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NOISE LIMITER

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Fig. 1.

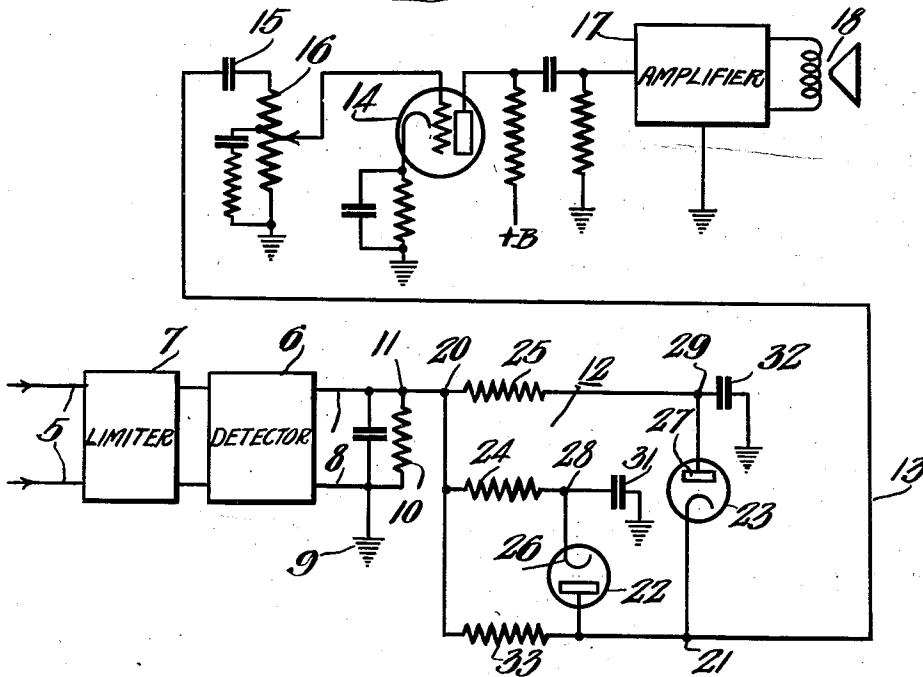
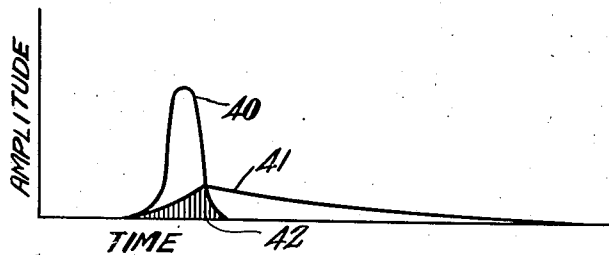


Fig. 2.



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NOISE LIMITER

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5 Claims. (Cl. 250—20)

This invention relates to noise limiters for radio receiving systems and the like which operate to attenuate signals of excessively high amplitude and noise voltages and other undesired impulse signals above a predetermined amplitude.

It is an object of this invention to provide an improved noise limiter which responds to noise voltages and other impulse signals without reference to any predetermined signal amplitude such as 100 percent modulation, for example. Thus, the present limiter is effective below as well as above a normal 100 percent modulation level.

It is, therefore, a further object of this invention to provide a noise limiter which limits both sides of the modulation wave, that is, both positive and negative peaks and which limits relatively sharp or steep wave fronts while following low frequency or normal signal amplitude variations without limiting action.

The present invention, therefore, is of the automatic level setting type which responds to impulses, but which follows low frequency amplitude variations without responding thereto.

Known limiter systems operate in response to noise peaks in but one side of the audio frequency wave of a demodulated signal, for example, since noise voltages stronger than the carrier produce voltages corresponding to an increase in the carrier level. When an attempt is made to limit at a voltage level less than that corresponding to 100 percent modulation, it is necessary to limit both halves of the audio frequency wave.

This follows because a noise wave train of less than carrier amplitude may be made up of radio frequency cycles which have a varying phase angle relative to the carrier. When such a noise wave train is in phase opposition to the carrier, the resulting audio frequency pulsations are opposite in phase from those which occur when the wave train cycles are in phase with the carrier.

In a system in accordance with the present invention, advantage is taken of the fact that impulsive noise has a short time duration with respect to the signal pulsations which have a much greater time duration in all cases.

It is a still further object of this invention to provide an improved noise limiter system which may operate effectively in circuit following a preceding limiter, such as the usual limiter-amplifier stage provided in frequency modulation receivers. As above pointed out, a limiter em-

bodying the invention is effective to limit both halves of the signal wave and may therefore be used when those signals applied to it are previously limited, for example to 100 percent modulation peaks or less.

The invention will, however, be further understood from the following description, when considered in connection with the accompanying drawing, and its scope is pointed out in the appended claims.

In the drawing,

Figure 1 is a schematic circuit diagram of a radio signal receiving system provided with a limiter embodying the invention; and

Figure 2 is a graph showing curves illustrating certain operating characteristics of the limiter of Fig. 1

Referring to Fig. 1, the signal amplifying channel of a radio receiving system is represented by an intermediate frequency supply circuit 5 which is coupled to a second or audio frequency detector 6 preferably through any suitable conventional limiter indicated at 7. The detector output circuit 8 is preferably connected to chassis or ground as indicated at 9 on the low potential side and is provided with a suitable output coupling impedance such as a coupling resistor 10 connected between ground and the high potential side 11 of the output circuit 8.

In the usual case, the detector 6 is a diode rectifier for which the resistor 10 is the output impedance. The high side 11 of the detector output circuit is connected through a limiter network 12 and a lead 13 to an audio frequency amplifier, the first stage of which is indicated at 14. The lead 13 is coupled to the amplifier stage through a coupling capacitor 15 and a suitable volume control device 16 in the present example. The amplifier stage, in turn, is coupled to a suitable power amplifier indicated at 17 and an output device such as a loudspeaker 18. The amplifier and loudspeaker represent suitable utilization means for the signals supplied by the detector through the limiter network 12.

The limiter network comprises an input terminal 20 connected with the high potential output lead 11 of the detector, and an output terminal 21 connected with the signal supply lead 13. Two diode rectifier devices 22 and 23 are reversely connected between the terminal 21 and the terminal 20 through high resistance elements 24 and 25, respectively, the resistor elements being connected adjacent to the terminal 20. With this arrangement, the cathode 26 of one recti-

fier and the anode 27 of the other rectifier are connected with the resistors 24 and 25, and the junction points 28 and 29 between each of the electrodes referred to and the corresponding resistor element are bypassed to ground or chassis through suitable capacitors, as indicated at 31 and 32. In the present example, the resistors 24 and 25 may be of the order of several megohms, while the capacitors 31 and 32 may be of the order of 1000 mmfd.

The input and output terminals of the network are further coupled through a series element, preferably comprising a resistor, as indicated at 33, the resistance of which is relatively low with respect to the resistance at 24 and 25. In the present example, this may be of the order of 200,000 ohms, with a detector output coupling impedance of substantially 100,000 ohms.

In a radio signal receiving system, as indicated, the detector output resistor 10 may be considered as a source of audio frequency and noise voltages coupled to the amplifier 14. The audio frequency and noise signal path may be traced from the input terminal 20 of the limiter network 12 through the coupling resistor 33 to the output terminal 21 and thence to the grid of the amplifier 14 through the connections 13, 15 and 16.

The diode rectifier devices 22 and 23 are the limiter elements of the network and operate to provide two shunt signal short circuiting paths across the output of the network between the terminal 21 and ground or chassis, one of which is through the rectifier 22 and the capacitor 31, and the other of which is through the rectifier 23 and the capacitor 32.

The voltage or signal level at which limitation takes place adjusts itself, that is, is automatically established in accordance with variations in the signal amplitude. If low audio frequency signals are present in the network, the terminals 28 and 29 follow the audio frequency wave along with the output terminal 21, and substantially no diode current flows through either limiter device.

The limiters, however, are in a condition to limit a sudden sharp pulse to a relatively low level regardless of what portion of the audio frequency cycle carries the pulse. In the presence of high audio frequency signals, the terminals 28 and 29 may not follow the audio frequency wave, but may charge to the peak of the audio frequency cycle and hold the charge from one cycle to the next, thus permitting the audio frequency wave to pass through. However, the limit at which bypassing of the high frequency waves occur is determined by the size of the capacitors 31 and 32 which are charged through the resistors 24 and 25.

Referring to Fig. 2, when a noise pulse occurs and is applied to the receiving system, the wave form of the response is a function of the selectivity and fidelity of the system, and in the absence of limiting means may take the form as indicated by the curve 40 in Fig. 2. If either of the condensers 31 or 32 were connected in shunt permanently by short circuiting one of the diode rectifiers or limiters 22 or 23, the response may take the form indicated by the curve 41. With the circuit as shown above, the response is that portion of the combined curve, above and outside the shaded area 42, thus indicating a marked improvement in the attenuation of undesired noise pulses. It will be noted also that an advantage in the present system is represented by the fact that this same degree of improvement may be obtained in the presence of low audio frequency

signals which are even greater in amplitude than the noise peaks.

High frequency signals above the response range of the resistor-capacitor network connected with the limiters tend to open up the limiters and permit noise to pass through for the duration of such high frequency signals. However, it should be noted that relatively strong or high amplitude high audio frequency signals are infrequent. Noise is most objectionable during pauses in modulation, when the present limiter system is most effective in reducing it.

The present system, therefore, provides two limiter diode rectifier devices in shunt paths across the signal circuit connected back-to-back, or in reverse relation, to bypass relatively steep wave front pulses of either positive or negative polarity. Since the diodes are connected back-to-back, both halves of a pulse or noise wave are eliminated, as is necessary when limiting noise amplitudes representing less than 100 percent modulation.

The limiter system shown is particularly effective in an audio frequency circuit following a frequency modulation detector, for the reason that the noise or impulse output has peaks of both polarities. In such a system, the peaks are usually limited in amplitude preceding the detector as shown in the present system by use of the limiter 7. Therefore, signal peaks on the input terminal 20 of the limiter network following the detector are already limited in amplitude to substantially 100 percent modulation so that the ordinary limiter at 12 would be substantially ineffective at that point.

In amplitude modulation reception, also, the limiter network 12 may be preceded as shown herein by a conventional limiter or AVC system as at 7 to limit the amplitude to signal and noise peaks which are applied to the network 12. This precludes strong pulses from causing some voltage drop across the limiter diodes 22 and 23. In other words, the residual pulse is lessened by the preceding limiter. For a similar reason, the limiter as shown at 12 may be used in a plurality of stages.

I claim as my invention:

1. In a modulated signal receiving system, a noise limiter for an audio frequency signal conveying circuit comprising means for limiting both halves of a noise voltage wave below 100 percent modulation level, and forward acting bias means for causing said limiter to follow normal amplitude and wave form variations of a received audio frequency signal without limiter action.

2. In a modulated signal receiving system, the combination of a noise limiter network comprising two signal conducting paths in shunt across said system each comprising a series connected bypass capacitor and a rectifier device, means for applying signals to the anode of one rectifier device and the cathode of the other rectifier device in parallel whereby said rectifiers are reversely connected said means including a low impedance series coupling element, and a pair of relatively high impedance series coupling elements for applying input signals to said shunt paths between the rectifier devices and bypass capacitors therein whereby said rectifier devices are maintained in an open circuit condition in response to predetermined normal signal amplitude and wave front variations.

3. In a modulated signal wave receiving system, a signal limiter network comprising an input terminal, an output terminal, a relatively

low resistance signal path between said terminals, a pair of rectifier devices connected back-to-back with the output terminal, a signal bypass capacitor connected between each of said rectifier devices and the low potential side of said system providing two parallel shunt signal paths across said system for limiting both halves of a noise voltage wave above and below a predetermined percentage modulation level, and means for maintaining said rectifier devices open in response to normal signal amplitude variations comprising a relatively high resistance connection from the junction of each of said capacitors and rectifiers to the input terminal.

4. In a signal receiving system, a signal limiter network comprising an input terminal, an output terminal, a low impedance coupling path between said terminals, a pair of rectifier devices reversely connected with said output terminal, a relatively high impedance connection between the input terminal and each of said rectifier devices,

and a bypass capacitor connected between the junction of each of said last named resistors and each rectifier device to the low potential side of said system.

5. In a signal receiving system, a signal limiter network comprising an input terminal, an output terminal, a low impedance coupling path between said terminals, a pair of rectifier devices connected back-to-back with said output terminal, a relatively high impedance connection between the input terminal and each of said rectifier devices, a bypass capacitor connected between the junction of each of said last named resistors and each rectifier device to the low potential side of said system, means for applying limited signals to said input terminal including a limiter device followed by a detector, and means for deriving signals from said output terminal including an amplifier input circuit and a coupling connection therebetween.

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