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STARTING AND OPERATING CIRCUIT FOR HIGH PRESSURE ARC LAMPS

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The present invention deals with a starting and operating circuit for high pressure arc lamps and more particularly with a starting and operating circuit for direct current operated high pressure arc lamps.

The line voltage usually required for starting high pressure arc lamps is from approximately two to five times that at which the lamp normally operates depending upon gas pressure, electrode spacing, electrode geometry and other particular lamp characteristics. High pressure arc lamps usually required a series ballast to reduce the voltage at the lamp terminals. The loss of power in the ballast, especially with a high voltage source, is usually several times that dissipated in the lamp thereby making a very poor efficiency for the system. The alternative of reducing the voltage at the source is impractical except under laboratory conditions. Radio frequency power is advantageously employed in the lamp circuit to ionize the gas filling to minimize the high voltage starting potential at the source, but in addition a certain minimum of voltage is required from the operating source of voltage to produce sufficient electron emission from the cold cathode to form a heated cathode spot for initiating electron emission. Once the cathode spot is formed, emission results and the lamp impedance drops with a resultant reduction of lamp voltage.

The invention comprises a novel lamp starting and operating circuit which permits the employment of a greatly reduced line voltage for direct current operated high pressure lamps, especially xenon lamps, whereby any requirement for a ballast which consumes substantial power is eliminated and the ballast consumes only a small portion of the power dissipated in the lamp during operation thereby providing a highly efficient system.

It is an object of the invention to provide a high pressure lamp starting and operating circuit whereby the source of voltage is only slightly greater than the lamp operating voltage.

It is another object of the invention to provide a high pressure lamp starting and operating circuit which employs a direct current source of voltage for operating a high pressure arc lamp.

It is a further object of the invention to provide a starting and operating circuit for direct current operated lamps, whereby the circuit provides a great improvement in starting and operating efficiency and reduction in cooling requirements of lamp operating circuit components.

Other objects and advantages of the invention will become apparent from the description hereinafter following and the drawings forming a part hereof, in which:

FIGURE 1 illustrates a diagrammatic illustration of the circuit of the invention, and

FIGURE 2 illustrates a diagrammatic illustration of a modification of the invention.

The invention deals with an ignition and operating system for high pressure discharge lamps operating on direct current and includes switch means which in combination with a particular D.C. ignition circuit and a particular D.C. operating circuit is capable of segregating the voltage requirements for the lamp in conformity with a starting and operating condition of the lamp, whereby it is possible to employ an economical substantially low voltage source for operating the lamp after ignition.

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While the ignition and operating circuit hereinafter particularly described may be advantageously applied for the ignition and operation of high pressure mercury vapor arc lamps, it is especially applicable for the ignition and operation of a compact type arc lamp containing solid electrodes spaced apart to provide a discharge path from a few millimeters to about two centimeters in length in an enclosed atmosphere consisting of xenon at a pressure exceeding about one atmosphere.

In accordance with the invention, the operating circuit comprises a pair of leads 1 and 2 connected or connectable to a source of direct current 3 and to electrodes 4 and 5 of a high pressure discharge lamp 6 with a resistance ballast 7, e.g. a variable resistance, a coil 8, and a rectifier 9 connected in a circuit lead, e.g. in lead 1, in series with the lamp 6. A booster circuit comprising conductors 10 and 11 with a switch 12 therebetween is connected across the rectifier 9 in lead 1. A variable resistance 13 is connected in conductor 10, and a battery 14, as shown in FIGURE 1, or a capacitor 15, as shown in FIGURE 2, is connected in the conductor 11. A current limiting resistor 16 is electrically connected between the battery 14, or capacitor 15, and lead 2, thereby connecting the battery 14, or capacitor 15, across the lamp operating power source 3 so that in accordance with the open and closed position of switch 12 the battery 14, or capacitor 15, is either in a series connection or parallel connection with the lamp 6.

While FIGURES 1 and 2 show either a battery 14 or a capacitor 15 in the conductor 11 of the ignition circuit, the invention may be advantageously modified to include a parallel arrangement of a battery 14 and capacitor 17 in the booster circuit as illustrated by FIGURE 1.

Although the D.C. operating circuit is capable of maintaining operation after the lamp is ignited, and the D.C. booster circuit is required to heat the electrodes sufficiently to provide for suitable electron emission from the electrodes, neither the operating circuit nor the booster circuit, nor the operating and booster circuits combined normally produce sufficient direct current flow and, therefore, sufficient electrode heating and sufficient ionization of the gas to assure ignition of the lamp.

The ignition circuit comprises a radio frequency circuit connected in parallel with the operating circuit and with ignition leads 18 and 19 connected across the D.C. source 3, the leads 18 and 19 being connected to a converter 20 through switch 12b for converting the D.C. to A.C. Leads 21 and 22 lead from the converter 20 and are connected across the primary winding 23 of ignition transformer 24. Leads 25 and 26 are connected across the secondary winding 27 of the transformer 24 and across the primary winding 28 of radio frequency transformer 29. A spark gap 30 is connected between the leads 25 and 26 with a radio frequency capacitor 31 being connected in lead 26. The coil 8 hereinbefore referred to is the secondary winding of the radio frequency transformer 29. A radio frequency by-pass capacitor 32 is connected across the leads 1 and 2 between the coil 8 and the ballast 7 to restrict the radio frequency components across the lamp 6.

When switch 12b is closed causing the ignition circuit to apply a high radio frequency voltage through transformer 29 to the lamp electrodes 4 and 5 causing the gas filling to ionize. With the leads 1 and 2 connected to the D.C. source 3 in series rectifier 9, e.g. a 28 volt battery, the voltage appearing across the lamp electrodes 4 and 5 is incapable of starting lamp 6. Since the lamp does not start with the voltage of D.C. source 3, switch 12, closed simultaneously with switch 12b, places the booster circuit in series with D.C. source 3, whereby the voltage of battery 14, e.g. 28 volts, or the charge voltage of

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capacitor 15, increases the D.C. voltage at the lamp electrodes 4 and 5 to 56 volts, a value sufficient to cause direct current to flow through lamp 6, and the electrodes are thereby heated to produce thermionic emission which, in addition to the ionized gas, reduces the lamp impedance sufficiently for stable operation on D.C. source 3 alone. Upon ignition of the lamp, switches 12 and 12b are opened and the lamp operates solely on the voltage of D.C. source 3. When switch 12 is opened, the battery 14, or capacitor 15 is effectively connected in a circuit parallel with the lamp circuit and across the D.C. source 3 and is therefore charged through the resistor 16, e.g. a resistor of 100 ohms, in readiness for the next starting of the lamp.

The rectifier 9 provides a high impedance path to prevent discharging the battery 14 of capacitor 15 through the switch 12.

FIGURE 1 shows the booster circuit comprising both a battery 15 and capacitor 17 in parallel connection, whereby it is possible to employ a battery 14 of low energy storage capacity in parallel with a capacitor 17 to supplement the power of the battery 14, or to use only the capacitor 15 as shown in FIGURE 2 if capacitor 15 has sufficient energy storage capacity. Such a capacitor 15 is quite large and heavy, and the battery is to be preferred because of its lower weight and smaller size.

Various modifications of the invention are contemplated within the scope of the appended claims.

What is claimed is:

1. An operating and ignition system for a high pressure gaseous discharge lamp comprising said lamp, a first source of D.C., and a pair of electrical leads connecting the lamp with the source of D.C., a radio frequency

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transformer having a primary and secondary coil, a radio frequency generator means connected to said radio frequency transformer primary coil, a rectifier, a ballast resistance and said secondary coil in a series connection in said leads, a radio frequency capacitor connected across said leads between the ballast resistance and said secondary coil, a circuit comprising a switch and a second source of D.C. connected in series, the switch and second source of D.C. being connected in one of said leads across the rectifier, a charging resistor connecting the second source of D.C. to the other of said leads.

2. An operating and ignition system according to claim 1, wherein the ballast resistance is a variable resistance.

3. An operating and ignition system according to claim 1, comprising a variable resistance means connected in series with the switch and second source of D.C., the said variable resistance means, said switch and said second source of D.C. being connected across the said rectifier in one of said leads.

4. An operating and ignition system according to claim 1, wherein said second source of D.C. is a battery.

5. An operating and ignition system according to claim 1, wherein said second source of D.C. is a capacitor.

6. An operating and ignition system according to claim 4, comprising a capacitor connected across said battery.

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