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G. W. FYLER

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NOISE LIMITING CIRCUIT

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Fig. 1.

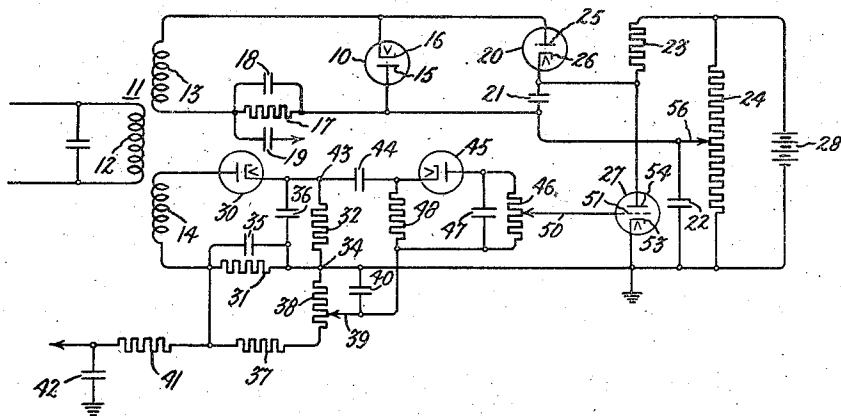


Fig. 2.

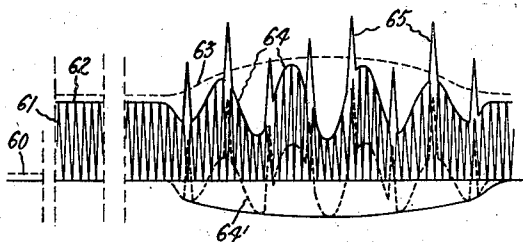
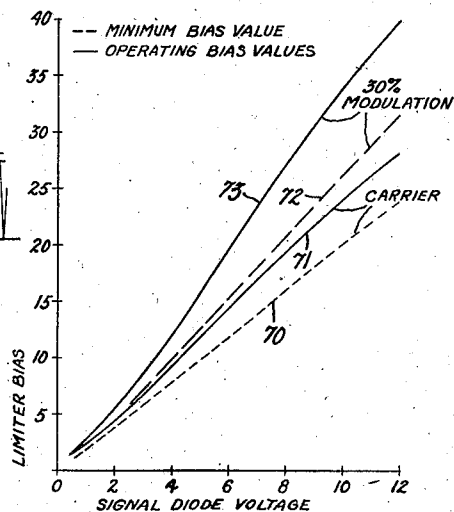


Fig. 3.



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UNITED STATES PATENT OFFICE

2,404,626

NOISE LIMITING CIRCUIT

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14 Claims. (Cl. 250—20)

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My invention relates to signal translating systems and has for its object to provide an improved control circuit for such systems.

More specifically, my invention relates to a noise limiting circuit particularly adapted for use in radio or television receiving apparatus.

It is an object of my invention to provide an improved noise limiting circuit which effectively discriminates between undesired noise impulses and desired signals impressed on the input of a radio or television receiving apparatus and which prevents such impulses from appearing in the output circuits of the apparatus.

In my copending application S. N. 354,160, filed November 4, 1940, entitled Control circuits, now matured as U. S. Patent 2,298,083, and assigned to the same assignee as the present invention, I have disclosed a noise limiting circuit in which a noise limiting diode is connected in shunt to a signal-rectifying diode, the noise limiting diode providing its own threshold bias for variations in both carrier and modulation levels by peak rectification of the voltages appearing across the signal diode. The threshold is maintained by a resistance-capacitance network which has a relatively long time constant.

It is an object of my invention to provide an improved noise limiting circuit of the shunt diode type in which the threshold bias for the noise limiting diode is obtained from a separate low impedance source and is adjusted in accordance with the magnitude of inward or negative peaks of the modulating wave.

Another object of my invention is to provide an improved noise limiting circuit in which the threshold level is maintained above the peaks of the modulating wave, is adjusted in accordance with the carrier level and the per cent modulation, and is substantially unaffected by repeated impulse noise.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which Fig. 1 diagrammatically represents a portion of the circuits of a radio receiving apparatus embodying my invention, and Figs. 2 and 3 are graphs to which reference is made for a better understanding of the operation of my invention.

The radio receiver circuits of Fig. 1 include a detector 10 which may be, for example, the second detector of a superheterodyne radio receiver.

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High frequency carrier waves, modulated by desired audio signals, are supplied from any suitable signal receiving apparatus, not shown, to the detector input through the input transformer 11 having a tuned primary winding 12 and a plurality of secondary windings 13 and 14, said secondary windings being connected to separate signal translating channels. The secondary winding 13 supplies the high frequency oscillations to the signal detector 10 which is shown to be of the diode type having an anode 15 and a cathode 16. The signal detector circuit extends from the anode 15 through a diode load resistor 17 and high frequency by-pass capacitor 18 in parallel and the secondary winding 13 to the cathode 16.

The operation of this portion of the circuit is well known to those skilled in the art and will not be detailed here. The detector is effective to demodulate the carrier waves impressed upon the transformer 11. In a superheterodyne receiver these carrier waves will generally be of an intermediate high frequency lower than the carrier frequency of the received signal. The demodulation products developed across the diode load resistor 17 include audio frequency components and a direct current component. The audio frequency components are coupled through the coupling capacitor 19 to a succeeding stage of the receiver which may be, for example, a first audio frequency amplifier, not shown. Subsequent stages of the receiver may include further audio amplification stages and a sound translating device.

As is well known, interfering electrical disturbances of short duration and considerable magnitude are often received on the signal channel along with the desired signal. These may form an undesirable noise background with the desired signal or even mask it completely. Such disturbances are generally grouped under the term "impulse noise" as distinguished from "shot noise" or "thermal agitation noise." These disturbances may arise from various causes. For example, within this category are natural atmospheric static surges; man-made electrical disturbances, as from high frequency apparatus; ignition systems, and similar apparatus; and other sharp impulses. The characteristics of these undesired noise impulses may vary widely depending upon their source. They may be of short duration occurring at irregular intervals or they may appear as repeated impulse noise. In all cases they have a deleterious effect upon the fidelity of signal reproduction either by direct interference with

the signals or through shock excitation effect in the receiving system.

Undesired noise pulses of the type under consideration are random in nature and, as such, their occurrence follows no regular pattern. They may be considered, therefore, as comprising a very large number of frequencies, having irregular phase and amplitude components. Because they are random in nature, it is characteristic that when they are superimposed on a given high frequency carrier wave, these noise pulses ordinarily, in the absence of cross modulation in the preceding stages of the receiving apparatus, occur only as outward modulation peaks. The reason for this phenomenon becomes apparent when it is realized that in order to occur as an inward or negative peak of modulation of a high frequency carrier wave, an impulse must have definite frequency, phase and amplitude characteristics, as well as an observable period of duration, so that an appreciable interval of the high frequency wave is canceled by the impulse. Noise pulses such as described above, being random in nature, do not have these requisites of definiteness. Hence, such pulses ordinarily do not occur with such regularity as to cancel a portion of the carrier wave and do not occur as inward modulation peaks, but only as outward or additive peaks of modulation. This characteristic of noise pulses is used to advantage in my noise limiting circuit in the manner described later.

In order to limit the effect of such noise impulses on the modulation voltages appearing on the network 17, 18, a noise suppression network is provided. As is disclosed in my aforesaid U. S. Patent 2,298,083, this network includes a second diode detector 20 reversely connected in parallel to the signal diode 10 through a capacitor 21. A discharge circuit comprising resistor 23 and the upper portion of resistor 24 in series is also connected across the capacitor 21. In order to control the potential across capacitor 21 an electron discharge device 27 is provided having its anode connected to the common point of resistor 23 and capacitor 21 and its cathode connected to a point of fixed potential at the lower end of resistor 24. Operating potential for the anode of device 27 may be provided from any suitable source, such as the battery 28; the resistor 23 serving as a load resistor for the device 27. In selecting the values of the elements of this portion of the circuit, capacitor 21 is made quite large, for example of the order of 1 mfd., and resistors 23 and 24 have as low a value as is permitted by the type of amplifying tube selected as the device 27. The internal resistance of the diode 20 in the current-conducting direction should also be approximately equal to the internal resistance of the signal diode 10 for best results.

Considering for the moment only those elements of the noise limiting network thus far described, it will be observed that the diode 20 is in circuit with the secondary winding 13 and the network 17, 18 and that it is poled to pass current through these elements when conductive in the opposite direction from current flowing in the signal diode 10. This circuit extends from the anode 25 of the diode 20 through the secondary winding 13 of the transformer 11, the network 17, 18 and the network 21, 23, 24, 27 to the cathode 26.

The signal diode 10 passes current on the peaks of those half cycles of the applied carrier wave which make its anode positive with respect to its cathode and the modulation voltages appear-

ing on the network 17, 18 reproduce the modulation envelope. On the peaks of alternate half cycles, the maximum voltage impressed across the diode 20 from the detector 10 is approximately equal to the sum of the maximum diode load voltage on the network 17, 18 and the peak voltage of the applied carrier wave. These two voltages are approximately equal and, hence, the peak voltages applied across the diode 20 and the network 21, 23, 24, 27, from the secondary winding 13 and the detector circuit are approximately equal to twice the peak amplitude of the carrier wave developed across the winding 13.

Impulse noise of the type discussed above appears as outward peaks of modulation on the carrier wave and the diode 20 functions as a limiter for these high outward peaks, the threshold level for the limiter being established by the voltage across capacitor 21. When an undesired noise impulse of greater magnitude than the threshold level and of short duration is impressed on the secondary 13 of the transformer 11, a low impedance path for voltages of either polarity is provided through one or the other of the two diodes since the diodes are reversely connected to pass current through the output load resistor 17 in both directions and capacitor 21 is of low impedance for impulses which are conducted, by diode 20. Therefore, since no net rectification of the intermediate frequency noise transient takes place, it is effectively suppressed producing substantially no effect on the audio output circuit supplied through the coupling capacitor 19.

In the operation of the limiter thus far described, it is observed that, while effective limiting is obtained for a sharp impulse noise, in the presence of repeated impulse noise the capacitor 21 tends to be charged to a higher threshold level by a first impulse so that a greater portion of a rapidly succeeding impulse is developed across the output resistor 17 before the diode 20 becomes conductive to limit the passage of further noise. This action is cumulative so that on repeated impulse noise, the limiting circuit tends to "open up" to permit the passage of noise to subsequent stages of the receiver.

The above-mentioned limitation operates also with certain types of signal to introduce distortion. When the limiter biasing capacitor is charged by narrow, widely separated modulating peaks, such as occur, for example, in speech currents, the charge on the capacitor 21 tends to leak off between peaks. If the limiter operates below the modulation level, such decrease of charge on the biasing capacitor tends to limit a succeeding wave of modulating voltage and introduce distortion in the output signal.

Ideal noise limiting is more closely approached if the threshold level is maintained a small amount above the signal level and held at this desired level in the presence of repeated impulse noise. In accordance with my invention, this is accomplished by utilizing a separate low impedance source to obtain the threshold capacitor biasing potential, by varying the threshold level in accordance with the strength of the carrier wave and the per cent modulation, and by deriving this level from inward peaks of modulation of the carrier wave.

The separate low impedance source comprises the secondary winding 14 supplying the modulated high frequency wave to the auxiliary detector 30, shown as a diode having the diode load resistors 31 and 32 connected in series. The common point 34 of load resistors 31, 32 is held at

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ground potential and the resistors are by-passed respectively by the high frequency by-pass capacitors 35 and 36. Resistors 31 and 32 preferably have about equal resistance values, for example 50,000 ohms. In order to obtain a control potential which varies in accordance with the strength of the carrier wave, a voltage divider is connected across the diode load resistor 31. This voltage divider comprises resistor 37 and resistor 38 having a variable contact arm 39. An audio frequency by-pass capacitor 40 is connected between the variable contact arm 39 and the point 34 at ground potential. Both resistors 37 and 38 are of large ohmic value and the capacitor 40 also is of a large capacitance, for example 1 microfarad. As a result the carrier control voltage network comprising the portion of the resistor 38 between the contact arm 39 and the point 34 and the capacitor 40 has a relatively long time constant. Hence, the unidirectional potential appearing across the portion of the resistor 38 between the contact arm 39 and the point 34 varies directly with the strength of the carrier wave and is unaffected by modulation voltages appearing on resistor 31.

The direct current component of the demodulated signals appearing on resistor 31 may be utilized for automatic gain control. Unidirectional potentials, negative with respect to ground, are developed at the left-hand end of resistor 31 and applied through a low pass filter comprising resistor 41 and capacitor 42 to the gain control connections of preceding stages of the receiver, not shown. Arrangement and operation of the gain control connections will readily be understood by those skilled in the art without elaboration. The potentials are applied to control electrodes of one or more of the tubes preceding the detector to vary the receiver gain in accordance with the strength of the received signals, as is well understood in the art.

In controlling the threshold bias of the noise limiter diode 20 in accordance with the per cent modulation of the high frequency carrier waves impressed across the detector 10, it is desirable to take advantage of the fact that impulse noise peaks occur ordinarily only as outward modulation peaks for the reasons discussed above and to obtain a control potential from the inward peaks of modulation. In accordance with my invention, a modulation control potential is obtained from the unidirectional potentials appearing across the diode load resistor 32. The potential at the upper end of the load resistor 32, that is at the point 43, is always positive with respect to ground. Since it is desired to obtain a negative potential varying in proportion to the negative peak value of modulation, the unidirectional component of the potential at the point 43 is eliminated by the capacitor 44. Then, by use of the diode 45 as the peak rectifier, a negative potential is produced on the resistor 46 which varies in accordance with the negative modulation amplitudes. The capacitor 47 by-passes the resistor 46 to prevent audio frequency voltages from appearing on this resistor. However, syllabic voltage variations do occur on resistor 46 in accordance with the negative modulation peak. The values of the resistor 46 and the capacitor 47 are sufficiently high that this network has a relatively long time constant with respect to audio frequency voltage variations and is responsive only to syllabic voltage variations. The load resistor 48 completes the circuit of the diode peak rectifier 45.

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The potential appearing across the resistor 46 is adjustably supplied by means of the variable contact arm 50 to the control electrode 51 of the control discharge device 27. The cathode 53 of the discharge device 27 is directly connected to ground and the anode is connected through the load resistor 23 to the source of operating potential shown as the battery 28. The anode 54 is likewise directly connected to the upper plate of the threshold bias capacitor 21.

The operation and adjustment of the noise limiting circuit is better understood from a consideration of the curves of Fig. 2 in conjunction with the following description. First, assume that the control electrode 51 is at ground potential, that no signals are being received and that anode potential is applied to the control device 27. The device 27 draws anode current through the resistor 23 producing a certain potential on the upper plate of the capacitor 21 and the cathode 26. The potential of the lower plate of the capacitor 21 is now adjusted by variation of the contact arm 56 on the voltage divider 24 to obtain a small biasing potential on the capacitor 21 such that the cathode 26 is slightly positive with respect to the anode 25. In Fig. 2, this slight bias potential is shown by the portion 60 of the curve at the left of the figure.

Assume now that an unmodulated high frequency carrier wave is impressed upon the receiver apparatus. A voltage is now developed across the diode 10 and the load resistor 17, the by-pass capacitor 22 maintaining the anode 15 at ground potential for alternating current. The capacitor 21 tends to be charged through the noise diode 20 due to the peak rectification action of the noise limiting circuit as previously described. If the carrier wave is represented by the curve 61 in Fig. 2, the line 62 represents the bias potential of the cathode 26 due to the action of devices 30 and 27 in conjunction with the separate low impedance source comprising the secondary winding 14 and its associated circuit. As pointed out previously, the negative unidirectional potential, developed across the portion of the resistor 38 between the contact arm 39 and the point 34, varies in accordance with the strength of the carrier wave impressed upon the receiver, audio and syllabic modulating waves being removed therefrom by the long time constant circuit comprising the resistor 38 and the capacitor 40. This carrier control potential is supplied by means of the contact arm 39 and resistor 46 to control electrode 51 and is effective to reduce the anode current drawn by the device 27. The reduction of the anode current of the device 27 results in a decrease in the potential drop across resistor 23 and an equal increase in the potential across the capacitor 21, the potential of the lower plate of the capacitor 21, of course, being determined by the position of the contact arm 56. It is apparent that the potential of the cathode 26, shown by the curve 62, is maintained above the maximum value of the wave 61 appearing across the diode 20.

In order that the diode 20 will not operate to limit very weak signals, it is desirable that the potential across the threshold bias capacitor 21 be raised to a value indicated by the curve 63. This is accomplished by adjustment of the contact arm 39 until the desired value of threshold bias potential is obtained. If the strength of the carrier wave 61 is subsequently increased, the bias on the control electrode 51 is correspondingly decreased so that the potential difference between

the curves 62 and 63 is maintained. By proper selection of the elements of the voltage divider circuit supplying control potentials to the electrode 51, the biasing potential may be made to vary substantially linearly with the carrier strength.

Assume now that the carrier wave 61 is modulated by a signal 64 which includes a plurality of impulse noise peaks, such as the peaks 65. As is pointed out above, the noise peaks 65 ordinarily occur only as outward or additive peaks of modulation. Accordingly, in my noise limiting circuit the inward or negative modulation peaks of the signal 64 are rectified and the threshold bias 63 is adjusted in accordance with the rectification voltages thus produced. As the result of such a system, the threshold bias 63 is substantially unaffected by the presence of the noise peaks 65. Instead of being reproduced in the output circuits of the receiver, the noise voltages are reduced to a low value by the short-circuiting action of the two reversely connected diodes 10 and 20, which action appears as a load of large magnitude in circuit of the primary winding 12. In order to obtain desirable operating characteristics for the noise limiter circuit, the secondary windings are closely coupled to each other and are critically coupled to the primary winding 12, so that the short-circuiting action of the diodes 10 and 20 on the winding 13 appears also in circuit of the winding 14.

The potential variations of the point 43 are similar to those represented by the curve 64 of Fig. 2, the potential comprising a unidirectional component due to the rectification of the carrier wave plus a modulating wave component. The capacitor 44 removes the unidirectional component leaving only the modulation wave, such as the wave 64'. The negative peaks of the wave 64' are rectified by the diode 45, audio frequency components are removed by the by-pass capacitor 47 and the syllabic voltage variations are reproduced on the resistor 46 by the negative modulation peaks. A portion of this negative voltage is supplied by means of contact arm 50 to the control electrode 51 of the device 27 and is effective to reduce still further the anode current flowing through the device 27 and the potential drop across the resistor 23. This reduction in anode current is effective to increase the potential across the capacitor 21 and to maintain this threshold bias slightly above the peaks of the signals appearing across the diode 20 in a manner illustrated by the right-hand portion of the curve 63 of Fig. 2.

The curves of Fig. 3 assist still further in explaining the operation of my noise limiting circuit. Curve 70 gives values of the bias voltages across the limiter 20 which are required to prevent limiting of a carrier wave. This value is a minimum value for the threshold bias that corresponds to the unmodulated conditions as discussed in connection with curves 61, 62, 63 of Fig. 2. Curve 71 illustrates the manner in which the potential supplied by the contact arm 39 to the control electrode 51 is effective to raise the threshold bias for different carrier levels. By adjustment of the position of contact arm 39 on the resistor 38, the curve 71 may be made to occur above or below curve 70. Curves 72 and 73 illustrate respectively the increased bias values and the operating bias values for a 30% modulation of the carrier wave. The position of curve 73 with respect to the optimum curve 72 can be adjusted by varying the position of contact arm 50

in a manner similar to the adjustment of arm 39. It is realized, of course, that the differences between curves 70 and 71 and curves 72 and 73 may represent a desirable safety factor which provides a complete absence of distortion for sudden transients in the received signals. Since the threshold bias potential is obtained from a source which is independent of the signal detector 10 and does not rely upon the self-rectification action of the diode 20, it is possible to obtain a complete absence of distortion in the received signals and there is no necessity for compromising between distortion and limiting. Furthermore, when inward negative peaks of modulation are used to provide a threshold bias, the tendency of the limiter to open up on large or repeated noise interference is eliminated.

It may be noted at this point that the effectiveness of the noise suppression circuit is materially increased by employing wide band intermediate frequency circuits preceding the detector and limiter and relatively narrow band audio circuits following them. This fact becomes apparent from a study of impulse excitation characteristics of tuned circuits. In a wide band circuit the train of oscillations, set up by single short sharp impulse, has a very high decrement whereas in a narrow band circuit, the converse is true. In other words, the length of the decay train is inversely proportional to the acceptance band width of the system. On the other hand, it has been found that the peak amplitude of the train is almost directly proportional to the band width. Therefore, it can be shown that the average value of a given impulse train is practically independent of band width.

From the above principles, it follows that sharp noise impulses impressed on the wide band intermediate frequency amplifiers preceding the detector 10 remain sharp and of short duration in transmission to those circuits. If these impulses are now limited substantially to the peak carrier level in the manner previously described, very little energy remains and if they are further filtered at the diode load 16, 18 and further reduced in peak amplitude by restriction in relatively narrow band audio circuits following the detection stage, they are actually reduced in amplitude far below the signal level.

Merely for purposes of illustration, the following data is given for a particular radio receiving apparatus embodying my invention. These values were found to give satisfactory results in a particular case, although they are not to be regarded as necessarily applicable to all embodiments of my invention.

Frequency of IF amplifier	megacycles...	8.25
Band width of IF amplifier		
Band width of IF amplifier	kilocycles...	About 300
Capacitors 18, 35, 36	micromicrofarads...	50
Capacitors 21, 22	microfarad...	1
Capacitor 44	do	.25
Capacitors 40, 47	do	1
Resistor 23	ohms	10,000
Resistors 17, 31, 32	do	About 50,000
Resistor 48	do	150,000
Resistors 37, 38	megohms	1
Resistor 46	do	5
Resistor 24	ohms	10,000
Control amplifier 52		Type 6J5
Anode voltage on amplifier 52	volts...	150

Many modifications within the scope of my invention will doubtless occur to those skilled in the art. Hence, while I have shown a particular embodiment of my invention, it will be understood that I do not wish to be limited thereto, but I contemplate by the appended claims to cover any modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, in an amplifier for signal modulated waves, a translating circuit for said waves and means including means responsive to the average level of said waves and means responsive to the amplitude of inward peaks of said modulating signal for preventing the translation of noise impulses by said circuit.

2. In a receiver for signal modulated carrier waves and subject to undesired noise impulses, the combination with means including a threshold bias for interrupting the output of said receiver upon the occurrence of an undesired impulse, of means for adjusting said bias and the operation of said interrupting means in accordance with the magnitude of inward peaks of said modulating signal.

3. In a receiver for signal modulated carrier waves, the combination of means for interrupting the output of said receiver upon the occurrence of a noise impulse therein, means establishing a threshold bias for said interrupting means, and means for adjusting said bias in accordance with the intensity of said wave and the magnitude of inward peaks of said modulating signal.

4. A noise suppression circuit for a receiver of modulated waves comprising, in combination, a first signal channel normally operative for the translation of an oscillation comprising a signal modulated carrier wave and subject to transient noise impulses having a duration shorter than a wave length of said modulating signal, means for disabling said channel when the intensity of said oscillation is greater than a predetermined threshold level and for restoring said channel to operative condition when said intensity is less than said level, and means including a second signal channel for adjusting said level in accordance with the per cent modulation of said wave.

5. A noise suppression circuit for a radio receiver comprising, in combination, a first signal channel normally operative for the translation of an oscillation comprising a signal modulated carrier wave subject to transient noise impulses, means for disabling said channel when the intensity of said oscillation is greater than a predetermined threshold level and for restoring said channel to operative condition when said intensity is less than said level, and means including a second signal channel for adjusting said level in accordance with both the intensity of said wave and the per cent modulation thereof.

6. A noise suppression circuit for a radio receiver comprising, in combination, a signal channel normally operative for the translation of an oscillation comprising a signal modulated carrier wave subject to transient noise impulses, means for disabling said channel when the intensity of said oscillation is greater than a predetermined threshold level and for restoring said channel to operative condition when said intensity is less than said level, and means for adjusting said level in accordance with the magnitude of inward modulation peaks of said wave.

7. In a receiving system for signal modulated

carrier waves, a first signal channel normally operative for the translation of signal voltages, a shunt circuit including a capacitor connected to said channel, a second signal channel operative to reproduce signal voltages from said waves, means responsive to the voltages in said second channel for charging said capacitor to a threshold limiting level, and means for disabling said first channel in response to a transient noise impulse therein which increases the voltage across said shunt circuit to a value greater than said level.

8. In a receiving system for signal modulated carrier waves, a first signal channel normally operative for the translation of signal voltages, a shunt circuit including a capacitor connected to said channel, a second signal channel operative to reproduce signal voltages from said waves, means in said second channel for rectifying said wave and for producing a voltage varying in accordance with the intensity thereof, means responsive to the sum of the voltages in said second channel for charging said capacitor to a threshold limiting level, and means for disabling said first channel in response to a transient noise impulse therein which increases the voltage across said shunt circuit to a value greater than said level.

9. In apparatus for receiving a signal modulated carrier wave a noise suppression circuit comprising, a first signal channel normally operative for the translation of said wave, means for disabling said channel when the intensity of said wave is greater than a predetermined threshold level and for restoring said channel to operative condition when said intensity is less than said level, and means for adjusting said level in accordance with the per cent modulation of said wave, said last means including a second signal channel and means for rectifying inward modulation peaks of waves in said second channel.

10. In combination with a source of signal modulated high frequency carrier potentials subject to interfering noise impulses, a first signal channel comprising a unilaterally conducting discharge device and an output impedance adapted to have demodulated signal potentials developed thereon, a second signal channel comprising a unilaterally conducting discharge device, an impedance adapted to have demodulated signal potentials developed thereon, and an impedance adapted to have potentials varying in accordance with the level of the unmodulated carrier developed thereon, means for interrupting said first channel upon the occurrence of a noise impulse, and means responsive to the potentials developed in said second channel for controlling the operation of said interrupting means.

11. In combination with a source of signal modulated high frequency carrier potentials subject to interfering noise impulses, a first signal channel comprising a unilaterally conducting discharge device and an output impedance adapted to have demodulated signal potentials developed thereon, a second signal channel comprising a unilaterally conducting discharge device, an impedance adapted to have demodulated signal potentials developed thereon, means for rectifying inward peaks of said signal potentials, and an impedance adapted to have potentials varying in accordance with the level of the unmodulated carrier developed thereon, means for interrupting said first channel upon the occurrence of a noise impulse, and means responsive to said rectified peaks and said carrier level varying potential for

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controlling the operation of said interrupting means.

12. In a receiving system for signal modulated carrier waves, a first signal channel normally operative for the translation of signal voltages, a second signal channel comprising means for producing a first voltage varying in accordance with the level of said carrier waves, means for reproducing said modulating signal from said waves, means connected to said reproducing means for producing a second voltage varying in accordance with syllabic variations of the inward peaks of said modulating signal, said first and second voltages being connected in series in said second channel, and means responsive to the sum of said first and second voltages for establishing a threshold limiting level in said first channel.

13. In a receiving system for signal modulated carrier waves subject to interfering noise impulses, a signal detection circuit comprising an input impedance, a signal diode and an output impedance network of suitable time constant for detection of said signals, a noise suppression diode reversely connected across said signal diode through a capacitor, a control circuit comprising an input impedance, a signal detection diode and an output impedance network, a voltage divider connected across a portion of said output im-

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pedance and adapted to produce a voltage responsive to the level of said carrier wave, a rectifier diode reversely coupled to said signal detection diode and adapted to rectify inward peaks of said modulating signal, an output impedance of suitable time constant for reproduction of syllabic voltage variations of said signal connected across said rectifier diode, said syllabic voltage and said carrier responsive voltage being connected in series, an electron discharge device having a control electrode and an output circuit adapted to charge said capacitor to a threshold limiting level, and means for supplying said series connected voltages to said control electrode, thereby to make said series connected voltages effective to control said threshold level.

14. In radio receiving apparatus for translating signal modulated carrier waves and subject to undesired noise impulses, the combination of a signal channel, a control channel, means responsive to the intensity of said waves in said control channel for establishing a threshold level to limit the magnitude of said impulses transmitted through said signal channel, and means whereby the limiting of said impulses in said signal channel is effective to limit the magnitude of impulses in said control channel.

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