April 10, 1945. H. A. BROOS 2,373,534

LOW FREQUENCY AMPLIFIER

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Fig. 1

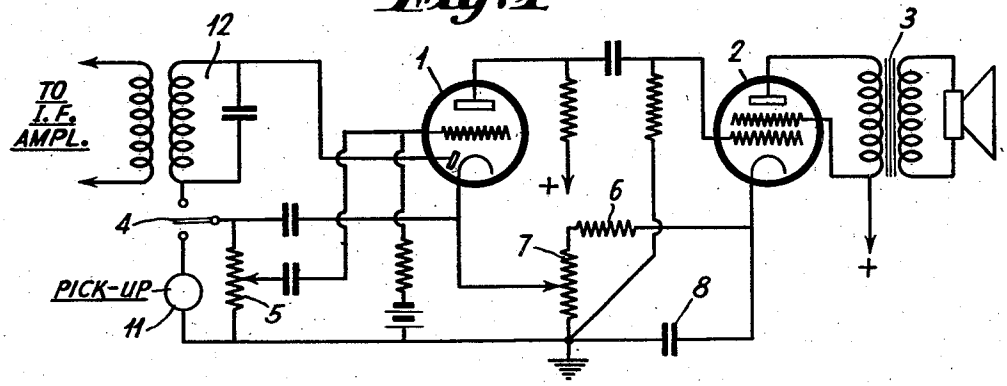

Fig. 2

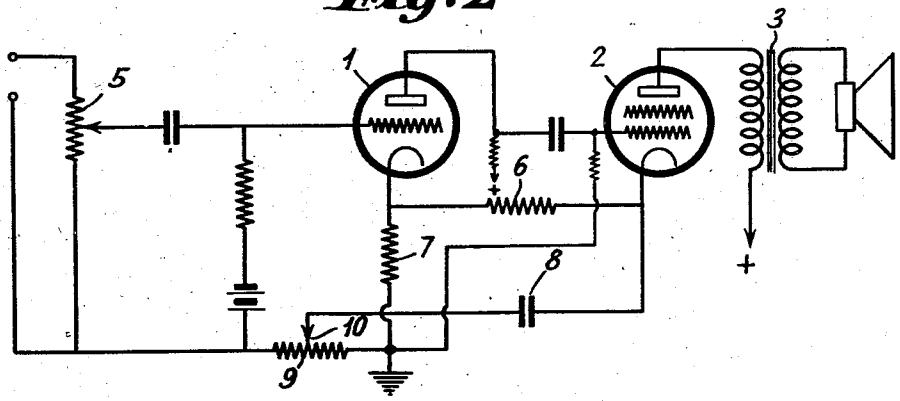

Fig. 3

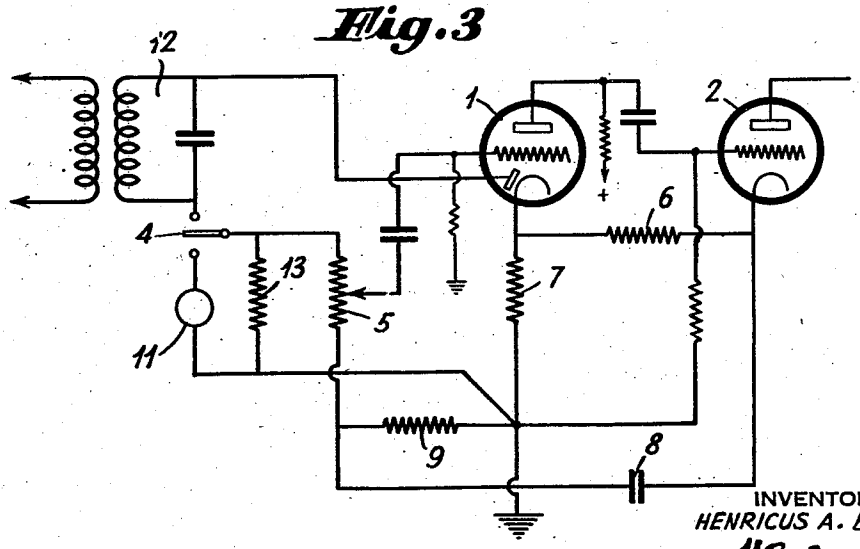

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Fig. 4

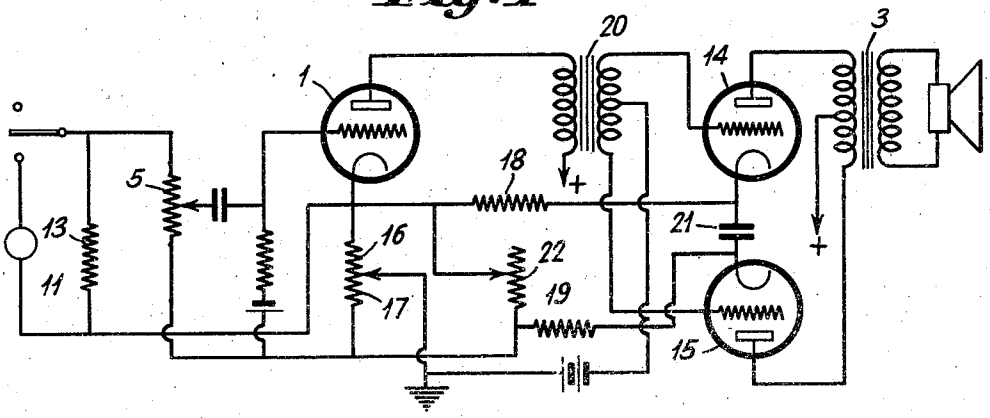


Fig. 5

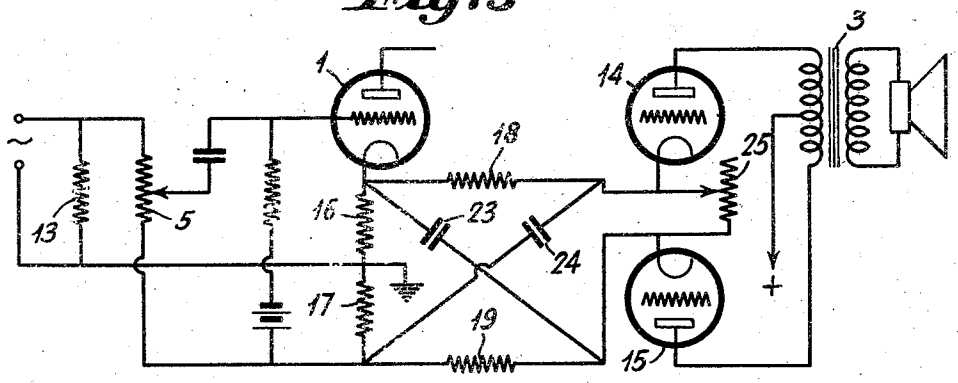
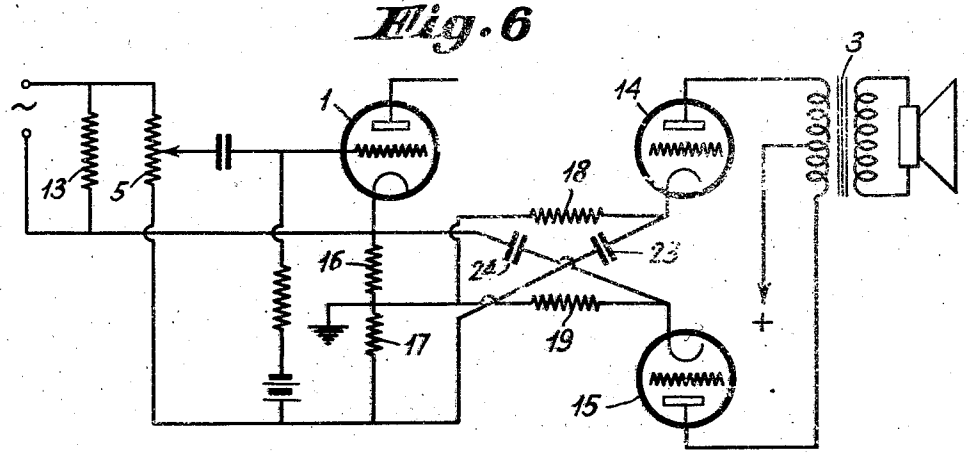


Fig. 6



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UNITED STATES PATENT OFFICE

2,373,534

LOW FREQUENCY AMPLIFIER

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Application August 3, 1937, Serial No. 157,078
In Germany August 3, 1936

4 Claims. (Cl. 179—171)

It is known to give the grid of an amplifying tube the required negative bias by interposing a resistance in the supply lead for the cathode, which resistance is traversed by the anode current, and by connecting the grid to the resistance end on the anode side. This resistance causes a negative back-coupling for the oscillations to be amplified. For this reason it was customary to connect a large condenser in parallel with the resistance. It has been found, however, that the decoupling in the region of the lower frequencies of the low frequency range is all but complete, so that the amplification is never uniform.

According to the invention this drawback is obviated by coupling the resistance to the grid circuit of a preceding valve so that unevennesses in the amplification caused by the combination of the resistance and of the decoupling condenser are at least partly compensated since the positive feedback by way of the preceding valve increases with decreasing frequency in exactly the same way as does the negative feedback between the output and input circuits of the final valve.

The invention will be more clearly understood by reference to the accompanying drawings representing, by way of example, several forms of construction thereof. In the drawings, Fig. 1 shows an amplifier employing separate controls for amplifier input and positive feedback respectively; Fig. 2 is a modification of the circuit of Fig. 1 in which negative feedback is employed; Fig. 3 is a further modification wherein a single control is used for amplifier input, negative feedback and positive feedback; Fig. 4 shows a modification with common control for amplifier input and negative feedback and a separate control over the low frequency feedback; Fig. 5 is a further modification of the circuit shown in Fig. 4; and Fig. 6 is a modification of the circuit of Fig. 3 applied to a push-pull output stage.

In Fig. 1, the penultimate tube of a low frequency amplifier is denoted by 1 and the terminal valve by 2. The anode circuit of the valve 2 comprises the primary winding of a transformer 3 whose secondary winding is connected to a loudspeaker. The arrangement is adapted both for receiving purposes and for record reproduction. Changing-over is effected by means of the switch 4. 12 is a tuned circuit which is preferably coupled to the final stage of the intermediate frequency amplifier of a receiving set. The voltages occurring thereover are rectified by a detector diode incorporated in the valve 1. A pick-up is denoted by 11. The rectified signals are supplied in the upper position of the switch 4, whereas in the lower position the oscillations generated in the pick-up 11 are supplied to a resistance 5. This resistance is connected to the grid of the valve 1 through a condenser by means of an adjusting contact. The anode circuit of the valve 1 is coupled in the usual way to the grid circuit of the tube 2. To produce a negative bias for the grid of the valve 2 resistances 6 and 7 are provided to which a condenser 8 is connected in parallel, and which are traversed by the anode current of the valve 2. The cathode of the valve 1 is connected to an adjustable point of the resistance 7, so that a positive back-coupling is obtained between the valves 1 and 2, which is most effective for low frequencies. The operation can be controlled by adjusting the contact on the resistance 7.

Fig. 2 shows a circuit arrangement which substantially corresponds to that represented in Fig. 1, but in which the electrode of the condenser 8 not directly connected to the cathode of the valve 2 is connected to an adjustable point 10 of the resistance 9 forming part of the grid circuit of the valve 1. In this manner a negative back-coupling is obtained which is particularly effective for high frequencies, and is practically zero for low frequencies. Thus the amplifying characteristic can still be improved. Similarly to Fig. 1 the sound strength can be controlled by shifting the contact on the resistance 5, whereas the degree of back-coupling can be controlled by shifting the contact 10 on the resistance 9.

Fig. 3 represents a circuit arrangement in which the quality is controlled automatically in accordance with the sound strength. In this figure the signals to be amplified are supplied to a resistance 13 one of whose ends is earthed, whereas the other end is connected to the upper end of the resistance 5. When the contact on the resistance 5 occupies the bottom position the complete back-coupling is operative in the input circuit of the valve 1. In this case the sound strength is minimum. The ratio between the strength of the low sounds, and that of the high sounds is maximum which is just desired. When the said contact is in its upper position the negative back-coupling is a minimum whereas the positive back-coupling which is particularly effective for the lower frequencies is still fully operative, so that a suitable ratio is ensured between low and high sounds and the amplification is maximum also for weak signals with which the contact is at the upper end of the resistance 5, since the negative back-coupling is small.

Figure 4 represents an arrangement according to the invention, in which the final stage comprises two push-pull connected valves 14 and 15. To avoid distortion the output voltage of the two terminal valves should be coupled back, which is effected by connecting the cathodes across resistances 18 and 19 to the resistances 16 and 17. These last-mentioned resistances form part of the input circuit of the valve 1. The common point of these resistances is earthed. A simple consideration shows that in this manner the two voltages are coupled back in the suitable phase if the polarity of transformer 20 is correctly chosen, as must be determined by the method of trial and error. The cathodes are connected through a condenser 21 due to which they have substantially the same potential for higher frequencies. The ratio between the higher and the lower frequencies in the output circuit can be controlled by means of a resistance 22 connected in parallel with the resistances 16 and 17 or in parallel with C_{21}.

Fig. 5 shows a circuit arrangement which comprises, moreover, a negative back-coupling for the high frequencies. This is effected through the condensers 23 and 24 connected between the cathode of the valve 15 and the cathode of the valve 1, and between the cathode of the valve 14 and the bottom end of the resistance 17 respectively. The back-coupling can be controlled by means of a variable resistance 25 which is interposed between the two cathodes, but may also be connected parallel with the resistances 16 and 17. In the arrangements represented in Figs. 4 and 5 is illustrated, moreover, how the back-coupling can be rendered dependent on the sliding contact on the resistance 5. The feedback voltage developed across resistance 22 of Fig. 4 is impressed upon the series combination of resistance 5 and the parallel arrangement of source 11 and resistance 13. The cathode of the first valve being connected directly to one side of resistance 22, the amount of voltage fed back between grid and cathode of the first tube is a maximum when the alternating current grid circuit connection to resistance 5 is at the lowest point on resistor 5. At this point, however, the signal input is a minimum. Thus, the feedback depends upon the position of the sliding contact of resistance 5. In Fig. 5 exactly the same control of feedback results from the movement of the slider to resistance 5, since the source of feedback voltage is connected on the one hand directly to the cathode of the first tube and on the other hand through the same arrangement of resistance as described before to the grid.

Fig. 6 represents a circuit arrangement comprising a negative back-coupling only for the higher frequencies in the grid circuit of the valve 1 across the resistances 16 and 17. A positive back-coupling for the low frequencies is not provided in this arrangement.

What is claimed is:

1. In combination, an electron discharge device having input electrodes, a potentiometer, means to supply signal oscillations across said potentiometer, said input electrodes being variably tapped from said potentiometer, thereby to vary the portion of said signal oscillations on said potentiometer supplied to said input electrodes, an output circuit, means to supply voltage from said output circuit to said input electrodes to produce degeneration, and means to reduce said voltage supplied to said input electrodes substantially to zero in one position of said potentiometer, thereby substantially to remove said degeneration.

2. In an audio amplifying system, an audio amplifier having an audio input circuit and an audio output circuit, said input circuit including an impedance across which is developed audio signal voltage, a resistive path in shunt with said impedance, a degenerative signal voltage feedback path connected between said output circuit and an intermediate point of said resistive path, and an adjustable connection between the input electrode of said amplifier and a portion of said path between one end thereof and said point.

3. In an audio amplifying system, an audio amplifier having an audio input circuit and an audio output circuit, said input including an impedance across which is developed audio signal voltage, a resistive path in shunt with said impedance, a degenerative signal voltage feedback path connected between said output circuit and an intermediate point of said resistive path, and an adjustable connection between the input electrode of said amplifier and a portion of said path between one end thereof and said point, said amplifier including at least two cascaded tubes each having a cathode, input electrode and anode, and resistive means connecting the cathodes of both tubes in common to the opposite end of said shunt resistive path.

4. In combination, an electron discharge device having input electrodes, a potentiometer, means to supply signal oscillations across said potentiometer, said input electrodes being variably tapped from said potentiometer, thereby to vary the portion of said signal oscillations on said potentiometer supplied to said input electrodes, an output circuit, means to supply voltage from said output circuit to said input electrodes to produce degeneration, and means to reduce said voltage supplied to said input electrodes substantially to zero in one position of said potentiometer thereby substantially to remove said degeneration, said output circuit including a second electron discharge device, a bias resistor common to the space current paths of both devices, and said degeneration means consisting of a condenser connected effectively in shut relation to a path consisting of said bias resistor in series with a portion of the potentiometer.

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