

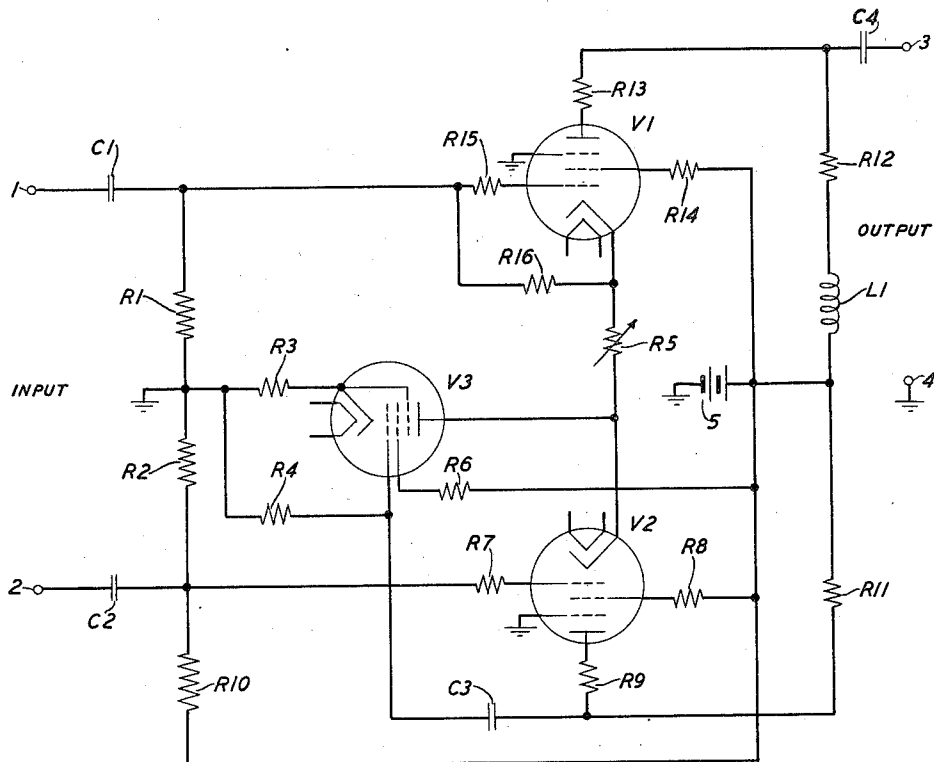
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BRIDGING AMPLIFIER

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BRIDGING AMPLIFIER

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This invention relates to electric wave amplifiers and particularly to amplifiers having balanced divided input circuits.

The object of the invention is an amplifier which will discriminate against longitudinal currents, and provide increased amplification for balanced signal currents.

A feature of the invention is an electric discharge device, having its anode-cathode path connected in the common branch of the divided input and divided output circuits of the amplifier, and its control electrode connected to one of the output circuits. This electric device should have a high impedance to alternating voltages applied to the anode, and a moderate direct resistance, and may conveniently be a pentode vacuum tube.

The drawing schematically shows an electric wave amplifier embodying the invention.

A balanced transmission line may be connected to the input terminals 1, 2, causing signal currents to flow through capacitor C1 and resistors R1 and R16, and through capacitor C2 and resistors R2 and R10. The voltages developed across grounded resistors R1, R2, are applied in push-pull, or differential relationship, through the small resistors R15, R7 to the control grids of the vacuum tubes V1, V2. The vacuum tubes V1, V2, preferably have high grid to anode transconductances and may conveniently be of the pentode type, though tetrodes and, in some cases, triodes are satisfactory. A battery 5, or other convenient source of power, is connected through the small resistors R14, R8, to the screen grids of the vacuum tubes V1, V2; through the small inductor L1, coupling resistor R12, and small resistor R13 to the anode of vacuum tube V1; and through the coupling resistor R11 and small resistor R9 to the anode of vacuum tube V2. The coupling resistor R12 is connected through capacitor C4 to the output terminal 3, while the output terminal 4 is grounded. The suppressor grids of vacuum tubes V1, V2, if any, may conveniently be grounded. The cathode of vacuum tube V1 is connected through an adjustable resistor R5 to the cathode of vacuum tube V2. R1 and R16 provide bias voltage for V1; R2 and R10 provide bias voltage for V2. The heaters of vacuum tubes V1, V2 are connected as usual, to some convenient source of power (not shown).

The vacuum tube V3 should have a high alternating impedance, and a moderate direct resistance and may conveniently be of the pentode or tetrode type. The anode of vacuum tube V3 is connected to the cathode of vacuum tube V2; the

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screen grid of vacuum tube V3 is connected through the small resistor R6 to the source 5; the suppressor grid and cathode of vacuum tube V3 are connected through a biasing resistor R3 to ground; and the control grid of vacuum tube V3 is connected through the grid leak resistor R4 to ground. The heater of vacuum tube V3 is connected to some convenient source of power (not shown).

The anode of vacuum tube V2 is connected through the small resistor R9 and coupling capacitor C3 to the control grid of vacuum tube V3.

The anode current of tube V1 flows from the grounded source 5 through inductor L1, resistors R12, R13, the anode-cathode path of tube V1, and resistor R5; the anode current of tube V2 flows from the source 5 through resistors R11, R9, and the anode-cathode path of tube V2. The anode currents of tubes V1, V2, then flow through the anode-cathode path of tube V3 and resistor R3 to ground, back to the source 5. Tube V3 is biased by means of R3 so that the anode current of tube V3 is twice the desired cathode current of each of tubes V1 and V2. Tube V1 is biased by means of resistors R1 and R16 to conduct a cathode current equal to one half the current required by the anode of tube V3. The remaining one half of the tube V3 anode current will be supplied by the cathode of tube V2 because the moderately high cathode to ground impedance provided for tube V2 by the cathode of tube V1 and the anode of tube V3 results in good automatic self bias of tube V2. Resistors R2 and R10 maintain the control grid to ground voltage of V2 at about one half the supply voltage 5, so that the anode to cathode voltage of all three tubes is substantially equal.

A modern pentode, such as the tubes V1, V2, may have a transconductance of several thousand micromhos, thus, the impedance of the tube viewed into the cathode, that is, the impedance the tube presents to a voltage applied between the ground and cathode, is only a few hundred ohms. On the other hand, a modern pentode, such as tube V3, will have an impedance viewed into the anode, that is, the impedance which the tube presents to a variation in the voltage applied to the anode, which is of the order of one hundred thousand ohms, or more.

The small resistors R6, R7, R8, R9, R13, R14, R15, prevent high frequency oscillations and, as they have resistances of only some fifty ohms, may be ignored in discussing the operation of the amplifier.

The small inductor L1, having an inductance of some 50 microhenries, or less, counteracts the effects of the parasitic capacitances in the amplifier and is selected to maintain more nearly constant the response-frequency characteristic of the amplifier at high frequencies, equalizing the response of the amplifier at the upper end of the characteristic. This inductor will have a resistance of a few ohms. The load resistors R11, R12, may have resistances of the order of a thousand ohms.

When balanced-to-ground voltages are applied to terminals 1 and 2 of the amplifier they tend to produce anode circuit currents in tubes V1 and V2 which are out of phase. These currents annul one another at the anode of tube V3 so that no current is required to flow through the anode circuit of V3 to ground. Thus tube V3 produces no degeneration to the amplification of balanced-to-ground input signal voltages.

For longitudinal noise currents, which tend to produce identical voltages, with respect to ground, on the control grids of the tubes V1, V2, the resulting currents in tubes V1, V2, are in phase, and the currents from the cathodes of these tubes are compelled to flow through tube V3, source 5, thence through the respective load resistors to the anodes of tubes V1, V2. The high impedance presented by the tube V3 to these currents will produce a large amount of degeneration, thus, the amplifier discriminates between balanced signal currents and longitudinal noise currents, amplifying the signal currents but suppressing the noise currents.

The alternating current from tube V2 produces a voltage drop in load resistor R11 which is applied to the control grid of tube V3 by any suitable coupling means such as the capacitor C3 and leak resistor R4. This voltage will be in reverse phase to the signal voltage applied to the control grid of tube V2, and in phase with the signal voltage applied to the control grid of tube V1. The resultant variation in the impedance of tube V3 will produce a powerful degenerative effect on tube V2, so that the voltage amplification of tube V2 is reduced, and very little alternating current will now flow in tube V2. As the voltage applied to the signal grid of tube V3 is in phase with the voltage applied to the signal grid of tube V1, the alternating current of tube V1 tends to flow from the cathode of tube V1 through resistor R5, tube V3, source 5, load inductor L1 and resistor R12 to the anode of tube V1. It may be shown that this connection of the signal grid of tube V3 to the anode circuit of tube V2 produces a voltage amplification of the signal which is approximately double the voltage amplification of the same circuit but without said connection.

As substantially all the amplified signal currents flow from the cathode of tube V1 through resistor R5 to the anode of tube V3, resistor R5 will produce a degenerative effect on the output of tube V1, thus, by adjustment of the resistance of resistor R5, the gain of tube V1 may be varied.

This amplifier may also be operated from an unbalanced line by connecting one of the terminals 1 or 2 to the line and connecting the other terminal to ground. In this case, signal voltages are applied to the control grid of one of the tubes V1 or V2, and the control grid of the other tube is held constant at ground potential. From the detailed description given hereinabove, the operation of the amplifier under these conditions is obvious.

What is claimed is:

1. An amplifier including first and second electronic devices, each having at least an activated cathode, an anode and a control electrode, means connecting both said control electrodes in balanced relationship, a circuit connecting both said cathodes, a third electronic device having at least an activated cathode, an anode and a control electrode, means connecting the anode of the third device to the circuit connecting the cathodes of the other two devices, means coupling the cathode of the third device to the control electrodes of the other two devices, a source of anode power having a negative pole connected to the cathode of the third device, circuits connecting the anodes of the first and second devices in balanced relationship to the positive pole of the anode source, a load coupled to the anode circuit of the first device, and a connection from the anode of the second device to the control electrode of the third device.

2. The combination of claim 1 with a gain controlling adjustable resistor in the circuit connecting the cathode of the first device and the anode of the third device.

3. The combination of claim 1 in which all said devices are pentodes having screen grids connected to said source.

4. A bridging amplifier for connection to a balanced transmission line having two conductors transmitting signal currents and susceptible to undesired potential differences between both said conductors and ground, including first and second electronic devices each having at least an activated cathode, an anode and a control electrode, means coupling the control electrodes of said devices respectively to said conductors, two impedances connecting said control electrodes in balanced relationship to ground, a circuit connecting both said cathodes, a third electronic device having at least a grounded activated cathode, an anode, and a control electrode, means connecting the anode of the third device to the circuit connecting the cathodes of the other devices, a source of anode power having a grounded negative pole, impedances connecting the anodes of the first and second devices in balanced relationship to the positive pole of the anode source, a load coupled to the anode circuit of the first device, whereby the amplifier provides full amplification for signal currents but discriminates against the undesired potential differences, and a connection from the anode of the second device to the control electrode of the third device, whereby the amplification of the signal currents is increased.

5. The combination of claim 4 with a gain controlling adjustable resistor in the circuit connecting the cathode of the first device and the anode of the third device.

6. The combination of claim 1 in which all said devices are pentodes having screen grids connected to said source.

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