combination of diode and output resistor and with the proper polarity to maintain a flow of current through said diode until the signal to be limited exceeds a predetermined amplitude, said direct current voltage having a value which is independent of the average carrier value of said transmitted signal, and means including said 25 direct current connection for applying said signal across the series combination of diode, output resistor and D.-C. voltage with such polarity as to oppose current flow through said diode, the resistance of the limiter output resistor being at least several times the resistance of the detector output resistor.

3. A television receiver for the reception of a carrier wave negatively modulated by a composite signal consisting of picture signals and synchronizing pulses and also modulated by the direct current component of the transmitted picture, said receiver comprising a diode detector for demodulating said received signal to produce

picture signals and synchronizing pulses, said detector including an output resistor, and an amplitude limiter circuit comprising a diode, an output resistor and means for providing a direct 5 current voltage in series with said diode and said output resistor, said series combination of diode, output resistor and direct current means being direct current connected across the output resistor of said detector, said diode being 10 connected in such a direction in the circuit that the synchronizing pulses appearing across the detector output resistor and applied to the diode through said direct current connection oppose current flow through the diode, and said direct 15 current voltage having the proper polarity to maintain a flow of current through the diode so long as the signal appearing across the detector output resistor having the polarity of the synchronizing pulses does not exceed a predetermined polarity, the resistance of the limiter 20 output resistor being at least several times the resistance of the detector output resistor.

4. In a television system of the type in which the direct current component of the picture is transmitted whereby the carrier varies in accordance with the changes in background of the transmitted picture, a receiver comprising a diode detector for demodulating said transmitted picture signals, said detector including an output resistor, a utilization circuit, and a signal 30 amplitude limiter through which the output of said detector is fed to said utilization circuit, said limiter being direct current connected to said detector and comprising a diode and an output resistor connected in series, means for inserting a direct current voltage in series with said series combination of diode and output resistor and with the proper polarity to maintain a flow of current through said diode until the signal 35 to be limited exceeds a predetermined amplitude, and means including said direct current connection for applying said signal across the series combination of diode, output resistor and D.-C. voltage with such polarity as to oppose 40 current flow through said diode, the resistance of the limiter output resistor being at least several times the resistance of the detector output resistor.

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