Dec. 22, 1936. L. KÖRÖS ET AL 2,065,280

ARRANGEMENT FOR DERIVING CURRENTS

Filed May 10, 1934 3 Sheets-Sheet 1

Fig. 1

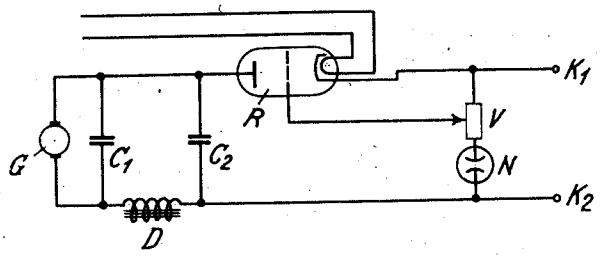


Fig. 2

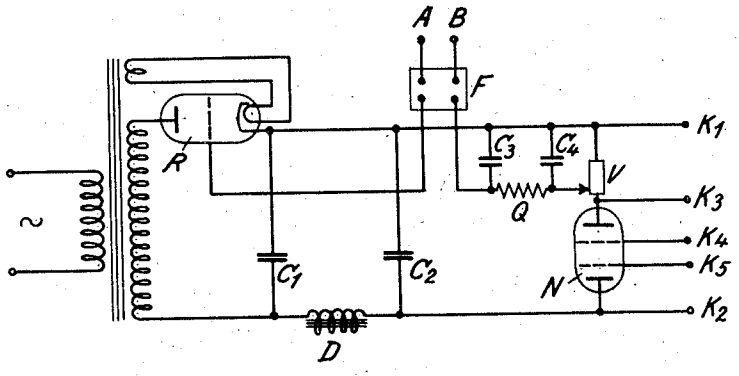
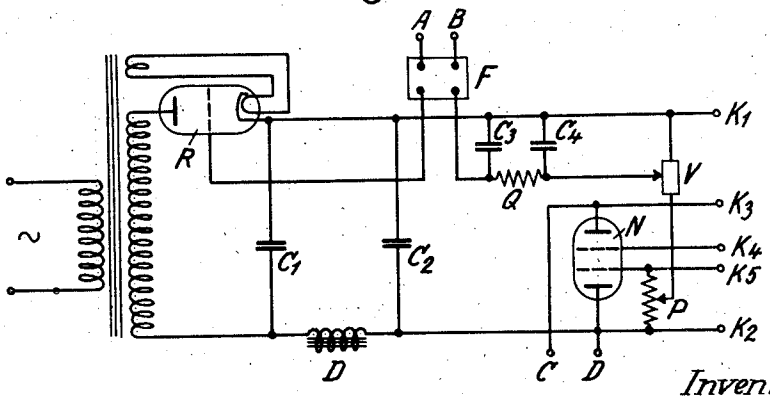


Fig. 3



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ARRANGEMENT FOR DERIVING CURRENTS

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Fig. 4

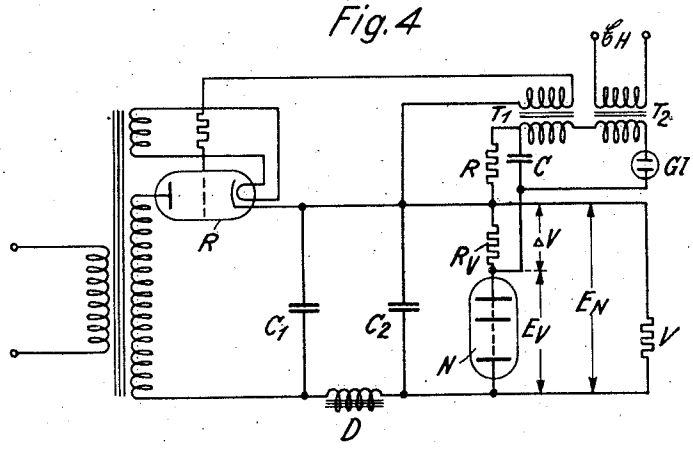
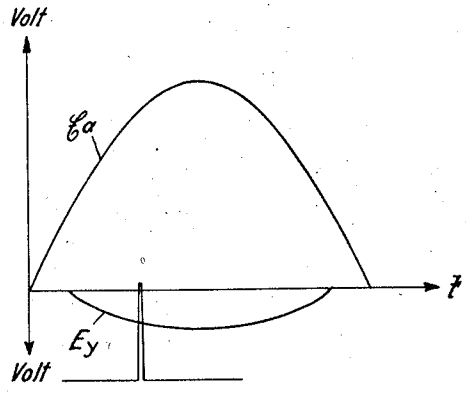


Fig. 5



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ARRANGEMENT FOR DERIVING CURRENTS

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Fig. 6.

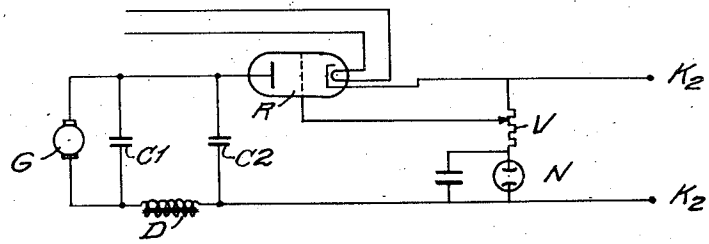


Fig. 7.

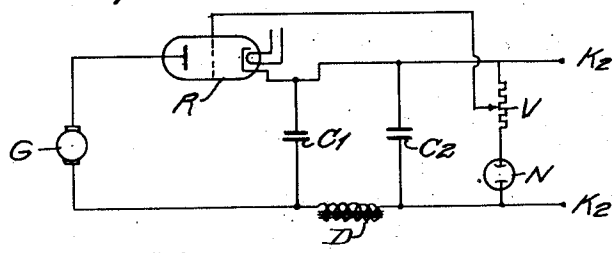


Fig. 8.

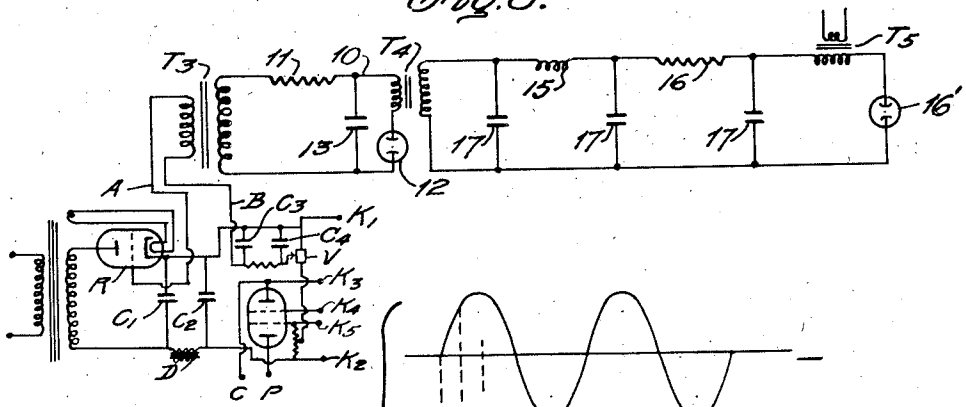


Fig. 10.

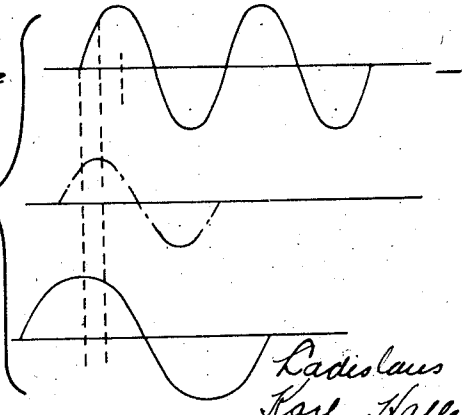
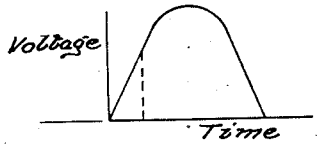


Fig. 9.



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2,065,280

ARRANGEMENT FOR DERIVING CURRENTS

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Application May 10, 1934, Serial No. 725,016
In Germany May 13, 1933

19 Claims. (Cl. 171—119)

This present invention relates to a circuit arrangement in which a controlled tube is inserted as a variable resistance between the current supply and the consumer's circuit. The controlled tube is intended to vary its resistance in conformity with the load and voltage variations imposed by the consumer's circuit. A discharge gap from which a voltage of comparison is derived is connected in parallel with the consumer's circuit. In the further development of this invention, however, another arrangement for the derivation of a voltage of comparison may be used instead of the said discharge gap.

In the case of direct current equipment it is useful to avail one's self of a high-vacuum tube having three or more electrodes; however, in the case of alternating current equipment, or respectively if it would be possible that the supply voltage could drop down to zero or below a certain limit (as for instance the operating voltage of the tube), the use of gas filled grid controlled tubes will be of advantage.

In view of obtaining inertialess regulation, the use of high-vacuum electron tubes is specially recommended. The use of such tubes is of advantage specially for the reason that these tubes permit, with a pure direct current, modulation of the current voltage as far down as zero, so that they can be connected between filter arrangements and the output for the consumer's circuit, whereby the time constant of the filtering device does not affect the regulation. In order to attain improvement in the possibility of modulation in gaseous discharge tubes, it is useful to superpose an auxiliary alternative voltage of known value. Also, according to the further development of the present invention, it is possible to use the tube as a rectifier at the same time, provided that it possesses sufficient puncture strength in the valved direction.

Fig. 1 annexed represents an embodiment of the present invention in the most simple case and in the case of its connection to a direct current supply network.

Fig. 2 is a wiring diagram of a second form of the invention.

Fig. 3 is a wiring diagram of a third form of the invention.

Fig. 4 is a wiring diagram of a fourth form of the invention.

Fig. 5 is a graph showing the relation between the input and output voltages in a device of this character.

Fig. 6 is a wiring diagram showing slight modification of the form shown in Fig. 1.

Fig. 7 is a wiring diagram showing a sixth form of the invention.

Fig. 8 is a wiring diagram showing a seventh form of the invention.

Fig. 9 is a graph showing the relation between voltage and time in the output from this invention.

Fig. 10 is a group of graphs showing the relationship between the voltages at various parts of the apparatus.

In Fig. 1, G is a direct current generator from which the voltage is derived through a filter arrangement C_1, C_2, D. In the lead to the consumer's circuit, connected to terminal K_1, tube R is inserted as a variable resistance in accordance with the invention. This tube, in the case under consideration, is separately heated. It is a grid controlled tube, the grid potential of which is derived from the series resistance V—forming a potentiometer—connected with discharge gap N. The consumer's circuit is then situated between K_1 and K_2. The discharge gap N, is not able to take up the whole consumer current. If stronger currents are derived from terminals K_1 and K_2, there will be a voltage drop at resistance V, due to the fact that owing to the physical properties of the discharge gap, the voltage at N will remain stable, and accordingly the grid of tube R will become less negative, i. e. a greater amount of current will pass through the plate circuit of the tube, or—in other words—the resistance in the power supply circuit has been reduced. However, if the current derived from points K_1 and K_2 becomes weaker, there will be a reverse action, and the flow of current will be reduced by the increased resistance of tube R.

If discharge gap N, for higher frequencies, possesses a higher internal resistance, it will be useful—if one wishes to derive a stable current—to connect in parallel a condenser of such a size that the resistance resulting has the desired value. If one inserts tube R before the choke arrangement C_1, C_2, D, the effect of the grid voltage influence is delayed by the time constant of the choke arrangement, i. e. it will not be inertialess.

It is a matter of course that the regulating action has nothing to do by itself with the kind of power supply used, and that, in the place of the direct current generator, as per Fig. 1, an alternating current battery eliminator, as shown in Figs. 2 and 3 may be used. In such a case it will be useful, in accordance with the description given later, and as will be seen in Figs. 2 and 3, to unite the necessary rectifier tube with the

regulating tube, which is, however, not absolutely necessary.

The corresponding switching elements in Figs. 2 and 3 have the same reference characters. It is assumed that not only one but a variety of consumer circuit voltages are to be derived (terminals K_3, K_4, K_5), the voltage being subdivided with the aid of the well known glow gap voltage divider. An auxiliary alternating current voltage is led, as mentioned above, to terminals A and B, which will be arranged with advantage to pass through a phase shifter F. The filtering device C_3, C_4, Q renders impossible the flow through the consumer's circuit of the auxiliary alternating current. The auxiliary alternating current voltage can also be derived from the network itself. The regulating action by itself will be eventually affected by the variation of the auxiliary voltage; however, by selecting suitable values it can be attained that the variations of the alternating current auxiliary voltage will not give rise to disturbing voltage variations at the output terminals.

The circuit arrangement shown in Fig. 3 is essentially identical with the one shown in Fig. 2. In the arrangement as in Figure 3, however, the exciter current for discharge tube N is supplied to terminals C and D from a foreign power supply. This is possible as discharge gap N has—first of all—to supply a stable voltage of comparison. Potentiometer P is connected in parallel to leads K_2, K_5; the suitable voltage is derived from that potentiometer.

In the further development of the invention represented by Fig. 4, the varying direct current voltage (voltage difference between rectifier and direct current voltage) is not led directly to the discharge gap, but a "Kipp" arrangement is to be supplied from it, which affects in its turn the tube controlled. The insertion of such a "Kipp"-arrangement offers essentially the feature of an improvement in the adjustment of the phase of the voltage controlling the grid controlled tube. Similar arrangements can be used wherever voltage variations are to be converted into phase variations.

A practical example of circuit arrangement for carrying out the idea of the present invention is shown in Fig. 4. The direct current power supply and the variable resistance inserted in the leads to the consumer's circuit are combined in the form of a grid controlled rectifier. It is possible, of course, as stated in the foregoing in reference to the forms shown in Figs. 1–3, to separate the power supply from the variable resistance. The direct current voltage is first led into a filtering device consisting of choke D and two condensers C_1, and C_2. A series connected circuit consisting of a glow gap voltage divider N and a series resistance R_V is connected in parallel with the filtering device. Another supply of voltage of comparison may be inserted instead of glow gap voltage divider N. When the useful voltage EN varies, the series resistance R_V counterbalances the total difference in voltage ΔV. However, the voltage on the glow gap voltage divider N remains stable due to the physical properties of the latter, the consequence being that the voltage variation on the series resistance R_V, in relation to its medium value, is of a very high percentage rate. The "Kipp"-generator, represented in the figure referred to above by the capacitive resistance link C_3 and R_3 and the glow discharge lamp Gl, is fed with the voltage differences derived from series resistance R_V in such a manner that due to its Kipp-oscillations, with varying useful voltage EN, accelerated or delayed ignition in conformity with these voltage changes is initiated. In the glow discharge lamp circuit the transformers T_1 and T_2 are inserted. The control voltage is fed to the grid of the rectifier through the impulse-transformer T_1. The control impulse generated in the Kipp device referred to above is of exceedingly short duration, and under certain circumstances its magnitude attains a multiple value of the minimum voltage necessary to initiate the sparking procedure proper; whereby, as will be found from Fig. 5, a very sharp cut with the sparking characteristic (E_a/E_g—characteristic=plate potential voltage in function of grid potential) is attained, so that the initiation of ignition is absolutely secured. The frequency necessary for the sparking voltage impulse, being in a constant relation to the power supply frequency, in addition to suitably chosen resistance and capacity, is attained by a supplementary synchronizing equipment. This synchronization, in the device described, is for instance attained by feeding an auxiliary alternating current voltage E, derived from the main transformer through a transformer T, into the glow discharge lamp circuit. With the help of such a "Kipp" relay the initiation of the ignition of the rectifier can be varied over a wide range of timing; however, by inserting a further phase shifting device, this range of timing can still be enlarged if necessary. This additional phase shifting device can for instance be formed by a second "Kipp"-relay connected in cascade circuit with the first one; the Kipp oscillation of the first Kipp relay is then fed into the second Kipp relay as synchronizing frequency. The phase shifting devices can for instance consist of bridges formed by variable or non-ohmic resistances or respectively electron valves controlled by the voltage variation on resistance R_V.

In Fig. 6 the construction is like that of Fig. 1, except that a condenser C^3 is bridged around the spark gap N.

In Fig. 7 the construction is also like that of Fig. 1 except that the tube R is arranged on the generator side of the filtering arrangement instead of being, as in Fig. 1, on the discharge gap side of the filtering arrangement.

In Figure 8 is shown an arrangement of the invention in accordance with such a cascade device, the main current being substantially identical with the arrangement of Figure 2 except that the terminals A and B are connected to the primary winding of a step-up transformer T_3 having its secondary forming part of a circuit **10** including in series a resistance **11**, the primary winding of a second transformer T_4 and a discharge gap **12**, a condenser **13** being bridged across this circuit. The secondary winding of the transformer T_4 is connected in series with an inductance **15**, the primary winding of a third transformer T_5 and a discharge gap **16'**. Condensers **17** are suitably connected across this last circuit and auxiliary terminals A_1 and B_1 are connected to the secondary winding of the transformer T_5. Thus the output from the terminals A and B is stepped up in voltage by the "cascade" arrangement shown. Figures 9 and 10 illustrate the relation between time and voltage in circuits of the kind set forth, the measurements on a vertical coordinate indicating voltage and the measurements along a horizontal coordinate indicating time.

In addition to the automatic regulation described above, this regulating principle can eventually be used at the same time for the regulation within a certain range in the way prescribed from hand or in dependence from any other action of the useful direct current voltage EN without having an output loss, by forming a potentiometer of series resistance Rv. The value of the voltage derived each time from this potentiometer determines the phase situation of the rectifier alternating current voltage in relation to the control voltage supplied from the Kipp relay, and thereby affects directly the magnitude of the direct current voltage supplied from the equipment.

What we claim is:

1. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

2. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

3. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element deriving current from a source other than the first mentioned source of current, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

4. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element deriving current from a source other than the first mentioned source of current, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

5. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element and being of the gas filled type, means to supply current to the heater element, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

6. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element and being of the gas filled type, means to supply current to the heater element, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection.

7. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection, and

a secondary power supply interspersed in the last mentioned connection.

8. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact movable over said resistor and forming a terminal for the last mentioned connection, and other current supply means connected to the terminals of said discharge gap.

9. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said grid control means including a discharge gap and a Kipp circuit connection between said grid and one terminal of the discharge gap.

10. A regulating circuit for direct currents, said circuit having an input and an output tending to vary from normal in accordance with the potential difference between the output and input, said circuit including a variable resistance tube, means for supplying a constant potential, and means to regulate the resistance of the tube in conformity with variations from normal of the potential difference between the first means and the output.

11. The circuit of claim 10 characterized by having the variable resistance tube constitute also a rectifier tube.

12. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

13. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

14. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element deriving current from a source other than the first mentioned source of current, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

15. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element deriving current from the first mentioned source of current, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

16. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element and being of the gas filled type, means to supply current to the heater element, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

17. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, said tube having a heater element and being of the gas filled type, means to supply current to the heater element, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-

put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, and a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection.

18. A voltage regulating device including a transformer having a primary winding connected to a source of alternating current and a secondary winding having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminal of the source of current, control means for said grid bridged between the last two connections, a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection, and a secondary power supply interspersed in the last mentioned connection.

19. A voltage regulating device including a source of current having a pair of terminals, a tube including electrodes and a grid, a conductive connection between one of said terminals and one of said electrodes, a connection leading from the other electrode, out-put means for the device connected at one side to the last mentioned connection, a connection leading from the remaining terminals of the source of current, control means for said grid bridged between the last two connections, a conductive connection between said grid and the controlling means, said controlling means including a discharge gap and a resistor in series with the discharge gap and a contact in series with said resistor and forming a terminal for the last mentioned connection, and other current supply means connected to the terminals of said discharge gap.

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