Jan. 25, 1944. R. S. HOLMES 2,339,857

NOISE LIMITER

Filed March 28, 1942

Fig. 1.

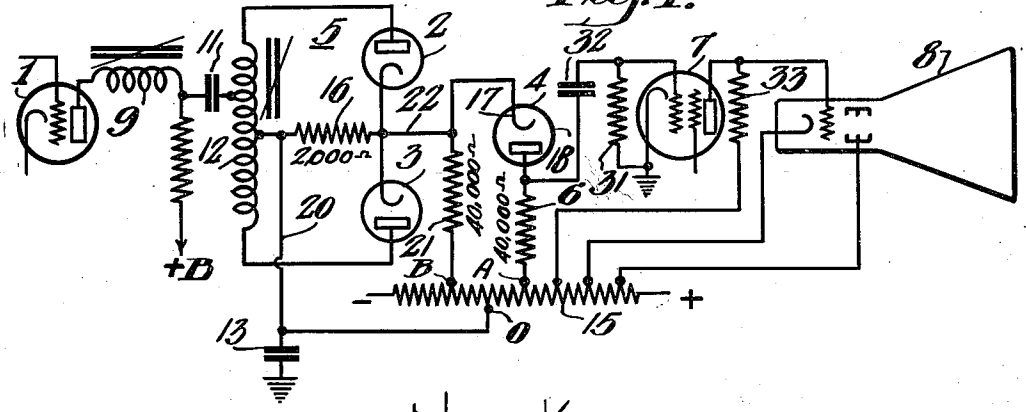


Fig. 2.

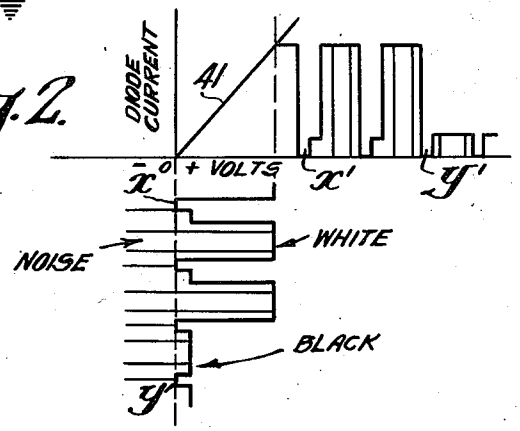
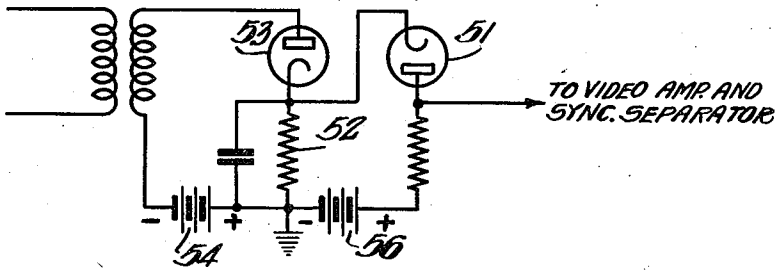


Fig. 3.



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Patented Jan. 25, 1944

2,339,857

UNITED STATES PATENT OFFICE

2,339,857

NOISE LIMITER

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Application March 28, 1942, Serial No. 436,559

5 Claims. (Cl. 178—7.5)

My invention relates to noise limiting circuits for radio receivers and particularly to noise limiters for television receivers that receive a picture signal containing the direct current component thereof.

An object of my invention is to provide an improved noise limiting circuit that will be effective in operation and simple in design and adjustment.

A further object of my invention is to improve the effectiveness of a noise limiting circuit in a television receiver that receives a signal containing the direct current component of the picture, while, at the same time, avoiding detector distortion.

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 and produce a signal voltage across the output resistor. 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 exceeding a certain limit.

Further in accordance with my invention the limiter circuit is conductively connected to the detector and means is provided for keeping the limiter current (due to the D. C. limiter or gate voltage) from flowing through the detector output resistor, thus preventing detector distortion that would result from such current flow.

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,

Figure 2 is a graph which is referred to in explaining the operation of the circuit of Fig. 1, and

Figure 3 is a circuit diagram illustrating another embodiment of my invention.

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 Martinelli application Serial No. 287,027, filed July 28, 1939, and assigned to the Radio Corporation of America, now Patent No. 2,299,333, issued Oct. 20, 1942. 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 anode of the amplifier tube 1 through the primary coil 9, a blocking condenser 11, through a portion of the secondary coil 12 to its midpoint and through a large capacitor 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.

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 appearing 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 an anode 18. A flow of current is normally maintained through the limiter diode 4 by applying a certain direct-current voltage thereacross. This voltage, which is referred to as the gate or limiter voltage, may be obtained from a voltage divider 15 by connecting the lower end of resistor 6 to a point A on resistor 15, the voltage between points O and A being the gate voltage. The path for the flow of diode current normally maintained by the gate voltage is completed by a resistor 21 connected between cathode 17 and a point B on resistor 15. This path may be traced from the cathode 17 of diode 4 through the resistor 21 to the point B on resistor 15, through a section of resistor 15, and through the resistor 6 to the anode 18 of diode 4.

For reasons discussed below, the limiter circuit

is conductively connected across the detector output resistor 16. This connection may be traced from the cathode 17 through a conductor 22 and the resistor 16, through a conductor 20 to a point intermediate points A and B on voltage divider 15, through a section of resistor 15, and through resistor 6 to the diode anode 18.

It will be evident that the picture signal output of the second detector 5 causes variations in the current flowing through the limiter diode 4 whereby there will be variations in the current flow in 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.

The input circuit of the video amplifier 7 includes a grid leak resistor 31. The value of this resistor and the value of the grid condenser 32 preferably 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 in Willans Patent 2,252,746, which issued August 19, 1941. The anode of the video amplifier 7 is then conductively connected to the control grid of the cathode ray tube 8. Operating voltage is applied to the anode of the video amplifier tube 7 from the voltage divider 15 through an anode resistor 33. The cathode of the cathode ray tube 8 is conductively connected to a suitable point on the voltage divider 15.

Referring now to the operation of the noise-limiter circuit, when a signal is being supplied from the second detector 5 and the limiter diode 4 is conducting, there will be a signal voltage appearing across the output resistor 6. 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 the signal appearing across the output resistor 6 is held at a fixed limiting value 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. 2, where the curve 41 represents the current flow through the limiter diode 4 plotted against voltage impressed across the diode electrode 17 and 18. The curves x and y represent the signal impressed across the limiter circuit 4—6 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 the gate voltage. Therefore, as shown by the curves x' and y' in Fig. 2, any noise signal in excess of the gate or limiting voltage will not appear across the output resistor 6 of the limiter circuit. Preferably the gate voltage is so adjusted that the signal output contains substantially no noise having an amplitude in excess of the synchronizing pulses. As a result of the conductive or direct current connection between the detector and limiter this is true for all the picture signal regardless of whether it represents a "white" picture or a "black" picture.

Since the limiter elments 4 and 6 are conductively connected to the detector 5 there normally would be current flow through the detector output resistor 16 caused by the gate voltage. This current flow, unless held to a small value, would introduce substantial detector distortion because it would put a negative bias voltage on the plates of the detector diodes.

I avoid such detector distortion by balancing out such current flow in resistor 16. This is accomplished in Fig. 1 by means of the balanced circuit comprising resistor 21 which, in the example illustrated, has the same resistance as that of the limiter output resistor 6. It is connected to a point on the voltage divider such that in the resistor 16 the flow of current through the path comprising the resistor 21 and the output resistor 16 of the second detector balances out the flow of limiter diode current through the path comprising the limiter resistor 6 and the detector output resistor 16. In this particular example the points A and B are at the same voltage (but of opposite polarity) with respect to the tap O.

It may be noted that the resistance of resistors 16, 21 and 6 in parallel should be such as to provide the proper load on the detector 5. In the example illustrated, most of this load is provided by the comparatively low impedance resistor 16. However, the resistors 6 and 21 may be given lower resistance values in which case they will provide a substantial part of the detector load.

Also, it should be understood that resistors 6 and 21 may have unlike resistance values so long as they are connected to the proper points on voltage divider 15. The main requirement for balancing out the undesired D. C. flow in resistor 16 is that, with no signal input, the upper ends of resistors 6 and 21 be at substantially the same potential.

In Fig. 3, the current flow of the limiter diode 51 through the output resistor 52 of the second detector 53 is prevented by means of a voltage source such as a battery 54 which is connected in the detector circuit to oppose the flow of current from the D. C. limiter voltage source 56. By means of arrangements, such as shown in Figs. 1 and 3, it is possible to avoid detector distortion while utilizing the advantages of applying the D. C. component to the limiter circuit.

In Fig. 1, the values of certain resistors have been indicated in ohms merely by way of example.

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 conductively connected across the output resistor 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 conductive connection oppose 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, and means for balancing out the flow of current through said detector output resistor that normally would be caused by said direct current potential.

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 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 to be limited exceeds a predetermined amplitude, 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 current flow through said diode, and means for substantially balancing out any direct current flow through the detector output resistor due to said direct current voltage.

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 gate or limiter 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 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, said gate 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, and means for substantially balancing out any direct currnt flow through the detector output resistor due to said gate voltage.

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 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 to be limited exceeds a predetermined amplitude, 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 current flow through said diode, and means for substantially balancing out any direct current flow through the detector output resistor due to said D. C. voltage.

5. A television receiver comprising a diode detector for demodulating transmitted picture signals, a voltage supply, 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 limiter comprising a diode and an output resistor connected in series with each other and with one end of the series combination D. C. connected to one end of the output resistor and with the other end of the series combination connected to a point on said voltage supply to maintain a flow of current through said diode until the signal to be limited exceeds a predetermined amplitude, a D. C. connection from the other end of the detector output resistor to a point on said voltage supply, and a resistor connected between said one end of the detector output resistor and a point on said voltage supply such that there is substantially no current flow through the detector output resistor due to said voltage supply.

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