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2,113,212

REDUCTION OF NOISE

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2 Sheets-Sheet 1

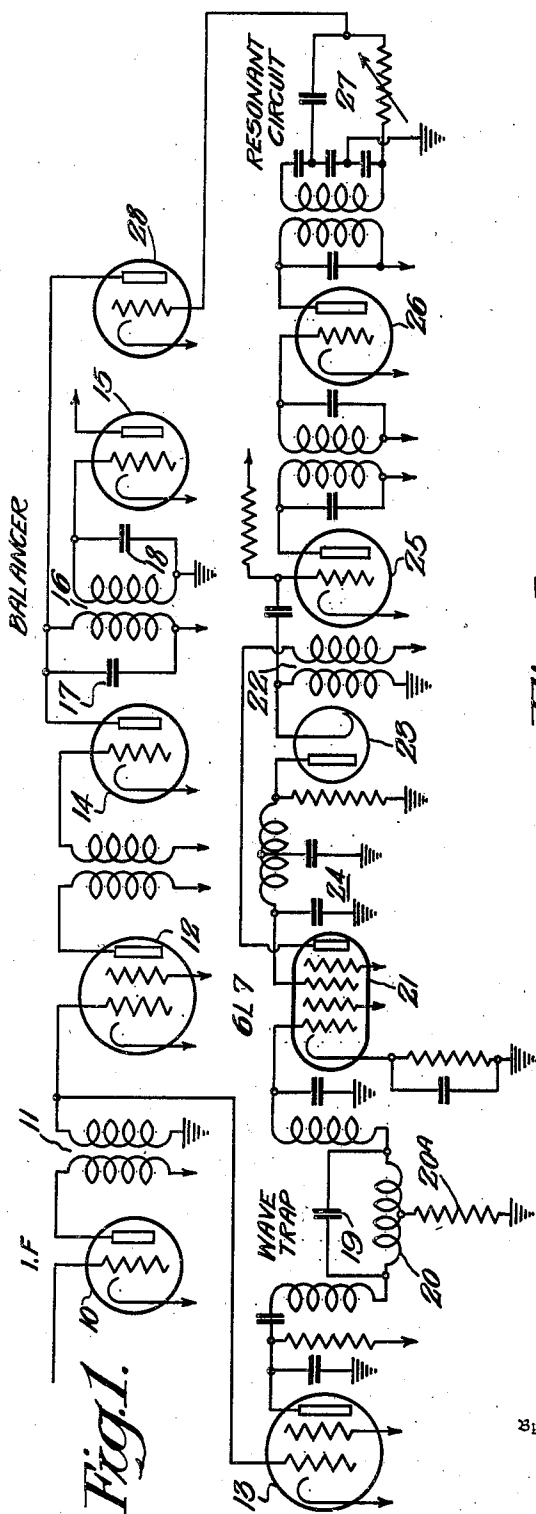
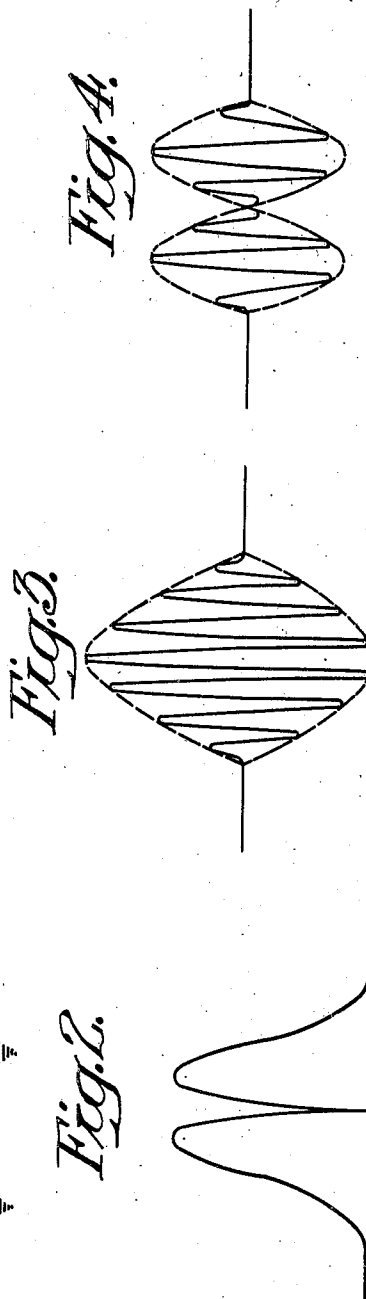


Fig. 1.



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2 Sheets-Sheet 2

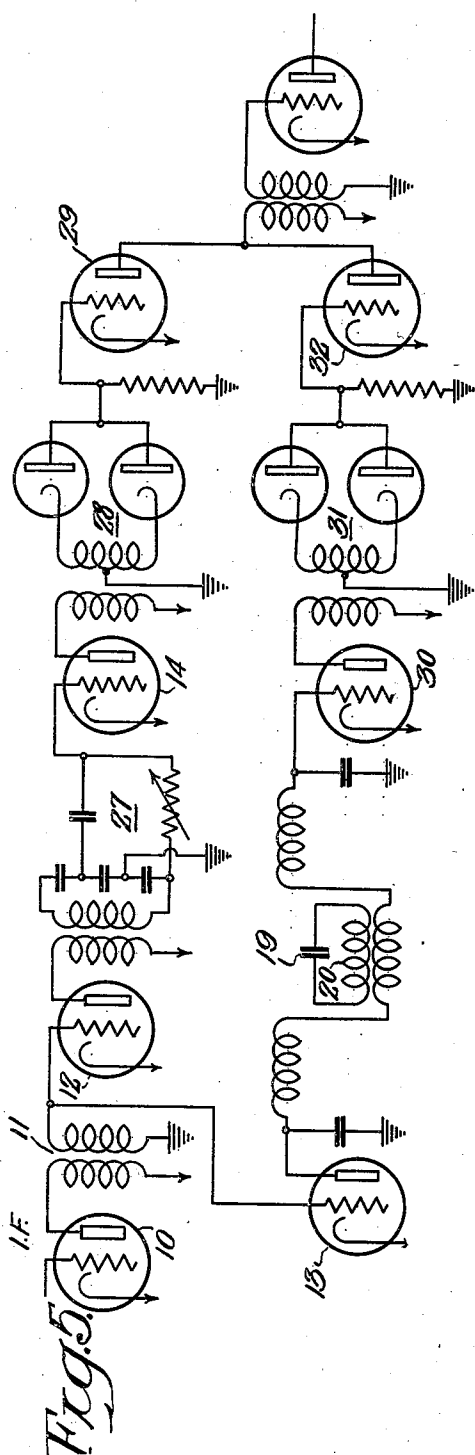


Fig. 7.

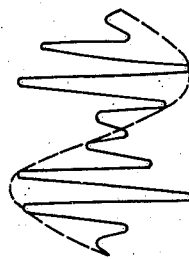
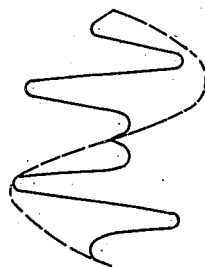


Fig. 6.



35

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UNITED STATES PATENT OFFICE

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REDUCTION OF NOISE

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8 Claims. (Cl. 250—20)

This invention relates to the reduction of noise such as that produced in radio receivers and like apparatus by impulses extraneous to the desired signal, and has for its principal object the provision of an improved apparatus and method of operation whereby the undesired effects of such extraneous or noise producing impulses are minimized or eliminated.

A further object is to provide an improved noise impulse eliminator which operates to eliminate noise impulses of an amplitude lower than that of the signal as well as those which are of greater amplitude than that of the signal. To this end, there is provided in parallel with the signal channel a control channel wherein the carrier is eliminated and the noise impulses thus segregated from the signal impulses are so modified and utilized as to cancel the noise impulses from the signal channel irrespective of the relative amplitudes of the noise and signal impulses.

More particularly, the invention involves the amplification of the signal and noise impulses to a relatively low level, such as one volt, and the diversion of a part of these impulses into a control channel where (1) the carrier is eliminated by a wave trap, (2) the noise impulse is converted into two impulses of opposite phase, (3) the first of these converted impulses is utilized to eliminate the second converted impulse and (4) the first converted impulse is modified as to amplitude, shape and phase and is introduced into the signal channel to cancel the noise component of the signal. A modified form of the invention somewhat less satisfactory than that just described involves the elimination of the carrier in the control circuit, the doubling of the noise impulse frequency in the control and signal channels and the combination of these doubled frequency or second harmonic impulses in such phase and amplitude relation that they cancel one another at the output of the signal and control channels.

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

Referring to the drawings,

Figure 1 is a wiring diagram of a preferred embodiment of the invention,

Figures 2 to 4 are explanatory curves relating to the operation of the system of Fig. 1,

Figure 5 is a wiring diagram of a modified form of the invention, and

Figures 6 and 7 are explanatory curves relating to the operation of the system of Fig. 5.

The system of Fig. 1 includes an intermediate

frequency input stage 10 which is coupled through a transformer 11 to the first stage 12 of a signal channel and the first stage 13 of a control channel. It is preferred that the stage 10 be designed to operate with an output level of relatively low value such as one volt or the like.

The signal channel includes a subsequent amplifier stage 14 and a detector stage 15 which are coupled together through a transformer 16 and capacitors 17 and 18. Into the high voltage primary terminal of the transformer 16 is introduced the control impulses by which the noise impulse component is balanced out of or eliminated from the signal before the signal reaches the detector 15.

The stage 13 of the control channel is followed by a sharply tuned wave trap 19—20—20A which eliminates the carrier and converts the noise impulse (Fig. 3) into adjacent impulses (Fig. 4) which are 180 degrees out of phase. Due to the fact that the wave trap 19—20 involves resistance cancellation, it functions to reject the carrier with a high degree of selectivity, as shown in Fig. 2. The functioning of resistance cancellation in wave rejectors is explained in detail in my article entitled "M-derived band pass filters with resistance cancellation" published in the RCA Review, October, 1936.

The control channel stage 21 transmits the first noise impulse lobe (Fig. 4) through its output circuit transformer 22 to the following stages of the control channel and also functions to reflect this same noise impulse lobe or wave train backwards through a detector 23 and a timing network 24 to the output control grid of the stage 21 with the proper time delay to prevent the passage of the second noise impulse lobe or wave train (Fig. 4) by biasing the grid to cut-off for the duration of the lobe.

The resonant stages 25, 26, and 27 serve to delay the wave train and to increase its duration. Circuit 27 gives a manual adjustment of the phase of the wave train. The selectivity characteristics of circuits 25, 26, and 27 are so chosen that the noise wave train transmitted by this path corresponds to that passed by the other channel, in time of occurrence, time of duration, and shape of envelope but with opposing phase as the two channels are reunited in transformer 16. Since the control impulses are thus independently phased and shaped in the control circuit, it will be apparent that noise impulses of a range of levels extending above and below that of the signal are readily eliminated by this system.

The system of Fig. 5 is similar to that of Fig. 1

in some respects but differs therefrom in that it includes means for doubling the frequency of the noise impulses in the signal and control channel paths and for bringing these doubled frequency noise impulses together in such a phase and amplitude relation that they cancel one another.

In this system, the stage 12 of the signal channel is followed by a network 27 which determines the phase of the impulses at the input terminals of the stage 14. The output circuit of stage 14 feeds through a frequency doubler 28 to the last signal channel stage 29. The control channel of the system of Fig. 5 differs from that of Fig. 1 in that the oppositely phased noise impulse lobes or wave trains (Fig. 6) appearing at the output of the wave trap 19—20 are fed through a stage 30 and a frequency doubler 31 to a stage 32 which functions with the signal channel output stage 29 to cancel the double frequency noise impulses in which the succeeding lobes are of the same phase as indicated by Fig. 7. As in the case of the system of Fig. 1, the absence of the carrier in the control channel makes it possible to determine the amplitude and phase of the control impulses so that the noise impulses are balanced out irrespective of the level of the signal.

I claim as my invention:

1. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, and signal and control channels connected in parallel to said source, said control channel including a sharply tuned wave trap for rejecting said modulated carrier and converting said noise impulse into similar successive wave trains of opposite phase, means for modifying the phase relation between said wave trains, and means for introducing the output of said control channel into said signal channel.

2. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, and signal and control channels connected in parallel to said source, said control channel including a sharply tuned wave trap for rejecting said modulated carrier and converting said noise impulse into similar successive wave trains of opposite phase, means for modifying the phase relation between said wave trains, means for introducing the output of said control channel into said signal channel, and means for adjusting the phase relation between the noise impulses of said channels.

3. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, a signal channel connected to said source and provided with an output stage, and a control channel connected to said source and provided with means for rejecting said modulated carrier and converting said noise impulse into similar successive wave trains of opposite phase, means for utilizing the first of said wave trains to cancel the second of said wave trains, means for adjusting the amplitude and phase of the first of said wave trains, and means for introducing said adjusted wave train into the input circuit of said output stage.

4. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, and signal and control channels connected in parallel to said source, said control channel including means for rejecting said modulated carrier and converting said noise impulses into similar successive wave trains of opposite phase, means including a detector and delay network for causing the first of said wave trains to cancel the second of said wave trains, means for adjusting the amplitude and phase of the first of said wave trains, and means for introducing said adjusted wave train into said signal channel.

5. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, and signal and control channels connected in parallel to said source, said control channel including a sharply tuned wave trap for rejecting said modulated carrier and converting said noise impulses into similar successive wave trains of opposite phase, means including a detector and timing network for causing the first of said wave trains to cancel the second of said wave trains, means for adjusting the amplitude and phase of the first of said wave trains, and means for introducing said adjusted wave train into a detector input circuit of said signal channel.

6. The combination of an intermediate frequency amplifier adapted to transmit noise and signal impulses, signal and control channels connected in parallel to the output of said amplifier, said signal channel including a detector provided with an input circuit and said control channel including means for rejecting said modulated carrier and converting said noise impulse into successive wave trains of opposite phase, means for causing the first of said wave trains to cancel the second of said wave trains, means for adjusting the amplitude and phase of the first of said wave trains, and means for introducing said adjusted wave train into the input circuit of said detector.

7. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, signal and control channels connected in parallel to said source, said control channel including means for rejecting said modulated carrier and converting said noise impulses into similar successive wave trains of opposite phase, said signal and control channels including frequency doubling means, and means for combining the outputs of said channels.

8. The combination of a source of noise impulses superimposed on a modulated high frequency carrier, signal and control channels connected in parallel to said source, said control channel including means for rejecting said modulated carrier and converting said noise impulses into similar successive wave trains of opposite phase, said signal and control channels including frequency doubling means, means for combining the outputs of said channels, and one of said channels including means for adjusting the phase relation of said outputs.

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