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[73] Assignee **General Electric Company**

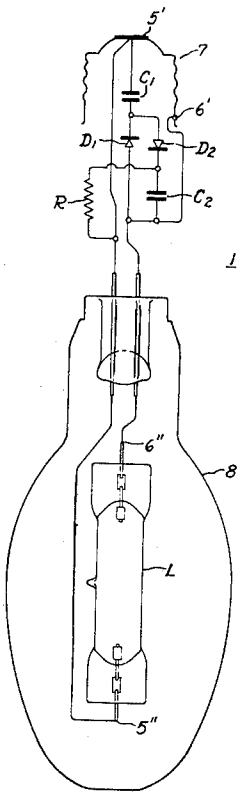
[54] **VOLTAGE DOUBLER STARTING CIRCUIT FOR DISCHARGE LAMP**
4 Claims, 2 Drawing Figs.

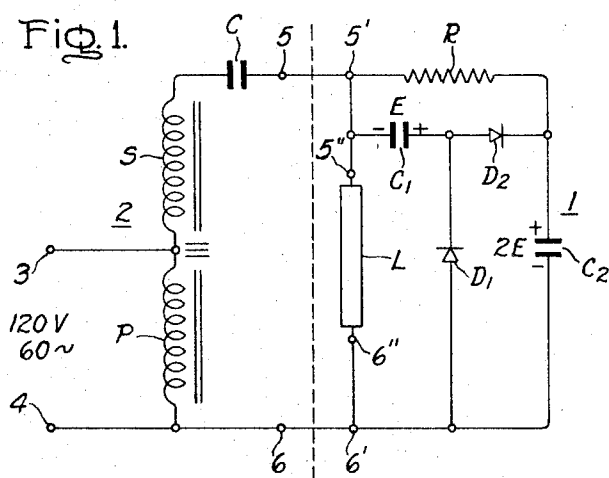
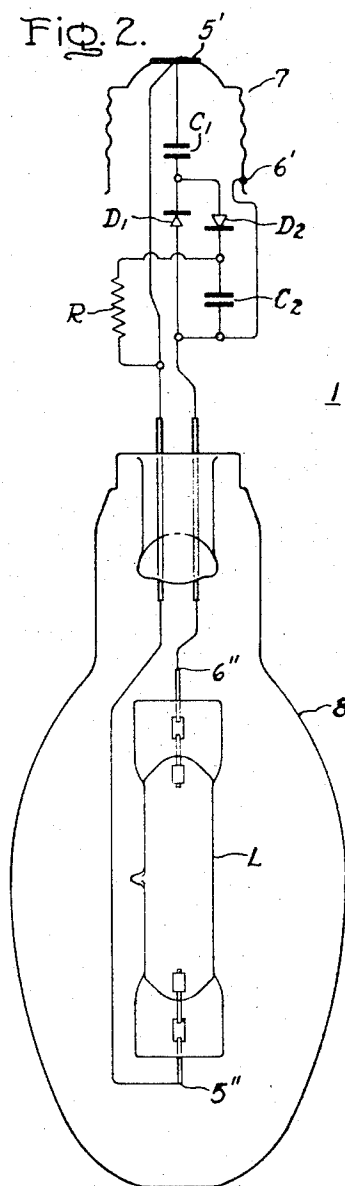
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H05b 31/30, H05b 41/231
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59, 200 R, 205, 207, 171, 174; 321/15

[56] References Cited			
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ABSTRACT: A voltage doubler starting circuit converting the AC voltage impressed on the lamp to a DC voltage of twice the peak AC amplitude which is fed back to the lamp terminals. The circuit includes two diodes and two capacitors arranged in a voltage doubling configuration along with a bleeder resistor, and may, if desired, be built into the lamp base or into the lamp itself in the case of a double envelope lamp. The circuit is used with a ballast of the magnetic type having a series secondary power factor correcting capacitor.





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VOLTAGE DOUBLER STARTING CIRCUIT FOR DISCHARGE LAMP

CROSS REFERENCES TO RELATED APPLICATIONS

Copending application Ser. No. 757,180, filed July 31, 1968 by William H. Lake, entitled Discharge Lamp Ballasting, now U.S. Pat. No. 3,527,982, and similarly assigned.

Copending application Ser. No. 54,880 filed July 15, 1970, by William H. Lake and Nicholas W. Medendorp, entitled Resistively Ballasted Discharge Lamp, and similarly assigned.

BACKGROUND OF THE INVENTION

The invention relates to a starting circuit for use with lamps having a high starting voltage and which may be built into the lamp itself or its base as an integral part of the lamp or provided as a separate unit.

In recent years some new high-intensity metal vapor discharge lamps have appeared which are difficult to start by comparison with conventional mercury vapor lamps of similar input rating. One such lamp is that covered by U.S. Pat. No. 3,234,421—Reiling, Metallic Halide Electric Discharge Lamps, which utilizes a quartz arc tube containing mercury and metal halides such as sodium, thallium and indium iodides. Another lamp is that covered by U.S. Pat. No. 3,248,590—Schmidt, High Pressure Sodium Vapor Lamp, which discloses a sodium vapor lamp utilizing an envelope of alumina ceramic containing a sodium filling in a new high-pressure range. In the metal halide lamp particularly, it has been a design goal to achieve a lamp which would operate interchangeably with a mercury vapor lamp of the same wattage or rating on the usual mercury vapor lamp ballast. In order to achieve reliable starting of the metal halide lamp, an auxiliary starting electrode has been provided but this solution tends to downgrade maintenance and overall lamp reliability. A bimetal switch was then added to the lamp according to U.S. Pat. No. 3,226,597—Green, High Pressure Metal Vapor Discharge Lamp, which connected the starting electrode to the adjacent main electrode after starting of the lamp to eliminate any potential difference between them tending to cause electrolysis. While this solution has been satisfactory, it has increased costs and contributed its own reliability problem.

The object of the invention is to provide an improved system to facilitate the starting of lamps and particularly one which can be added to a metal halide lamp to improve its starting characteristics to the level of the conventional mercury vapor lamp.

SUMMARY OF THE INVENTION

In accordance with the invention, a separate starting circuit is provided in the form of a rectifier capacitor network comprising two stages each consisting of a rectifier and a capacitor connected in a voltage-doubling circuit. This circuit causes the AC voltage impressed on the lamp to be converted to a DC voltage having twice the peak amplitude of the applied AC voltage. This DC voltage is fed back to the lamp terminals through a bleeder resistor and builds up to a charge having a magnitude of 2.8 times the open circuit AC voltage generated by the ballast. The charge builds up to this value over a few cycles before the lamp becomes ionized. As soon as the lamp starts, the charge across the first stage voltage doubling capacitor is substantially dissipated and the circuit thereafter draws such a small current from the line that it has no significant effect upon the operation of the lamp.

DESCRIPTION OF DRAWINGS

In the drawing wherein like reference characters indicate corresponding elements in the several figures:

FIG. 1 illustrates schematically a lamp starting circuit embodying the invention.

FIG. 2 illustrates somewhat diagrammatically a high pressure metal vapor arc lamp having an integral starting circuit according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

In FIG. 1, the portion of the circuit to the right of the vertical dotted line represents a discharge lamp 1 provided with an auxiliary starting circuit according to the invention, while the portion to the left represents a common type of high reactance magnetic ballast provided with a series secondary power factor correcting capacitor. In FIG. 2 the lamp is represented somewhat diagrammatically to indicate and auxiliary starting circuit built into the base.

Referring to FIG. 1, ballast 2, which may be of the kind sometimes known as a constant wattage ballast, comprises a primary winding P which is connected across 115–120 volt, 60 cycle AC terminals 3,4. The output circuit comprises a secondary winding S connected in series with the primary winding and a secondary power factor correcting capacitor C to output terminals 5,6. The primary and secondary are magnetically coupled together but with substantial leakage reactance between them in order to effect current regulation in the output circuit. The terminal 5,6 would normally be the eyelet and shell terminals of a conventional mogul screw socket (not shown) adapted to accommodate the mogul screw base 7 of a high-intensity metal vapor discharge lamp comprising center contact 5' and screw shell 6' as shown in FIG. 2.

The discharge or arc tube proper indicated L has its terminals 5'',6'' connected across terminals 5',6', all similarly numbered terminals being electrically coincident. The first stage of the voltage doubling circuit consisting of capacitor C₁ and diode D₁ connected in series is shunted across arc tube L with diode D₁ conducting forwardly from terminal 6'. The second stage consisting of diode D₂ and capacitor C₂ connected in series is shunted across diode D₁ of the first stage, with diode D₂ conducting forwardly from the junction of D₁ and C₁. A bleeder resistor R connects the junction of diode D₂ and capacitor C₂ to terminal 5'. It is important that the series power factor correcting capacitor C be much larger (preferably 10 times or more) than capacitor C₁ in the first stage, and that capacitor C₁ in the first stage be much larger (preferably 10 times or more) than capacitor C₂ in the second stage of the voltage doubling circuit. By way of example, in a conventional constant wattage power factor-corrected ballast for a 400-watt mercury lamp, the capacitance of C may be 25 microfarads, that of C₁ may be 0.5 microfarad, that of C₂ may be 0.01 microfarad, and the bleeder resistor R may be 40,000 ohms. Since R in series with D₁ and D₂ is shunted across the lamp during operation and conduction occurs on one half cycle, R should be large enough to limit the wasted current to a small value.

In the operation of the circuit, the arc tube L may initially be considered as an open circuit. When a voltage is applied across two capacitors in series, the voltage division between them is inversely proportional to the capacitance of each. Thus letting V be the voltage applied across capacitors C and C₁ in series, the voltage across C will be given by $V_C = V \times \frac{C_1}{C+C_1}$, and the voltage across C₁ will be $V_{C_1} = V \times \frac{C}{C+C_1}$. In this instance the capacitance of C is 50 times greater than that of C₁. Therefore for practical purposes as regards the division of voltage between C and C₁, C may be considered a short circuit and the entire voltage considered to be developed across C₁. Likewise since C₁ is 50 times greater than C₂, as between C₁ and C₂, C₁ may be considered a short circuit and the entire voltage considered to be developed across C₂.

Considering a half cycle when terminal 6 is positive relative to terminal 5, forward conduction through diode D₁ will charge capacitor C₁ substantially to the peak E of the applied voltage with the polarity indicated (neglecting charge on C). On the next half cycle when terminal 5 is positive relative to terminal 6, forward conduction through diode D₂ will cause capacitor C₂ to charge with the polarity indicated. The voltage effectively applied is the open circuit voltage plus the charge already stored in capacitor C₁. The voltage division between capacitor C₁ and C₂ will again be proportional to the inverse of capacitance. So practically the entire voltage will occur across

capacitor C_2 , and C_2 will charge to $2E$ with the polarity indicated.

The voltage developed across capacitor C_2 is slowly discharged through bleeder resistor R into the power factor correcting capacitor C . The time constant of the discharge of C_2 into C is given by CR and is quite long. This means in effect that capacitor C will take several cycles of the applied AC voltage to charge up to a voltage of approximately $2E$. However, before such a voltage is reached, arc tube L will ionize and the lamp will start. After the lamp is started, the voltage doubling circuit is effectively disabled because capacitor C_1 discharges through arc tube L at every half cycle.

In a practical lamp such as represented diagrammatically in FIG. 2, the voltage-doubling starting circuit may be made of an integral part of the lamp. The two diodes D_1 and D_2 may be grain of wheat size silicon rectifiers sealed in vitreous material and capable of withstanding temperatures of several hundred degrees centigrade. The capacitances C_1 and C_2 may consist of compact ceramic capacitors using barium titanate for the dielectric which are likewise capable of withstanding high temperatures. The resistor R may consist of a spirally cut thin film on a ceramic tube and is likewise compact and capable of withstanding high temperature. All the components of the voltage-doubling circuit may be mounted either within the outer jacket 8 of the lamp or within the mogul screw shell of the lamp base 7.

The physical arrangement of the components within the base shell may be similar to that described and illustrated in copending application Ser. No. 54,880 filed by myself and Nicholas W. Medendorp on July 15, 1970, entitled Resistively Ballasted Discharge Lamp and assigned to the same assignee as the present invention, which application is hereby incorporated herein by reference.

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

1. A discharge lamp for operation on a ballast of the kind

which includes a series power factor correcting capacitor comprising:

an arc tube having terminals for connection across said ballast;

a voltage-doubling feedback circuit comprising a first stage including in series a first capacitor and a first diode connected shunt across said arc tube;

and a second stage including in series a second diode and a second capacitor connected in shunt across said first diode;

said second diode having forward conduction in the shunt circuit in a direction opposite to the first diode, said second capacitor being connected to one side of said arc tube,

a bleeder resistor connecting the junction of said second diode and second capacitor to the other side of said arc tube;

said first capacitor having a capacitance which is smaller than that of the series power factor correcting capacitor; and

said second capacitor having a capacitance which is smaller than that of the first capacitor.

2. A lamp as in claim 1 wherein the capacitance of said first capacitor is not more than one-tenth that of the series power factor correcting capacitor, and that of said second capacitor is not more than one-tenth that of the first capacitor.

3. A lamp as in claim 1 of the double envelope type including an outer jacket surrounding said arc tube and wherein said voltage-doubling feedback circuit is an integral part of the lamp.

4. A lamp as in claim 1 of the double envelope type including an outer jacket surrounding said arc tube, a screw base mounted on the neck of said outer jacket and wherein elements of said voltage doubling feedback circuit are located within said screw base.

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