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IGNITION CIRCUIT FOR AN ARC-DISCHARGE LAMP AND DEVICES THEREFOR

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FIG. 1.

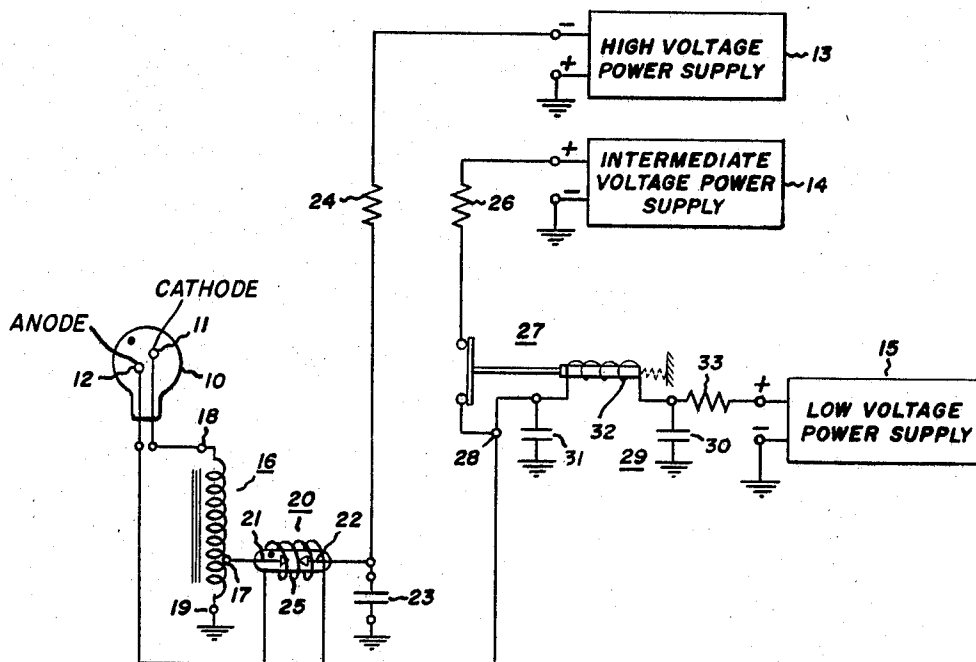


FIG. 2.

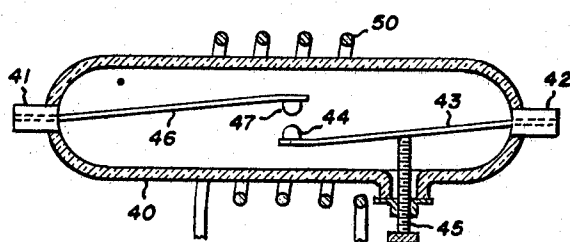
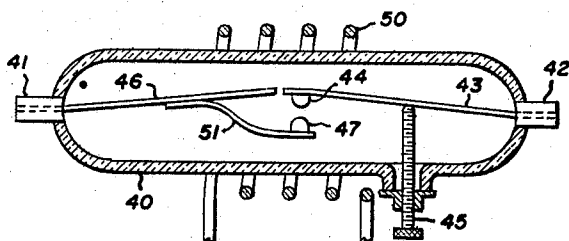


FIG. 3.



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IGNITION CIRCUIT FOR AN ARC-DISCHARGE LAMP AND DEVICES THEREFOR

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3 Claims

ABSTRACT OF THE DISCLOSURE

A pair of spaced electrodes providing an arc gap for generation of arc starting oscillations is responsive to current flow in the lamp load supplying circuit for changing the spacing of the electrodes to quench the oscillations.

This invention relates to ignition circuits for an arc-discharge lamp of the kind utilizing spark gaps and switches and particularly relates to improved devices of such character for incorporation in such ignition circuits. The present invention represents an improvement in ignition circuits such as are disclosed and claimed in copending patent application Ser. No. 177,658, filed Mar. 5, 1962, now patent 3,219,756, and assigned to the assignee of the present invention.

When placing an arc-discharge lamp, such as a gaseous Xenon lamp in operation, it is necessary for proper arc striking and maintenance that a sequential three-step arc ignition and sustaining procedure be followed. First, a very high voltage is coupled to the lamp for causing ionization of the gaseous atmosphere between the two electrodes of the lamps and a consequent arc-discharge therebetween. Next, a relatively low direct current voltage, hereinafter referred to as the intermediate voltage, is coupled to the electrodes for heating the cathode electrode of the lamp in order to provide a source of electrons for conduction and consequent low impedance path between the electrodes. Finally, a relatively low voltage derived from a high current capacity source is coupled to the lamp for providing an operating current for the lamp to sustain the high brilliance arc which has been "struck" in the prior steps. The respective aforementioned voltage requirements for a 500 watt Xenon lamp are approximately 30,000 volts, 100 volts and 25 volts. The current requirements for the 25 voltage source are in the range of 20 amperes. Thus, the electrical lamp starting and arc maintenance characteristics range from a requirement for a very high arc-"striking" voltage source to a requirement for a substantially low arc-maintaining voltage source having a relatively high output current capacity.

The high voltage circuit may comprise a spark gap, an inductor and capacitor connected in series circuit. The capacitor is charged from a high voltage source to a value sufficient to breakdown the gap and cause oscillations in the circuit. Such oscillations are coupled to the electrodes of the arc discharge lamp. The intermediate voltage source, which provides heating of the electrodes of the arc discharge lamp to a value sufficient for conduction to be maintained therethrough, and the low voltage source for arc maintenance are connected to the electrodes of the arc discharge lamp. Current flow either of a particular magnitude or for a particular duration is utilized to disconnect the high voltage supply from the oscillator circuit and the intermediate voltage source from the electrodes of the lamp. The present invention is directed to an improved

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circuit and device in which the electrodes of the spark gap device function as a switch for deactivating the oscillatory circuit as well as providing the gap to initiate oscillations.

The objects and advantages which characterize my invention will become more apparent as the following description proceeds reference being had to the accompanying drawing, and the scope will be pointed out in the appended claims.

FIGURE 1 is a schematic diagram, partly in block form, illustrating the ignition circuit for an arc discharge lamp in accordance with the present invention.

FIGURE 2 is a sectional view of a combination spark gap and switch device in accordance with the present invention.

FIGURE 3 is a sectional view of another combination spark gap and switch device in accordance with the present invention.

Referring now to FIGURE 1 there is shown an arc discharge lamp 10 including an anode electrode 12 and a cathode electrode 11, a high voltage power supply 13, an intermediate voltage power supply 14 and a low voltage power supply 15. The high voltage power supply is utilized for the generation of a high alternating voltage at the arc discharge lamp electrodes for ionizing the atmosphere thereof. Such is accomplished by means of an auto transformer 16 having a primary terminal 17, a secondary terminal 18 and a common terminal 19, a spark gap device 20 having a pair of electrodes 21 and 22, a capacitor 23 and a combination charging and current limiting resistance 24 interconnected with the arc discharge lamp 10 and the high voltage supply 13 in a manner to be described. The positive terminal of the high power supply is connected to ground. The negative terminal of the high power supply is connected through resistance 24 to one terminal of the capacitor 23, the other terminal of which is connected to ground. The one terminal of the capacitor 23 is connected to terminal 22 of the spark gap device 20, the other terminal 21 of which is connected to the primary terminal 17 of the auto transformer 16. The common terminal 19 of the auto transformer is connected to ground. The secondary terminal 18 of the auto transformer is connected to the cathode 11. The anode 12 of the arc discharge lamp is connected through a coil 25 surrounding the electrodes 21 and 22 of device 20 to terminal 28. At least one of the electrodes of device 20 is constituted of a material responsive to the magnetic field produced by current in coil 25 to alter the gap formed by electrodes 21 and 22, i.e., to either close the gap by shorting of electrodes 21 and 22 or by increasing the spacing therebetween to prevent any discharge thereacross as will more fully be described in connection with FIGURES 2 and 3.

The intermediate voltage power supply functions to provide current to the arc discharge lamp for the purpose of heating the cathode to a sufficient temperature to enable conduction to be maintained therethrough. To this end the negative terminal of the intermediate voltage supply 14 is connected to ground. The positive terminal of the intermediate voltage is connected through a current limiting resistance 26 and a normally close set of contacts of a relay 27 to the output terminal 28 of a filter network 29, the other terminal of which is connected to ground.

The low voltage power supply 15 includes the necessary well known elements for rectifying alternating voltage which is derived for a line source of power and provides the operating current to the lamp subsequent to the strik-

ing of an arc and the heating of cathode electrode of the lamp. The filtering network for filtering the output of the power supply 15 includes capacitors 30 and 31 which are connected between ground and respective terminals of the inductance 32 which forms the coil of relay 27. The negative terminal of the power supply 15 is connected to ground, and the positive terminal is connected through resistance 33 to one terminal of coil 32, the other terminal of which is connected to terminal 28.

When the power supplies are energized the high voltage and intermediate voltage power supplies 13 and 14 rapidly achieve their rated output. Capacitor 23 will begin to charge to the output voltage of the high voltage power supply. The capacitor 23 will charge at a rate determined by the time constant of the circuit consisting of capacitor 23 and resistor 24. When voltage across the capacitor 23 reaches a value sufficient to cause the formation of an arc between electrodes of the spark gap device 20, capacitor 23 will rapidly discharge across the gap through the primary winding of auto transformer 16. The impulse of current supplied to the primary of the auto transformer 16 will induce a very high voltage across the secondary terminals 18 and 19 thereof sufficient to cause ionization of the gaseous atmosphere between the electrodes of the arc discharge lamp 10. Such voltages may be of the order of 30,000 to 50,000 volts for a Xenon lamp.

Concurrently with the charging of the capacitor toward the voltage of the negative terminal of high voltage supply 13, for example minus 5000 volts, the capacitors in the low voltage power supply filter circuit will be charging both from the low voltage source through resistor 33 and inductance 32, and from the intermediate source through resistor 26. After a no load low voltage source output voltage has been reached, capacitor 31 will continue to charge to the output voltage of the intermediate supply at a rate determined by the time constant of the circuit consisting of capacitor 31 and resistor 26. The values of the aforementioned charging time constants provided by resistor 24 and capacitor 23 and by resistor 26 and capacitor 31 are selected to provide simultaneously the required amplitude unidirectional heating voltage at anode 12 and the required arc over voltage between lamp electrodes 11 and 12. Electrode heating current will thus be available to heat electrode 11 when arc over occurs. The heating of electrode 11 provides electrons for current flow. A decrease in voltage at anode 12 and increase in the heating of electrode 11 occurs cumulatively until necessary electron flow through the lamp to maintain the desired arc current at a voltage equal to the output voltage of the terminal 28 of the filter is obtained.

As current flows between terminal 28 and anode 12 through the coil 25 of the spark gap device 20, one or both of the electrodes of the spark gap device 20 are caused to move at a predetermined current to either separate the electrodes 21 and 22 sufficiently or short them out to deactivate the oscillator circuit from applying energization pulses to the arc discharge lamp. Also, the previously referred to normally closed contacts of relay 27 are opened by energizing of coil 32 when operating current flows in the lamp. Thus the intermediate voltage power supply as well as the high voltage power supply are decoupled from the lamp when the ignition is completed. A device which has electrodes which contact or short out on energization is shown in FIGURE 2. A device which has electrodes which open further on energization is shown in FIGURE 3.

If desired, the intermediate voltage power supply may be eliminated and in place of the intermediate voltage power supply and the low power supply and associated circuits a power supply such as described in U.S. Patent application Ser. No. 309,179, filed Sept. 16, 1963, and, now abandoned, assigned to the assignee of the present invention may be used. Such a power supply has the characteristic of providing a high voltage at low current and

a progressively low voltage at high currents. It will be apparent that such a power supply fulfills the heating and operating requirements of the arc discharge lamp.

Referring now to FIGURE 2 there is shown in detail a combination spark gap and switch device in accordance with one aspect of the present invention. The device comprises an enclosure 40 which may include a suitable gas under appropriate pressure, for example, air under atmospheric pressure, at opposite ends of which are located a pair of electrodes 41 and 42, corresponding to electrodes 21 and 22 of FIGURE 1. To one of the conductors 42 a relatively fixed but adjustable arm 43 of conductive non-magnetic material is secured. The end of the arm remote from the electrode 42 may include a suitable contact 44 of a suitable refractory material such as tungsten. To the other electrode 41 another arm 46 of conductive and magnetic material is secured at the end remote from the electrode and a suitable contact 47 also of refractory material such as tungsten is provided thereon. A screw 45 threaded into the enclosure 40 and contacting the arm 43 may be provided for the purpose of positioning the arm 43 in relation to arm 46 to provide the appropriate gap between contacts 44 and 47 in the absence of current flow in the coils. A coil 50 is provided about the enclosure to deflect the magnetizable arm toward the relatively fixed arm. The number of turns in a coil, the spacing of the arms within the field produced by the coil is so arranged that for a predetermined current the desired force is produced to cause contact 44 to engage contact 47.

Referring now to FIGURE 3 there is shown in detail another combination spark gap device in accordance with another aspect of the present invention. The device of FIGURE 3 is similar to the device of FIGURE 2 and corresponding parts have been designated by the same numerals. Contact 47 is supported on nonmagnetic conductive strip 51 secured to arm 46. Contact 44 is secured on arm 43 to provide the desired gap between contacts 44 and 47. When sufficient current is passed through coil 50, arm 46 moves downward, thus causing the contacts 44 and 47 to separate sufficiently to render the gap too large to permit an arc discharge in the circuit of FIGURE 1.

While I have described and claimed particular embodiments of my invention, it will be apparent to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects and I aim, therefore, in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. An ignition circuit for an arc discharge lamp having a pair of arc discharge electrodes enclosed in an ionizable atmosphere, said ignition circuit comprising a pair of spaced electrodes for providing a spark gap, an inductance and a capacitance connected in a series circuit with the electrodes of said spark gap, a first source of unidirectional voltage, means for charging said capacitance from said source to a value to cause said capacitance to discharge across said spark gap and produce oscillations in said inductance, means for coupling said oscillations to the arc discharge electrodes of said lamp to cause the ionization of the atmosphere therein, a second unidirectional voltage source coupled to the arc discharge electrodes of said lamp to provide heating and operating current to said arc discharge electrodes, and means responsive to current flow from said second source of unidirectional voltage for moving at least one of the electrodes of said spark gap to quench oscillations in said series circuit.

2. The ignition circuit of claim 1 in which said last mentioned means is provided with means for separating sufficiently said electrodes in response to current from said second source to quench oscillations in said series circuit.

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3. The ignition circuit of claim 1 in which said last mentioned means is provided with means for bringing said electrodes into contact in response to current from said second source to quench oscillations in said series circuit.

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