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AMPLIFIER

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Fig. 1.

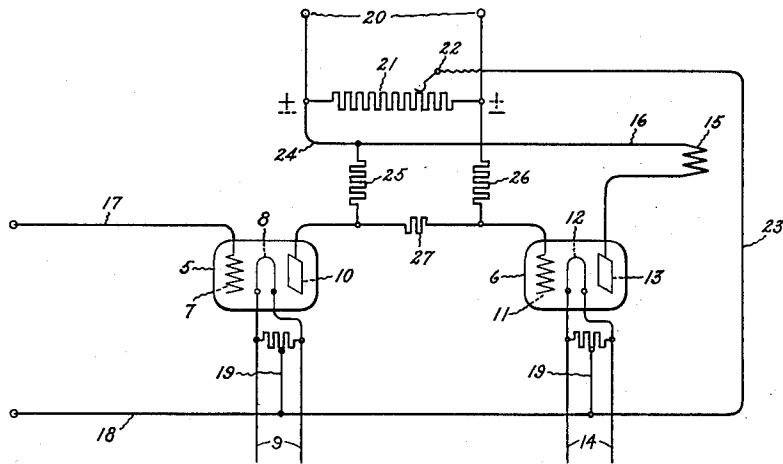
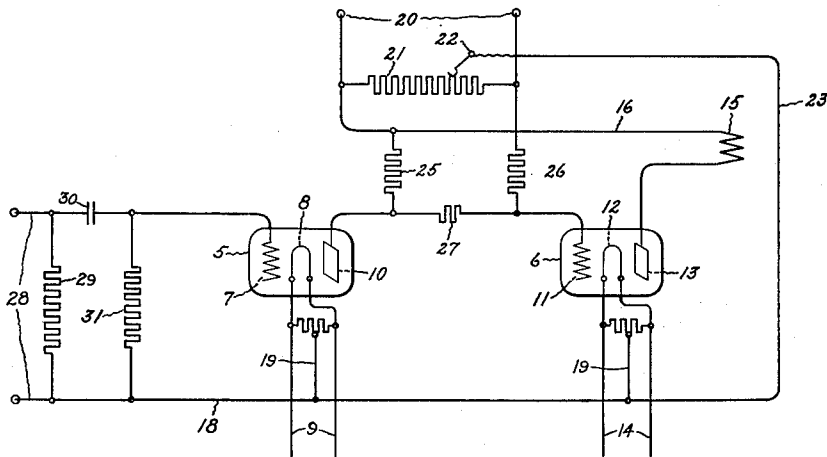


Fig. 2.



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UNITED STATES PATENT OFFICE

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AMPLIFIER

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The present invention relates to an amplifier embodying electric discharge devices, and has for its object to provide an improved and simplified amplifier which is adapted to receive its operating potentials directly from a source of unrectified alternating current for the operation of current responsive devices.

A practical application for an amplifier of this character is found in the operation of small relays and the like from weak control voltages or signals, where the use of batteries to supply operating potentials involves considerable attention or frequent replacement, and where the cost of a rectifying means for an alternating current supply is not justified.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a wiring diagram of an amplifier embodying the invention and adapted for direct current control; and Fig. 2 is a wiring diagram of the same amplifier adapted for alternating current control.

Referring to Fig. 1, 5 and 6 are electric discharge devices providing the initial and output stages of the amplifier and representing any suitable number of stages in an amplifier. These devices are shown by way of example as being of the usual 3-element hot cathode type although other types of such devices may be used. Tube 5 is preferably of the highmu type having a control grid 7, a cathode 8 heated from a suitable source of current such as alternating current supply leads 9, and an anode 10, while 6 is a suitable output tube having similar elements 11, 12 and 13 for which similar cathode heating supply leads 14 are provided. These tubes may be of any suitable type however, and may be operated from any suitable source of heating current.

The amplifier operates a relay or other suitable current responsive device 15 connected in the output or anode circuit 16 of tube 6. Direct current control voltage to be amplified for operating the relay is applied between the grid and filament of the initial or input tube 5 through control leads 17 and 18, representing any suitable control circuit,

lead 17 being connected with the grid of tube 5 and lead 18 being connected with the cathodes of both tubes through suitable leads 19 which in the present example are tapped into the electrical center of the cathode supply leads as indicated.

Raw or unrectified alternating current for supplying alternating operating voltages to the amplifier is supplied through alternating current terminals 20 between which is connected a resistance network including a potentiometer or resistor 21 having a contact 22 which is movable between the terminals of the potentiometer.

Contact 22 is connected through a cathode return lead 23 with leads 18 and 19 and the cathodes. Leads 18 and 23 together with leads 19 form a common anode and grid return lead or circuit for the amplifier.

The anode circuits of both tubes are connected with one terminal of the alternating current supply and one terminal of the potentiometer 21 through a lead 24, the anode circuit of tube 6 including the relay 15, and the anode circuit of tube 5 including an anode resistor 25. The other or opposite terminal of the alternating current supply and the remaining terminal of the potentiometer are connected through a grid resistor 26, with the grid of tube 6.

The high potential ends of the resistors 25 and 26, that is, the anode and grid ends of said resistors, are connected through a resistor 27 which also conductively connects anode 10 with grid 11. The closed loop resistance network thus completed, serves to connect the amplifier tubes in cascade and to supply operating voltages thereto, the arrangement being such that voltages amplified by tube 5 and established across anode resistor 25, are applied across grid bias resistor 26 and directly to grid 11 of the succeeding tube through the conductive coupling means provided by resistor 27.

If the resistor 27 were not provided and the grid 11 were connected directly to the plate of the preceding tube 5 the potential of the grid 11 would be as positive as the plate of tube 5 during part of each cycle. The resistor 27 thus keeps the grid of tube 6 mostly

in the negative range of grid potentials, since, if the grid were positive, the resulting current that it would draw from the filament could not leak off thru either 27 or 26. This arrangement of the resistors 25, 26 and 27 makes the voltage on the grid of tube 6 sensitive to small changes in plate current of tube 5.

When the alternating current terminals are positive and negative, as indicated in the drawing by the positive and negative signs in solid, it will be seen that the anodes will have a positive voltage applied to them, represented by the voltage across the potentiometer between the contact 22 and the positive terminal, while the grid of output tube 6 will have a negative potential represented by the voltage between contact 22 and the negative terminal applied to it. During each negative half cycle indicated by the positive and negative signs in dotted, no anode current will flow. The grid voltage applied between the sliding contact 22 and the connection of grid 11 with the potentiometer 21 may be varied by moving contact 22 along the potentiometer. The direct current control voltage applied to the input circuit represented by control leads 17 and 18 is amplified and will cause a variation in the anode current of the output tube to operate relay 15.

Viewed in another aspect, the resistance network including potentiometer 21 and resistors 25, 27 and 26 in the order named, provide a bridge circuit one arm of which is connected with the supply terminals and the opposite arm of which is connected at its ends with the anode and grid of two different amplifier devices. The amplifier having its grid so connected is the output device and this has its anode circuit connected between one end of the first named arm and a point intermediate its ends. The intermediate connection serves as a cathode connection for the amplifier devices.

The sensitivity of the amplifier may be made relatively high by the use of a highmu tube at 5. For example, it has been found that when operating an amplifier substantially as described with a highmu tube at 5, and a suitable output tube at 6, in connection with a relay where the applied alternating voltage across terminals 20 was in the neighborhood of 220 volts, with 7 megohm grid and anode circuit resistors 25 and 26, and with coupling resistor 27 of a value approximately 2 megohms, an amplification of approximately 15 could be obtained from grid to grid. This was with a setting on the potentiometer such that the anode voltage was substantially +30 while the negative grid voltage was substantially -30. The low anode voltage is due to the resistance at 25 and 26. However, different values of resistance may be used. With this arrangement a very small change in D. C. potential ap-

plied to grid 7 of tube 5 through the control circuit 17-18 produced a response in the output anode circuit sufficient to operate the relay.

It should be understood that the resistance, voltage and amplification values above given are only by way of example as representing one group of a plurality of suitable resistance and voltage values which depend upon the type of tubes employed, and the operating voltage which is available, as well as the amount of amplification which is required between the control circuit and the output or anode circuit in which the current responsive device is located.

Referring now to Fig. 2, the amplifier of Fig. 1 bearing the same reference numerals throughout, is shown in connection with an alternating current control circuit. The amplifier tubes 5 and 6 are connected in cascade by resistors 25, 26 and 27 and supplied with alternating operating potentials from terminals 20 through the potentiometer 21 for the operation of the relay 15 in the output or anode circuit of tube 6. The conductor 23-18-19 is the common cathode return circuit for the amplifier. An alternating current control circuit for the amplifier is represented by leads 28 and a resistor 29 connected between them, across which resistor an alternating voltage is developed by the current flowing through it from leads 28. The input circuit is connected at one terminal with the grid 7 of the input tube through a stopping condenser 30 while the remaining terminal is connected with the cathode circuit 18. The grid is connected with the cathode circuit 18 through a grid leak resistor 31.

With this arrangement the alternating voltage is applied through leads 28 to the resistor 29 and by means of the detector grid leak resistor 31 and condenser 30 to the input circuit of the tube 5. In all other respects the operation of this amplifier is the same as described in connection with the D. C. control amplifier of Fig. 1.

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

1. An alternating current amplifier including electric discharge devices, alternating current supply terminals, a resistance network including a potentiometer connected between said terminals, anode and grid resistors, connected between said devices and said potentiometer and a coupling resistor connected between said resistors, a cathode return circuit, and a contact movable between the terminals of the potentiometer and connected with the cathode return circuit.

2. An alternating current amplifier including electric discharge devices, alternating current supply terminals, and a closed loop resistance network including a potentiometer and coupling, anode, and grid resis-

tors connecting said devices in cascade and providing a voltage supply means therefor.

3. An alternating current amplifier including electric discharge devices provided
5 with grid and anode circuits, alternating current supply terminals, a resistance network interposed between said terminals and said devices and arranged to form a bridge circuit having four arms connected respectively
10 between said terminals, between the anode of one of said devices and the grid of another of said devices in the anode circuit of one of said devices, and in the grid circuit of another of said devices.

4. In an alternating current amplifier provided with electric discharge amplifier devices, the combination of alternating current supply terminals, a potentiometer connected
15 across said terminals, an anode circuit including an anode resistor connected with one of said supply terminals, a grid circuit including a grid resistor connected with the
20 other of said terminals, a cathode return circuit, and a contact movable between the terminals of the potentiometer connected with the cathode return circuit.

5. An alternating current amplifier including electric discharge devices, the combination of alternating current supply terminals, a potentiometer connected across said
25 terminals, a coupling resistor connected between the controlled and controlling elements of two of said devices, an anode circuit including an anode resistor, said resistor being connected at one end with one terminal
30 of said potentiometer and connected at its opposite end with said coupling resistor, a grid circuit including a grid resistor, said resistor being connected at one end with the
35 other of said terminals of the potentiometer, and connected at its opposite end with said coupling resistor, a cathode return circuit, and a contact movable between the terminals
40 of the potentiometer connected with the cathode return circuit.

6. An alternating current amplifier including electric discharge devices provided with grid and anode circuits alternating current supply terminals, a coupling resistor
45 connected between the anode circuit of one of said devices and the grid circuit of the other of said devices, an anode resistor connected between one of said terminals and one
50 terminal of said coupling resistor, a grid resistor connected between the other of said terminals and the remaining terminal of said coupling resistor, an output anode circuit connected with the first named alternating
55 current supply terminal, a current responsive device in said circuit, a potentiometer connected across said alternating current supply terminals, a cathode return lead, and
60 a contact movable between the terminals of

said potentiometer connected with said cathode return lead.

7. An alternating current amplifier including electric discharge amplifier devices, alternating current supply terminals, a coupling resistor, an anode resistor connected
70 between one of said terminals and one terminal of said coupling resistor, a grid resistor connected between the other of said terminals and the remaining terminal of said coupling
75 resistor, an output anode circuit connected with the first named alternating current supply terminal, a current responsive device in said circuit, a potentiometer connected across said alternating current supply terminals,
80 a cathode return lead, and a contact movable between the terminals of said potentiometer connected with said cathode return lead, an alternating current control circuit including a pair of control leads connected
85 with one of said electric discharge devices and means interposed in said connection for operating said device as a detector.

8. The combination with a pair of electric discharge devices each of which has an anode, a cathode and a control electrode, of a conductive resistance coupling means connecting
90 said devices in cascade, said means being provided with an anode voltage terminal and a grid voltage terminal, means for supplying an alternating voltage between said
95 terminals, an output anode circuit for one of said devices connected with said anode voltage terminal, a current responsive device in said circuit, a potentiometer connected between
100 said terminals, circuit means connecting the cathodes of said devices with said potentiometer at a point intermediate said terminals, means for applying an alternating
105 voltage to the grid of another of said devices, said means being connected between the grid and the cathode of said device and including a stopping condenser whereby said device
operates as a detector and a grid leak resistor interposed between said grid and said
110 cathode.

In witness whereof, I have hereunto set my hand this 19th day of February, 1929.

PAUL C. GARDINER.

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