

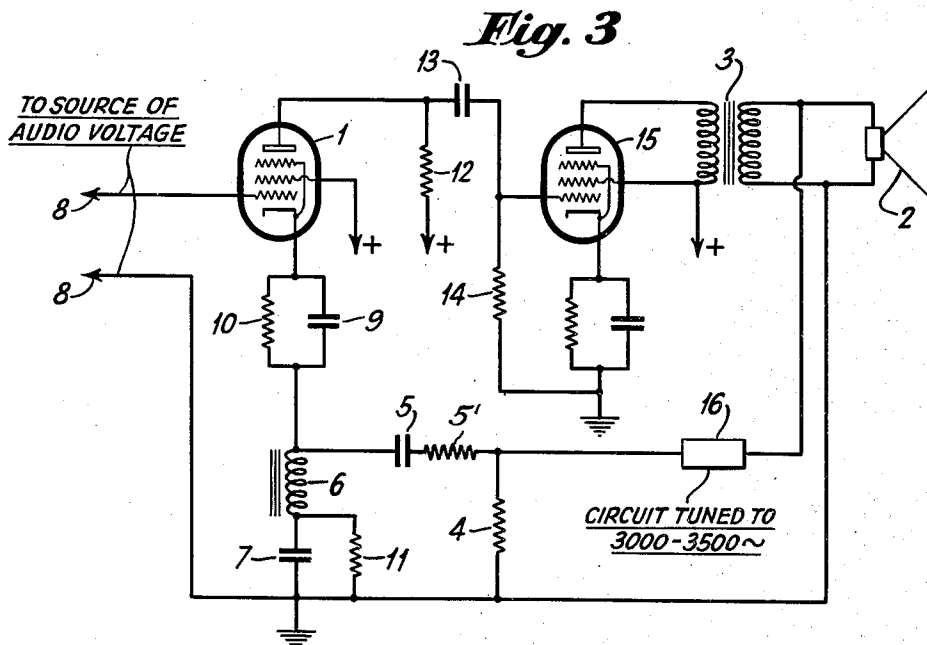
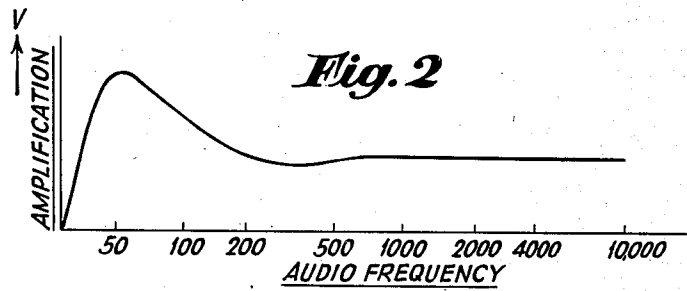
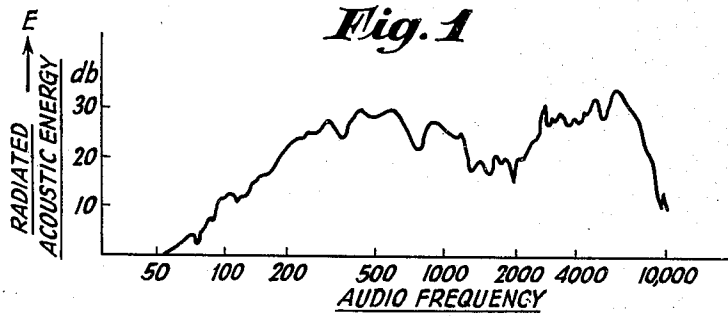
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NEGATIVE FEEDBACK AMPLIFIER

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NEGATIVE FEEDBACK AMPLIFIER

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This invention relates to a low frequency amplifier to whose output circuit is connected a loudspeaker, and in which use is made of negative feedback dependent on frequency.

In the drawing, Fig. 1 shows the usual type of loudspeaker characteristic. Fig. 2 shows the audio response curve secured by means of the present invention. Fig. 3 shows a circuit embodying the invention.

The usual loudspeaker often has a reproduction characteristic which is schematically shown in Fig. 1; and the latter shows how the radiated acoustic energy E expressed in decibels (db.) above a definite zero-level depends on the frequency, if the loudspeaker is fed with a constant current. From this characteristic it appears that below a certain frequency which lies, for instance, in the vicinity of 200 cycles/sec., the emitted energy decreases with the frequency which, as is well known, is due to the finite dimensions of the sound screen. Hence, for low frequencies, for which the wave length of the sound vibrations is of the same order of magnitude as the size of the sound screen, the sound vibrations radiated on the front side and back of the loudspeaker counteract each other. In order to improve the reproduction it has already been suggested to make use of a frequency-dependent negative feedback which is so arranged that the amplification increases for frequencies below 200 cycles/sec. In this case, however, the drawback occurs that low frequencies, for instance of the order of 30 cycles/sec., whose reproduction is undesirable, are also strongly amplified.

The present invention provides means for obtaining such an amplification characteristic that all desired frequencies are uniformly reproduced, whereas the said undesired very low frequencies are suppressed.

According to the invention this purpose is attained by connecting the output circuit of the amplifier to a resistance with which the series connection of a condenser, an inductance and a second condenser is connected in parallel, whereas the series connection of the inductance and the second condenser is interposed in the cathode lead of one of the amplifying tubes, the first-mentioned condenser together with the inductance are tuned to a higher frequency than the frequency to which the inductance together with the second condenser are tuned.

By means of this circuit a frequency-dependent negative feedback is obtained in such a manner that the characteristic curve of the ampli-

fier, i. e. the amplification V as a function of the frequency exhibits the shape as shown in Fig. 2. From this curve it appears that while the amplification at first increases below 200 cycles/sec., and, consequently, compensates the decreasing reproduction characteristic of the loudspeaker, whereas below the lowest frequency to be transmitted the amplification decreases again, thus avoiding reproduction of undesired low frequencies.

Fig. 3 shows an audio amplification circuit including an amplifying tube 1 which, through the intermediary of a resistance-condenser coupling 12, 13, 14 is connected to an output tube 15. A loudspeaker 2 is connected through a transformer 3 to the output circuit of the tube 15. The secondary winding of the transformer has connected to it, through an impedance 16, a resistance 4 with which the series-connection of a condenser 5, an inductance 6 and a parallel second condenser 7 is connected in parallel. The impedance 16 may, for instance, consist of a resonant circuit which is tuned to a frequency of 3000-3500 cycles/sec., and serves to cause an increase in amplification of high audio frequencies by a decrease in negative feedback. The series connection of coil 6 and condenser 7 is interposed in the cathode lead of the amplifying tube 1. The voltage set up across this series connection and originating from the secondary winding of transformer 3 causes negative feedback. The oscillations to be amplified are supplied to the terminals 8. Furthermore, the cathode lead includes a resistance 10 which is bridged by a condenser 9, and serves to obtain the required negative grid bias. The condenser 7 is bridged by a resistance 11 in order to prevent the direct anode current of the tube 1 from being blocked by this condenser. Condenser 5 prevents the direct current voltage developed across 11 from being short-circuited by speaker 2. The cathode resistance 10 and the condenser 9 may be omitted, and the required negative grid bias may be obtained from the voltage drop caused by the direct anode current of the tube 1 across the resistance 11. The condenser 7 is of the same order of magnitude as the condenser 9. The ratio between the impedance of condenser 7 and resistance 11 is such that the influence of the resistance 11 becomes noticeable only with very low frequencies (below the resonance frequency of coil 6 and condenser 7) so that this resistance has no appreciable influence at the two resonance frequencies.

The series connection of condenser 5 and coil

6 is tuned to a frequency which is higher than the frequency to which is tuned the coil 6 and the condenser 7, and more particularly to that frequency below which the reproduction characteristic of the loudspeaker decreases with a decreasing frequency. As has already been stated this frequency lies at about 200 cycles/sec. Condenser 7 together with coil 6 are tuned to a frequency which lies in the vicinity of the lowest frequency to be reproduced, for instance 40 to 60 cycles/sec. The impedance of the circuit attains a minimum with the resonance frequency, and consequently also the negative feedback voltage, so that the amplification attains a maximum. On either side of the resonant frequency 6—7 the negative feedback will increase again owing to which the amplification decreases. Condenser 5 is preferably so chosen that it resonates coil 6 at about 200 cycles. Hence, at some frequency above 200 cycles the series resonance of 5—6—7 will slightly increase the degenerative voltage across 6—7 and thus produce a slight dip in the amplification characteristic of Fig. 2. This dip is not serious, however, due to the damping provided by resistance 4 and other resistances. By a suitable choice of the damping of the resonant circuits it can be insured that the decrease in negative feedback begins rather abruptly with the desired frequency. The damping of the resonance of coil 6 together with condenser 7 is determined by the ratio between self-inductance and capacity, and, moreover, by the resistance of coil 6. The damping of the resonance of coil 6 together with condenser 5 is determined by the ratio between the self-inductance and capacity, and, in addition by the resistance 4 and the resistance of coil 6. If desired, another resistance 5' may be connected in series with condenser 5. It will be appreciated that the amplification circuit set out above has a frequency characteristic as shown in Fig. 2. This characteristic is adapted to the reproduction characteristic of the loudspeaker 2 in the frequency range to be transmitted; thus obtaining uniform reproduction of the desired frequencies, whereas very low undesired frequencies are suppressed.

What is claimed is:

1. In an audio frequency transmission network having input and output terminals, a degenerative feedback circuit connected between the output and input terminals, a reactive im-

pedance common to said feedback circuit and input terminals, said impedance being resonated to a low audio frequency thereby to cause a substantial change in the magnitude of the feedback voltage for audio frequencies less than said resonant frequency, and said reactive impedance frequency being between 40 to 60 cycles, said change being in an increasing sense.

2. In an audio amplifier circuit comprising a plurality of tubes in cascade, a negative audio voltage feedback circuit connected between the output electrodes of the last of said tubes and the input electrodes of the first of said tubes, a series resonant network terminating said feedback circuit and being included between said input electrodes, said resonant network being tuned to a low audio frequency between 40 and 60 cycles whereby the feedback voltage magnitude substantially increases for audio frequencies above or below said low audio frequency.

3. In an audio amplifier circuit comprising a plurality of tubes in cascade, a negative audio voltage feedback circuit connected between the output electrodes of the last of said tubes and the input electrodes of the first of said tubes, a series resonant network terminating said feedback circuit and being included between said input electrodes, said resonant network being tuned to a low audio frequency between 40 and 60 cycles whereby the feedback voltage magnitude substantially increases for audio frequencies above or below said low audio frequency, and a reactive element included in said feedback circuit and cooperating with a reactive element of the series resonant network to provide a network tuned to an audio frequency above said low frequency and of the order of 200 cycles.

4. In an audio amplifier circuit comprising a plurality of tubes in cascade, a negative audio voltage feedback circuit connected between the output electrodes of the last of said tubes and the input electrodes of the first of said tubes, a series resonant network terminating said feedback circuit and being included between said input electrodes, said resonant network being tuned to a low audio frequency whereby the feedback voltage magnitude substantially increases for audio frequencies above or below said low audio frequency, and an impedance included in the feedback circuit which is tuned to a frequency of the order of 3,000 to 3,500 cycles.

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