

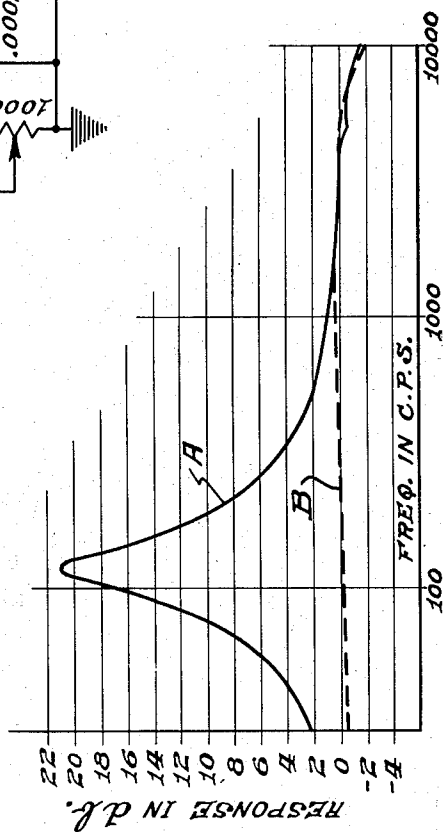
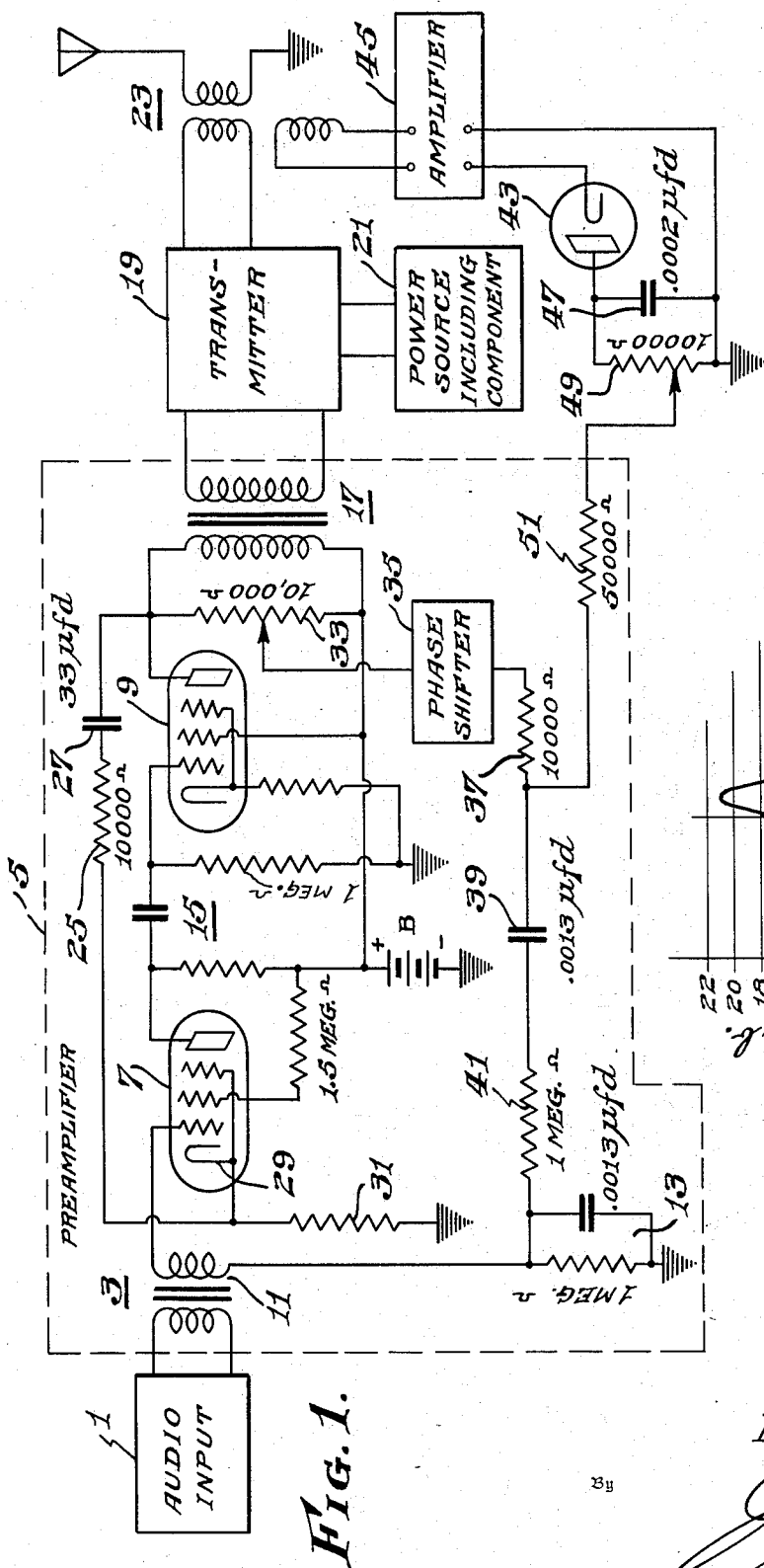
Dec. 22, 1942.

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2,305,893

FEEDBACK AMPLIFIER

Filed June 29, 1940



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UNITED STATES PATENT OFFICE

2,305,893

FEEDBACK AMPLIFIER

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Application June 29, 1940, Serial No. 343,148

8 Claims. (Cl. 179—171)

This invention relates to amplifiers and especially to an amplifier and network in which undesired noise-producing components are reduced by feedback.

Numerous amplifier networks including feedback connections for reducing hum or other undesired components are known to those skilled in the art. While such feedback connections may be used, the reduction of hum or noise is often accompanied by excessive regeneration and instability. It is an object of the present invention to provide means for reducing undesired components by feedback connections in which the regeneration and stability of an amplifier may be controlled. Another object is to provide means in an amplifier for feeding back components of a determinable and self-selecting frequency so that undesired components of the same frequency may be reduced by degenerative feedback. Another object is to provide a means or a method for reducing the hum in a radio transmitter by selecting regeneratively the hum components in a preamplifier and degeneratively feeding the hum component of the transmitter to the preamplifier.

The invention will be described by referring to the accompanying drawing in which Figure 1 is a schematic diagram of one embodiment of the invention and Figure 2 is a graph illustrating the operating characteristics of the invention.

Referring to Fig. 1, an audio or other signal source 1 is connected to the input of a preamplifier 3 which is included within the broken lines 5. The amplifier 3 may include a pair of thermionic tubes 7, 9. The input of the first 7 of these tubes is connected through an input transformer 11, and a capacitance-resistance filter 13 to ground. The output of the first tube is coupled by a resistor-capacitor network 15 to the input of the second tube 9. The output of the second tube includes a transformer 17 which applies the signal currents to the transmitter 19. The transmitter is energized by a power source 21, which includes hum, noise, or other undesired components. The output of the transmitter 19 is applied to an antenna 23 or other load.

The preamplifier 3 includes a stabilizing network consisting of a resistor 25 and a capacitor 27 which are serially connected between the output of the second tube 9 and the cathode 29 of the first tube 7. The cathode 29 is at a higher potential than ground because it is connected to ground through a resistor 31. A potentiometer 33 is connected across the primary of the output transformer 17. The movable contact of the po-

tentiometer is connected through a phase shifter 35, a resistor 37, a capacitor 39, and a resistor 41 to the upper terminal of the filter 13.

The undesired hum components are derived by 5 coupling a rectifier 43, through an amplifier 45 (which may generally be omitted) to the load source 23. The rectifier output includes a capacitor 47 and a resistor 49 which are shunt-connected to form a filter. A slidable contact on the 10 resistor 49 is connected through a series resistor 51 to the junction of the resistor 37 and capacitor 39 in the regenerative feedback path from the output of the second tube 9 to the input of the first tube.

15 The mode of operation is as follows: The preamplifier 3 is stabilized by the stabilizing connection including the resistor-capacitor (25-27) combination. The regenerative feedback connection from the potentiometer 33 in the output circuit of the second tube 9 to the input of the first tube 7 includes the shunt filter 13 and series filter including the capacitor 39-resistor 41 combination. By way of example, this filter system 13, 39, 41 is designed to pass currents including the 20 undesired hum components. While a resistor-capacitor filter is ordinarily not very selective, in the present arrangement the selectivity may be made very great because the regenerative feedback increases the selectivity. Thus the gain of the preamplifier is greatly increased at the undesired frequency by means of the regenerative feedback which is so selected that its maximum effect occurs at the frequency of undesired components.

25 If the transmitter 19 includes thermionic tubes whose cathodes are heated by a low frequency (for example, sixty cycles per second) alternating current, undesired hum components of twice the applied frequency will appear in its output. Currents corresponding to these components may 30 be derived by rectifying the transmitter carrier and by filtering the radio frequency from the rectifier current. A portion of the filtered current is applied, in a degenerative phase to the feedback path 37, 39, etc. The degenerative feedback, operating at the hum frequency, may be made large enough to reduce substantially the hum in the transmitter 19. It should be realized 35 that reducing the hum by a degenerative connection is not equivalent to reduction by bucking. In the former connection, the hum may be made decreasingly small but never eliminated; in the latter connection, the hum may be eliminated 40 or even "over-neutralized" by applying opposing

currents greater in amplitude and opposite in phase to the original hum currents.

The characteristic of the system is illustrated by the graph of Figure 2. In the graph curve A represents the amplitude-frequency characteristic of the amplifier without the degenerative connection. The gain at 120 cycles is due to the regeneration. The shape of the curve at this frequency is due to the combination of the regeneration and frequency selection of the filters. The broken line curve B represents the overall characteristic of the system when the degenerative feedback is operating. It will be noted that the response at 120 cycles has been reduced 20.8 db. It should be understood that the response may be adjusted to reduce the hum by about 50 db. which appears to be an upper limit due to the difficulty in maintaining a stable amplifier gain.

Thus, the illustrated form of the invention involves a feedback amplifier, which includes a stabilizing path, a regenerative feedback path, and a degenerative path. The feedback path is made selective at the frequency of the undesired current components by means of the regenerative connection acting through the filter 39, 41, 13. The undesired components are applied degeneratively to the system to minimize the undesired hum. By way of example, a number of the constants for the reduction of undesired currents of a frequency of 120 cycles per second have been indicated on the drawing. It should be understood that the invention is not limited to the precise frequencies nor to these constants. Furthermore, the method may be practiced with one or more tubes in the pre-amplifier, with or without the load amplifier 45, and with or without the phase shifter 35.

I claim as my invention:

1. An amplifier including an input circuit and an output circuit, means including a filter selectively responsive at a predetermined frequency connecting said input and said output, said input and output connecting means providing a regenerative path, additional means connecting said input and said output to stabilize said amplifier, and means for applying degeneratively an undesired current component to said regenerative path so that said component is applied at said predetermined frequency to reduce said undesired component to a minimum in said output circuit and to obtain a uniform frequency response.

2. An amplifier including an input circuit and an output circuit, a regenerative feedback path including a resistor and capacitor connected between said input and output, said resistor and capacitor having resistive and reactive values which together with said regeneration provide a filter selective at a predetermined frequency, and

means for applying undesired currents to said regenerative path to effect degeneration at said predetermined frequency and thereby to minimize the response of said amplifier to said undesired currents.

3. An amplifier according to claim 2 including means connected between said output and input for stabilizing said amplifier.

4. An amplifier according to claim 2 including a capacitor and a resistor serially connected between said output and said input for stabilizing said amplifier.

5. A hum-reducing amplifier including in combination a source of current including undesired hum components, said amplifier having an input circuit and an output circuit, means regeneratively connecting said output and input, said connecting means including a filter selectively responsive to feedback at the hum frequency, means for deriving currents corresponding in frequency to said hum, and means for applying said derived currents to said connecting means in a degenerative phase.

6. A hum reducing amplifier including in combination a source of current having undesired components of a predetermined frequency, said amplifier including an input circuit and an output circuit, means regeneratively connecting said output to said input, said connection including resistor-capacitor filters responsive at said predetermined frequency, means for deriving from said source currents corresponding to said undesired components, means for applying said derived currents to said connecting means in a degenerative phase, and means for stabilizing said amplifier.

7. The method of reducing undesired noise components in an amplifier system which includes amplifying currents covering a band of frequencies, increasing the amplification in a predetermined range of frequencies within said band, deriving from said system currents including the undesired noise components, and applying said derived currents to the input of said amplifier to offset said increasing amplification.

8. The method of reducing undesired noise components in an amplifier network which includes amplifying currents covering a band of frequencies, increasing the amplification of said currents by applying regeneratively currents including a predetermined range of frequencies, deriving from said network currents including the undesired noise currents within said range of frequencies and applying said derived currents to the input of said network in a degenerative phase to reduce the amplification within said range of frequencies.

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