

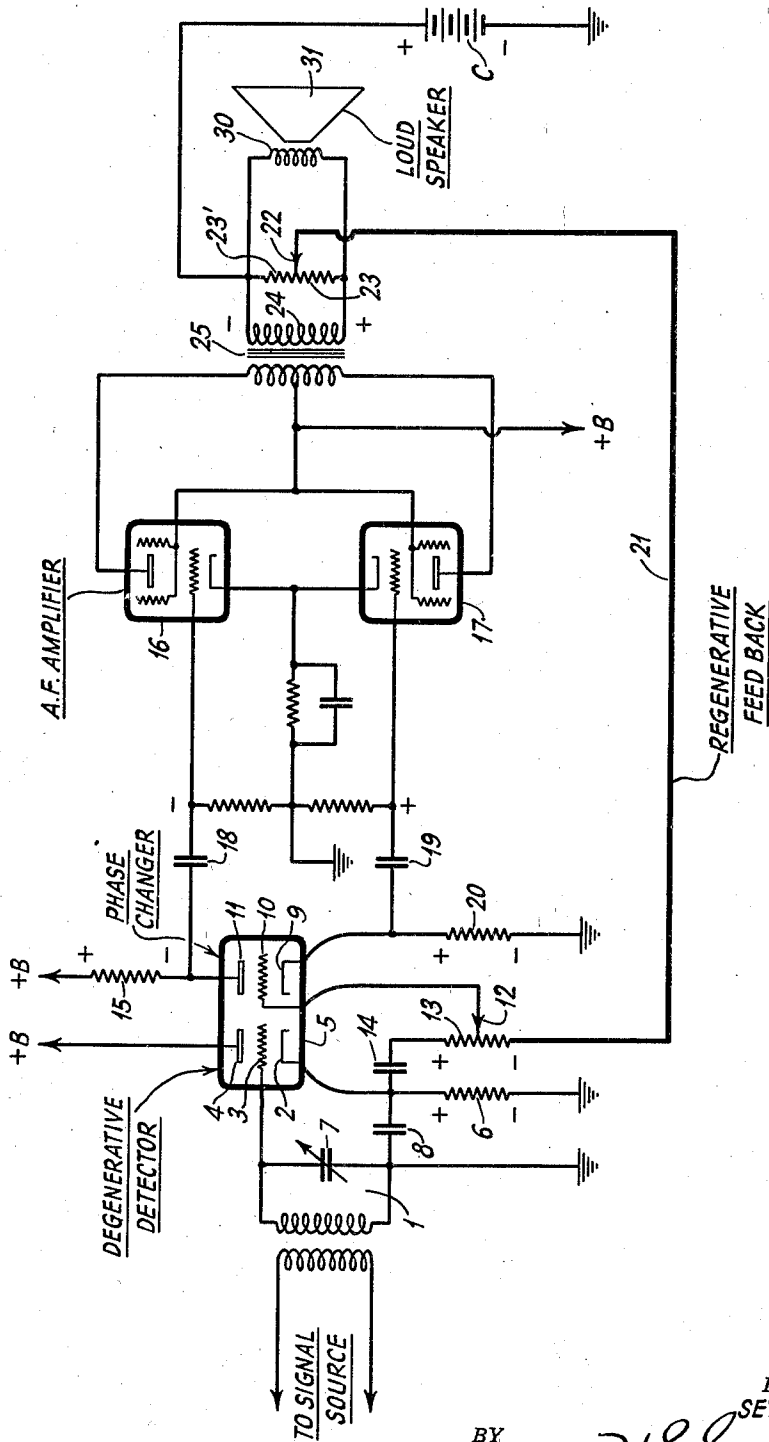
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AUDIO AMPLIFIER CIRCUIT

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## AUDIO AMPLIFIER CIRCUIT

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## 6 Claims. (Cl. 250—27)

My present invention relates to audio amplifier circuits, and more particularly to audio amplifier circuits of the type employing a phase changer network adapted to feed a push-pull output stage.

One of the main objects of my present invention may be stated to reside in the provision of a regenerative feedback circuit for obtaining a gain greater than unity from a tube used as an audio phase changer between a demodulator network and a push-pull output stage, which phase changer tube employs resistive plate and cathode load impedances.

Another important object of my present invention may be stated to reside in the provision of a radio receiving system of the type utilizing an infinite impedance diode detector, and which detector feeds a push-pull audio output stage through a phase changer tube provided with resistive plate and cathode load impedances; the receiving system employing regenerative feedback between the output circuit of the push-pull stage and the grid circuit of the phase changer for the purpose of securing a gain greater than unity from the phase changer tube.

Still other objects of my invention are to improve generally the simplicity and efficiency of audio systems employing phase changers which feed an audio output network, and more particularly to render such arrangements more reliable in operation, and economically manufactured and assembled in radio receivers.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically a circuit organization whereby my invention may be carried into effect.

Referring now to the accompanying drawing, there is shown a signal demodulation and audio amplification system, a loud speaker being utilized to reproduce the audio output energy of the audio amplifier network. The signal energy may be derived from any type of radio frequency amplification network, and it may be pointed out that the demodulator of the circuit shown in the drawing may be fed from the I. F. amplifier of a super-heterodyne receiver; or it may be fed from the plate circuit of the last radio frequency amplifier of a receiver of the tuned radio frequency amplifier type. In any case, the signal energy, which may be of a frequency chosen from the broadcast band of 500 to 1500 K. C., is ultimately impressed,

at the carrier or I. F. frequencies, upon the tuned input circuit 1 of the demodulator. The demodulator is shown as of the degenerative plate circuit type, also termed an infinite impedance diode detector; the demodulator comprising the cathode 2, control grid 3 and plate 4 of a tube 5 which may be of the 6C8G type. Such type of tube is well known at this time, and generally comprises a pair of independent triode sections.

The cathode 2 is connected to ground through a load resistor 6, and the tuned input circuit 1 is connected between the control grid 3 and ground. The numeral 7 designates the variable tuning condenser of the detector input circuit if the receiver is of the tuned radio frequency amplifier type; and, of course, the condenser 7 will be fixed if the circuit 1 is fixedly resonant to an operating I. F. The plate 4 of the detector section of tube 5 may be connected to a proper positive potential point on the power supply bleeder resistor customarily used for energizing a radio receiver. Between the ground side of the input circuit 1 and the cathode end of resistor 6, there is connected a condenser 8 which has a magnitude such that the condenser by-passes only signal carrier frequencies, but does not bypass audio frequencies. The resistor 6 has a magnitude such that in the absence of signals the voltage across resistor 6 biases the grid 3 substantially to plate current cut-off. Due to the lack of audio frequency bypassing through condenser 8, there is developed across resistor 6 audio voltage which is impressed between the control grid 3 and cathode 2 in degenerative phase. It is not believed necessary to enter into any theoretical discussion of the operation of this type of detector; it is believed sufficient to point out that it has been disclosed and claimed by P. O. Farnham in application Serial No. 8864, filed March 1, 1935. This type of detector is of particular value in receivers of the high fidelity type; it is, also, of value in receiving systems wherein it is desired to feed a push-pull audio output stage through resistance capacity coupling.

In order to feed the audio voltage to the push-pull audio amplifier output stage, there is utilized a phase changer tube; such a tube employing resistive impedances in its plate and cathode circuits so that the voltages developed across these impedances are of the proper phase to energize a push-pull audio output stage. For this phase changer function there is employed the second triode section of the tube 5. The second triode section comprises a cathode 9, the control grid 10 and the plate 11. The control grid 10 is connect-

ed by an adjustable tap 12 to any desired point along the resistor 13. The latter has its positive potential end connected to the cathode terminal of resistor 6 through a condenser 14 which has a low impedance to audio frequency voltage, the opposite terminal of resistor 13 being connected by lead 21 to an adjustable tap 22. It will be recognized that the tap 12 and the resistor 13 function as a potentiometer, and may be used as the manual audio volume control device of the receiver.

The plate 11 of the phase changer section of tube 5 is connected to a desired point of positive potential on the power supply bleeder resistor through a resistive load impedance 15. The audio amplifier tubes 16 and 17, which may be of the 6L6 type, have their plate and control grid circuits connected in push-pull arrangement. Thus the control grid of tube 16 is connected to the plate end of resistor 15 through coupling condenser 18, while the control grid of tube 17 is connected to the cathode end of the cathode resistive load impedance 20 through coupling condenser 19. The negative potential end of resistor 13 is connected by lead 21 and adjustable tap 22 to any desired point along the resistor 23. The latter resistor is connected in shunt across the secondary winding 24 of the audio output transformer 25. Through its connection to the positive terminal of bias source C, one terminal of resistor 23 is connected to ground, and the audio transformer 25 is so phased that the grounded end of resistor 23 is negative with respect to the opposite end.

It will be seen that the grid resistor 13 returns to ground through a path which includes lead 21, adjustable tap 22 and the resistive portion 23' between ground and the tap 22. Adjustment of the tap 22 varies the relative magnitudes of the voltages developed across the tapped sections of resistor 23. The common cathode lead of tubes 16 and 17 is connected to ground through the usual grid bias resistor, the latter being shunted by an audio frequency bypass condenser. Appropriate grid leak resistors connect each of the control grids of tubes 16 and 17 to ground. The screen grids and plates of tubes 16 and 17 are supplied with positive potential from the power supply bleeder resistor. The numeral 30 denotes the voice coil employed to actuate the loud speaker 31; it is to be understood that the loud speaker may be of any desired type.

The phase changer section of tube 5 is employed, by virtue of its cathode and plate load resistors 20 and 15, to provide the audio voltages of proper phase to drive the push-pull audio outputs tubes 16 and 17. If the grid resistor 13 were returned directly to ground, instead of to resistor 23 as shown, the phase changer could not have its gain greater than unity. In other words, it would be necessary to employ additional amplifier tubes in cascade in order to secure amplification of the audio voltage output of the detector. This follows from the fact that the audio voltage across resistor 13 is in phase opposition to the audio voltage developed across resistor 20. If the resistor 13 were directly connected to ground, the two voltages would produce a decrease in the negative potential of control grid 10 of tube 5. It will, therefore, be seen that the phase changer functions as a degenerative device.

However, according to my present invention, it is possible to obtain a gain greater than unity from the phase changer device; this being accomplished by connecting the resistor 13 to ground through a predetermined resistive section of re-

sistor 23. The audio voltage appearing across resistor section 23' is applied in series with the voltage across resistor 13; these voltages are in phase. For example, suppose at a given instant the audio voltage appearing across resistor 13 has a value of 10, and the audio voltage appearing across resistor section 23' is equal to 5. Then, the phase changer tube would have applied to its control grid an effective degenerative voltage equal to 5, rather than a degenerative voltage of 10; assuming in the latter case that resistor 13 were directly connected to ground. The phase changer tube will, therefore, have a gain greater than unity. It will be seen that by the utilization of a positive, or regenerative, feedback of audio voltage, the degenerative action of the phase changer is greatly reduced with a consequent benefit in gain. As long as some degenerative action is present in the phase changer tube circuit, the audio system will not oscillate.

To further illustrate the operation of the circuit: assume that the phase changer tube normally has a gain of 14, and when used as a phase changer its gain is 1.75. In that case, for 1 volt input there would be developed 0.88 volt across each of resistors 15 and 20. The gain is less than unity, since one half the output (across resistor 20) affects the input by inverse feedback. However, when using the regenerative feedback connection 21, and assume that the tap 22 is placed at the midpoint of resistor 23, there will be a substantial reduction in the degenerative effect of the voltage across 20; say to 25%. In that case it can readily be shown that there will result a gain of 3.1 for the phase changer tube, with 1.55 volts developed across each of resistors 15 and 20. Even with the regenerative feedback reduced to 10%, a gain of 1.05 will result. The source C may be a tap on the common bleeder resistor; its value is less than the drop across 20 in the absence of signals so as to provide normal bias for grid 10. The grid 10 could, also, be tapped at a desired point on 20 for bias. The polarity of the windings of transformer 25 determine the voltage phase across 23.

While I have indicated and described a system for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organization shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What is claimed is:

1. In combination with a signal source, a detector adapted to derive audio voltage from impressed signals, a phase changer tube, said detector including an output impedance, means connecting the control grid of the phase changer tube to a desired point on the detector output impedance, a path between the cathode of said phase changer tube and a point on said detector output impedance which assumes a negative potential with respect to the first point, said path including an impedance developing an audio voltage thereacross which is impressed on said phase changer control grid in degenerative phase to the audio voltage developed across said detector output impedance, an audio utilization network including a third impedance included in said path, and said third impedance developing an audio voltage thereacross which is in regenerative phase with the voltage developed across said detector output impedance.

2. In combination with a signal source, a detec-

tor adapted to derive audio voltage from impressed signals, a phase changer tube, said detector including an output impedance, means connecting the control grid of the phase changer tube to a desired point on the detector load impedance, a path between the cathode of said phase changer tube and a point on said detector load impedance which assumes a negative potential with respect to the first point, said path including an impedance developing an audio voltage thereacross which is impressed on said phase changer control grid in degenerative phase to the audio voltage developed across said detector load impedance, an audio utilization network including a third impedance included in said path, and said third impedance developing an audio voltage thereacross which is in regenerative phase with the voltage developed across said detector impedance, and said audio utilization network comprising a pair of tubes connected in push-pull relation and having a common input circuit connected to points of opposed polarity in the circuit including said phase changer tube, and said third impedance being connected across the output circuit of said push-pull tubes.

3. In combination with a signal detector tube adapted to produce an audio voltage, a push-pull output stage, a phase changer tube having a control grid connected to the detector for the impression of the audio voltage upon said control grid, a load resistor in each of the plate and cathode circuits of the phase changer tube, connections from the common input circuit of said push-pull stage to points of opposed polarity on said load resistors, and a regenerative feedback connection between the output circuit of said push-pull stage and the input of the phase changer tube.

4. In combination with a signal detector tube adapted to produce an audio voltage, a push-pull output stage, a phase changer tube having a control grid connected to the detector for the impression of the audio voltage upon said control grid, a load resistor in each of the plate and cathode circuits of the phase changer tube, connections from the common input circuit of said push-pull stage to points of opposed polarity on

said load resistors, and a regenerative feedback connection between the output circuit of said push-pull stage and the control grid of the phase changer tube, said regenerative feedback connection including a resistor connected across the common output circuit of said push-pull stage, and an adjustable connection between said last resistor and said phase changer control grid.

5. In combination with an audio amplifier network and a source of audio voltage, a phase changer tube having at least a cathode, control grid and an output electrode, means impressing said audio voltage from said source upon the phase changer control grid, a load resistor included in the cathode circuit of the phase changer tube, the audio voltage developed across the load resistor being in degenerative phase with respect to the audio voltage impressed on said control grid whereby said tube has less than unity gain, means impressing said degenerative voltage upon the input of said audio amplifier network, an impedance connected across the output of said latter network and developing an audio voltage which is in regenerative phase with respect to said degenerative voltage, and means for impressing said regenerative voltage upon the phase changer control grid to an extent such that the phase changer tube has a gain greater than unity.

6. In a wave transmission system, a source of waves, a detector of the degenerative plate circuit rectification type, an audio amplifier having input and output circuits, a tube having input and output electrodes, the tube input electrodes being coupled to said detector to change the phase of the audio voltage output thereof, means coupling the tube output electrodes to said amplifier input circuit, said phase changing tube being degenerative and having a gain less than unity, and means for feeding back from the amplifier output circuit audio voltage in regenerative phase with the audio voltage impressed on said tube input electrodes whereby the said gain is made to exceed unity.

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