

May 7, 1940.

G. MOUNTJOY
NOISE LIMITING CIRCUIT
Filed Nov. 2, 1937

2,200,036

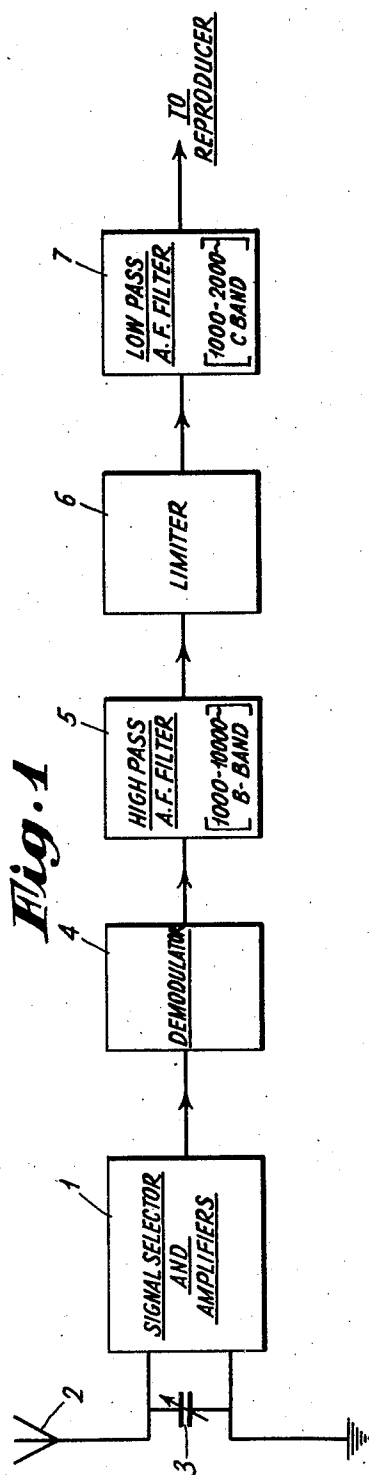


Fig. 3

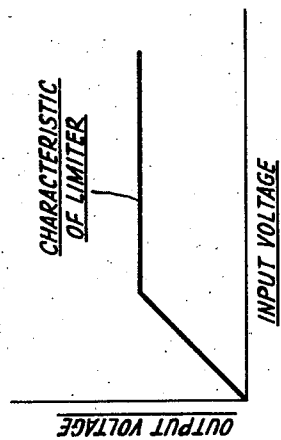
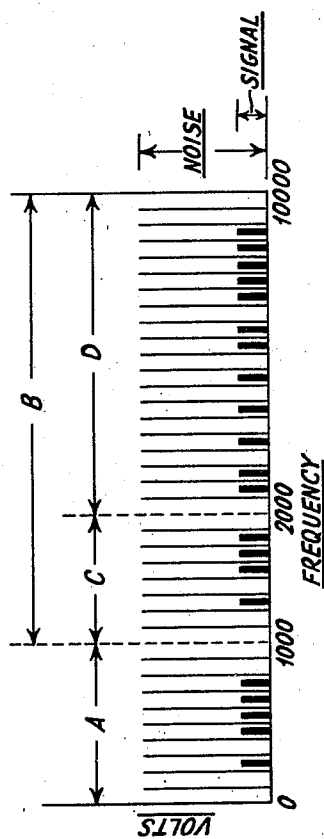


Fig. 2



INVENTOR
GARRARD MOUNTJOY
BY *H. S. Snover*
ATTORNEY

UNITED STATES PATENT OFFICE

2,200,036

NOISE LIMITING CIRCUIT

Garrard Mountjoy, Manhasset, N. Y., assignor to
Radio Corporation of America, a corporation of
Delaware

Application November 2, 1937, Serial No. 172,323

4 Claims. (Cl. 250—20)

My present invention relates generally to circuit arrangements for improving the signal to noise ratio in signal transmission systems, and more particularly to an improved circuit arrangement for minimizing hiss and noise components in the audio output of a radio receiving system.

Many circuit arrangements have been proposed in the past for improving the signal to noise ratio of the audio output energy of radio receiving systems. These prior arrangements have utilized different circuits for interrupting signal transmission for brief periods when the noise to signal ratio increased to an undesirable extent. Such earlier arrangements, as well as others, have, in general, the disadvantage of interfering with continuous signal reception.

It may be stated, therefore, that it is one of the main objects of my present invention to provide a signal transmission system whose audio output energy contains intelligible signals as well as hiss and noise components; and the system including networks for treating the audio output energy of the demodulator in such a manner that the signal to noise ratio is considerably improved and without substantial interference with the intelligibility of the signals.

Another important object of the invention may be stated to reside in the provision of a radio receiving system containing networks, between the audio demodulator and the audio reproducer, which function simultaneously to restrict reproduction to a selected portion of the audio range while greatly increasing the signal to noise ratio for the selected frequency range.

Another object of the invention may be stated to reside in a method of improving the signal to noise ratio of a wide signal frequency range, and which method includes the steps of selecting a portion of the frequency range which includes intelligible signals, and then treating the selected portion in such a manner as to substantially increase the signal to noise ratio of the selected frequencies.

Yet another object of the invention may be stated to reside in the provision of a radio receiver which includes, between the audio detector and the reproducer, a high pass audio filter for selecting a high frequency portion of the audio range; a limiting device which functions to reduce the noise to signal ratio in the selected audio range, and a low pass audio filter which functions to restrict the reproduction of the selected high frequency portion of the audio range to a second portion which includes signals of a relatively high degree of intelligibility.

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.

In the drawing:

Fig. 1 shows in schematic manner a receiving system embodying the present invention.

Fig. 2 shows graphically the function of the invention.

Fig. 3 shows the electrical characteristic of the limiter network in Fig. 1.

Referring now to the accompanying drawing, and particularly to Fig. 1, the receiving system shown therein is schematically represented. The various networks which are to be employed in the receiving system are conventional, and those skilled in the art are fully acquainted with the construction of the circuits which are to be employed in performing the network functions. The numeral 1 denotes the customary signal selector and amplifier circuits. These circuits are fed by a signal collector 2, and the latter may be of any desired type; as, for example, a grounded antenna circuit, a radio frequency distribution line, a loop collector, or any well known type of signal pickup device used on mobile structures. The numeral 3 denotes the usual tuning mechanism which is employed in a radio receiver. For example, if the receiver is of the superheterodyne type then the numeral 1 will denote the tunable radio frequency amplifiers, the first detector and local oscillator, as well as one or more stages of IF amplification.

In that case, numeral 3 denotes the gang condenser used in the signal and local oscillator circuits, and which is adjustable to tune the receiver circuits through a signal range of say 500 to 1500 k. c. if the receiver is used in the broadcast range. Of course, it is to be understood that the circuits of network 1 can be employed in a multi-wave arrangement. If the receiver is of the tuned radio frequency type, then the numeral 1 will represent a plurality of cascaded tunable radio frequency amplifiers whose tunable input circuits are all resonated to a common carrier frequency of a desired signal frequency range. The demodulator 4 can be of any desired detection type; and a grid leak detector, or a biased detector or even a diode detector, may be used in network 4. When the receiver is of the superheter-

odyne type, then the demodulator 4 will be the usual second detector and its input circuit will be fixedly tuned to the operating IF. Of course, an automatic volume control (AVC) circuit can be used to maintain the carrier amplitude at the demodulator input circuit substantially uniform, and, as is well known, such AVC circuit is responsive to carrier amplitude variation for decreasing the gain of the radio frequency amplifiers in a sense to maintain the carrier amplitude substantially uniform at the demodulator input circuit.

The audio component of the demodulated signals is transmitted through a high pass audio frequency filter so that the low frequency portion of the audio range may be suppressed. In order to illustrate the invention let it be assumed that the audio range, as shown in Fig. 2, extends up to 10,000 cycles. Let it further be assumed that the relation between the noise voltage and the signal voltage throughout the audio range is as represented in Fig. 2. From this figure it will be seen that the short, thick, vertical lines represent the signal energy distributed throughout the audio range. The thin, taller lines denote the hiss and noise components which are distributed throughout the audio range, and which interfere with a proper understanding of the reproduced signals.

The high pass audio frequency filter 5 may, for example, cut out the section, or band, A of the audio range, and let it be assumed that this band is between zero and 1,000 cycles. Hence, there will be transmitted to the following network only signal and noise voltages distributed between 1,000 and 10,000 cycles. The transmitted band is denoted by the reference letter B, and this band is then impressed upon a limiter circuit.

The characteristic of the limiter is shown in Fig. 3, and it will be observed that the relation between the input voltage and output voltage is substantially linear up to a predetermined input voltage amplitude; from that limiting amplitude the curve is a substantially horizontal line. In other words, up to a predetermined amplitude of input voltage the noise and signal voltages will be transmitted through the limiter network 6 in a substantially equal manner. However, beyond that input voltage amplitude the noise voltage will be considerably attenuated with a resulting benefit to the signal to noise ratio. Any desired type of limiter circuit can be used in the network 6. Those skilled in the art are fully aware of the construction of limiter circuits. For example, a tube biased to its saturation point on its characteristic may be employed for this purpose.

One other type, and one which would probably be more effective, would be to pass the audio voltage to the grid of an unbiased tube through a small coupling condenser and have a grid leak from grid to cathode of the tube. The function of the coupling condenser and grid leak would be to produce a bias on the tube, which bias might correspond to cutoff for the large noise voltages, and thus "clip" the noise voltage peaks off.

The limited band of audio frequencies B is then subjected to the action of a low pass audio frequency filter 7. Let it be assumed that the network 7 functions to pass only the frequencies between 1,000 and 2,000 cycles. This band is denoted by the reference letter C in Fig. 2, and the band D, between 2,000 and 10,000 cycles, is suppressed by the filter network 7. The band C includes such frequencies as is required for a proper understanding of the signals. That is to say, the low pass filter 7 is designed in such a

manner that it will transmit a sufficient band of audio frequencies to permit a relatively satisfactory degree of intelligibility. The network 7 is employed to cut out the audio band D in order to eliminate from reproduction the harmonics produced in the transmission of the audio frequencies through the limiter network 6.

As is well known, a limiter circuit produces harmonics of frequencies impressed upon it. By cutting out all audio frequencies above the upper limit of the audio band C, harmonic distortion is eliminated and without appreciable detriment to the intelligibility of the reproduced signals. Band A is cut out at network 5 so that the limiter will not convert the frequencies of A to harmonics which would fall in band C. The audio output energy of network 7 may then be impressed upon any desired type of audible, or visual, reproducer. It is to be clearly understood that the network 5 can be designed to transmit solely the audio band C, and in that case the filter 5 would be of the band pass type. Of course, those skilled in the art are well acquainted with the manner of constructing low pass, high pass, or band pass audio filters; it is not believed necessary to show any specific filter circuits in view of this prior knowledge. It will be observed that by means of the present method of treating the audio output energy of the demodulator the signal to noise ratio of the reproduced signals is substantially increased, and yet the reproduced signals are sufficiently intelligible.

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. A method of improving the signal to noise ratio in a receiving system which includes the steps of demodulating received signals, selecting a high frequency portion of the demodulated signal range, reducing the noise to signal ratio of the selected portion, and selecting from the said portion for reproduction a second portion in the lower frequency section thereof thereby to prevent reproduction of harmonics produced during said reduction step.

2. A method of improving the signal to noise ratio in a receiving system which includes the steps of demodulating received signals, selecting a high frequency portion of the demodulated signal range with complete rejection of the remaining frequencies of the range, reducing the noise to signal ratio of the selected portion, and reproducing only a band of low frequencies of the selected portion thereby to prevent reproduction of harmonics produced during said reduction step.

3. In a radio receiver of the type including a signal amplifier followed by a demodulator, a high pass audio filter transmitting only a high frequency band of the audio signals, a limiter network for reducing the noise to signal ratio of the output of said filter, and a low pass audio filter for transmitting to a reproducer only a lower frequency portion of the output of the limiter network thereby to prevent reproduction of harmonics produced during transmission of said high frequency band through said limiter network.

4. A method of improving the signal to noise

ratio of a wide band of signal frequencies which includes the steps of selecting from the wide band a second band comprising a predetermined portion of the high frequencies with complete rejection of the remaining frequencies of said wide band, reducing the noise to signal ratio of the selected second band of frequencies, and selecting from the second band of reduced noise to signal ratio a third band comprising the lower frequencies thereby to suppress harmonics produced during said reduction step.

GARRARD MOUNTJOY.