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LOW PASS SPEECH AMPLIFIER

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Fig. 1.

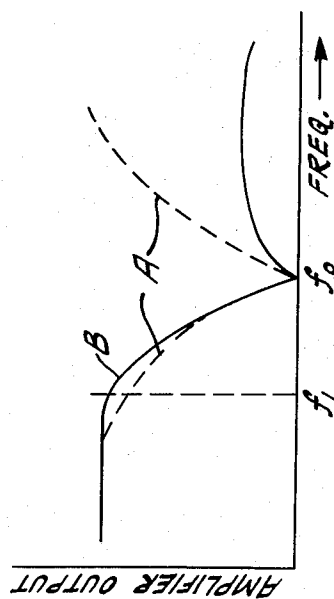
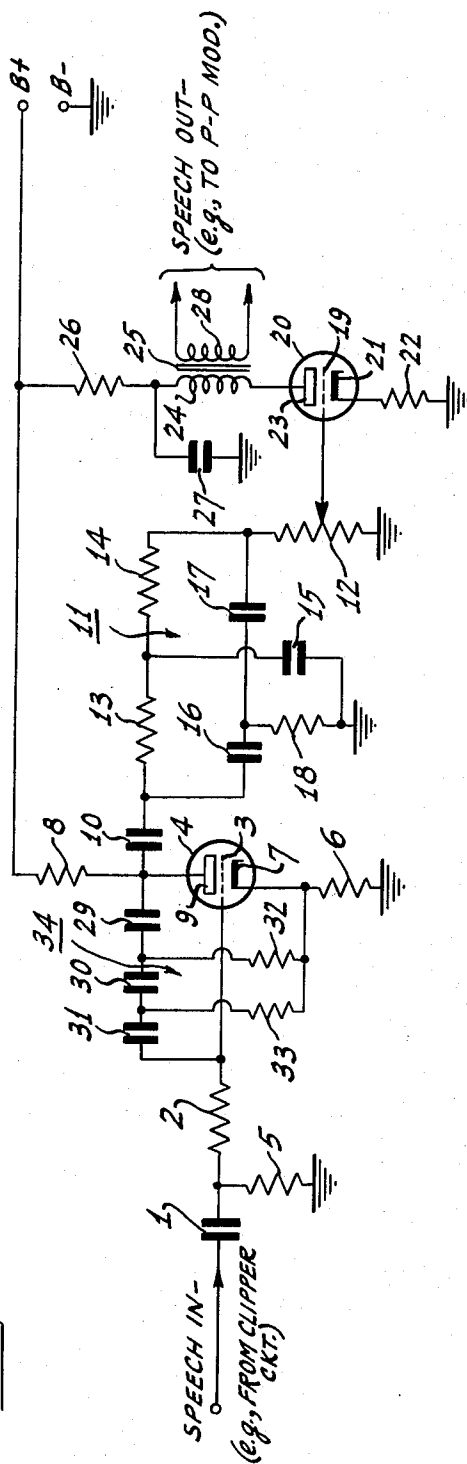


Fig. 2.

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1

2,901,559

LOW PASS SPEECH AMPLIFIER

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6 Claims. (Cl. 179—171)

This invention relates to an amplifier, and more particularly to a low-pass speech amplifier useful in radiotelephone transmitters.

Some types of speech communications equipment, such as radiotelephone equipment installed aboard ships, do not necessitate, for good intelligibility and good recognizability, the transmission of higher audio frequencies, and in fact for amplitude modulated transmitters it is rather wasteful of frequency spectrum to transmit such higher audio frequencies. Therefore, such radiotelephone transmitters commonly include a network or networks whose purpose is to restrict the band of audio frequencies actually applied to the transmitter. These networks take the form of low-pass filters since the object is to eliminate all audio frequencies above a certain predetermined cut-off frequency. The low-pass filters are inserted in the speech amplifier of the radio transmitter and heretofore were commonly constructed of inductors and capacitors. Low-pass audio filters of this type, including inductors, are quite expensive and are also quite heavy.

An object of this invention is to devise a novel and inexpensive low-pass speech amplifier.

Another object is to provide a low-pass speech amplifier which is substantially lighter in weight than prior amplifiers commonly used for the same purpose.

A further object is to devise a novel low-pass speech amplifier which utilizes only resistors and capacitors in the filter networks.

The objects of this invention are accomplished, briefly, in the following manner: A null network is inserted between the output of one amplifying stage and the input of the following stage, in the speech amplifier of a radio transmitter. In addition, a phase-shift network is used to provide feedback between the output and input of said one amplifying stage. This last network is constructed and arranged to change the sense of the feedback provided thereby from positive to negative around the null frequency of the null network. The response of the two networks provides an overall low-pass characteristic for the amplifier with a steep slope near the cutoff frequency.

The foregoing and other objects of the invention will be better understood from the following description of an exemplification thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a circuit diagram of a speech amplifier according to this invention; and

Fig. 2 is a set of characteristic curves useful in explaining the invention.

Referring to Fig. 1, the input signal to the speech amplifier is supplied by way of a coupling capacitor 1 and a resistor 2 to the grid 3 of a speech amplifier triode electrode structure 4, which may for example be one-half of a 12AU7 twin triode vacuum tube. A leak resistor 5 is connected from the common junction of components 1 and 2 to ground. The speech input to the amplifier of the invention may be obtained from any suitable source of speech signals. For example, it may be obtained from the output of a full-wave clipper circuit (not shown)

2

which is in turn supplied with signals from a microphone. As an example, the clipper circuit may be of the type illustrated in Crosby Patent No. 2,276,565.

Tube 4 is self-biased by means of a resistor 6 connected from the cathode 7 thereof to ground. The amplified speech signal appears across an anode load resistor 8 which is connected between the anode 9 and the positive terminal B+ of a source of unidirectional potential on the order of 300 volts, the negative terminal B- of this source being grounded. The signal output of tube 4 is applied through a coupling capacitor 10 to the input end of a null network 11 of the bridged-T type, sometimes termed a "twin-T" network. A potentiometer 12 is connected from the output end of network 11 to ground. Network 11 consists of two separate resistance-capacitance T's which are connected in parallel with each other between capacitor 10 and potentiometer 12. One of these T's consists of two resistors 13 and 14 connected in series and a capacitor 15 connected from the common junction of these resistors to ground. The other T consists of two capacitors 16 and 17 connected in series and a resistor 18 connected from the common junction of these capacitors to ground.

The amplified signal appearing at the anode 9, as modified by the transmission characteristics of the null network 11, is fed from the movable arm of potentiometer 12 to the grid 19 of a driver triode electrode structure 20, which structure may be one-half of a twin triode 12AU7 vacuum tube. The cathode 21 of structure 20 is connected to ground through a resistor 22, while the anode 23 of this tube is connected through the primary winding 24 of an output transformer 25 and also through a resistor 26, to the positive terminal B+ of the unidirectional potential source. From the common junction of winding 24 and resistor 26 a capacitor 27 is connected to ground. The output of the low-pass speech amplifier of this invention is taken by way of the secondary winding 28 of transformer 25 and fed to a suitable utilization circuit, such as a push-pull modulator for amplitude modulating the radio frequency carrier of a radiotelephone transmitter.

The twin-T null network 11 has a frequency response characteristic as represented by the dashed-line curve A in Fig. 2, so that if this network were the only frequency-responsive network in the speech amplifier the amplifier output characteristic would be as represented by curve A. The curve A is the usual and familiar response curve or characteristic of a twin-T null network, with a deep null (substantially zero transmission) at frequency f_0 . The null frequency f_0 is of course determined by the constants of the network 11, that is, the component values thereof. The curve A is symmetrical about f_0 and the slope of the curve on either side of f_0 is gradual. Since the curve A is symmetrical about f_0 , the amplifier would have substantial output at frequencies somewhat above f_0 , and this is not the optimum characteristic for a low-pass filter, being in fact undesirable. Also, since the slope of the curve is gradual, the cutoff would not be as rapid as desired.

To provide a more desirable low-pass characteristic for the amplifier, an RC phase-shift network 34 is connected between anode 9 and grid 3 of tube 4 (between the output and input of this tube), to provide a desirable amount of feedback between the output and input of tube 4. The phase-shift network referred to comprises three cascaded sections, each composed of a resistor and a capacitor. The capacitors of the three sections are capacitors 29, 30 and 31 connected in series between anode 9 and grid 3. A first resistor 32 is connected from the common junction of capacitors 29 and 30 to cathode 7. A second resistor 33 is connected from the common junction of capacitors 30 and 31 to cathode 7, while the third resistor is constituted by resistor 2.

Since the component values of network 34 are fixed, as the frequency of the signal varies the phase shift provided by this network also varies. The component values of phase-shift network 34 are such that this network introduces positive feedback from output to input of tube 4 near the frequency f_1 (see Fig. 2) at which the amplifier output begins to fall off appreciably. Frequency f_1 may be termed the cutoff frequency. This positive feedback increases the amplifier output, so that the overall amplifier output characteristic (represented by the solid-line curve B in Fig. 2) in the vicinity of frequency f_1 is greater than it would be if feedback network 34 were not present. Therefore, the slope of the overall characteristic curve B is steeper than characteristic curve A near the frequency f_1 . Near frequency f_1 , the characteristic curve A is steepened into curve B. The cutoff at frequency f_1 is thus quite rapid.

Phase-shift network 34 has such component values that it introduces negative feedback from output to input of tube 4 above the null frequency f_0 of the twin-T network 11. This negative feedback decreases the amplifier output, so that the overall amplifier output B above the null frequency f_0 is much less than it would be if feedback network 34 were not present. Therefore, the rise of characteristic A above frequency f_0 is greatly attenuated, as indicated by characteristic curve B in this region. The amplifier output above frequency f_0 is thus greatly attenuated due to the presence of the feedback network 34.

It may be seen that the amplifier of this invention, using the combination of a null network and a phase-shift feedback network, has a low-pass filter characteristic which is suitable for the speech amplifier of a radio transmitter. Curve B in Fig. 2 indicates that the amplifier has high output up to the cutoff frequency f_1 , above which it falls off rapidly to substantially zero output at frequency f_0 , and even above frequency f_0 it is very low. This provides a low-pass characteristic.

The following representative values are given for a circuit built according to this invention and successfully tested:

Resistor 2	ohms	330,000
Resistor 5	do	470,000
Resistor 6	do	820
Resistor 8	do	22,000
Resistor 12	megohms	1
Resistor 13	ohms	100,000
Resistor 14	do	100,000
Resistor 18	do	47,000
Resistor 22	do	820
Resistor 26	do	3,300
Resistor 32	do	220,000
Resistor 33	do	220,000
Capacitor 1	mfd	.01
Capacitor 10	do	.01
Capacitor 15	mmfd	470
Capacitor 16	do	240
Capacitor 17	do	240
Capacitor 27	mfd	10
Capacitor 29	mmfd	330
Capacitor 30	do	100
Capacitor 31	do	100

What is claimed is:

1. A low-pass speech amplifier having first and second amplifying stages coupled in cascade, each stage comprising an electron discharge device having an anode, a grid and a cathode; a null network coupling the output of said first stage to the input of said second stage, and a phase-shift feedback network connected between said anode and cathode of said electron discharge device of said first amplifying stage coupling the output of said first stage to the input of the same stage, the component values of said phase-shift network being so chosen that the same network provides positive feedback at a frequency below the null frequency of said null network and negative feedback at a frequency above said null frequency.

2. An amplifier in accordance with claim 1, wherein said phase-shift feedback network is of the resistance-capacitance type having series capacitance and shunt resistance, said shunt resistance being connected between said anode and said cathode of said electron discharge device of said first amplifying stage.

3. An amplifier in accordance with claim 1, wherein said null network is of the resistance-capacitance twin-T type.

4. An amplifier in accordance with claim 1, wherein said null network is of the resistance-capacitance twin-T type, and wherein said phase-shift feedback network is of the resistance-capacitance type having series capacitance and shunt resistance.

5. A low-pass speech amplifier having first and second amplifying stages coupled in cascade, each of said stages comprising an electron discharge device having an anode, a grid, and a cathode; a null network coupled between the anode of the first device and the grid of the second device, a phase-shift feedback network comprising a plurality of capacitors and means connecting said capacitors in series, said series combination being connected between said anode and grid of said electron discharge device of said first stage, said phase-shift feedback network also comprising a plurality of resistors, said resistors being connected from points on said capacitor connecting means between said capacitors to said cathode of said electron discharge device of said first amplifying stage, the component values of said phase-shift network being so chosen that the same network provides positive feedback at a frequency below the null frequency of said null network and negative feedback at a frequency above said null frequency.

6. An amplifier in accordance with claim 5, wherein said null network is of the resistance-capacitance twin-T type.

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