

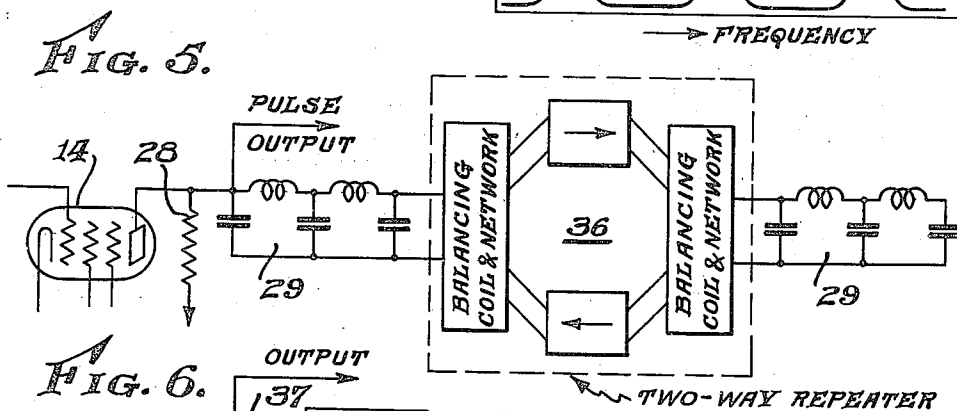
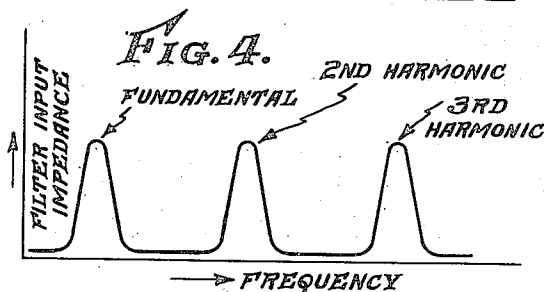
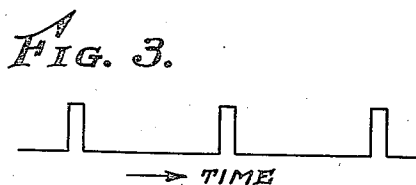
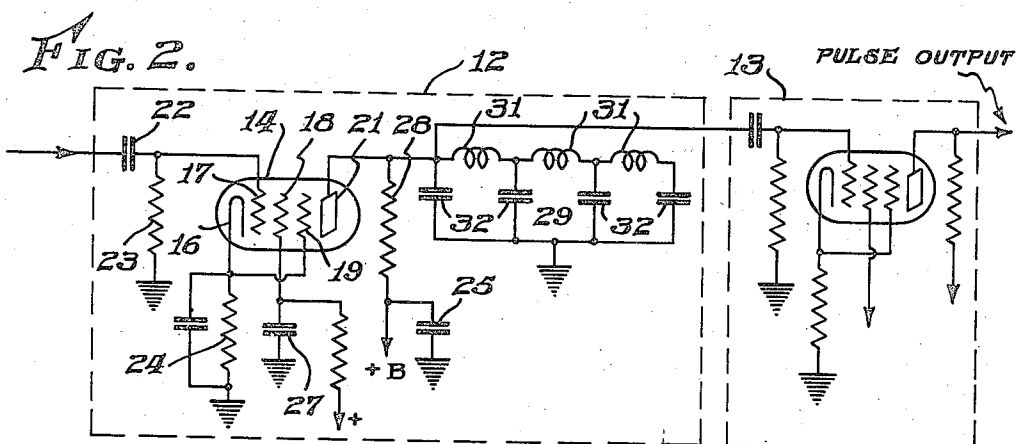
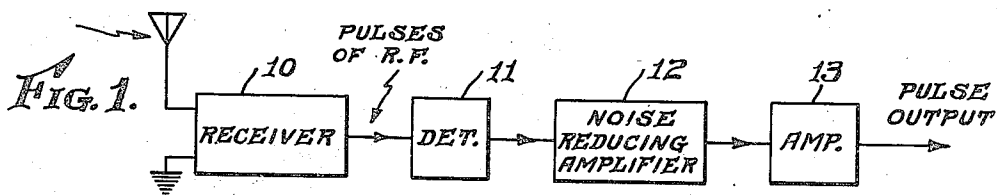
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AMPLIFIER FOR PULSES

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AMPLIFIER FOR PULSES

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Our invention relates to noise reducing circuits for non-sinusoidal electric waves and particularly to an amplifier or noise reducing circuit for the amplification or transfer of periodically recurring electrical pulses.

An object of the invention is to provide an improved method of and means for improving the signal-to-noise ratio of a non-sinusoidal signal. A further object of the invention is to provide an improved frequency selective circuit for passing electrical pulses or other non-sinusoidal waves. A still further object of the invention is to provide an improved amplifier for periodically recurring electrical pulses or the like.

It is well known that periodically recurring pulses or other periodic non-sinusoidal waves are composed of a fundamental frequency component and of harmonic frequency components. Hence, if an amplifier or other signal transferring circuit is designed to have a comparatively high gain for these frequency components and a comparatively low gain for undesired signals comprising other frequency components, it is evident that the amplifier will pass the desired pulses or other non-sinusoidal waves substantially to the exclusion of interfering signals or noise.

In a preferred embodiment of our invention an open ended delay line or circuit is connected to the plate circuit of an amplifier tube so that the plate circuit impedance depends upon the input impedance of the delay circuit. It is a well known characteristic of such a line that it will have maximum input impedance at a certain fundamental frequency and at the harmonic frequencies and have a comparatively low input impedance at other frequencies. Since the amplifier gain is equal to the mutual conductance of the tube times the plate circuit impedance it follows that our improved amplifier may be designed to pass the frequency components of a pulse or the like and reject noise or other interfering signals.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which

Fig. 1 is a block diagram of a pulse receiver which includes an amplifier designed in accordance with the invention, Fig. 2 is a circuit diagram of an amplifier embodying the invention, Figs. 3 and 4 are graphs that are referred to in explaining the invention, and Figs. 5 and 6 are diagrams of other embodiments of the invention. In the several figures like parts are indicated by similar reference characters.

In Fig. 1 our invention is shown applied to a radio pulse receiver 10, a detector 11, a noise

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reducing amplifier 12 designed in accordance with the invention, and a video frequency amplifier 13.

Fig. 2 shows one embodiment of the noise reducing amplifier 12. It comprises an amplifier tube 14 which may be of the pentode type having a cathode 16, a control grid 17, a screen grid 18, a suppressor grid 19 and an anode 21. The input circuit of the tube 14 includes a grid capacitor 22, a grid leak resistor 23 and a bypassed cathode biasing resistor 24. A positive D.-C. voltage is applied to the screen grid 18 through the usual filter comprising a resistor 26 and a filter capacitor 27. The plate circuit of tube 14 includes a plate resistor 28 or other impedance unit through which operating voltage is applied to the anode 21. A bypass or filter capacitor is shown at 25.

An open-ended delay circuit 29 has its input end connected across the plate resistor 28. In this specific example circuit 29 is in the form of a low-pass filter having series inductance coils 31 and shunt capacitors 32. The other end of filter 29 will reflect signal components since it is not terminated for non-reflection. Also, the reflected components will again be reflected at the input end of filter 29 because the resistance of resistor 28 is made large compared with the surge impedance of the filter. For example, the surge impedance of filter 29 may be 1000 ohms and the resistance of resistor 28 may be 20,000 ohms. As a result, the impedance looking into filter 29 from tube 14 varies with frequency as shown in Fig. 4. It is evident that the amplifier output taken off the plate resistor will be small except at a particular frequency and its harmonics.

As previously stated, periodically recurring non-sinusoidal waves, such as the pulses shown in Fig. 3, consist of fundamental and harmonic frequency components. It is evident that the plate circuit of the amplifier tube 14 may be designed so that the impedance peaks shown in Fig. 4 occur at the fundamental and harmonic frequencies of any particular non-sinusoidal wave that it is desired to amplify. The impedance peaks will occur at such frequencies if the delay provided by circuit 29 is made such that an impedance peak occurs at the fundamental frequency of the signal, provided the circuit 29 introduces a delay that is independent of frequency.

If the pulse repetition rate is low enough to require the use of a long delay line or circuit, the delay line attenuation may be great enough to make desirable the use of a two-way repeater 36

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as shown in Fig. 5. The repeater 36 is of well known design and in the specific example illustrated is located in the middle of the delay circuit 29. By using the repeater 36 the impedance peaks (Fig. 4) are prevented from dropping to a low value because of delay circuit attenuation.

It should be understood that the invention is not limited to the specific delay circuits and connections that have been described. As shown in Fig. 6, for example, the vacuum tube 14 may be replaced by a high impedance resistor 35. Also, the delay circuit 29 may be coupled through a transformer 37 to the signal transferring circuit which includes resistor 35. The delay circuit may, of course, be a line having distributed capacity and inductance.

We claim as our invention:

1. In apparatus for transferring a non-sinusoidal periodic signal, a signal transferring circuit comprising a vacuum tube having an anode circuit, and an open-ended delay circuit having input terminals connected to said anode circuit, the impedance of said anode circuit looking into it from said input terminals being comparatively high and the surge impedance of said delay circuit looking into it from said input terminals being comparatively low, said delay circuit providing the proper amount of delay for the fundamental and harmonic frequency components of said signal to make the impedance of said anode circuit at said input terminals the maximum at said frequencies, and means for taking signal off said input terminals.

2. An amplifier for amplifying periodically recurring waves of non-sinusoidal wave form, said

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amplifier comprising an amplifier tube having an anode circuit, an anode impedance element in said circuit and a delay circuit which has one end thereof connected across said anode impedance element and which has the other end open to cause reflections, the impedance of said anode impedance element being several times the surge impedance of said delay circuit whereby there is reflection at both ends of said delay circuit.

3. In a circuit for transferring a non-sinusoidal periodic signal having fundamental and harmonic frequency components, a vacuum tube having an output circuit, and a delay circuit having one end connected to said output circuit, said delay circuit being reflecting at both ends and having a delay characteristic such that the said frequency components appearing at said one end of the delay circuit both before and after reflection are in phase whereby the impedance of said anode circuit is the maximum at said frequencies.

4. An amplifier for amplifying periodically recurring waves of non-sinusoidal wave form, said amplifier comprising an amplifier tube having an anode circuit, an anode impedance element in said circuit and a delay circuit which has one end thereof connected across said anode impedance element and which has the other end open to cause reflections, the impedance of said element being several times the surge impedance of said delay circuit, and at least one two-way repeater connected in said delay circuit at some point intermediate its ends.

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