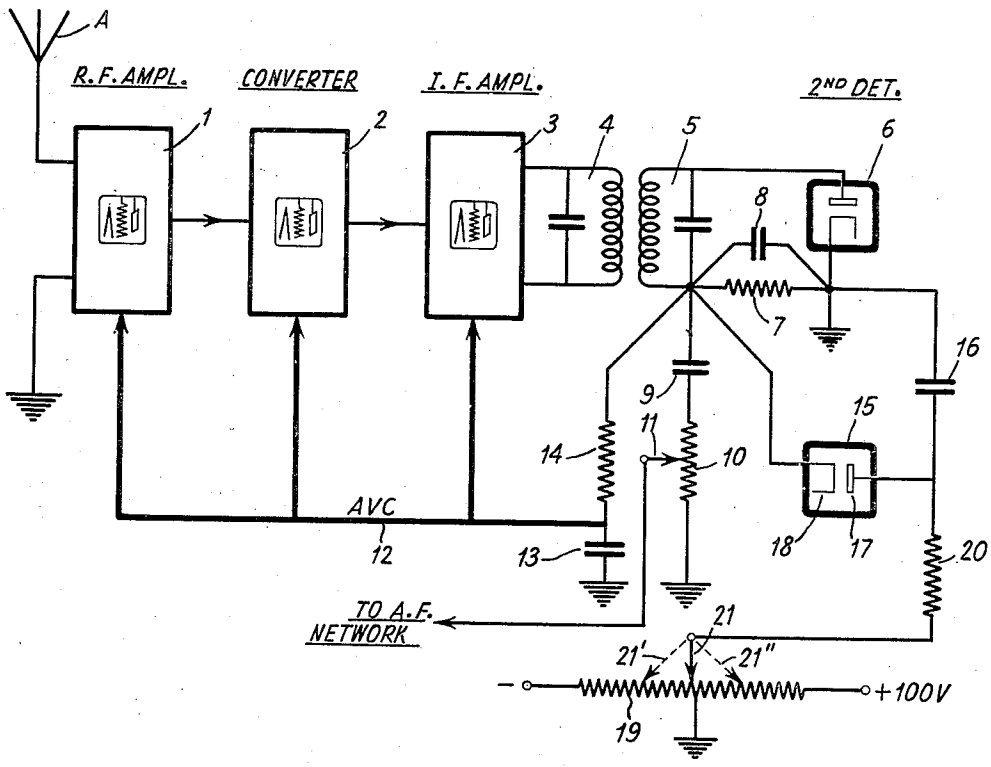
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NOISE-LIMITING CIRCUIT

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NOISE-LIMITING CIRCUIT

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My present invention relates to radio receivers, and more particularly to receiving circuits which include noise limiting networks.

One of the main objects of my present invention is to provide a noise limiter network in a radio receiving system; the limiter functioning to short circuit the detector for the duration of a sudden pulse of noise, and thus suppressing the audio response of the receiving system for the noise pulse interval.

Another important object of the invention is to provide a noise suppression arrangement for a signal receiving system, wherein the suppression action is secured by shunting a diode across the detector output load, and rendering the diode conductive to short circuit the detector load when a pulse of noise, of a predetermined amplitude, affects the system; the detector tuned input circuit being damped at the same time.

Still other objects are generally to improve noise limiting circuits for receiving systems, and more especially to provide limiting circuits which are not only reliable and efficient in operation, but are, in addition, economically manufactured and readily assembled in radio receivers.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

The receiving system shown in the drawing is of a conventional superheterodyne type, the present invention being embodied in the second detector network. Those skilled in the art are fully aware of the details of the system shown in the drawing. In general, the signal collector A, such as a grounded antenna circuit, feeds signals to a tunable radio frequency amplifier 1, and the latter may comprise one, or more, amplifier tubes. The converter 2 produces I. F. energy from the amplified signals; it may employ a pentagrid converter of the 6A7 type, or separate local oscillator and first detector tubes can be used. Of course, the tunable signal grid circuits of the various networks are uni-controlled in tuning adjustment. The I. F. energy which may have a frequency value chosen from a range of 75 to 500 k. c., is amplified by the I. F. amplifier 3. The latter may employ one, or more, amplifier tubes, and the resonant circuits thereof are fixedly tuned to the operating I. F.

The amplified I. F. energy in the output circuit 4 is impressed upon the input circuit 5 of the second detector. Circuits 4 and 5 are each tuned to the operating I. F., and the detector employs a diode 6. The load resistor 7 is connected between the grounded cathode and the low alternating potential side of circuit 5. Resistor 7 is shunted by an I. F. by-pass condenser 8, and the audio and direct current voltage components of the voltage developed across resistor 7 are used for different purposes. The audio component is tapped off from a path, including a condenser 9 and resistor 10 in series, connected in shunt to load resistor 7. The adjustable tap 11 may be connected to one, or more, stages of audio amplification followed by a reproducer, and tap 11 functions as a manual volume control device.

The direct current voltage component of detected I. F. currents is used for automatic volume control (AVC). The AVC circuit comprises the lead 12 connected between the signal grids of the controlled tubes and the anode side of resistor 7. The filter network 14—13 in the AVC circuit functions to suppress all pulsating voltage components in the gain control bias. In the absence of received signals, or if the signals are less than a desired amplitude, the controlled tubes in networks 1, 2 and 3 operate at maximum gain. As the received signal amplitude increases the anode side of resistor 7 becomes more negative, and causes the signal grids of the controlled tubes to become more negative. As a result the controlled tubes decrease in gain; and the signal amplitude at the input circuit 5 is thus maintained substantially uniform despite a wide range of amplitude variation at collector A. The network 13—14 has usually a time constant such that the AVC action is relatively slow. It responds only to slow changes in collected waves, such as fading.

However it often happens that sudden and abrupt noise impulses affect the receiving system. For example, crashes of static, man-created electrical disturbances and other undesired electrical impulses that produce shock effects in the receiving system, all come under a category of undesired noise impulses. When the amplitude of the latter exceeds the useful signal amplitude, the reproduction of the noises seriously interfere with the understanding of the reproduced useful signal. In broadcast reception, reproduction of music and speech is seriously affected; in code communication systems, the intelligibility of the code signals is greatly increased. The noise limiting network associated with the diode 6 substan-

tially reduces the interfering effects of the noise impulses.

The limiting action is secured by the relatively simple connection shown wherein the diode 15 is connected in series with condenser 16, and the series connection so formed is connected in shunt to resistor 7. Condenser 16 has a low impedance at all frequencies in the audio and I. F. ranges. Diode 15 has its cathode 18 connected to the anode end of resistor 7 so that any potential across resistor 7, due to the signal rectification by diode 6, causes the cathode of diode 15 to be biased negatively with respect to ground. Plate 17 of diode 15 is connected through resistor 20 to an adjustable tap 21 on potentiometer 19, which has its center tap grounded and its opposite ends connected to positive and negative voltage points respectively of a 100 volt (D. C.) source. Thus, the bias of plate 17 of diode 15 can be adjusted either positively or negatively, as may be necessary, for reasons to be set forth later. It can then be seen that the total net bias between cathode 18 and anode 17 of diode 15 is made up of; first, any direct current potential across resistor 7 due to rectification of signal energy by diode 6; second, any direct current potential across resistor 20 due to rectification of audio frequency interference peaks which may exist across resistor 7; and third, the potential of tap 21 due to its position on potentiometer 19.

To examine the instantaneous operation of the device assume an incoming signal is rectified by diode 6, and thus produces a direct current voltage E across resistor 7. If the signal is 100% modulated there will also exist an audio component of voltage across resistor 7 whose magnitude will be approximately E cos 2 ft. Thus, the maximum instantaneous negative potential at the anode end of resistor 7 will be the sum of the D. C. plus the peak A. C. potentials, or 2E. Then, if tap 21 on potentiometer 19 is moved to position 21′ so that it has a negative potential equal to 2E, the plate 17 of diode 15 will be biased as far negative as the most negative swing of cathode 18 of diode 15 and thus no current will normally flow through diode 15. However, if an impulse of interference is encountered of sufficient intensity so that it would normally produce a negative potential across resistor 7 greater than 2E, diode 15 becomes conducting and resistor 7 is effectively short circuited through diode 15 and condenser 16. The net effect is to keep the potential across resistor 7 from exceeding 2E except; first, by a small amount due to the impedance of the diode; and, second, by another small amount due to the accumulation of a charge on condenser 16 which occurs when diode 15 passes current. Thus an interfering impulse which might normally create a potential of, say, 4E across resistor 7 is decreased in magnitude to aboue 2.05 E, or a value only slightly greater than that due to audio modulation of the signal. Furthermore, if the impulse occurs at an instant when a negative potential of 2E exists across resistor 7 due to desired audio voltages, its effect is decreased to .05 E, or to $\frac{1}{80}$ of its original value. If the interference is a single isolated pulse as described, the additional accumulated charge on condenser 16 leaks off through resistor 20 after the pulse is over, and the circuit is restored exactly to its original condition of potentials. However, if the impulses are rapidly recurrent the continued accumulation of charges on condenser 16 passing off through resistor 20 cause a net D. C. voltage to exist across resistor 20 which in effect biases anode 17 of diode 15 negatively. To overcome this additional bias, tap 21 on potentiometer 19 must be moved to a less negative position, and, if the interference is strong enough and rapidly recurrent, it becomes necessary to adjust tap 21 to a positive position, as shown at 21″, to overcome the negative bias produced across resistor 20.

A further action of the device is to effectively short circuit tuned circuit 5 during periods when interfering impulses cause diode 15 to become conducting. This action is explained as follows. It is well known to those skilled in the art that the impedance which a diode exhibits to a tuned circuit is approximately equal to ½ the instantaneous modulation frequency impedance of the output load network of the diode. It can be seen that during periods of conduction by diode 15 this output impedance of diode 6 is practically zero; therefore, the damping of tuned circuit 5 is greatly increased for the duration of the pulse and additional reduction of interference results.

Another action of the circuit can be explained as follows: For radio communication work where entertainment value is not a function the intelligibility of received signals may be greatly improved, and a still greater improvement in signal to interference ratio can be effected if the device is adjusted somewhat differently than explained above. In this case resistor 20 together with condenser 16 are chosen to have a time constant approximating that of the syllabic inflections of the human voice, and tap 21 on potentiometer 19 is adjusted so that with no interfering impulses and no audio potentials across resistor 7, the net bias from cathode 18 to anode 17 of diode 15 is zero. Under this condition the first few cycles of a spoken syllable are rectified by diode 15, and pass current through resistor 20 which biases the anode 17 more negatively for the duration of the word or syllable. Thus the bias is automatically adjusted to a value which gives the greatest "squelch" action for interfering impulses. Operation of the device in this manner causes some distortion of the desired audio signal; but I have found that it is possible to receive signals with 100% intelligibility which were so badly submerged in interference that their presence was scarcely discernible without the device.

The following specific examples of the magnitudes of various elements is given by way of illustration, and it is to be understood that such constants are not restrictive in any manner:

Resistor	7=	0.5	megohm
Resistor	14=	1	megohm
Resistor	20=	1	megohm
Condenser	8=	200	mmf.
Condenser	16=	0.05	mf.
Condenser	13=	0.01	mf.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. In combination with a signal transmission tube having a signal input circuit including an impedance across which an audio signal voltage exists, a tube including at least a cathode and a cold electrode, means connecting the said

cathode and cold electrode of the second tube across said impedance, additional means connected between said cathode and cold electrode and responsive to the peak value of alternating current voltage developed across said impedance for providing a current blocking bias between said cathode and cold electrode and said additional means comprising a resistive impedance arranged to be traversed by space current flowing between the cathode and cold electrode of said second tube.

2. In combination with a signal transmission tube having a signal input circuit including an impedance across which an audio signal voltage exists, a tube including at least a cathode and a cold electrode, means connecting the said cathode and cold electrode of the second tube across said impedance, additional means connected between said cathode and cold electrode and responsive to the peak value of alternating current voltage developed across said impedance for providing a current blocking bias between said cathode and cold electrode, said means comprising a resistor and condenser whose time constant is chosen to approximate the syllabic inflections of the human voice.

3. In combination with a signal source, a diode detector, a path including a resonant input circuit in series with a load resistor connecting the anode and cathode of the diode, means establishing a point of said resistor at a relatively fixed potential, a second diode having its cathode connected to a point on the resistor which assumes a negative potential with respect to the first point when signals are impressed on the said input circuit, a path of low impedance to alternating current connecting the second diode anode to said first point, and a second path connecting the second diode anode to said first point, said second path including means responsive to the peak value of alternating voltage developed across said load resistor to establish the last named anode at a desired direct current potential with respect to the second diode cathode.

4. In combination with a signal source, a diode detector, a path including a resonant input circuit in series with a load resistor connecting the anode and cathode of the diode, means establishing a point of said resistor at a relatively fixed potential, a second diode having its cathode connected to a point on the resistor which assumes a negative potential with respect to the first point when signals are impressed on the said input circuit, a path of low impedance to alternating current connecting the second diode anode to said first point, and a second path including a resistor connecting the second diode anode to said first point and responsive to the peak value of alternating voltage developed across the load resistor for providing a current blocking bias for said second diode anode.

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