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CIRCUIT FOR REDUCING STATIC

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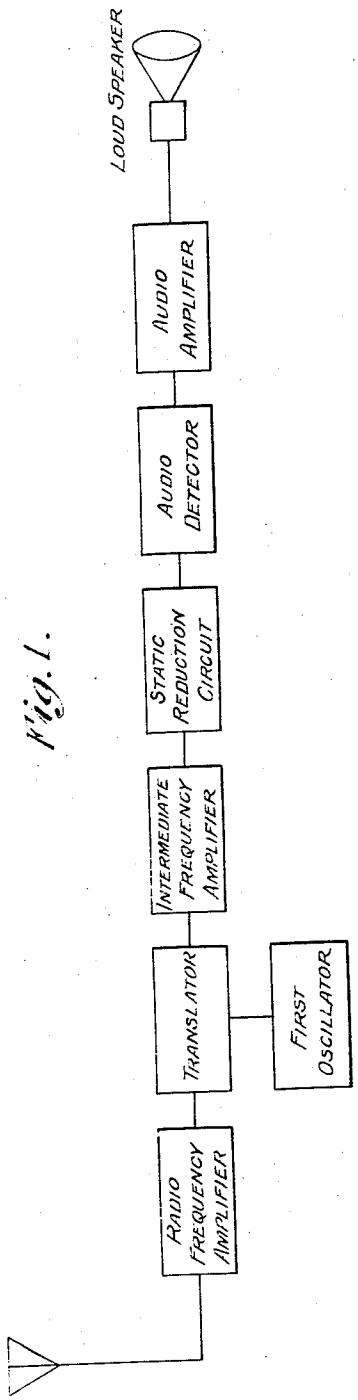


Fig. 1.

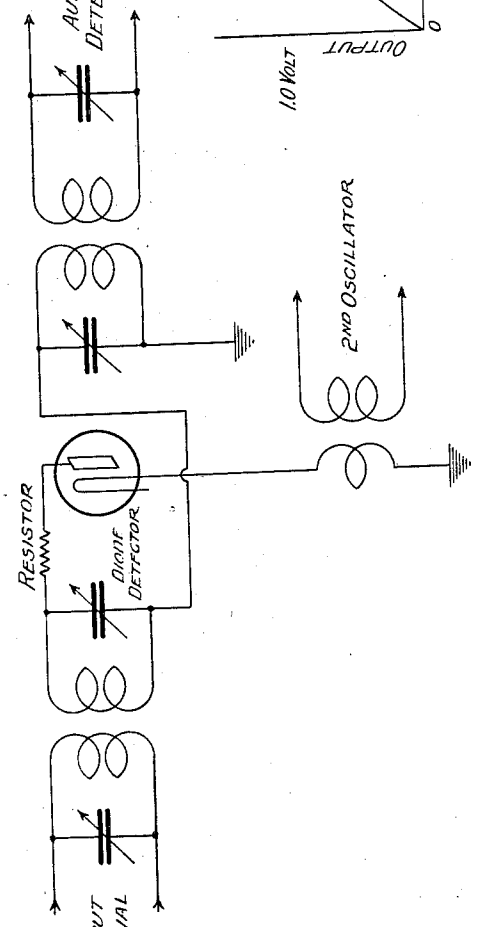


Fig. 2.

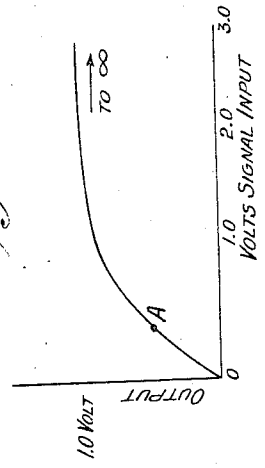


Fig. 3.

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CIRCUIT FOR REDUCING STATIC

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4 Claims. (Cl. 250—20)

The present invention relates to a circuit designed to reduce the effect of certain forms of static which at present seriously interfere with the reception of signals by a radio receiving set. More particularly it contemplates the reduction or elimination of static crashes of the manmade type, such as automobile ignition noises, vacuum cleaners, sewing machine motors, electric fans and similar electrical devices. The nature of the disturbance from most of these devices is fundamentally the same as the static of long waves, that is, a pulse, or series of pulses, each of which lasts only a very short time, but due to their extremely great amplitude, they deafen the listener to such a degree as to make a signal unintelligible.

In ordinary reception, the signal, which may be arriving at the receiver, will, 95% of the time, be undisturbed, while the other 5% of the time the signal is blotted out by the static pulses. If the receiver could be made dead during this 5% of static pulses, the signal would be practically unimpaired. Even if these static pulses could be kept from reaching amplitudes greater than that of the signal, it would still be easily readable.

For many years it has been appreciated that a desirable circuit for accomplishing this purpose would be one which would readily overload or be blocked by these static crashes when they exceed the amplitude of the signal. A circuit that has been used heretofore to limit static embodies the use of a very low plate voltage on the last audio stage. This form of circuit, however, has several disadvantages, first, the static crash is reduced but not kept down to signal level, mainly due to the large amount of audio frequency harmonics generated; second, in order to utilize the advantages to be derived it is necessary to maintain the signal voltage of the tube in the last audio stage at an amplitude just below that which overloads this stage.

The circuit contemplated by the present invention is in principle the same as the overloading audio amplifier but is carried on at radio frequencies, and by the proper choice of circuit elements it is possible to obtain a circuit which is free from the first fault above mentioned. That is to say, the harmonics generated in the circuit by the static crashes are of such frequencies as not to be admitted, in any appreciable magnitude, to the circuit presently to be described. In the case of keyed carrier code the circuit of itself has inherently automatic volume control characteristics over a fairly large signal range such that there is no trouble holding any signal which is sufficiently strong to be received.

The circuit organization which is the subject of my invention may be applied to keyed carriers and modulated carriers. It will be described in particular as incorporated in a superheterodyne receiver. This form of the circuit may be said to consist of three parts: first, a diode detector having a resistor in series, said detector being actuated by the last intermediate frequency stage in a superheterodyne receiver; second, a beat frequency oscillator the frequency of which differs from the intermediate frequency by a superaudible frequency; and, third, a radio frequency coupling device such as a transformer, tuned to a frequency which is either the sum or difference of the oscillator frequency and the intermediate frequency, which feeds the audio detector.

My invention is illustrated schematically in the accompanying drawing, in which:

Fig. 1 is a block diagram of a complete superheterodyne receiver incorporating the invention.

Fig. 2 illustrates schematically the diode detector and oscillator associated therewith comprising the static reduction circuit indicated in block in Fig. 1.

Fig. 3 is a graph showing the relation between input and output voltage of a diode translator.

Referring now to the circuit shown in Figure 2, it will be seen to embody a diode detector with a resistor, a second oscillator, input and output transformers. Although this circuit is in reality the essence of my invention it is auxiliary in nature and its insertion or inclusion in a standard superheterodyne receiving circuit at the point contemplated by me accomplishes results not obtained heretofore.

Such a circuit using the diode as a wiper tube will have the following characteristics: The output of this diode is proportional to the input as long as the oscillator voltage is substantially greater than the input voltage. On the other hand, if the signal voltage is larger than the oscillator voltage, the output is practically independent of the input. It is the latter characteristic around which the present invention is based and not the former. Figure 3 shows the foregoing characteristic graphically for oscillator voltage of 1.0, an output circuit with no losses, and a theoretical diode, that is, with no contact potential differences and with no curvature. In the actual case where the load does not have infinite impedance, nor the signal source zero impedance, a resistor in series with the diode will tend to maintain the impedance of the circuit constant, thereby obtaining results more nearly

coinciding in shape with the curve of Figure 3 even though the efficiency is reduced. Actually, the results obtained are substantially the same as those possible theoretically.

In the case of keyed carrier code reception, it will be apparent from Figure 3 that there is less than 2 decibels change in output, for any change whatsoever in the input, so long as it is greater than the oscillator voltage. This holds true for any type of signal or static disturbance. Therefore, if the signal voltage is maintained above that of the oscillator a static disturbance can never be more than 2 decibels louder than the signal, even though static disturbances reaching the receiver may have been 60 or 80 decibels greater than the signal.

For telephone reception (modulated carrier) it is desirable to have a very good automatic volume control, so as to operate the diode about half way up the curve, as indicated at point "A" in Figure 3. If the automatic volume control does not have sufficient control to hold the signal to this point, two effects will be noted, namely, first, if the signal level rises up on to the flat portion of the curve, the modulation will be distorted, and the percentage of modulation will appear greatly reduced; second, if the signal level falls below this point, the signal reaching the audio detector will fall off proportionally as the operating point is moved down the curve, the result is, the signal-to-noise ratio is poorer. If the actuating voltage for the automatic volume control is taken off before the signal passes through the static reducing circuit, loud static pulses will actuate the automatic volume control making the signal disappear during a series of static pulses which are separated by a length of time less than the time constant of the automatic volume control system. If the actuating voltage is taken off after passing through the static reducing circuit, the same difficulty is encountered, but to a much less degree. This may be reduced still further by passing the actuating voltage through a very selective circuit, before applying it to the automatic volume control. In certain special cases it is possible to place this sharply tuned circuit between the static reducing circuit and the audio detector, in which case the actuating voltage is taken directly off the audio detector; if it is a diode detector, there is the possibility of taking the direct current component and, by amplifying it, have the necessary voltage to control the grids of the radio frequency and intermediate frequency tubes.

The action of the selective circuit in reducing the effect of static pulses upon the automatic volume control tube is brought about in the following way: these static pulses are composed of radio-frequency components which cover wide frequency bands, usually megacycles wide, and with a rather uniform distribution. Since these are passed through tuned circuits which, all together, have a band width of only a few kilocycles, the resulting disturbance reaching the static reducing circuit has a frequency distribution coinciding with the resonance curve of the receiver up to this point. The output of the diode has a frequency distribution similar to its input, but limited in amplitude to the maximum which the circuit will pass. If this is passed through a selective circuit which has, for example, a band width of only one tenth of that of the circuits up to this point, the energy of the noise will be reduced tenfold, while that of the signal will not be reduced at all, providing the signal does not have a band width greater than that of the added very selective circuit. Where this circuit is added for clearing up the actuating voltage for the automatic volume control tube, one is only concerned with the carrier getting through and does not care if some of the side bands are cut. With such a large ratio as ten, the voltage arriving at the automatic volume control tube would actually decrease during the time when a static pulse is arriving, which would result in causing the automatic volume control to tend to make the radio set more sensitive, just the opposite of the result if the selective circuit had not been added. A selectivity ratio of two to one would probably give the most constant automatic volume control action through static pulses where the diode is being operated half way up the characteristic curve shown in Figure 3.

The use of added selectivity, between the static reducing circuit and the audio detector, will result in a better signal-to-noise ratio, being roughly proportional to the ratio of selectivities of the receiver and the added circuit. This is true for both telephone and keyed carrier code; in the latter case much more selectivity can be used since the transmission is mainly confined to a single frequency. As selectivity is added, the receiver approaches the condition of being silent during static pulses, but with full sensitivity at all other times.

While the invention has been set forth and described in a preferred form nevertheless obvious modifications of the circuit arrangement can be made. It is desired to cover all such modifications as come within the scope of the appended claims.

What is claimed is:

1. In a radio receiving signaling system, a static reducing circuit, comprising a diode detector having a resistor in series, said detector being actuated by the last intermediate frequency stage in a superheterodyne receiver, an oscillator the frequency of which differs from said intermediate frequency by a superaudible frequency, and a radio-frequency coupling device tuned to a frequency which is the resultant of the oscillator and the intermediate frequencies, said coupling device feeding an audio detector.

2. In a radio receiving set, a static reducing circuit comprising a diode detector which is fed by the signal from the last intermediate frequency stage in a super-heterodyne receiver, a beat oscillator whose applied voltage to said diode is approximately twice that of the voltage of the unmodulated signal from said last intermediate frequency stage, whereby said diode provides limiting action for noise impulses whose amplitudes exceed twice said unmodulated signal voltage but still providing for normal modulation range, the frequency of said oscillator being different from the intermediate frequency, and a radio frequency coupling device tuned to a frequency which is the resultant of said frequencies which feeds an audio detector.

3. In a radio receiving system, a static reducing circuit, comprising a diode detector having a resistor in series, said detector being actuated by a radio frequency signal, an oscillator the frequency of which differs from the frequency of said signal by a super-audible frequency, and a radio frequency coupling device tuned to a frequency which is the resultant of the oscillator frequency and the frequency of said signal, said coupling device feeding an audio detector.

4. In a radio receiving system, a static reducing circuit comprising a diode detector which is

fed by the last intermediate frequency stage in a superheterodyne receiver, a beat oscillator whose applied voltage to said diode is approximately twice that of the output voltage of said last intermediate frequency stage, whereby said diode provides limiting action for noise impulses whose amplitudes exceed twice said unmodulated signal voltage but still providing for normal modulation range, the frequency of said oscillator being different from the intermediate frequency, and a radio frequency coupling device tuned to a frequency which is the resultant of said frequencies which feeds an audio detector.

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