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D. S. BOND

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INVERSE FEEDBACK AMPLIFIER SYSTEM

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FIG. 1.

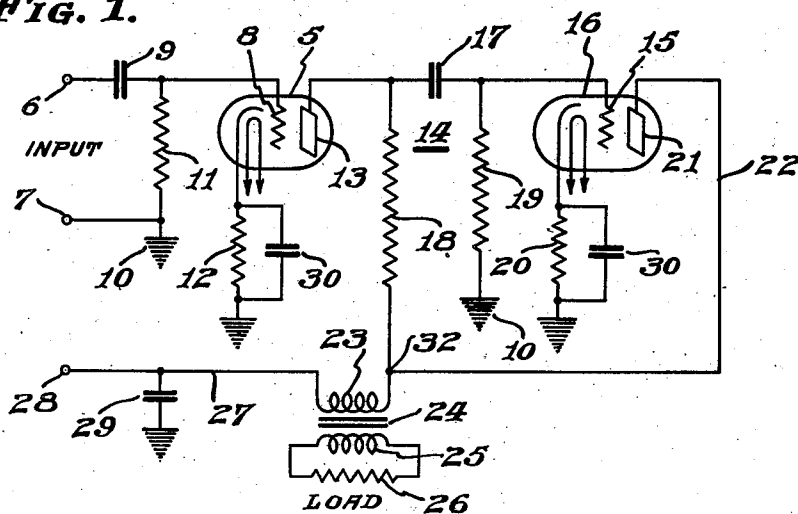
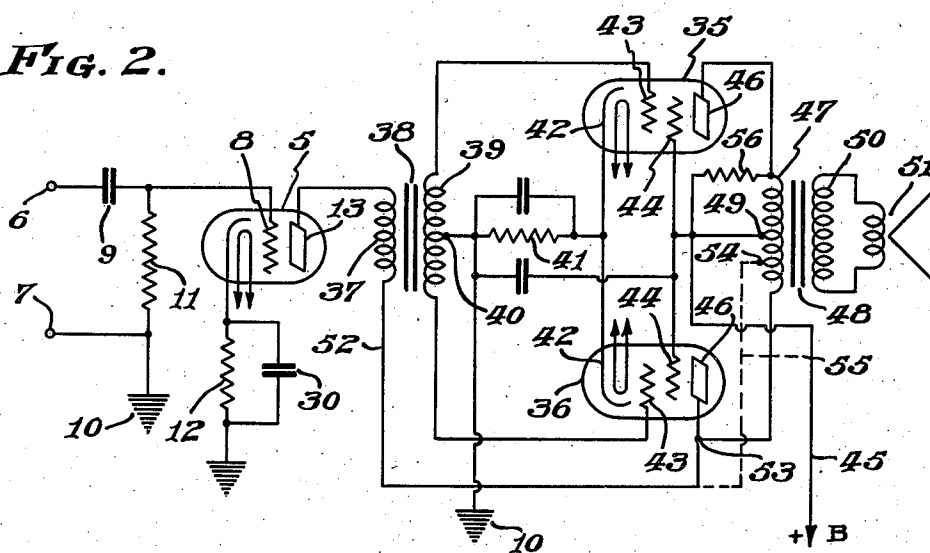


FIG. 2.



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INVERSE FEEDBACK AMPLIFIER SYSTEM

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1 Claim. (Cl. 179—171)

The present invention relates to inverse feedback amplifier systems and has for its primary object to provide improved coupling means for a feedback circuit of an amplifier of the character referred to whereby inverse feedback may be obtained with a minimum number of circuit components.

It is also an object of the present invention to provide an improved and simplified inverse feedback amplifier circuit including a pair of cascade-connected amplifier stages in which inverse feedback and anode currents are supplied to a preceding stage through a common anode circuit, thereby simplifying the circuit and reducing the number of circuit components to a minimum.

The invention will, however, be better understood from the following description when considered in conjunction with the accompanying drawing, and its scope is pointed out in the appended claim.

Referring to the drawing,

Figure 1 is a schematic circuit diagram of an inverse feedback amplifier system embodying the invention, and

Figure 2 is a similar schematic circuit diagram showing a modification of the invention.

Referring to Fig. 1, 5 is an audio frequency amplifier tube having an input circuit indicated by terminals 6 and 7, the former being coupled to the input grid 8 through a coupling capacitor 9 and the latter terminal being connected to ground or chassis 10. A biasing potential is supplied to the grid 8 through a grid resistor 11 connected to ground and through ground to the negative end of a self-bias resistor 12 in the cathode lead of the tube.

The amplifier tube anode indicated at 13 is coupled through a suitable coupling network 14 with the input grid 15 of a second stage amplifier tube 16, the network shown comprising a coupling capacitor 17, and anode and grid circuit impedances 18 and 19 respectively of the usual impedance coupling network, although it should be understood that a transformer coupling may be employed, as will hereinafter be shown.

The coupling impedance 18 is connected with the anode 13, while the grid impedance 19 is connected with the grid 15 and with ground 10, and thence to the negative end of a second self-bias resistor 20 in the cathode lead of the tube 15.

The output circuit for the second stage amplifier tube 16 comprises the anode 21, a lead 22, and the primary 23 of an output transformer 24, across a secondary 25 to which is connected any suitable load indicated by a resistor 26. Anode

current is supplied to the anode 21 through the transformer primary 23 from a supply lead 27 connected with a positive supply terminal 28. A bypass 29 to ground is provided for the supply lead 27 as a filter capacitor and as an alternating current low impedance path to ground and to the cathodes of amplifier tubes. This path is completed to the cathodes through suitable bypass capacitors 30, as shown.

The usual inverse feedback amplifier circuit includes a connection from the output circuit of one stage to the input circuit of another stage through suitable coupling elements. In accordance with the invention, however, in the present example, the low signal potential end of the coupling or anode impedance 18 is connected to the anode side of the coupling transformer primary 23, as indicated at 32. Thus, both anodes 13 and 21 draw current through the primary winding 23 from the positive supply lead 27, it being understood that ground or chassis represents the negative B supply connection.

With this arrangement, the output anode circuit of the tube 5 comprises the impedance element 18 and the impedance element 23 in series together with the bypass capacitor 29 to ground. The feedback circuit from the output anode 21 includes only the impedance element 23. Thus, the amount of feedback obtained is dependent upon the relative impedances of the elements 18 and 23.

Broadly, this involves coupling the input signal through an equivalent series impedance, which may be the plate impedance of the tube 5, into a voltage divider which comprises the said plate impedance and the plate load impedance 18 with the grid 15 of the following tube 16 connected to a tap on the divider and with the high impedance feedback circuit connected to the same or a different tap, such as the tap 32. The tube impedance of the tube 5 and the plate load impedance 18 in series constitute a common voltage divider for both the signal amplified by the tube 5 and the feedback voltage developed across the impedance 23 in the plate circuit of the second stage 16. It is preferable that the plate impedance of the tube 16 be greater than the sum of the impedances of the element 18 and of the tube 5. Normally, impedance 19 will be chosen considerably larger than impedance 18 under which conditions the fraction of the voltage developed across the impedance 23 which is applied to the grid 15 of tube 16 is equal to the ratio of the plate impedance of tube 5 to the sum of this impedance and the impedance of 18.

Referring now to the modification shown in Fig. 2, the input or driver stage 5 is shown transformer-coupled to a pair of balanced output amplifier tubes 35 and 36. In this arrangement, the input terminals 6 and 7 are coupled through a coupling capacitor 9 to the control grid 8 of the input stage 5 and the output anode 13 is connected through the primary 37 of the balanced or push-pull input transformer 38 to the secondary 39 having a center tap 40 connected through a bias resistor 41 to the cathodes 42 and directly to chassis or ground 10.

The outer terminals of the secondary 39 are connected with the signal input grids 43 of the tubes 35 and 36. The tubes are shown as being of the screen grid type having screen grids 44 connected to the positive anode supply lead 45.

The anodes 46 are connected in balanced relation to each other through a balanced primary winding 47 of an output transformer 48. The center tap 49 is connected with the lead 45 to supply anode current to the anodes 46. The secondary 50 of the transformer is connected with a suitable load device such as a loudspeaker 51.

The inverse feedback voltage divider circuit is provided in the present example by connecting the anode current supply lead 52 for the anode circuit of the tube 5 with one of the anode terminals of the primary 47 as indicated at 53 or with a suitable tap 54 on the primary 47, as indicated by the dotted connection 55, so that the resultant potential applied to the primary 37 is equal to the signal potential from tube 5 developed across 37 less a voltage dependent upon the potential developed between the terminal 53 and the terminal 49 or between the terminal 54 and the terminal 49. The connection to the terminal or tap 54 provides a lesser degree of feedback.

The manner in which the voltage derived from terminals 53 and 49 or 54 and 49 is related to the signal potential from tube 5 developed across 37 is the same as the relationship existing for the circuit of Figure 2 except that the input impedance of 37 is substituted for the impedance 18.

The anode circuit of the input stage 5 includes, in series, the plate impedance of the tube, the impedance of the primary winding 37 and the input impedance of one-half of the primary 47, and anode current is supplied to both the tube 36 and the tube 5 through one-half of the primary 47, and this may, in certain cases, be balanced by suitable impedances in shunt with the other half of the transformer winding, as indicated, for example, by a resistor 56 so that the load on each half of the primary 47 is the same, as the input stage 5 places an additional load on the primary 47.

From the foregoing description, it will be seen that inverse feedback may be provided between an output circuit and an input circuit of an amplifier stage, or of an amplifier, by utilizing a voltage divider network comprising the output load impedance of an amplifier stage, the load impedance of the preceding stage and the tube plate impedance of said preceding stage in series, whereby inverse feedback is effected without additional coupling elements being required in the amplifier circuit.

An audio frequency amplifier comprising, in combination, a balanced power output stage including an input transformer and an output transformer provided with a center tap, a driver stage coupled to said first-named stage, an output circuit for said driver stage including the primary of said input transformer and a connection on the primary of said output transformer in spaced relation to the center tap thereon, whereby at least a portion of said output transformer primary is included in said driver stage output circuit for establishing a predetermined degree of inverse feedback in said amplifier, and means included in shunt with another portion of said output transformer primary on the opposite side of said center tap for balancing the load on the output transformer.

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