

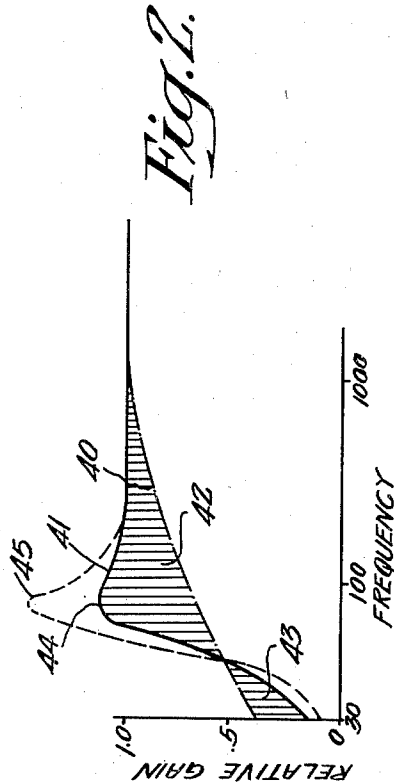
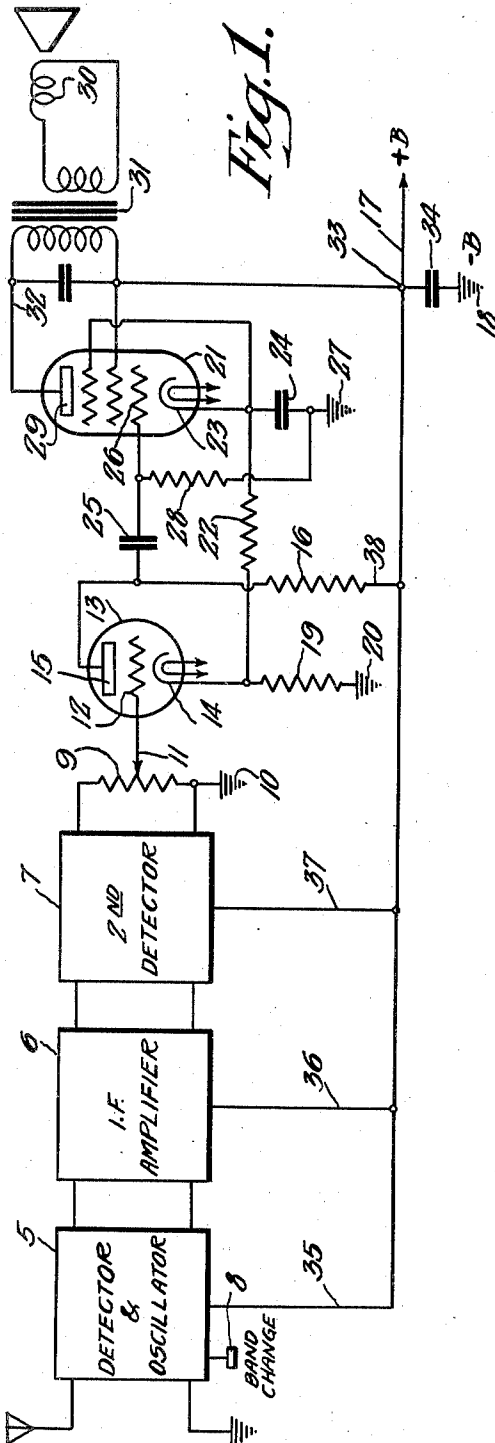
Nov. 7, 1939.

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2,179,260

AUDIO FREQUENCY AMPLIFIER

Filed April 30, 1938



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2,179,260

AUDIO FREQUENCY AMPLIFIER

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Application April 30, 1938, Serial No. 205,231

8 Claims. (Cl. 250—20)

The present invention relates to audio frequency amplifiers for superheterodyne receivers and the like wherein an oscillator is supplied with operating potential from the same plate or anode supply source as the audio frequency amplifier, and has for its primary object to provide an improved audio frequency amplifier circuit adapted to prevent variations in the plate supply to the oscillator and an intermittent or fluttering action of the oscillator.

This interaction between the oscillator and the audio frequency amplifier is particularly noticeable in multiple wave band receivers when operating at high frequencies such as in the so-called C-band, and is ordinarily prevented by the use of filter networks in the plate or anode supply to the oscillator and in the plate supply means itself. Such filters involve the use of relatively large filter capacitors of the electrolytic type and these are relatively costly and add appreciably to the cost of the receiver.

It is, therefore, a further object of the present invention to provide an audio frequency amplifier which may operate at relatively low audio frequencies without appreciably loading the plate supply in a superheterodyne receiver, thereby causing variations or fluttering in the oscillator operation.

It is a further object of the invention to provide an improved audio frequency amplifier wherein controlled degeneration and regeneration may be employed with extended low frequency cut-off to prevent fluctuations in the loading of the plate supply and fluttering. In this improved audio frequency amplifier, the low frequency response is maintained at a low critical frequency below that required for good fidelity in the response characteristic of the amplifier, and above a low frequency range within which the output tube of the amplifier may develop enough voltage across the plate supply circuit to produce intermittent or fluttering action in an oscillator or similar device connected with the same plate supply means.

It is also an object of the present invention to provide a multi-stage audio frequency amplifier and a feedback circuit therefor including means for causing the feedback to vary in magnitude and phase below a certain predetermined low frequency, regeneratively over a limited range and degeneratively below that range whereby a rapid low frequency cut-off is provided.

It is also a further object of the present invention to provide an improved audio frequency amplifier providing for regenerative feedback and

degeneration by means of phase shift in the cathode and grid coupling circuits of the amplifier, thereby to improve the low frequency response characteristic.

The invention will be further understood from the following description when considered in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing

Figure 1 is a schematic circuit diagram of a superheterodyne receiver provided with an audio frequency amplifier embodying the invention, and

Figure 2 is a series of curves illustrating the operation of the amplifier of Fig. 1.

Referring to Fig. 1, the receiver illustrated represents a superheterodyne type of radio receiver comprising a detector and oscillator 5, an intermediate frequency amplifier 6, and a second detector 7. The receiver may further be provided with a wave-band change means 8, or may be of the type operating at relatively high signal frequencies within which range the oscillator plate voltage is more critical.

The second detector signal output is applied to a suitable volume control device such as a potentiometer 9 having a ground connection 10 and a movable volume control tap 11 connected with the control grid 12 of a first stage audio frequency amplifier tube 13.

The tube may be of any suitable type having a cathode 14 and an output anode 15 in addition to the control grid. The output anode 15 is connected through an output resistor 16 to the +B supply lead 17 of the plate or anode supply source (not shown), while the -B side of the plate or anode supply is, in the present example, the chassis or ground indicated at 18. The latter is returned to the cathode 14 through a self bias resistor 19 from a chassis or ground connection 20.

The cathode current for the second stage amplifier or output tube 21 is also taken, as indicated, through the resistor 19 and a series biasing or feedback resistor 22 to the cathode 23. The anode circuit of the tube 13 is coupled through a coupling capacitor 25 to the control grid 26 of the output amplifier tube which grid is connected to chassis or ground 27 through a grid resistor 28. Both cathode resistors 19 and 22 are bypassed by a relatively large bypass capacitor indicated at 24.

The power output tube 21 is of the pentode type and may be provided by an R. C. A. 6F6. The output anode is indicated at 29 and is cou-

pled to an output device or loudspeaker 30 through a coupling transformer 31 in an output anode circuit 32. The anode circuit is connected with the +B or anode supply lead 17, as indicated at 33.

With this circuit arrangement, a filter capacitor 34 between the positive supply lead 17 and the ground 18, may be relatively small in size and the oscillator and other plate supply circuits indicated at 35, 36, 37 and 38 may be connected directly thereto as shown.

Referring to Fig. 2, along with Fig. 1, the frequency response of an ordinary impedance coupled amplifier in the low audio frequency range below 1000 cycles follows the general curve indicated at 40. This response curve may be improved to provide increasing low frequency response by regeneration introduced into the amplifier. However, if this is carried too far, the loading of the plate supply by the output tube at low frequencies may necessitate the use of expensive filtering means to prevent fluttering in the associated apparatus, such as the oscillator, when operating at relatively high frequencies.

In the present system, regeneration is provided and controlled to provide an improved response below 100 cycles and to a sufficiently low frequency to provide good fidelity and is then sharply cut off by introducing degeneration through the same circuit and circuit elements.

The response curve of the amplifier shown in Fig. 1 is indicated by the curve 41, and it will be noted that, as compared with the ordinary amplifier, the shaded area 42 indicates the regeneration, and the shaded area 43 indicates the degeneration effects whereby a relatively sharp cut-off is effected below the useful audio frequency range, that is, below substantially 60 to 80 cycles. As fluttering is found to be within the range of 10 to 20 cycles, this cut-off characteristic is sufficient to prevent undesirable operation of the oscillator or other apparatus connected to the same plate supply as the amplifier.

The response curve 41 is obtained in the amplifier of Fig. 1 by utilizing impedance or resistance coupling which does not cause phase shift above the low audio frequency range and controlling the relation between the coupling capacitor 25 and the grid resistor 28, and the relation between the resistors 19 and 22 and the by-pass capacitor therefor 24 for the low audio frequency range. The peak of the response curve 41 indicated at 44, that is, the frequency at which the peak occurs, is determined by the value of the capacitor 25 and the resistor 28. These are designed to permit the plate voltage from the first amplifier stage to be transferred to the grid 26 without appreciable phase shift below a critical frequency such as a frequency within the range of from 60 to 80 cycles, which is below the desired cut-off point in the low frequency end of the audio frequency range.

The value of the resistor 19, which is a common cathode resistor with both amplifier stages, is such that feedback from the cathode of the second stage causes the voltage on the first stage cathode 14 to vary in magnitude within a desired range and the value of capacitor 24 is such that this voltage varies with frequency below a certain frequency, such as 1000 cycles in the present amplifier, to provide increasing feedback and gain over the area 42 under the curve 41. With a coupling capacitor 25 of .0025 mfd., a resistor of .5 megohm at 28, and resistors 22 and 19 of 330 and 33 ohms, respectively, the bypass capaci-

tor 28 may have a capacity value of 20 mfd. to provide the curve 41, while with a capacity value of 15 mfd., it provides the increased response indicated by the dotted curve 45.

The operation is such that down to the critical frequency of 60 to 80 cycles, the interstage impedance coupling network comprising the capacitor 25 and the resistor 28, introduces relatively small phase shift. Hence, the feedback voltage on the cathode resistors 19 and 22 and that portion of it which appears across the resistor 19, is applied to the cathode 14 in such phase relation to the grid voltage on the control grid 12 that a regenerative action occurs causing the response to be increased in accordance with the curves 41 or 45.

Above a predetermined frequency, such as 1000 cycles, for example, or a frequency at which the amplifier response would tend to droop toward the low frequency end of the audio frequency range, the capacity of the capacitor 24 is such that it provides an effective shunt for the feedback voltage across the resistors 22 and 19, thereby preventing the feedback to the first stage cathode as above described.

Below that frequency, however, the shunting effect of the capacitor 24 becomes less and the feedback becomes more effective down to the critical frequency as determined by the interstage coupling elements. Below that frequency the latter become effective to cause a phase shift in the signals transferred from the plate 15 to the grid 26. Because of this phase shift, the voltage at the cathode 23 applied across the capacitor 24 results in an out-of-phase relation between the feedback voltage at the first stage cathode 14 with respect to the control grid voltage at 12, and rapid degeneration occurs below that critical frequency as indicated by the shaded area 43 in Fig. 2.

The operation, therefore, is such that by means of the interstage coupling means and the common cathode resistor and by-pass capacitor network for the amplifier, the feedback circuit automatically opens to provide feedback toward the lower end of the audio frequency range for a limited range wherein feedback and increased gain is provided. Below a critical low frequency, the interstage coupling means and the common cathode coupling means or resistor and bypass capacitor network, becomes effective to shift the phase and provide degeneration.

By providing the critical or cut-off frequency below the useful audio frequency range and above the range of frequencies in which fluttering may occur in the supply circuit, the fidelity of operation of the amplifier is not affected, and the output tube of the amplifier is prevented from developing enough voltage across the plate supply circuit and the capacitor 34 to produce a fluttering action in the oscillator 5 without increasing the size of the capacitor 34 or utilizing filter networks in the supply circuits 17 or 35.

I claim as my invention:

1. In a radio receiving system including an oscillator, an audio frequency amplifier and a common plate supply circuit for said oscillator and amplifier, means for preventing the amplifier from appreciably loading the common plate supply circuit to cause fluttering in the oscillator at low frequencies comprising two amplifier stages, each including an amplifier tube having a cathode, an interstage impedance coupling network and a common cathode coupling network therefor, said networks jointly providing

a frequency response characteristic in a predetermined low audio frequency range for introducing regenerative feedback between said amplifier stages and degenerative feedback below that range through the same circuit and circuit elements thereof.

2. In a radio signal receiving system, an audio frequency amplifier comprising an output amplifier tube and a preceding amplifier tube coupled thereto, and coupling means including an interstage impedance coupling network and a common cathode coupling network jointly providing feedback between said tubes and having a frequency characteristic such that the feedback is regenerative in a low audio frequency range and degenerative in a limited range below said first range.

3. In a radio signal receiving system, an audio frequency amplifier comprising an output amplifier tube and a preceding amplifier tube coupled thereto, and coupling means including an interstage coupling network and a common cathode coupling network jointly providing feedback between said tubes and a frequency characteristic such that the feedback is regenerative in a range below 1000 cycles and substantially above 60 cycles and a degenerative in a limited range below said first-named range and above 20 cycles.

4. An audio frequency amplifier comprising a power output tube, an amplifier tube, means coupling said amplifier tube to said output tube for the transmission of audio frequency signals without appreciable phase shift above a relatively low critical audio frequency below 100 cycles, means including a common cathode coupling network for said tubes effective to provide regenerative feedback and a peak in the low frequency response of said amplifier, and said coupling means and coupling network including circuit elements effecting a phase shift in the feedback and degeneration in response to signals below said critical frequency whereby regeneration and degeneration may be effected through the same circuits and circuit elements of the amplifier in differing frequency ranges.

5. The combination with a common plate supply circuit for an electric discharge oscillator, of an audio frequency amplifier comprising a first stage amplifier tube having a control grid, a cathode, a source of signal potential and a self-bias resistor connected in series between said grid and said cathode, an output amplifier stage including an amplifier tube connected with said plate supply circuit and having a cathode connected in parallel with said first named cathode, a bypass capacitor for said resistor effective as a low impedance shunt above a predetermined low frequency range, and an interstage impedance coupling network between said tubes operative with said bypass capacitor to provide a phase shift in signal potentials transferred therethrough below said range.

6. An audio frequency amplifier comprising a first stage amplifier tube and an output amplifier

tube, a plate supply circuit therefor, and means for preventing the output amplifier tube from developing voltages of a magnitude and frequency to cause fluttering in the plate supply circuit comprising an interstage coupling network between said tubes operative to cause a phase shift in the signal voltage transferred therethrough below a predetermined critical low frequency and having a common cathode network including a common cathode resistor for said tubes and a bypass capacitor for said resistor effective to aid regeneration through said resistor over a limited low frequency range and degeneration below said critical frequency when the interstage coupling network becomes effective to shift phase of said signals.

7. In a superheterodyne receive having an oscillator operative at relatively high frequencies, the combination with a common plate supply means for said oscillator, of an audio frequency amplifier comprising a first stage amplifier tube and an output amplifier tube, and means for preventing the output amplifier tube from developing voltages of a magnitude and frequency to cause fluttering in the oscillator circuit comprising an interstage coupling network between said tubes operative to cause a phase shift in the signal voltage transferred therethrough below a predetermined critical low frequency and having a common cathode network including a common cathode resistor for said tubes and a bypass capacitor for said resistor effective to aid regeneration through said resistor over a limited low frequency range and degeneration below said critical frequency when the interstage coupling network becomes effective to shift the phase of said signals.

8. The combination with a common plate supply circuit for electric discharge apparatus, of an audio frequency amplifier comprising a first stage amplifier tube having a control grid, a cathode, a source of signal potential and a self-bias resistor connected in series between said grid and said cathode, an output amplifier stage including an amplifier tube connected with said plate supply circuit and having a cathode connected in parallel with said first named cathode, a feedback resistor in said connection, a bypass capacitor for said resistors, and an interstage coupling network between said tubes operative to provide a phase shift in signal potentials transferred therethrough below a relatively low critical audio frequency, below 80 cycles and above 20 cycles, and said bypass capacitor having a capacity value such that an increase in feedback potential is applied across said first-named resistor below a predetermined frequency above said critical frequency, thereby to provide a predetermined range of regeneration in the first stage amplifier above said critical frequency and a range of degeneration below said critical frequency.

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