

Aug. 22, 1939.

M. A. EDWARDS
ELECTRIC DISCHARGE APPARATUS

2,170,448

Filed March 22, 1938

Fig. 1.

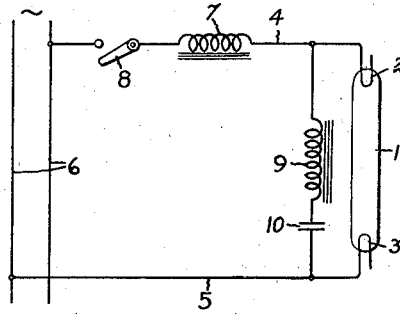


Fig. 2.

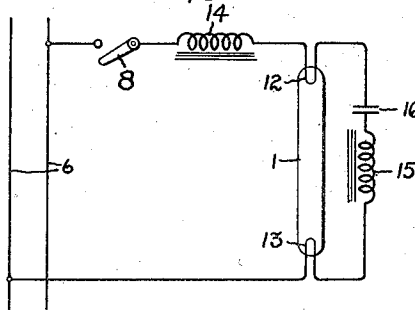
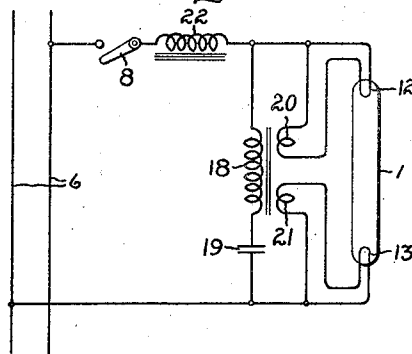


Fig. 3.



Inventor:
Martin A. Edwards,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,170,448

ELECTRIC DISCHARGE APPARATUS

Martin A. Edwards, Schenectady, N. Y., assignor
to General Electric Company, a corporation of
New York

Application March 22, 1938, Serial No. 197,528

5 Claims. (Cl. 176-124)

My invention relates to gaseous electric discharge devices and apparatus for operating the same from alternating current circuits. It relates particularly to electric discharge devices which require the application of a higher voltage for starting them than for the subsequent operation thereof. Certain forms of apparatus of this character which have been constructed heretofore and which have included capacitors for obtaining the required higher starting voltage have not been entirely satisfactory for various reasons; the cathodes of the devices often have been damaged by the high current peaks produced by the capacitors employed, and the apparatus has not had as good operating characteristics as desired.

One object of my invention is the provision of improved apparatus of the above mentioned character which employs simple means including capacitors by which the desired starting voltage may be obtained without danger of damage to the cathodes. Another object is the provision of improved apparatus of this character which will operate with high efficiency and good stability, which will not be critical to reasonable variations in line voltage and whose construction will be simple and inexpensive to manufacture.

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 in which an electric discharge device is employed having non-thermionic electrodes and Figs. 2 and 3 are circuit diagrams showing modifications in which the discharge device is provided with thermionic electrodes.

While my invention is applicable to apparatus employing various forms of electric gas discharge devices it is of particular interest and has been especially developed for use in connection with low pressure discharge devices which are employed to give light. A preferred form of such device is a lamp of the positive column type comprising a tubular envelope having electrodes at its ends and containing a gaseous atmosphere such as a few millimeters of a rare gas, for example argon, and a small quantity of a vaporizable metal, such as mercury. Preferably the envelope is coated internally with a suitable fluorescent material in order that the electric discharge, which in itself may be scarcely visible, shall produce the desired high degree of illumination. The coating may also contain a suitable material to cause the lamp to continue to give light during the intervals of current reversal therein. In the description to follow therefore I shall refer to the discharge devices as lamps. It is well known that to start a discharge in such a

lamp by the application of a voltage to its electrodes a higher voltage must be employed than that required to maintain the discharge after it has been started.

In Fig. 1, I have shown the electric discharge device or lamp at 1, the same being provided at its ends with the thermionic electrodes 2 and 3 which are heated by the discharge which takes place between them rather than being previously heated to an electron emitting temperature as, for example, by passing a current through them. Before starting, the lamp has a high resistance and may require a voltage considerably higher than that of the circuit from which it is supplied to start a discharge therein. A lamp, for example, that is adapted to operate on a 115 volt circuit may require the application of approximately 300 volts between its electrodes to cause it to start. After it has started, however, the arc drop will be approximately only 65 volts but a voltage somewhat greater than that is required to maintain the discharge. This required voltage has been found to be of the order of the

$$\sqrt{2}$$

times the voltage of the arc drop. In the circuits now to be described the difference between the voltage of the source of supply and the arc drop voltage is absorbed by the ballast employed.

As shown by Fig. 1 the lamp is connected through the connections 4 and 5 with source of supply 6 of alternating current which, for example, may be a 60 cycle, 115 volt lighting circuit. These connections include the ballast reactor or choke coil 7 which, for example, may have an inductance of 1.1 henries and the switch 8. Connected across the lamp is a shunt circuit comprising a second reactor or choke coil shown at 9 which, for example, may have an inductance of 1.1 henries in series with the capacitor 10 which, for example, may have a capacitance of 3 mfd.

When the switch 8 is closed to energize the lamp the reactors 7 and 9 and the capacitor 10 constitute a circuit which is in a condition of partial resonance, that is, the inductance and the capacitance of the circuit are not such that the circuit is tuned or in exact resonance at the frequency of the source of supply but rather is only partly tuned or, in other words, is operated off the resonance peak. As a result of that condition the voltage across the reactor 9 and capacitor 10 and hence the voltage applied to the lamp is raised considerably above that of the supply circuit and is sufficient to cause a discharge to start in the lamp. As soon as the discharge starts, however, the lamp substantially short circuits the shunt circuit comprising the reactor 9 and capacitor 10 inasmuch as the impedance offered by the lamp is materially below that of the shunt

circuit. The lamp continues to operate therefore on the circuit comprising substantially only the reactor 7. Since the ballast is that provided by the reactor 7, the apparatus draws a lagging current from the supply circuit.

I have found that when a capacitor is employed in the circuit with such a lamp the high current peaks due to the capacitor often seriously injure the cathodes of the lamp if the lamp is allowed to continue in circuit therewith for any appreciable length of time. In the circuit which I have devised and have just described the current peaks arising from the action of the capacitor in the shunt circuit during the starting of the lamp are dissipated and smoothed out to such an extent by the reactor 9 that no harmful results are apparent in the electrodes of the lamp.

In the modified form of my invention illustrated by Fig. 2, the electrodes 12 and 13 are initially heated to an electron emitting temperature by passing a current through them. In this case also I employ in series with the lamp a reactor 14 whose inductance for example may be 1.1 henries and the controlling switch 8. Connected across the lamp is the shunt circuit comprising the reactor 15 whose inductance for example may be 1.1 henries and the capacitor 16 whose capacitance may for example be 3 mfd. In this case the shunt circuit is arranged in series with the electrodes 12 and 13 whereby before the lamp starts the current that passes the shunt circuit also traverses the two electrodes and heats them.

When the switch 8 is closed for energizing the lamp the two reactors and the capacitor together with the electrodes 12 and 13 form a circuit in partial resonance as in Fig. 1 whereby the electrodes are heated by the current which is approximately two times the normal lamp current and at the same time a sufficiently high voltage is obtained between the electrodes to cause a discharge to start in the lamp. It having started, the shunt circuit including the elements 15 and 16 is substantially short circuited by the lamp and the electrodes are kept hot chiefly by the cathode spot formed thereon. Thereafter the lamp operates with inductive ballast and the electrodes are protected by the reactor 15 from current peaks originating in the capacitor.

That form of my invention illustrated by Fig. 3 also has its electrodes 12 and 13 heated by current flow therethrough being similar to that shown in Fig. 1 except that instead of the reactor 15 I employ a split core transformer, that is a transformer having an air gap in its magnetic circuit. The primary 18 of this transformer together with the capacitor 19 whose capacitance may be, for example, 2 mfd. are arranged to shunt the lamp. The transformer has the two secondaries 20 and 21 which are connected to supply heating current to the lamp electrodes 12 and 13 respectively. In this case the series reactor 22 may have an inductance of .9 henry and the primary 18 may have an inductance of 1.7 henries. As in the forms of my invention previously described the primary 18, the capacitor 19 and the reactor 22 form a circuit in partial resonance before the discharge starts whereby the electrodes are heated, in this case by the current induced in the windings 20 and 21, and a sufficiently high voltage is supplied to the lamp to start the discharge therein. During the subsequent operation of the lamp the voltage across the shunt circuit comprising the primary 18 and capacitor 19 is insufficient to produce any appreciable heating current in the two secondary wind-

ings but the lamp electrodes are maintained at an electron emitting heat by the cathode spot formed therein.

While in Fig. 1 I have not shown any means for initially heating the electrodes, it will be understood that its electrodes may be heated if desired at starting by supplying current thereto from any suitable source. Moreover the lamp of Figs. 2 and 3 may be provided with a well known form of indirectly heated electrode in which case the members 12 and 13 would constitute the heaters therefor, the electrodes and the heaters being electrically connected together.

I have chosen the particular embodiments described above as illustrative of my invention and it will be apparent that various other modifications may be made without departing from the spirit and scope of my invention which modifications I am to cover by the appended claims.

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

1. In combination, a source of alternating current supply, an electric discharge device provided with thermionic electrodes and connected to be supplied therefrom, a ballast reactor in said connection and a capacitor and reactor arranged in series between said electrodes whereby a starting voltage is applied thereto and the electrodes are heated by the current traversing said capacitor.

2. In combination, a source of alternating current supply, an electric discharge device provided with thermionic electrodes and connected to be supplied therefrom, a ballast reactor in said connection and a capacitor and reactor connected between and in series with said electrodes, said capacitor, reactors and electrodes forming a circuit in partial resonance before a discharge starts in the device whereby a starting voltage is supplied to the device and the current in said circuit is supplied to heat the electrodes.

3. In combination, a source of alternating current supply, an electric discharge device provided with thermionic electrodes and connected to be supplied therefrom, a ballast reactor in said connection, a transformer having a primary and a plurality of secondaries, a capacitor and said primary connected in series across said device and connections for supplying heating current from said secondaries to said electrodes.

4. In combination, a source of alternating current supply, an electric discharge device provided with thermionic electrodes and connected to be supplied therefrom, a ballast reactor in said connection, a transformer having a primary and a plurality of secondaries, a capacitor, means connecting said primary and said capacitor in series across said device, said capacitor and reactors form a circuit in partial resonance whereby a starting voltage is supplied to said device and means connecting said secondaries with electrodes for supplying heating current thereto.

5. In combination, a source of alternating current supply, a circuit connected to be supplied therefrom including a ballast reactor, a capacitor and a second reactor arranged in series and an electric discharge device arranged in shunt relation to said capacitor and second reactor, the inductive reactance in said circuit being materially greater than the capacitive reactance therein whereby a condition of resonance does not occur and excessive current flow in the circuit is avoided.

MARTIN A. EDWARDS.