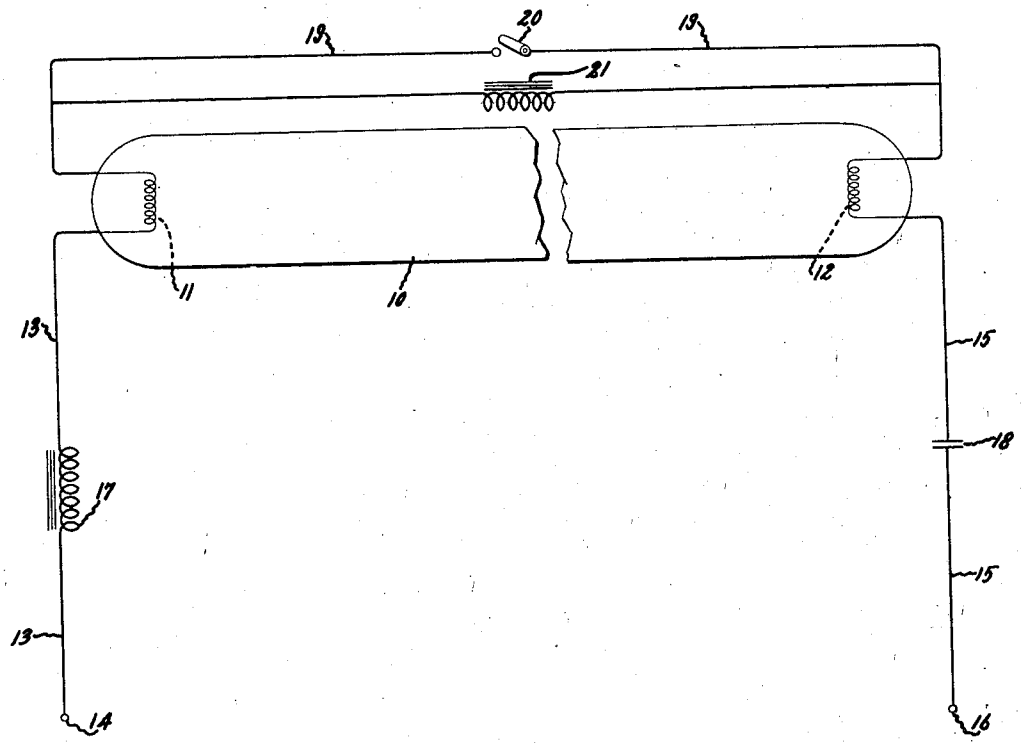
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CIRCUIT FOR ELECTRIC DISCHARGE DEVICES

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CIRCUIT FOR ELECTRIC DISCHARGE DEVICES

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My invention relates to gaseous electric discharge devices generally, and more particularly to starting and operating circuits for such devices.

It has been proposed heretofore to provide a gaseous electric discharge tube at each end with an incandescent electrode and to connect one of the lead wires of each electrode to one of the terminals of a source of alternating current; to insert a choke coil in the circuit; and to interconnect the other lead wires of the electrodes through a switch. To start the lamp, the switch is temporarily closed so that the discharge path is short-circuited and the electrodes are connected directly to the source of current and are heated thereby. When the electrodes are heated sufficiently, the switch is opened to initiate a discharge between the electrodes, the ignition being facilitated by the voltage impulse produced in the choke coil upon opening of the switch.

It has also been proposed to provide a circuit comprising an inductance and capacitance in series with a gaseous discharge tube to minimize the effect of voltage changes in the current supply source on the lamp. However, in this case there is no short-circuiting connection of the electrodes through a switch as employed in the above-mentioned circuit.

According to the present invention, an improved circuit having many advantages is provided by employing an inductance and a capacitance in series with the discharge tube, and also a short-circuiting switch member across the electrodes, which switch member is opened to start the lamp into operation after a preliminary heating of the electrodes. Such a circuit provides certain starting due both to the heating of the electrodes and to the high energy stored in the semi-resonant inductance-capacitance circuit. Moreover, stable operation is possible with high power factor and with lamp voltages approaching or equal to line or source voltages because the semi-resonant circuit furnishes the required voltage for restarting the arc each half cycle. Further advantages are: leading power factor, relatively constant current for wide changes in line or lamp voltage, low blink-out voltage, and the ability to start and maintain longer arc gaps than with the simple hot-starting reactor circuits. Further features and advantages of my invention will appear from the following detailed description of species thereof.

The drawing is a wiring diagram showing an embodiment of the invention.

Referring to the drawing, the lamp comprises an elongated tubular glass container or envelope 10 containing a gaseous atmosphere such as rare gas, like argon or neon, or a metal vapor such as mercury, or mixtures of rare gases and metal vapors. The envelope may contain, for example, a filling of argon at a pressure of the order of 1–10 mm. (preferably about 4 mm.) and a small quantity of mercury. The lamp may have associated therewith a luminescent material, such as zinc silicate, calcium tungsten, cadmium borate or the like, or mixtures thereof, preferably applied as a coating on the interior surface of the lamp envelope.

During operation, the lamp exhibits a positive column discharge and it has two incandescent electrodes 11, 12 each consisting, preferably, of a coil or coiled-coil of tungsten wire coated with a material having strong electron-emitting properties, such as alkaline earth oxides, like barium or strontium oxides or mixtures thereof. One end of the electrode 11 is connected by a conductor 13 to one terminal 14 of a source of alternating current, such as an ordinary commercial 115-volt 60 cycle line. One end of electrode 12 is connected by a conductor 15 to the other terminal 16 of the current source. An inductance (choke coil) 17 and a capacitance 18 are connected in series with the lamp. In this instance, the inductance 17 is shown interconnected in the conductor 13 and the capacitance 18 in the conductor 15, but it will of course be understood that both the inductance and the capacitance may be interposed in one of the said conductors. The other ends of the electrodes 11—12 are interconnected by a conductor 19 through a switch 20 and by the second inductance or choke coil 21.

To start the lamp into operation, the switch 20 is temporarily closed to short-circuit the arc gap and connect the electrodes 11, 12, inductance 17 and capacitance 18 in series with the terminals 14, 16 of the current source. The electrodes are quickly heated to an electron-emitting discharge-supporting temperature and a high amount of energy is stored in the semi-resonant inductance-capacitance circuit, so that upon opening of the switch 20 after a brief interval, a discharge is initiated with certainty between the electrodes 11, 12. In the further operation of the circuit, the said electrodes 11, 12, which act alternately as anode and cathode, are maintained by the discharge current at the required temperature. The inductance 17 and capacitance 18 serve as the ballast during operation of the lamp.

The following set of values for particular cases are given as an illustration: a low pressure 15 watt fluorescent lamp with an envelope eighteen

inches long and one inch in diameter containing argon at 4 mm. Hg pressure and a small amount of mercury may be started and operated from a 115-volt 60 cycle alternating current line using 3.75 mfd. capacitance and .82 henry inductance, choke coil 17, in series. In another illustration, a fluorescent lamp with an envelope thirty inches long and one and one-fourth inches in diameter and containing the same gaseous atmosphere, may be started and operated from a 115 volt line using 3.5 mfd. capacitance and .82 henry inductance. The eighteen inch lamp has a voltage drop thereacross of about 60 volts, and the thirty inch lamp about 100 volts.

By proper selection of values of inductance and capacitance, lamps with a voltage drop approximately the same as the supply line voltage may be started and operated. For such operation with the lamp voltage at or near the supply line voltage, it has been found that the ratio of impedance of the inductance to impedance of the capacitance must not exceed a certain maximum. This maximum ratio is about 0.85. The minimum ratio has been found to be about 0.50; a lower ratio results in an undesirable wave shape. The circuit thus is capacitive since the capacitive impedance is greater than the inductive impedance.

For either of the cases where the lamp voltage is approximately the same as or considerably below the supply voltage, the voltage drop through the inductance should not be less than the voltage drop of the lamp. This is required to choke out harmonics encouraged by the lamp and by the capacitor.

The second inductance or choke coil 21 serves to permit operation with a lamp voltage slightly higher (about 10 volts, for example) than the line or source voltage. The inclusion of the switch 20 in this circuit has, in addition to the advantages mentioned heretofore, the further advantage that the parallel choke 21 may be made small since it does not have to carry the cathode preheating current (being short-circuited by switch 20 during starting) and it need not serve to build up the voltage to start the lamp. The fact that the addition of the small choke coil 21 enables a higher voltage lamp to be operated from the same circuit probably is due to several causes: the choke coil assists in maintaining a current flow through the lamp ballast during those times at which the lamp voltage passes through zero or when the lamp is out, thus increasing the stability of the lamp circuit; because of the current in the choke coil 21 the lamp electrodes are maintained at a somewhat higher temperature and hence have a greater electron emission; greater stability of the lamp circuit also results from the greater current flow or circulating kva. in that circuit due to the presence of the choke 21. It is well known that if the stability of the lamp circuit can be increased, a lamp of greater length can be used. During each of the two periods in each cycle when the voltage applied to the lamp is less than the arc drop voltage thereof, namely, when the lamp is out, the reactor 21 causes a certain amount of current to continue to circulate through the lamp filaments and through the ballast elements 17 and 18 of the supply circuit. It is because of this influence of the reactor 21 on the supply circuit that the stability of the lamp in the circuit is increased and hence one is enabled to start and operate a lamp whose operating voltage is higher than that of the source of supply.

It will be obvious to those skilled in the art that various modifications may be made in the circuit illustrated. For example, the circuit arranged may be applied to tubes having indirectly heated hot cathodes wherein the coils 11, 12 serve as the heaters and are each surrounded by a metal tube connected electrically to one end of the coil and having thereon a coating of highly electron emissive material, as exemplified by the well-known Hull cathode, Reissue Patent 19,057, January 23, 1934. The switch 20 is preferably automatically operable, as by constituting it a thermal switch as disclosed in the Wels Patent 1,951,112. The electrodes 11, 12 may also be so proportioned that, during starting of the lamp, a local arc discharge is caused to form across the extremities of the electrodes to assist in starting, as disclosed in the Inman Patent 2,103,034.

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

1. A starting and operating circuit for a gaseous electric discharge device having electrodes adapted to be preheated by the passage of current comprising means forming a partially resonant series circuit for connecting said device with a source of alternating current supply, said means being capacitive and including a reactor and a capacitor, a starting switch connected across said device and arranged to control said electrode preheating current and a small additional reactor connected across said switch, said reactor influencing said partially resonant series circuit whereby a discharge device of higher operating voltage than that of the source may be started and operated.

2. A starting and operating circuit for a gaseous electric discharge device having filamentary electrodes adapted to be preheated to an electron emitting temperature by the passage of current therethrough comprising means for connecting one end of each of said electrodes with a source of alternating current supply, said means including a reactor and a capacitor forming a partially resonant series circuit, the impedance of the capacitor being greater than that of the reactor, a starting switch connected between the other ends of said electrodes and a small reactor connected across said switch, whereby a discharge device having an operating voltage higher than the voltage of said source may be started and operated.

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