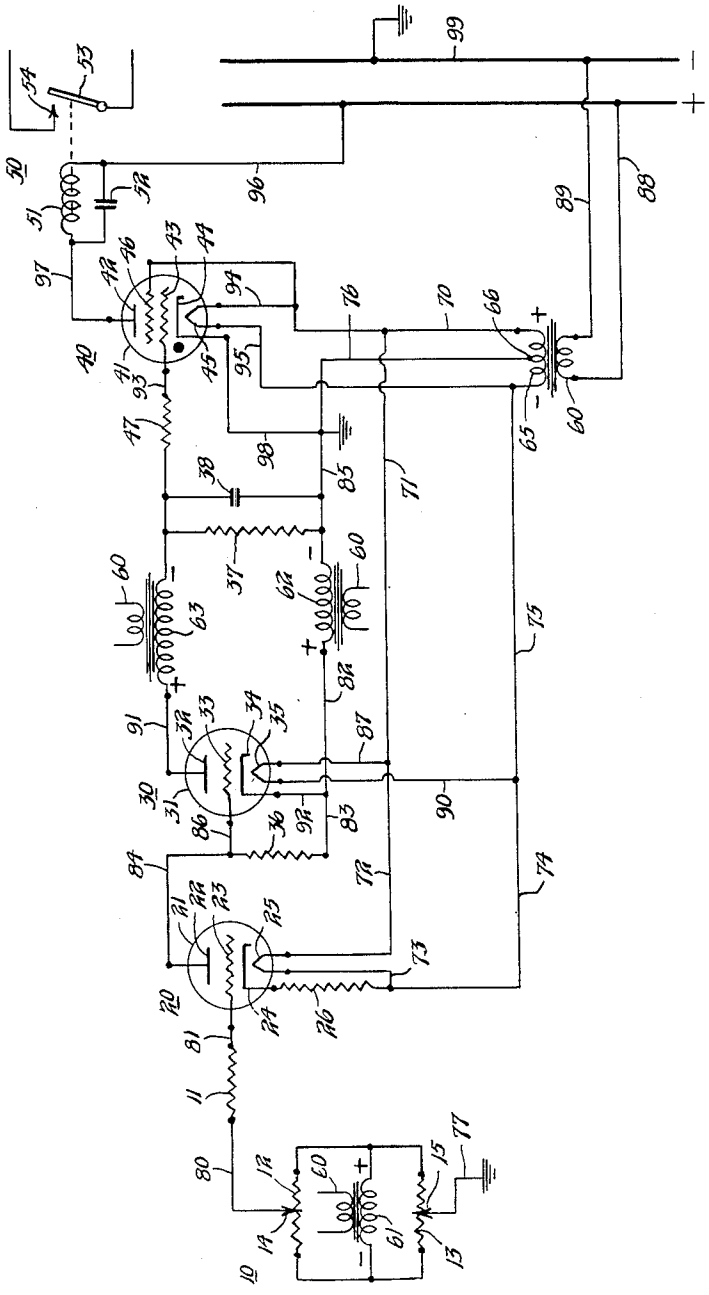
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ELECTRONIC ALTERNATING CURRENT AMPLIFIER

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ELECTRONIC ALTERNATING CURRENT AMPLIFIER

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The present invention relates to electronic amplifiers in which the plate potentials of the various stages have been placed closer to ground than has hitherto been customary.

Another object of the invention is to reduce the signal potential necessary to cause operation of the amplifier.

Another object of the invention is to advance the firing of the electron tube in one of the stages.

I accomplish the above objects by placing the plate supply of one of the stages in the cathode circuit of the succeeding stage. I also place a portion of the filament voltage in the cathode circuit of one stage in such a manner as to drive the cathode negative with respect to the grid. A portion of the filament voltage is also placed between the cathode and screen grid of another of the stages such that the screen is positive with respect to the cathode and tends to advance the firing of that stage.

For a further understanding, reference may be made to the drawing which shows a circuit embodying the principles of the invention.

In the drawings, a bridge 10 feeds a signal to a first amplifying stage 20 through a grid current limiting resistor 11. Stage 20 is electrically coupled to a second amplifying stage 30. This in turn is coupled to the thyratron output stage 40 which operates a load circuit designated as 50.

If desired, all voltage supply sources may be taken from a single transformer having a primary 60 and secondaries 61, 62, 63 and 65. An advantage of having all voltage supply sources from one transformer is to more easily obtain the desired phase relation between the various voltage supplies. Secondary 65 is a heater filament supply voltage transformer having a center tap 66 to ground. The bridge 10 has a power source which may be, and in this case is shown to be, the secondary winding 61 of the transformer above described. The bridge also has two resistors 12 and 13 which are joined together at opposite ends of transformer secondary 61. Two adjustable contacts 14 and 15 are operatively connected to resistors 12 and 13 respectively. Movement of contact 14 or 15 with respect to the other contact along resistor 12 or 13 determines the phase and magnitude of the signal sent to stage 20.

Amplifying stage 20 has a tube 21 containing an anode 22, control electrode or grid 23, cathode 24, and a heater filament 25. A cathode bias resistor 26 has also been provided. The plate supply voltage for stage 20 is furnished by transformer secondary 62 mentioned above. The filament 25 is energized by transformer secondary 65 through leads 70, 71, 72, filament 25, leads 73, 74 and 75 back to transformer secondary 65.

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The cathode to grid circuit of stage 20 is from cathode 24, resistor 26, leads 74, 75, the left half of transformer secondary 65, center tap 66, lead 76, ground, lead 77, bridge 10, lead 80, resistor 11, and lead 81, to grid 23.

The plate to cathode circuit of stage 20 is from the left hand terminal of transformer secondary 62, leads 82 and 83, resistor 36, lead 84, anode 22, cathode 24, resistor 26, leads 74 and 75, the left half of transformer secondary winding 65 to center tap 66, leads 76 and 85, to the right hand terminal of transformer secondary 62.

Stage 30 has an amplifier tube 31 containing an anode 32, grid or control electrode 33, cathode 34, and heater filament 35. A grid biasing resistor 36 is also electrically connected between grid 33 and cathode 34. The output of stage 20 is impressed upon grid 33 of stage 30 through leads 84 and 86. Heater filament 35 is energized by a circuit extending from transformer secondary winding 65 through leads 70, 71 and 87, filament 35, leads 90 and 75 back to transformer secondary 65. The plate supply for stage 30 is obtained from transformer secondary winding 63 which is shown in this case to be a secondary winding of the transformer having a primary 60 which supplies all the voltage sources needed in this circuit.

The anode to cathode circuit of stage 30 is from the left hand terminal of transformer secondary 63, lead 91, anode 32, cathode 34, leads 92 and 82, transformer secondary winding 62, resistor 37 having condenser 38 in parallel therewith, to the right hand terminal of transformer secondary winding 63.

Stage 40 has a tube 41 shown as a gas filled tube and having an anode 42, control electrode 43, cathode 44, and heater filament 45. A second control electrode or screen grid 46 is also shown in this tube. The output of stage 30 is fed from the anode 32 of stage 30, lead 91, transformer secondary winding 63, grid current limiting resistor 47 and lead 93 to control grid 43 of stage 40. Heater filament 45 is energized from transformer secondary 65 through leads 70 and 94, filament heater 45 and lead 95 back to transformer secondary 65. The plate potential supply for stage 40 is fed from across the line.

The anode to cathode circuit in stage 40 is from lead 96, energizing coil 51 of relay 50, having condenser 52 in parallel therewith, lead 97,

anode 42, cathode 44, lead 98, ground, and lead 99.

The load circuit 50 is shown in this circuit to be a relay having an energizing coil 51, a condenser 52 in parallel with relay energizing coil 51 and relay contacts 53 and 54 which are biased to open position and are moved to closed position upon energization of coil 51.

Though it is understood that the disclosure in this invention is not confined to the use of the following values of components in this circuit it has been found that the following set of figures will cause the circuit to operate satisfactorily. In the bridge 10:

Transformer secondary 61	volts	10–20
Resistor 12	ohms	1,000
Resistor 13	do	1,000

As to the rest of the circuit:

Resistor 11	megohms	0.4
Resistor 26	ohms	13,000
Resistor 36	megohms	1.0
Resistor 37	do	0.05
Resistor 47	do	0.1
Condenser 38	microfarads	0.6

In stage 40 the tube 41 used is a GL546 thyratron tube. Tubes 21 and 31 in stages 20 and 30 are two halves of a 12AN7 duotriode. The voltage across transformer secondary 62 is 30 volts and the voltage across transformer secondary 63 is 60 volts.

Operation

As can be seen from the drawing, the plate supply of all three amplifying stages 20, 30 and 40 are positive simultaneously. During the same half of the cycle when the plates 22, 32 and 42 are positive the right hand terminal of filament transformer secondary 65 is positive with respect to its left hand terminal. As a result of this polarity of the filament transformer secondary the screen grid 46 of tube 41 is positive during the conducting half cycle of tube 41. This results in advancing the firing point of this tube during that portion of the cycle when the plate is positive with respect to the cathode.

The left hand portion of the filament transformer secondary winding 65 is also connected between the grid and cathode of the stage 20. The circuit has already been described and it can easily be seen that on the half cycle when the plate is positive with respect to the cathode that portion of the filament secondary in the grid to cathode circuit drives the cathode 24 more negative with respect to the grid 23. As a result, the operating point of the bridge 10 necessary to open or close the relay 50 has been reduced a substantial amount. With the constants named above used in this circuit, the operating signal given off by the bridge which would be necessary to open and close the contacts 53 and 54 of relay 50 if this portion of the filament transformer secondary were not in the grid to cathode circuit of stage 20 would be: 2.8 volts to energize the relay and close the contacts 53 and 54, and 2.50 volts necessary to deenergize the relay coil 51 and open the relay contacts 53 and 54. With the left hand portion of the filament transformer secondary 65 in the grid to cathode circuit of stage 20, the necessary operating point of the bridge has been reduced to: 0.010 volt to energize coil 51 of relay 50 and close contacts 53 and 54, and 0.004 volt to deenergize relay coil 51 and open contacts 53 and 54.

As has been described above the plate supply of stage 20 which is transformer secondary 62, is in the plate to cathode circuit of stage 30. As can be seen by the drawing the polarity of the two transformer secondaries 62 and 63 are such that the voltage across transformer secondary 62 will subtract from that voltage across transformer secondary 63.

In this way it has been possible to effectively ground the plate supply for stage 20 by placing the plate supply between the cathode 34 of stage 30, and ground. This prevents any possibility there might be of the plate supply 62 "floating" as it would if it were placed between plate 22 in stage 20 and grid 33 in stage 30.

The general operation of the circuit is as follows: When a signal of proper polarity is sent from bridge 10 to grid 23 of stage 20 tube 21 will be made to conduct. Upon firing by tube 21, a voltage will be impressed across resistor 36 in stage 30 and drive the grid 33 sufficiently negative with respect to cathode 34 to prevent the tube 31 from conducting. When tube 31 does not conduct there will be no voltage impressed across resistor 37 to drive grid 43 sufficiently negative with respect to cathode 44 of stage 40 as to prevent tube 41 from firing. Thus tube 41 will fire, energizing relay coil 51 which will close contacts 53 and 54.

Upon zero signal or a signal of wrong polarity given from the bridge 10 the grid 23 will be driven negative with respect to cathode 24 of stage 20 and prevent tube 21 from conducting. When tube 21 does not conduct, there will be no voltage across resistor 36 to drive grid 33 negative with respect to cathode 34 in stage 30. As a result tube 31 will conduct and place a potential across resistor 37. Resistor 37 is tied between grid 43 and cathode 44 of stage 40 and the polarity placed upon resistor 37 by tube 31 will be such as to drive grid 43 negative with respect to cathode 44. As a result tube 41 will not fire and relay coil 51 will be deenergized permitting relay contacts 53 and 54 to open.

It will thus be seen that I have provided an amplifier in which a small signal of proper polarity will be sufficient to cause operation of the amplifier such that the relay will be energized.

Although a specific example of the invention has been shown and described, it will be understood of course, that it is but illustrative and that various modifications may be made therein without departing from the scope and spirit of the invention as described in the appended claims.

I claim as my invention:

1. In combination: a plurality of electron discharge devices, including a first and a second of said devices each having an anode, a control electrode, a cathode and a separate cathode heater for heating said cathode; means electrically interconnecting the first and second of said devices, said means including a connection between each of said cathodes and a point of reference potential and a connection between the anode of said first device and the cathode of said second device; separate means connecting an alternating voltage source between the cathode of said second device and said reference point and the anode of said second device and said reference point such that the anodes of said devices are positive simultaneously with respect to the cathodes; a single alternating cathode heater voltage supply source electrically connected in energizing relation to all of said cathode heaters;

means electrically connecting a first portion of said cathode heater voltage source between the point of reference potential and the cathode of the first of said devices in series with the means applying the alternating voltage between the cathode of said second device and said reference point and in such a phase relation with said means as to increase the maximum potential difference between the anode and cathode of said first stage; means electrically connecting said first portion of said cathode heater voltage source between the cathode and control electrode of the first of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anode and the control electrode of the first device have the same polarity with respect to the cathode of the first device; and means electrically connecting a portion of said cathode heater voltage source between the cathode and control electrode of the second of said devices in such a phase relation with respect to the potential applied between the anode and cathode of said second device that the anode and control electrode of the second device have the same polarity with respect to the cathode of the second device.

2. In combination: a plurality of electron discharge devices including a first device having an anode, a cathode, and a separate heater for heating said cathode, and a second device having an anode, a control electrode, a cathode, and a separate cathode heater for heating said cathode; means electrically interconnecting said first and second devices, said means including a connection between each of said cathodes and a point of reference potential; means connecting an alternating voltage source between said anode and said cathode of said first device, said means including an alternating voltage supply source connected between said reference point and the cathode of said second discharge device; means connecting an alternating voltage between the anode and the cathode of said second device in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anode of said first and said second devices are positive simultaneously; a single alternating cathode heater voltage supply source electrically connected in energizing relation to both of said cathode heaters; means electrically connecting a portion of said cathode heater voltage source between said point of reference potential and the cathode of the first of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point as to increase the maximum potential difference between the anode and the cathode of said first stage; and means electrically connecting a portion of said cathode heater voltage source between the cathode and the control electrode of the second of said devices in such a phase relation with respect to the potential applied between the anode of said second device and said reference point that the anode and control electrode have the same polarity with respect to the cathode thereof.

3. In combination: a plurality of electron discharge devices, including a first and a second of said devices each having an anode, a cathode and a separate cathode heater for heating said cathode, and a third of said devices having an anode, a control electrode, a cathode, and a separate cathode heater for heating said cathode;

means electrically interconnecting said first, said second and said third of said devices, said means including a connection between each of said cathodes and a point of reference potential; means connecting a potential source between the anode and the cathode of said first device comprising a first alternating voltage supply source electrically connected between the cathode of said second device and said point of reference potential; means connecting an alternating voltage source between the anode and the cathode of said third device in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anodes of said first and said third devices are positive simultaneously; a single alternating cathode heater voltage supply source electrically connected to all of said cathode heaters; means electrically connecting a portion of said heater voltage source between the point of reference potential and the cathode of the first of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point as to increase the maximum potential difference between the anode and the cathode of said first stage; and means electrically connecting a portion of said cathode heater voltage source between the cathode and the control electrode of the third of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anode and the control electrode have the same polarity with respect to the cathode thereof.

4. In combination: a plurality of electron discharge devices, including a first and a second of said devices each having an anode, a cathode, and a separate cathode heater for heating said cathode, and a third of said devices having an anode, a control electrode, a cathode and a separate cathode heater for heating said cathode; means electrically interconnecting said first, said second, and said third of said devices, said means including a connection between each of said cathodes and a point of reference potential; means connecting a potential source between the anode and the cathode of said first device comprising a first alternating voltage supply source electrically connected between the cathode of said second device and said point of reference potential; means connecting a potential source from a second alternating voltage supply source between the anode and the cathode of said second device in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anodes of said first and said second devices will be positive simultaneously; means electrically interconnecting said voltage sources such that the voltage supply for said first device will oppose the voltage supply for said second device and reduce the potential between the anode and the cathode of said second device; means connecting an alternating voltage source between the anode and the cathode of said third device in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point and the potential applied between the anode and cathode of said second device that the anodes of said first, said second, and said third devices are positive simultaneously; a single alternating cathode heater voltage supply source electrically connected in energizing relation to all of said cath-

ode heaters; means electrically connecting a portion of said cathode heater voltage source between the point of reference potential and the cathode of the first of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point as to increase the maximum potential difference between the anode and the cathode of said first stage; and means electrically connecting a portion of said cathode heater voltage source between the cathode and the control electrode of the third of said devices in such a phase relation with respect to the potential applied between the anode and cathode of said third device that the anode and the control electrode of said third device have the same polarity with respect to the cathode thereof.

5. In combination: a plurality of electronic discharge devices each having an anode, a cathode, and a control electrode; a plurality of sources of alternating voltage supplies; a reference point; circuit means connecting the anode of one of said discharge devices to the control electrode of the second of said discharge devices; a resistor; circuit means connecting said resistor between the control electrode and the cathode of said second of said discharge devices; circuit means connecting one of said voltage sources between said reference point and the cathode of said second of said discharge devices; a load circuit, comprising a third of said discharge devices having an anode, a cathode, and a control electrode, and a condenser and a resistor connected in parallel between the control electrode and the cathode of the third of said discharge devices; circuit means connecting the cathode of the third of said discharge devices to said reference point; and circuit means connecting a second of said voltage sources between the anode of said second of said discharge devices and said load circuit.

6. In combination: a plurality of electronic discharge devices each having an anode, a cathode, a control electrode, and a separate heater circuit for the cathode; a plurality of alternating voltage supply sources, one of said sources having two end terminals and a center tap thereon; a reference point; circuit means connecting said center tap to said reference point, the one of said end terminals to the cathode and the heater circuit of one of said discharge devices and to the heater circuit of the second and third of said discharge devices, and the other of said end terminals to the heater circuits of said discharge devices and the control electrode of said third discharge device; circuit means connecting a second of said voltage sources between said reference point and the cathode of said second discharge device; a circuit network comprising a condenser and resistor connected in a parallel relation; circuit means connecting said circuit network between said reference point and the control electrode of said third discharge device; and circuit means connecting a third of said voltage sources between the anode of the second of said discharge devices and said circuit network.

7. In combination: a plurality of electron discharge devices including a first and a second device each having an anode, a cathode and a separate cathode heater for heating said cathode; means electrically interconnecting said first and second devices, said means including a connection between each of said cathodes and a point of reference potential and further including a connection between the anode of said first device and the cathode of said second device; means applying a potential from a first alternating voltage source between the anode and cathode of said first device, said first source being electrically connected between the cathode of said second device and said point of reference potential; and means applying a potential of a larger magnitude than the potential from said first source from a second alternating voltage source between the anode and cathode of said second device, said second source being electrically connected between the anode of said second device and said point of reference potential such that said first and second sources are connected in series between the anode and cathode of said second device and the potentials from said first and second sources are in opposition to each other such that the anodes of said first and second devices are positive simultaneously and the potentials across the anode and cathode of each of said devices are substantially the same.

8. In combination: a plurality of electron discharge devices including a first and a second device each having an anode, a cathode and a separate cathode heater for heating said cathode; means electrically interconnecting said first and second devices, said means including a connection between each of said cathodes and a point of reference potential and further including a connection between the anode of said first device and the cathode of said second device; means applying a potential from a first alternating voltage source between the anode and cathode of said first device, said first source being electrically connected between the cathode of said second device and said point of reference potential; means applying a potential of a larger magnitude than the potential from said first source from a second alternating voltage source between the anode and cathode of said second device, said second source being electrically connected between the anode of said second device and said point of reference potential such that said first and second sources are connected in series between the anode and cathode of said second device and the potentials from said first and second sources are in opposition to each other such that the anodes of said first and second devices are positive simultaneously and the potentials across the anode and cathode of each of said devices are substantially the same; a single alternating cathode heater voltage supply source electrically connected in energizing relation to both of said cathode heaters; means electrically connecting a portion of said cathode heater voltage source between the control electrode and the cathode of the first of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anode and the control electrode vary in magnitude in the same polarity with respect to the cathode thereof; and means electrically connecting a portion of said cathode heater voltage source between the control electrode and the cathode of the second of said devices in such a phase relation with respect to the potential applied between the cathode of said second device and said reference point that the anode and the control electrode have the same polarity with respect to the cathode thereof.

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