

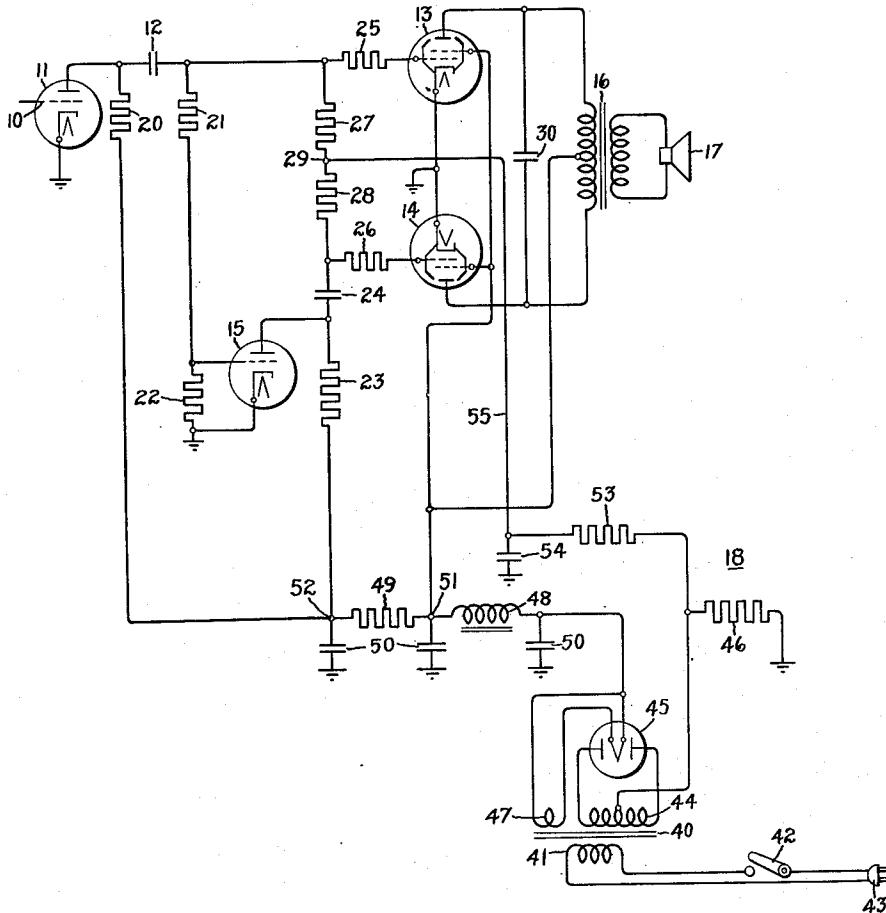
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PUSH-PULL CIRCUIT

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PUSH-PULL CIRCUIT

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My invention relates to push-pull amplifier circuits and in particular to push-pull circuits in which a fixed bias is supplied to the grids of the amplifier tubes. It is an object of my invention to provide an improved push-pull amplifier circuit in which undesirable hum from the bias supply is substantially reduced in the amplifier output circuit.

Another object of my invention is to provide an improved push-pull amplifier circuit in which hum in the output circuit is reduced substantially without the use of expensive filters in the bias supply circuit.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing, in which the single figure of the drawing represents a portion of a radio receiver circuit embodying my invention.

In the drawing, audio frequency signals from previous portions of the receiver are supplied to the control electrode 10 of amplifier 11 and the amplified audio voltages are coupled through capacitor 12 to the output amplifiers 13 and 14, the voltages being supplied directly to the control electrode of amplifier 13 and to amplifier 14 through a phase inverter 15. The output circuits of the amplifiers 13 and 14 are connected in push-pull through the primary winding of an audio transformer 16, the secondary winding of which is connected to a suitable translating device, such as the loud speaker 17. Operating potentials for the various electrodes of the amplifying devices are supplied from the power supply circuit 18.

The signals supplied to control electrode 10 of amplifier 11 may be obtained from the usual radio frequency and detection circuits of a radio receiver. Since these circuits form no part of the present invention, they are not included in the drawing. Potential for the anode of amplifier 11 is supplied from the power supply circuit 18 through the load resistor 20. The output of amplifier 11 is resistance-capacitance coupled to the input electrodes of amplifier 13 and the phase inverter 15, resistances 21 and 22 being connected between the coupling capacitor 12 and ground to form a voltage divider, the values of the component resistances of this divider being determined in a manner to be pointed out in detail

later. Audio voltages appearing across resistor 22 are impressed between the control electrode and cathode of phase inverter 15 and the amplified voltages developed across load resistance 23 in the anode circuit of phase inverter 15 are coupled by means of capacitor 24 to the control electrode of amplifier 14. Audio signals from amplifier 11 are supplied to the control electrode of amplifier 13 through resistor 25 and the inverted audio voltages in the output circuit of phase inverter 15 are supplied to control electrode of amplifier 14 through resistance 26. Resistances 27 and 28 are connected in series between resistances 25 and 26 and unidirectional bias potential for the control electrodes of the amplifiers 13 and 14 is connected to the common point 29 of resistances 27 and 28 from the power supply circuit 18. The cathodes of amplifiers 13 and 14 are connected directly to ground, as shown. Operating potentials for the screen electrodes and anodes of amplifiers 13 and 14 are derived from the same tap of the power supply circuit 18, the operating potential for each of the anodes being supplied through a respective one half of the primary winding of audio transformer 16, load capacitor 30 being connected across the primary winding of the transformer.

The power supply circuit 18 comprises transformer 40 having a primary winding 41 connected through an on-off switch 42 to a suitable source of alternating current potential by means of the usual receptacle plug 43. The terminals of the secondary winding 44 of transformer 40 are connected to the anodes of a full-wave rectifier 45, the center point of the winding 44 being grounded through a resistor 46. The filament of rectifier 45 is heated in the usual manner with current supply from a separate winding 47 on the transformer 40. The cathode of rectifier 45 is connected to ground through a filter circuit comprising the series connected iron core reactor 48 and resistor 49, filter capacitors 50 being connected between the terminals of reactance 48 and resistor 49 and ground. Tap 51 on the filter circuit is utilized for supplying operating potential to the anodes and screen electrodes of amplifiers 13 and 14 and tap 52, for supplying potential to the anode of phase inverter 15. Biasing potential for the control electrodes of amplifiers 13 and 14 is developed across resistor 46 and supplied through the filter comprising resistor 53 and capacitor 54.

Use of a power supply circuit of the type disclosed above is attended with a certain amount of hum which, especially when biasing potentials

for control electrodes are obtained from such a source, is amplified in the cascaded tube circuits and appears with considerable intensity in the output circuits of the amplifiers unless certain precautions are taken to eliminate this hum. One such precaution is the use of extensive filtering in the bias supply circuit. Complete removal of voltages of hum frequency is difficult to obtain and the circuits needed for such filtering require expensive capacitors and other equipment. When a potential source having a certain percentage of hum voltages present therein is used for operating push-pull amplifiers of the type described, hum voltages of considerable magnitude are introduced in the circuit through amplification of the undesired hum by the phase inverter needed for producing the negative half cycles of audio voltages required for operation of push-pull amplifiers.

In order to prevent amplification of the hum voltages by the phase inverter 15, resistance 21 is made large with respect to resistance 22 and the ratio of the sum of resistances 21 and 22 to resistance 22 is made equal to the amplification factor of the phase inverter tube 15. In this manner, the hum at the anode of the inverter tube is kept to the same level as that at the bias source itself and which is supplied over conductor 55 to the control electrodes of amplifiers 13 and 14. The result is that the hum voltages supplied to the grid of tube 14 from the bias source cancels that supplied thereto from the phase inverter circuit, leaving in the output circuit only the hum supplied to the grid of tube 13. As a result, the total hum produced in the output circuits of the amplifiers is much reduced over that normally present. The bias potential supplied to the control electrodes of amplifiers 13 and 14 over conductor 55, of course, is maintained larger than that of signal voltages supplied to these electrodes in order to prevent distortion of the audio signal voltages in the output circuit.

It is thus seen that my invention provides a bias supply input for push-pull amplifiers in which hum amplification by the phase inverter tube is prevented. Utilizing grid bias for the control electrodes of push-pull amplifiers permits operation of the tubes at full anode potentials and avoids the decrease in power output which is present whenever cathode resistors in the circuits of the push-pull amplifiers are used for biasing the tubes. A circuit of the type described is particularly desirable in so-called A. C.-D. C. radio receivers, for use of the fixed negative bias on the control electrodes of the power amplifiers is effective to increase the power output of the receiver by a substantial amount. The invention also is well adapted for use in radio receivers having a battery supply source and which utilizes filament type tubes, for in such receivers self-biasing is impractical for it reduces the power output of the receiver.

By way of illustration only and not in any sense by way of limitation, the following representative values are those that have been found suitable in a particular radio receiver embodying my invention. In this receiver a type 6J5G tube was used as the phase inverter tube 15 and type 6V6

tubes were used as the beam power amplifiers 13 and 14. A fixed resistor having a value of 3.3 megohms was used as resistor 21 and a resistor having a value of 220,000 ohms, as resistor 22. The value of both resistances 27 and 28 was 100,000 ohms. Such a circuit arrangement was effective to eliminate unbalanced hum in the output circuit to an extent which previously had been achieved only by expensive filtering arrangements in the biasing circuit.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a radio receiver having a source of voltage supply subject to undesired hum voltages, the combination of a pair of series connected resistances across which audio voltages are developed, a pair of amplifiers connected in push-pull, each of said amplifiers having a control electrode and a cathode, both of said resistances being connected between the control electrode and cathode of one of said amplifiers, a phase inverter having input electrodes and an output electrode, one of said resistances being connected between said input electrodes and said output electrode being coupled to the control electrode of the other of said amplifiers, and means supplying a unidirectional bias potential from said voltage source to said control electrodes with like polarity, said resistances being so proportioned that audio voltages are supplied to said control electrodes with substantially equal magnitude and opposite phase and hum voltages are supplied to one of said control electrodes by said phase inverter with opposite phase to that supplied thereto by said bias potential.

2. In an audio amplifier having a source of voltage supply subject to undesired hum voltages, the combination of a pair of series connected resistances across which audio voltages are developed, a pair of amplifiers connected in push-pull, each of said amplifiers having a control electrode and a cathode, both of said resistances being connected between the control electrode and cathode of one of said amplifiers, a phase inverter having input electrodes and an output electrode, one of said resistances being connected between said input electrodes and said output electrode being coupled to the control electrode of the other of said amplifiers, means supplying a unidirectional bias potential from said voltage source to said control electrodes with like polarity, and the product of said one resistance times the gain of said phase inverter being substantially equal to the sum of said pair of resistances whereby audio voltages are supplied to said control electrodes with substantially equal magnitude and opposite phase and hum voltages are supplied to one of said control electrodes by said phase inverter with opposite phase to that supplied thereto by said bias potential.

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