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REDUCTION OF NOISE

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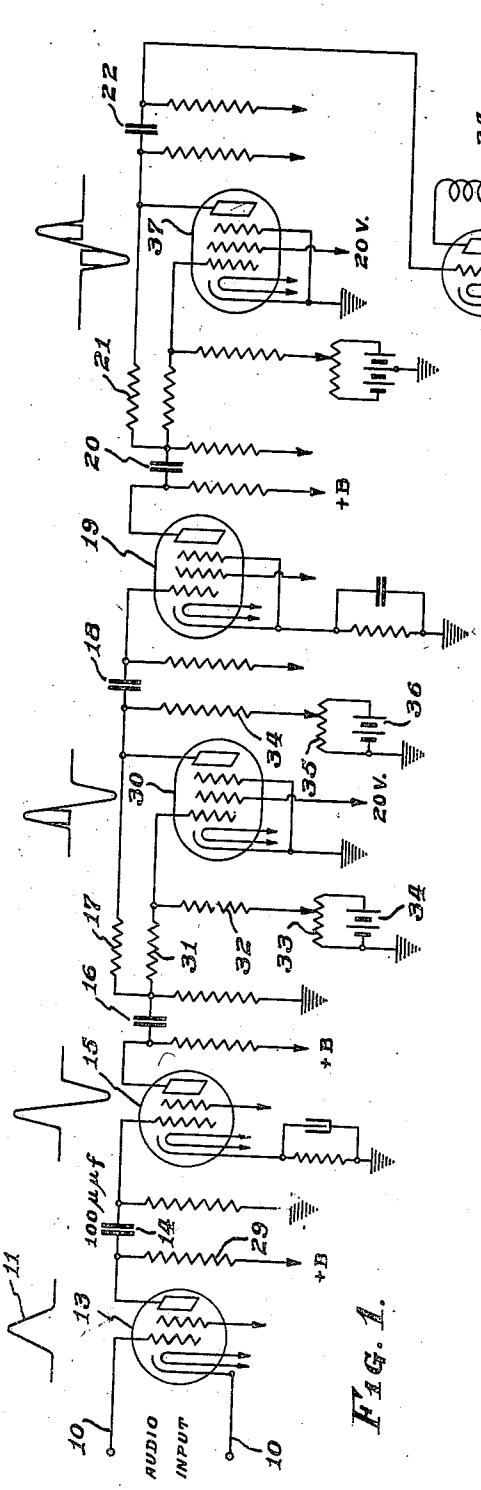


FIG. 1.

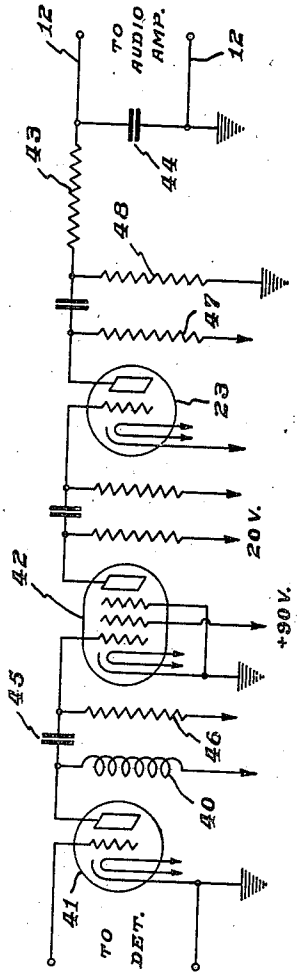


FIG. 2.

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REDUCTION OF NOISE

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9 Claims. (Cl. 250—20)

This invention relates to reduction of the noise sometimes produced in radio receivers and similar apparatus by electrical impulses extraneous to the signal impulses, and has for its principal object the provision of an improved apparatus and method of operation for increasing the range of levels over which the disturbance effects of noise impulses are minimized or obviated.

Many of the noise reduction systems heretofore proposed are not altogether satisfactory for the reason that they operate to minimize the effect of only relatively high level noise impulses or also tend to operate on the peaks of the high level signal impulses. In accordance with the present invention this difficulty is avoided by the provision of means for successively (1) amplifying the impulse voltages in direct proportion to their frequency, (2) suppressing the noise impulses, and (3) amplifying the impulse voltages inversely as their frequency. As will be readily understood by those skilled in the art, this method of noise reduction has the important advantage that operation of the noise suppressor or limiter is restricted to high frequencies where the amplitude is usually relatively low, thus permitting its operation on noise pulses of lower level than is otherwise permissible.

The invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

Referring to the drawing:

Fig. 1 is a wiring diagram of a noise reduction system constructed in accordance with the invention, and

Fig. 2 is a similar diagram of a somewhat different embodiment of the invention.

The system of Fig. 1 includes input terminals 10 from which signal impulses similar to that indicated at 11 may be supplied to output terminals through a circuit, the high voltage lead of which includes an audio amplifier 13, a coupling and high frequency accentuating capacitor 14, a resistor 17, a coupling capacitor 18, an impulse phase reverser 19, a coupling capacitor 20, a resistor 21, a capacitor 22, an amplifier 23, a coupling including the series connected reactor 24 and resistor 25 and the capacitor 26, and an amplifier 27.

Connected between the above traced lead and the ground terminal, which is the low voltage lead of the circuit, are (1) a resistor 29, connected in the output circuit of the amplifier 13, (2) a limiter or suppressor device 30 provided with a grid potential control 31—32—33—34 and with an anode potential adjustment circuit 34—35—36, (3) a limiter device 37 having input and output circuits similar to those of the device 30 and (4) a low frequency accentuator including the reactor 24, the resistor 25, the capacitor 26. The coupling resistors, by-pass condensers, and other unmentioned elements of the circuit are well known features of noise reduction systems and perform functions which will be readily understood without detailed explanation. The important features of the present invention are the high frequency peaker or accentuator which emphasizes the high frequency components of the signal, the noise suppressors 30 and 37 which function with the phase reverser 19 to short circuit both the positively and negatively polarized relatively high level impulses and the low frequency accentuator which functions to restore the desired relation between the high and low frequency components of the signal.

In the operation of this modification of the invention, the suppressor devices 30 and 37 are biased beyond cutoff and draw no plate current in the absence of impulses exceeding a predetermined level when a noise impulse of positive polarity exceeds a level predetermined by the grid bias potential applied through the resistor 33, plate current flows through the suppressor device 30 and the plate potential is pulled down to approximately no signal value. Since this plate potential with no signal is adjustable by means of the potentiometer 35, this control allows the "short circuit" level and the no signal level to be adjusted to the same or different levels as desired. The operation of the suppressor device 37 is similar to that of the device 30 except that the impulses are fed to it through the phase reverser 19 and it therefore acts on the impulse half wave not affected by the device 30.

As previously indicated, the high frequency components of the impulses delivered to the suppressors 30 and 37 are accentuated by means such as the capacitor 14 which may have a capacity of the order of 100 micro-microfarads. Suitable balance between the high and low frequency components of the signal is restored at the output of the amplifier 23. To this end the external plate impedance of the amplifier 23 should exceed the plate impedance of the amplifier at all audio frequencies but should be highest at the high frequencies. Thus if the audio plate voltage is μEg, the plate current is approximately

$$\frac{\mu Eg}{jwL}$$

and the voltage across the resistor 25 is inversely proportional to frequency. Since this voltage is applied to the input circuit of the amplifier 27, any desired balance between the different frequency components may be restored at the output terminals 12.

When a high level impulse is applied to the antenna of a receiver it results in a decay train being applied to the detector. Rectification of

this group of waves results in a uni-directional pulse in the audio circuit, as illustrated at the input of Fig. 1. Passing this pulse through a high frequency accentuator is equivalent mathematically to taking the derivative of the pulse. This is illustrated in the wave drawn above tube 30. In this wave the height of each point is equal to the slope of each corresponding point of the input wave. Thus the uni-directional impulse which is applied to the input is transformed into two adjacent impulses of opposite direction. This is what makes it necessary to limit both the positive and negative halves of the cycle.

The noise suppressor system of Fig. 2 is similar in some respects to that of Fig. 1, but differs therefrom in that a reactor 40 is provided in the output circuit of the amplifier 41 for accentuating high frequencies, a single electron discharge device 42 functions to control the impulse transmitting efficiency of the channel when a predetermined level is reached, and the output circuit of the amplifier 23 is coupled to a network including a resistor 43 and a capacitor 44 which function to restore a desired balance between the high and low frequency components delivered at the output terminals 12.

As will be understood, the reactor 40 should have such a value L that its impedance (together with the shunt capacity and series resistance) does not deviate very far from the value jwL. A suitable value is 0.1 henry. The coupling capacitor 45 should be large enough to be of lower impedance than the resistor 46 at the lowest frequency over which a response is desired and the impedance of the resistor 46 should be larger than wL at the highest frequency transmitted. The impedances of resistors 46, 47 and 43 should be larger than

$$\frac{1}{jwC_2}$$

at the lowest frequency desired when C_2 is the capacity of the capacitor 44. The values assigned to these various elements will, of course, be determined in each case by the particular conditions under which the system is to be operated. It will be apparent that the device 42 operates by plate current cut off to suppress noise impulses of one polarity and by plate voltage saturation (plate voltage drops to zero) to suppress noise impulses of the opposite polarity. This mode of operation is well known and will be understood without detailed explanation, keeping in mind that the plate of this device is subjected to a relatively low voltage of the order of 20 volts or the like.

I claim as my invention:

1. The noise reduction method which includes accentuating the high frequency components of the impulses to be transmitted, decreasing the level of said components in response to noise impulses exceeding a predetermined amplitude, and restoring a desired balance between said components.

2. The noise reduction method which includes accentuating the high frequency components of the impulses to be transmitted, interrupting said components in response to the positive half cycles of noise impulses exceeding a predetermined amplitude, reversing the phase of said impulses, interrupting said components in response to the negative half cycles of noise impulses exceeding a predetermined amplitude and accentuating the low frequency components of said impulses.

3. A noise reduction system including means for accentuating the high frequency components of the signal to be transmitted, means operable to interrupt said components in response to noise impulses exceeding a predetermined level, and means for restoring a desired balance between said components.

4. A noise reduction system including means for accentuating the high frequency components of the signal to be transmitted, means operable to decrease the level of said components in response to noise impulses exceeding a predetermined level, means for restoring a desired balance between said components, and means for adjusting said predetermined level.

5. The combination of a high frequency accentuator including an amplifier and a reactor connected in the output circuit of said amplifier, a low frequency accentuator, and means interconnected said accentuators and operable in response to noise signals of an amplitude exceeding a predetermined value to decrease the level of the signals transmitted between said accentuators.

6. The combination of a high frequency accentuator, a low frequency accentuator including a resistive capacitive network, and means connected between said accentuators and operable in response to noise impulses of an amplitude exceeding a predetermined value to decrease the level of the signals transmitted between said accentuators.

7. The combination of a high frequency accentuator, a low frequency accentuator, including a resistive capacitive network, and means connected between said accentuators and operable in response to noise impulses of an amplitude exceeding a predetermined value to decrease the level of the signals transmitted between said accentuators, and means for adjusting said predetermined value.

8. The system of noise reduction of claim 4 in which the means for suppressing impulses consists of, first, a device which short circuits the signal path for the duration of a positive high amplitude impulse, second, a phase reversing tube and, third, another short circuiting device.

9. The noise reduction method which includes changing the relation between the frequency components of the impulses to be transmitted, decreasing the level of said impulses in response to noise impulses of an amplitude exceeding a predetermined level, and restoring a desired balance between said components.

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