July 8, 1941. W. D. COCKRELL 2,248,611

CONTROL APPARATUS FOR VAPOR ELECTRIC DISCHARGE DEVICES

Filed Aug. 28, 1940

Fig. 1.

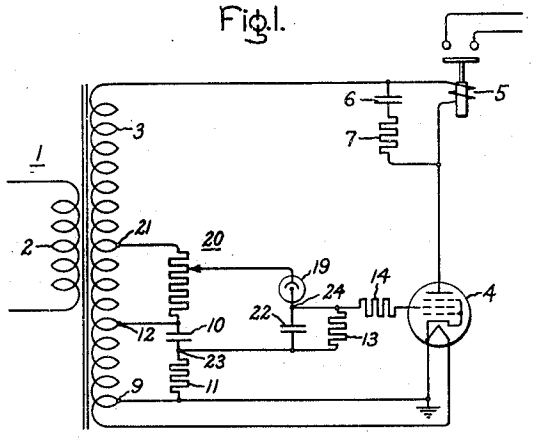
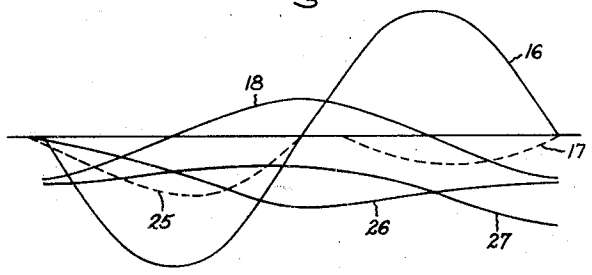


Fig. 2.



Inventor:
William D. Cockrell,
by Harry E. Dunham
His Attorney.

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CONTROL APPARATUS FOR VAPOR ELECTRIC DISCHARGE DEVICES

William D. Cockrell, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

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4 Claims. (Cl. 250—41.5)

My invention relates to control apparatus for vapor electric discharge devices operated on alternating current and in response to the output of photoelectric devices. My present invention is a further development of that disclosed in my Patent No. 1,947,189, February 13, 1934, and it has for its object the provision of improved apparatus for that purpose characterized by greater simplicity, improved operation and greater reliability.

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

Referring to the drawing, Fig. 1 is a circuit diagram illustrating one embodiment of my invention and Fig. 2 is a diagram illustrating the characteristics of the apparatus shown in Fig. 1.

In Fig. 1, the transformer 1 has the primary winding 2 which may be connected with a suitable source of alternating current supply, such for example as a 115 volt, 60 cycle lighting circuit. The secondary of the transformer comprises the single winding 3 which may produce a total voltage of approximately 146 volts between its ends. At 4 is shown a vapor electric discharge device of a recently developed type making use of the shield grid principle, such a device being disclosed and claimed in Livingston Patent 2,044,618. The anode of the device 4 is shown connected with the upper end of the secondary winding 3 through the winding of the relay 5, the winding being shunted by the usual capacitor 6 which preferably is of the electrolytic type. In series with this capacitor I employ the resistor 7 to prevent oscillation or polarity reversal in the capacitor. The cathode of the device 4, which is indirectly heated, connects with the tap 9 on the winding 3 near the lower end thereof and the cathode heater connects at one end with the cathode and at the other end with the lower end of the secondary winding, the voltage between that end and the tap 9 being approximately 6 volts.

The vapor electric device 4 being of the shield grid type, as mentioned above, is operative with a grid circuit having a large impedance, for example 10 megohms, hence the device 4 is especially well adapted to be controlled directly by a high resistance photoelectric device such as a photoelectric tube without the use of an intermediate amplifier.

In the present arrangement the grid of the device 4 has applied to it two voltages. One of these voltages is obtained from a bridge circuit including the capacitor 10 which may have a capacitance of .02 m. f. in series with the resistor 11 which may have a resistance of 7500 ohms, the circuit being connected between the taps 9 and 12 on the secondary winding 3 between which taps there may be a voltage of approximately 30 volts. The voltage drop across the resistor 11 is supplied to the grid through the resistor 13 whose resistance may be 5 megohms and the resistor 14 whose resistance may be 3 megohms. Inasmuch as the current in the resistor 11 is the reactive current of the capacitor 10 the voltage wave applied to the grid from this source is substantially 90° in advance of the voltage wave applied to the anode-cathode circuit.

Referring now to Fig. 2, the voltage wave applied by the transformer to the anode-cathode circuit is represented at 16, the tripping voltage of the device 4 being represented by the dotted line 17. In this figure, the voltage wave applied to the grid from across the resistor 11 is represented at 18. It will be seen from Fig. 2 that were the voltage wave 18 the only voltage applied to the grid the device 4 would continuously pass current.

The other voltage applied to the grid is obtained from the secondary winding 3 through another branch circuit controlled by the rectifying photoelectric device 19 such as a photoelectric tube. The cathode of this device connects with the adjustable arm of the potentiometer 20 whose ends connect with the winding 3 at the taps 21 and 12, the voltage between said taps being approximately 30 volts. The anode of the device 19 connects through the capacitor 22 which may have a capacitance of .003 m. f. with the junction 23 of the capacitor 10 and resistor 11. The grid connects through the resistor 14 with the junction 24 of the device 19 and the capacitor 22, hence the resistor 13 shunts the capacitor 22 and thereby serves as a discharge path through which the charges on the capacitor 22 may equalize. Inasmuch as the photoelectric device 19 has its anode and cathode arranged in the manner shown and described and is rectifying, it will be seen that the capacitor 22 receives charges only during the negative half cycles of voltage supplied by the transformer, that is, during those half cycles at which the discharge device 4 will not conduct, the current in the circuit of 19 and 22 being shown by the dotted line 25. The voltage applied to the grid of the device 4 by reason of the charges given to the capacitor 22 is represented by the curve 26 in Fig. 2, this curve repre-

senting the form of the voltage wave which would be applied to the grid from capacitor 22 during the first half cycle of operation since the curve is shown starting from zero at the beginning of the negative half cycle of the curve 16. After a few half cycles the curve 26 will start at some small residual negative value.

From the above description it will be seen that when the photoelectric device is subjected to light the charge on the grid of the discharge device 4 will be that due to the combined effect of the biasing voltage obtained from across the resistor 11 and as shown by the curve 18 and the voltage obtained from across the capacitor 22 shown by the curve 26. The combined or net voltage wave impressed upon the grid is represented by the curve 27. Since this curve during each positive half cycle of anode voltage is negative to the tripping voltage of the device 4 the device will not fire. If, however, the intensity of the light affecting the photoelectric device is decreased the voltage wave 26 accordingly becomes less negative while the wave 18 remains the same so that at a certain reduced value of light the resultant curve 27 will intersect the tripping curve 17 and cause the device to fire during each positive half cycle, the shape of the curve 27 being such as to cause the firing of the device to occur early in each positive half cycle or in the first quarter of each cycle.

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

1. In combination, a transformer having a secondary winding, a grid controlled vapor electric discharge device having its anode-cathode circuit connected to be energized by a part of said winding, means connected to be energized by a part of said winding common to said first mentioned part for supplying a grid bias wave approximately 90° in advance of the voltage wave of the anode-cathode circuit, a capacitor for supplying a negative bias to said grid during the current conducting half cycles of said anode-cathode circuit and a rectifying photoelectric device connected in series with said capacitor to control the supply of energy thereto from a part of said winding.

2. In combination, a transformer having a secondary winding, a grid controlled vapor electric discharge device having its anode-cathode circuit connected to be energized by a part of said winding, a capacitor and a resistor connected in series across a part of said winding common to said first mentioned part, a rectifying photoelectric device and a second capacitor connected in series across a part of said winding common to said first mentioned part, and means for applying to said grid the voltage across said resistor combined with the voltage across said second capacitor.

3. In combination, a transformer having a secondary winding, a grid controlled vapor electric discharge device having its anode and its cathode connected with spaced points on said winding and operative to pass current during the positive half cycles, a load device in said anode connection, a capacitor and a resistor connected in series between an intermediate point of said winding and the point of the cathode connection therewith, a rectifying photoelectric device and a second capacitor connected in series between an adjustable intermediate point of said winding and the junction of said resistor and the first mentioned capacitor, said device being arranged to pass current during the negative half cycles, and means for applying to said grid the combined voltage across said resistor and across said second capacitor.

4. In combination, a transformer having a secondary winding, a grid controlled vapor electric discharge device having its anode connected with said winding at one end thereof and its cathode connected with said winding at a point near the opposite end thereof, a heater for said cathode connected between said point and said opposite end, a relay having its coil in said anode connection, a capacitor and a resistor connected in series across said coil, a second capacitor and a second resistor connected in series, the free terminal of said second capacitor being connected with an intermediate point of said winding and the free terminal of said second resistor being connected with said point of cathode connection, a potentiometer having its ends connected with spaced intermediate points of said winding, a photoelectric tube and a third capacitor connected in series between the arm of said potentiometer and the junction of said second resistor and said second capacitor, said tube having its cathode connected with said arm, a third resistor bridging said third capacitor, and a fourth resistor connecting said grid with the junction of said tube and said third capacitor.

WILLIAM D. COCKRELL.