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SYSTEM COOLING FOR DISCHARGE LAMP

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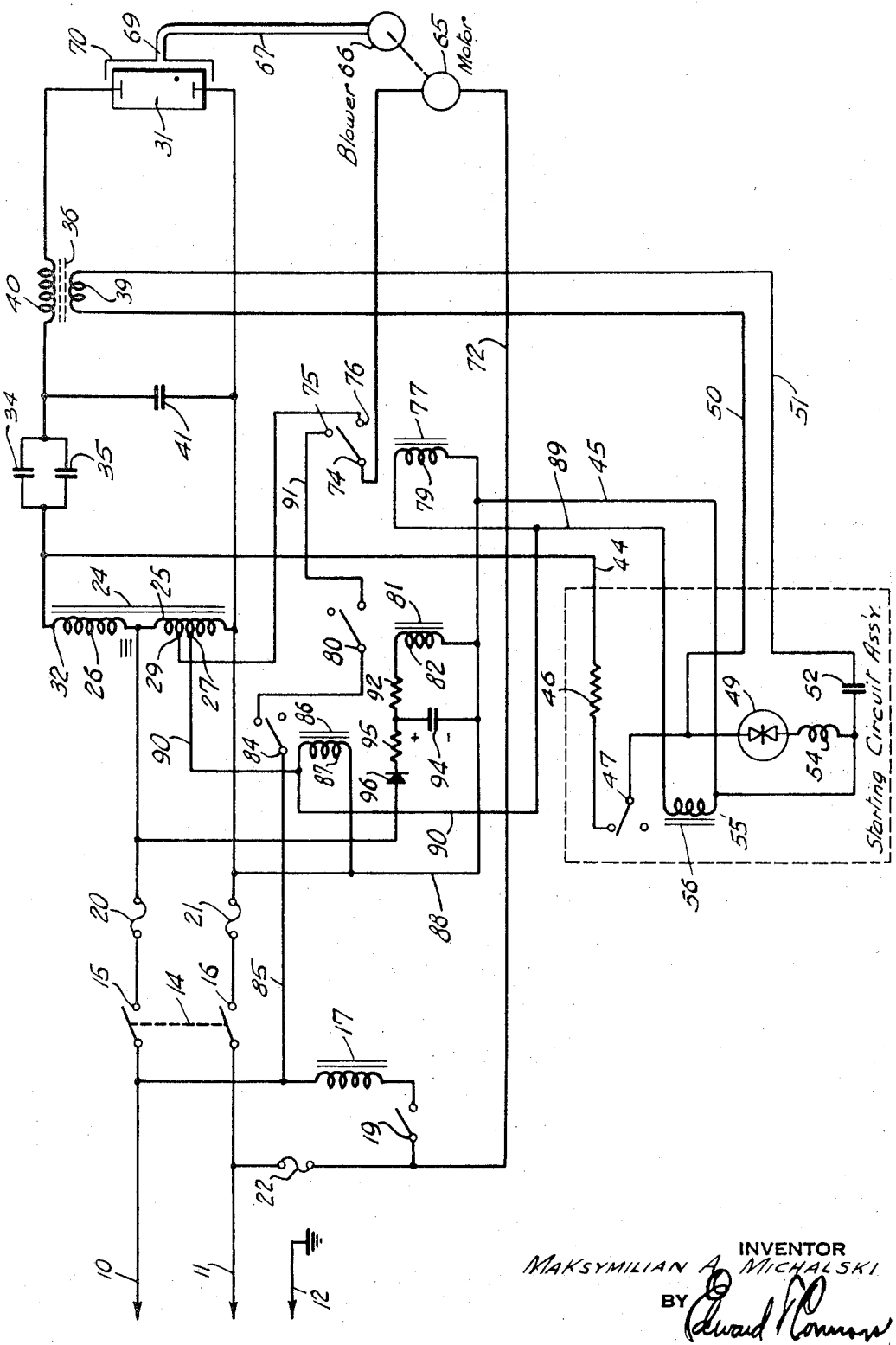

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SYSTEM COOLING FOR DISCHARGE LAMP

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ABSTRACT OF THE DISCLOSURE

An electric system supplies a gas discharge lamp. A motor operated blower is provided to cool the lamp by blowing air thereover, the blower motor being adapted to be operated at two speeds, a lower speed on partial voltage and a higher speed on full voltage. Switching means are provided so that upon first being energized the blower is not operated so that there is no cooling, thus allowing the lamp to reach operating temperature at a rapid rate. Timing means are provided so that after the lamp has been in operation for a predetermined time switching means is actuated causing the blower motor to operate under partial voltage. Holdover time delay means are provided so that the blower motor is operated after the lamp is deenergized, this phase of operation being at full voltage so that the lamp is rapidly cooled so as to be ready for a subsequent operation. The time delay of the switching means is achieved by the use of R-C circuits.

The present invention relates to an electric system including a gas discharge lamp and more particularly for such a system incorporating cooling means for the lamp so as to provide more efficient operation and a quicker starting up characteristic.

In the use of the discharge lamps, particularly those including metal halides for use in the photocopy and graphic arts fields, it is important that the discharge lamp be operated at optimum temperature in order that the desired spectral output may be had. The lamps include mercury and other metallic elements which must be vaporized and the internal pressure raised to the level where the additive elements in the form of halides are also vaporized. The operating level temperature of the lamp should be between 500 and 700 degrees C. At a lower temperature the metal iodide cycle will not work and condensation of the halide may result. If the temperature is above 700 degrees C. bending or deformation of the quartz tube might result. Also the higher temperatures cause a greater probability of seal failure.

The warm-up time of a halide gas discharge lamp depends on the characteristics of the lamp and its ballast design and also on the temperature of the envelope. In order to have a short warm-up time it is desirable that the envelope achieve operating temperature as soin as possible. Thereafter the lamp must be maintained at optimum operating temperature by providing cooling as necessary. If the lamp is to be used in on and off applications the lamp should be cooled off as rapidly as possible at the end of an exposure in order that its temperature be lowered so that it can be reignited. In the usual halide gas discharge lamp if no after cooling provisions are made, it takes about two to three minutes before the lamp cool sufficiently so that they may be restarted. However, with an adequate after cooling operation the lamps may be started again in 30 to 45 seconds. Of course the lamp restart time is very important and should be minimal, especially if the lamp is used in on and off cycles as for example in making a plurality of repetitive short exposures.

Likewise it is important that the warm-up time be as short as possible. Therefore the lamp should not be

cooled until it reaches its operating temperature and then only sufficiently to maintain the operating temperature in the optimum range.

In accordance with the present invention an electric system is provided incorporating a gas discharge lamp. Air cooling means is provided in which a blower is not operated until the lamp reaches operating temperature. Thereafter the blower is operated at a rate so as to maintain the temperature at a desired level. As soon as the power is shut off from the lamp the cooling rate is increased so that the temperature of the lamp is rapidly brought down to the temperature at which reignition is easily possible.

Objects and advantages of the invention will be apparent from the following description and from the accompanying drawing which shows, by way of example, an embodiment of the invention.

The drawing is a schematic circuit of a system in accordance with the invention.

Referring to the drawing there is shown in the figure a pair of terminals **10** and **11** adapted to be connected to an alternating current source preferably in a voltage range of 200 to 250 volts. A ground terminal **12** is also provided. A main electric switch **14** includes terminals **15** and **16**. The switch **14** may be operated with a relay **17** controlled by a remotely positioned manual switch **19**. Suitable fuses **20** and **21** are provided for the main circuit and a fuse **22** is provided for the starting circuit. The alternating current source is supplied to an autotransformer **24** having a primary coil **25** and a secondary coil **26**. The primary coil **25** may be tapped as indicated at **27** to provide one voltage which may be a control circuit voltage and tapped also at **29** to provide a somewhat higher voltage for slow speed blower operation. The bottom terminal of the autotransformer **24** is directly connected to one of the terminals of a discharge lamp **31**. Terminal **32** of the autotransformer **24** is connected through parallel connected capacitors **34** and **35** and through a starting transformer **36** to the other terminal of the discharge lamp. The discharge lamp **31** may be of the order of 2000 watts and may have a 4 inch arc length one inch in diameter, and is of the metal halide type which provides a spectral output in the desirable range which depends on the type of the halide usde.

The lamp may be started in any suitable manner although a preferred starting means is shown in U.S. Patent 3,309,566, issued Mar. 14, 1967, to the applicant herein. In the starting circuit of the patent coupling transformer **36** is preferably of the ferrite core type having low inductance at operating frequency so that it may be left in the circuit during operation. This transformer has a primary **39** of few turns and a secondary **40** of more turns so as to provide a step up ratio. A bypass capacitor **41** is connected across the series connected starting transformer **36** and the lamp **31** to pass the high frequency pulses provided by the starting circuit. At the operating frequency the bypass capacitor **41** has practically no effect. The starting circuit is supplied by a pair of leads **44** and **45** supplied by alternating current at the voltage of the output of the autotransformer **24**. Terminal **44** is connected through a resistor **46** and a relay operated starting switch **47** to one terminal of a switching diode **49**. The same terminal of the switching diode **49** is connected through a lead **50** to one side of the primary **39** of the starting transformer **36**. The other side of the primary **39** is connected by a lead **51** through a capacitor **52** and an inductance **54** to the other side of the switching diode **49**. The connection point between the capacitor **52** and the inductance **54** is connected to coil **55** of a time delay relay **56** actuating the starting switch **47**.

In the operation of the starting circuit, when the alternating current is applied to the switching diode **49** and

to the capacitor 52 the capacitor is charged to the breakdown voltage of the switching diode 49 which discharges the capacitor through the starting winding 39, one or more of high frequency damped pulses being provided for each half cycle of alternation of the main supply.

A blower motor 65 is adapted to power a blower 66 in fluid communication with the discharge lamp 31 by air passage means 67, the air passage means 67 being terminated by one or more nozzles 69 directed at the surface of the discharge lamp 31. If desired the nozzles 69 may extend through a reflector 70 for the discharge lamp 31. The motor 65 is adapted to operate under partial or full voltage, the output of the blower 66, of course, depending upon the voltage applied to the motor 65. The motor 65 is connected by a lead 72 through the fuse 22 to the alternating current supply terminal 11. The other terminal of the blower motor 65 is connected through midpoint 74 of a double throw switch having terminals 75 and 76, the double throw switch being actuated by a relay 77 having a relay coil 79. Terminal 75 is connected through a relay operated switch 80 actuated by a relay 81 having a relay coil 82. The switch 80 is series connected through a switch 84 and a lead 85 to the alternating current supply terminal 10. The switch 84 is actuated by a relay 86 having a relay coil 87.

The relay 56 is provided for time delay disconnect means operative after 2 or 3 seconds of operation so that the starting circuit is disconnected after this time. Relay 77 is provided with a time delay period of one minute, this relay being connected through a lead 88 to one terminal of the alternating current supply, its other terminal being connected by a lead 89 leading to one side of the coil 55 of the time delay starting relay 56 and also through lead 90 to the low voltage terminal 27 of the autotransformer 24. The higher voltage terminal 29 of the autotransformer 24 is connected through a lead to the terminal 76 of the double throw switch 74 thereby providing a source of partial voltage for the motor 65 when the switch 74 is making contact with the terminal 76. However, under no voltage condition for the coil 79 of the relay 77 the double throw switch 74 is normally making contact with terminal 75 connected to the switch 80.

Switch 80 is controllable by the relay 81 having its coil 82 connected through a resistor 92 across the terminals of a capacitor 94, the capacitor 94 in turn being connected at one side through lead 88 to the alternating current supply. The other side of the capacitor 94 is connected through a resistor 95 and a diode 96 to the other side of the alternating current supply line on the load side of the switch 15 so that this circuit is deenergized by the opening of the main switching means 14. The diode 96 is poled so as to apply the proper polarity to the capacitor 94 so that the relay 81 is held closed for a predetermined time after the main switch 14 has been opened, the period of time being determined by the R–C constant of the resistance 92 and the capacitance 94. The capacitance 94 is selected with a large value so that the switch 80 is held closed for approximately one minute. It is this switch 80 which controls operation of the blower motor 65 after the main switch 14 has been opened.

In the operation of the electric system in accordance with the invention manual switch 19 is closed actuating relay 17 and closing the main switch 14 which energizes the autotransformer 24. The starting circuit applies pulses for two or three seconds across starting transformer 36. The discharge lamp 31 becomes ignited and the starting circuit is cut off by action of the time delay relay 56. The lamp 31 is then in operation through capacitors 34 and 35 across the output terminals of autotransformer 24. The lamp becomes warmed in about a minute and at this time the time delay relay 77 is actuated causing switch contact 74 to make contact with terminal 76 thereby applying partial voltage to the motor 65 which actuates the blower 66 and starts the cooling of the discharge lamp 31. The cooling effect provided by the blower 66 under partial voltage operation of the motor 65 is such as to maintain the discharge lamp 31 at the desired operating temperature. During this period of operation the relay switch 80 is closed by energization of the coil 82 from the alternating current supply connected at the load side of the switch 14. The capacitor 94 is quickly charged through the resistor 95. At the end of an exposure the main switch 14 is opened thereby deenergizing the coil of the relay 82. However, by reason of the charge on the capacitor 94 the relay coil 82 is maintained energized for the predetermined one minute interval so that the switch 80 is held in the closed position, thereby providing a source of full voltage from the line side of the main switch 14 through switch 84 and contact 75 of switch 74 to the blower motor 65. The blower motor 65 is thus operated at full voltage to provide a high rate of cooling for the discharge lamp 31 so that it is quickly reduced in temperature so that it may be easily restarted.

While the invention has been described and illustrated with reference to a specific embodiment thereof it will be understood that other embodiments may be resorted to without departing from the invention. Therefore, the form of the invention set out above should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. An electric system comprising a gas discharge lamp, means providing a source of electric current of full voltage, means providing a source of electric current of partial voltage, a blower motor operative on either partial or full voltage, a blower driven by the blower motor, the blower in fluid communication with said discharge lamp whereby said lamp is cooled at a low cooling rate when the blower motor is connected to partial voltage and cooled at a high cooling rate when the blower motor is connected to full voltage, main switching means connecting said discharge lamp to said source of full voltage, normally open first blower switching means connecting said blower motor to said source of partial valtage, time delay means energized when said main switching means is closed, said time delay means operative a predetermined time after said main switching means is closed and connected to close said first blower switching means, so that said blower motor is operated on partial voltage, normally open second blower switching means connecting said blower motor to said source of full voltage, relay means connected to close said second blower switching means operative when said main switching means is opened, holdover time delay means operative after a predetermined time interval connected to said second blower switching means, said holdover time delay means including a relay coil, a resistance, and a capacitor, the resistance and the capacitor connected in series across the relay coil, a diode connected between one end of the relay coil and the load side of said main switching means so that the capacitor is charged and the relay coil is energized while the main switching means is closed, the relay coil being kept energized for a predetermined time after the main switching means is opened by R-C discharge of the capacitor through the relay coil, the diode blocking current flow towards the main switching means, whereby said blower motor is operated at high cooling rate for a predetermined time interval starting immediately after the lamp is deenergized.

2. An electric system comprising a gas discharge lamp, means providing a source of electric current of full voltage, means providing a source of electric current of partial voltage, a blower motor operative on either partial or full voltage, a blower driven by the blower motor, the blower in fluid communication with said discharge lamp whereby said lamp is cooled at a low cooling rate when the blower motor is connected to partial voltage and cooled at a high cooling rate when the blower motor is connected to full voltage, main switching means connect-

ing said discharge lamp to said source of full voltage, normally open first blower switching means connecting said blower motor to said source of partial voltage, time delay means energized when said main switching means is closed, said time delay means operative a predetermined time after said main switching means is closed and connected to close said first blower switching means, so that said blower motor is operated on partial voltage, normally open second blower switching means connecting said blower motor to said source of full voltage, relay means connected to close said second blower switching means operative when said main switching means is opened, holdover time delay means operative after a predetermined time interval connected to said second blower switching means, a double throw switch having a center point and two contacts, the center point connected to said blower motor, said contacts being respectively said first and said second switching means, a relay operated normally closed switch, said contact forming said second switching means being connected through said

relay operated switch to said source of full voltage, said relay energized from the load side of said main switching means so that said source of full voltage is disconnected from said second switching means while said main switching means is closed.

3. An electric system according to claim 2 in which stepdown control voltage means is provided connected so as to be energized by the closing of said main switching means, and said relay operated switch is energized by said stepdown control voltage.

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