United States Patent

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[54] **MERCURY VAPOR LAMP WITH AUXILIARY LIGHT SOURCE**

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[51] **Int. Cl.**.....**H05b 37/02,** H05b 39/04

[58] **Field of Search**.....315/154, 156, 159, 157, 155, 315/149, 151, 153, 92, 90

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[57] **ABSTRACT**

An auxiliary lamp is energized to illumination in response to a mercury vapor lamp being energized to less than full illumination because of either a cold start or a hot start condition existing in the mercury vapor lamp. The mercury vapor lamp is energized from an a.c. source through a ballast circuit including a capacitor. In response to the a.c. voltage across the mercury vapor lamp being less than a predetermined magnitude, as exists during cold start condition, or in response to the capacitor a.c. voltage being less than a predetermined magnitude, as exists in response to hot start conditions, a switch having an a.c. control terminal is closed to enable activation of the auxiliary lamp. In certain embodiments, voltage detectors for the mercury lamp and capacitor a.c. voltages are neon tubes optically coupled with photocells controlling the impedance between the a.c. source and the control electrode of a semiconductor switch, such as a triac. In another embodiment, the voltage detectors for the mercury vapor lamp and capacitor voltage are energizing coils of a.c. relays adapted to handle voltages having a substantial range without inducing chatter into contacts of the relays.

20 Claims, 3 Drawing Figures

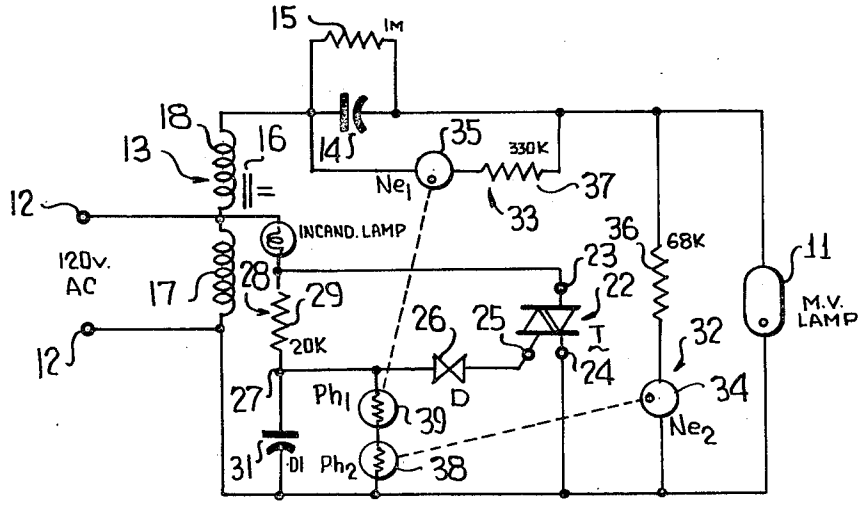


FIG. 1

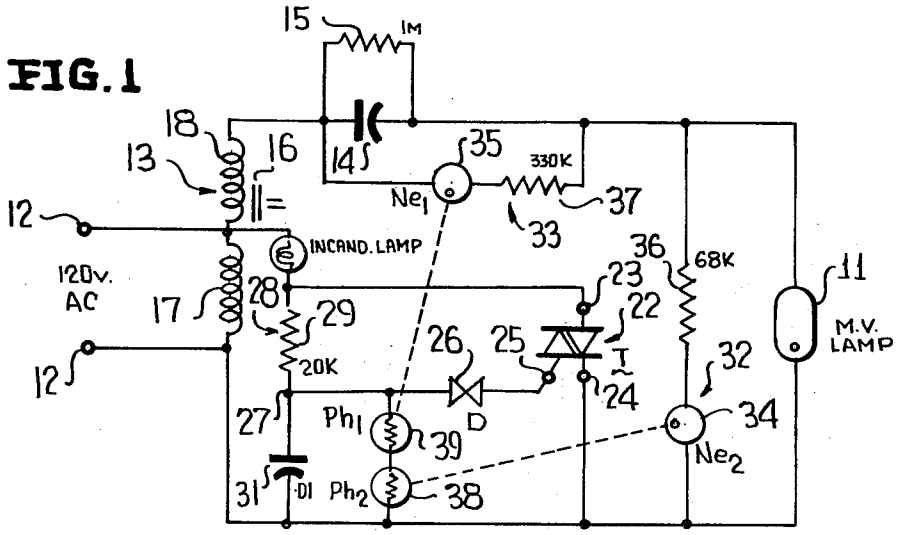


FIG. 2

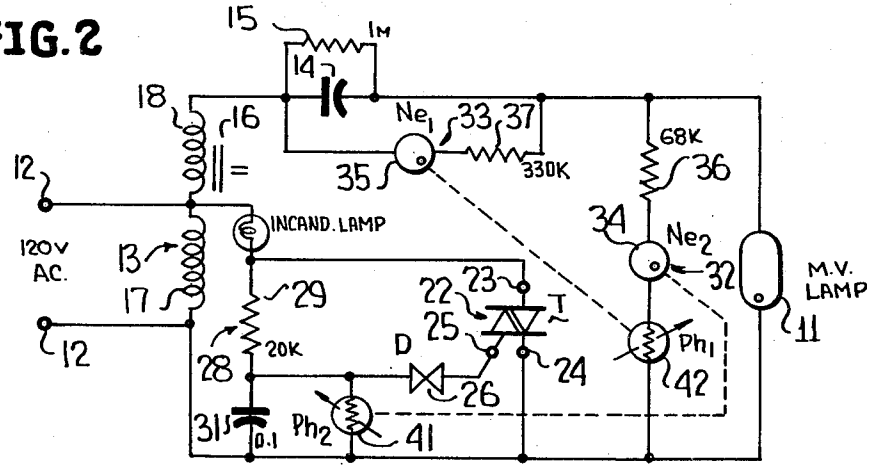
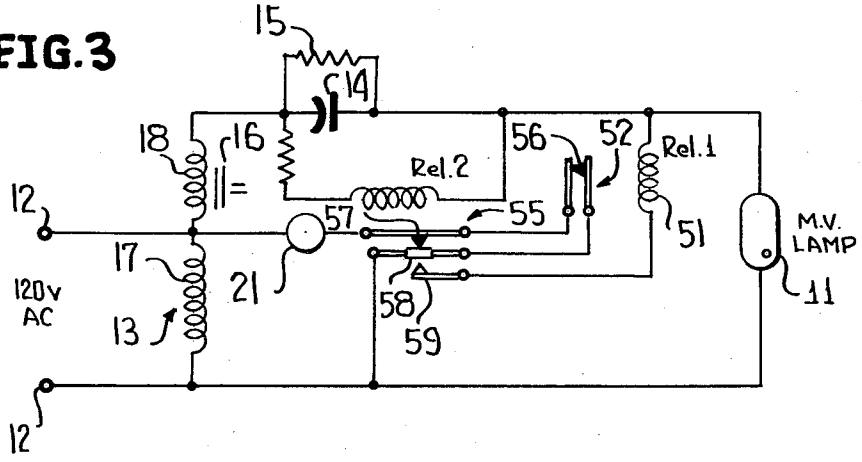


FIG. 3



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MERCURY VAPOR LAMP WITH AUXILIARY LIGHT SOURCE

FIELD OF THE INVENTION

The present invention relates generally to systems for energizing mercury vapor lamps and, more particularly, to a system for energizing an auxiliary lamp utilized in conjunction with a mercury vapor lamp, wherein the auxiliary lamp is energized in response to the mercury vapor lamp being in either a cold start or hot start condition.

BACKGROUND OF THE INVENTION

Presently employed high pressure mercury vapor lamps of the type frequently employed for street lamps, in gymnasiums, and in stadiums, usually do not reach peak illumination levels until activated for several minutes by an a.c. source. These lamps are also characterized by a substantial decrease in illumination for several minutes in response to even a momentary interruption in the a.c. voltage applied to the mercury vapor lamp, as can occur in response to a momentary power shortage or in response to accidental open circuiting of a switch between the power source and mercury vapor lamp. The former and latter low illumination periods are frequently referred to in the art as cold start and hot start conditions, respectively.

Because of the low level illumination derived from a mercury vapor lamp during cold and hot start conditions, there have been numerous systems developed in the prior art to energize an auxiliary lamp, such as an incandescent lamp, during the cold and hot start periods. Some of these prior art systems have included timing circuits for controlling the energization of the auxiliary lamp, while others have included photocells responsive to the illumination level of the mercury vapor lamp. Both systems are seldom used due to technical difficulties encountered.

Another prior art system that has been developed includes circuitry for detecting the voltage levels across the mercury vapor lamp and a capacitor in a ballast circuit for driving the mercury vapor lamp. During cold start and prior to full illumination of the mercury vapor lamp, the voltage drop across the mercury vapor lamp is below a predetermined level, while the voltage across the capacitor is less than a predetermined level during hot start conditions. The prior art system includes first and second full wave rectifiers, respectively, having input terminals connected across the mercury vapor lamp and capacitor. The d.c. voltages derived by the first and second full wave rectifiers drive coils of first and second single pole, single throw d.c. relays having contacts in circuit with the auxiliary lamp. In response to the voltage level across the mercury vapor lamp or capacitor dropping below predetermined levels, one of the d.c. relay coils is deactivated in such a manner as to close its contacts and connect the auxiliary lamp in circuit with an a.c. supply source.

The prior art system has been found to be relatively expensive, primarily because of the requirement for a pair of full wave rectifiers capable of operating at high voltages. In the prior art system, it was felt that full wave rectifiers were required because of the considerable voltage range which may exist across either the mercury vapor lamp or capacitor. For one particular

frequently utilized mercury vapor lamp powered by a 120 volt a.c. source through a typical circuit including a saturable reactor and ballast capacitor, the voltage applied to the mercury vapor lamp is approximately 15 volts immediately after the application of power to the saturable reactor during cold start conditions and, thereafter, builds up gradually over a time period of several minutes, approximately 5 minutes, to approximately 135 volts. During the entire cold start condition and while the mercury vapor lamp is illuminated during normal operation, the a.c. voltage across the ballast capacitor is approximately 420 volts. During hot start conditions, there is initially a very low voltage, on the order of 10 volts, across the ballast capacitor, while a voltage of approximately 270 volts initially exists across the mercury vapor lamp. After several minutes, approximately 3 minutes, have elapsed the mercury vapor lamp again restrikes, and illumination therefrom begins to increase. Full illumination of the mercury vapor lamp, however, is not achieved until several additional minutes have elapsed. At full illumination 420 volts is developed across the capacitor electrodes and approximately 135 volts is developed across the mercury vapor lamp.

In the prior art device, this extremely wide range of voltages was handled by employing relatively expensive full wave rectifiers in combination with d.c. relays. This expensive arrangement, however, suffers from certain problems because a voltage of 270 volts is developed across the mercury vapor lamp during hot start conditions. The 270 volt level across the mercury vapor lamp is coupled through one of the full wave rectifiers to the coil of one of the d.c. relays which is set to trip at approximately 100 volts. Thereby, an overvoltage of approximately 170 volts is developed across one of the relay coils each time a hot start condition exists. The overvoltage on the relay coil has a tendency to reduce the life expectancy of the circuit.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

In accordance with the present invention, a system for energizing an auxiliary lamp to illumination while a mercury vapor lamp is in either a cold start or hot start condition includes detectors for the a.c. voltages across the mercury vapor lamp and ballast capacitor. The a.c. voltage detectors do not include rectifiers and are not adversely affected by the 270 volt a.c. potential developed across the mercury vapor lamp during hot start conditions.

In accordance with certain embodiments of the invention, the a.c. voltage detectors include neon bulbs connected in circuits in parallel with the mercury vapor lamp and ballast capacitor. In response to the a.c. voltages across the mercury lamp and ballast capacitor exceeding a predetermined level during each half cycle of the a.c. excitation for the mercury vapor lamp, the neon bulbs are ionized. Each neon bulb is optically coupled with a different photoresistor that controls the voltage applied to a control electrode of a solid state switching device, such as a triac. A path of the switching device is connected in series circuit with an auxiliary lamp and a.c. supply so that the auxiliary lamp is energized in response to one of the neon bulbs being extinguished, as occurs in response to either cold start

or hot start conditions. To provide the proper phase relationship for energization of a triac semiconductor switch in response to the light emitted by the neon bulbs during each half cycle of the a.c. source while the mercury vapor lamp is energized to full illumination, the gate electrode of the triac is connected to the a.c. excitation source via a bilateral, two element switching device and a phase shifting network. In one embodiment, the two photoresistors are connected in series with each other and in shunt with the triac gate electrode. In a second embodiment, the photoresistor responsive to the neon bulb detecting the ballast capacitor voltage is connected in series with the neon bulb detecting the mercury vapor lamp voltage, whereby the 270 volts across the mercury vapor lamp during hot start conditions is decoupled from the neon bulb detecting the mercury vapor lamp voltage. The neon tube shunting the mercury vapor lamp is optically coupled with a photoresistor shunting the gate electrode of the triac. In both of these embodiments, neon bulb photoresistor combinations establish desired voltage isolation between the various detecting and sensing elements.

In accordance with still another embodiment of the invention, coils of first and second a.c. relays are connected to be responsive to the voltages developed across the ballast capacitor and mercury vapor lamp. Contacts of the relay connected across the ballast capacitor are of the single pole, double throw type, while contacts of the relay sensing the mercury vapor lamp voltage are of the single pole normally closed type. The single pole normally closed contacts are connected to the normally closed contacts of the single pole double throw relay, whereby during hot start conditions no overvoltage is applied to the relay coil utilized to sense the mercury vapor lamp voltage. The a.c. relays employed are of the type that do not chatter even though a relatively wide range of voltages is applied thereto.

A further feature of the invention concerns its universality in functioning with mercury vapor lamps having different wattages, provided they are energized by ballast saturable reactors having a 135 volt secondary winding. Since the vast majority of excitation systems employs ballast reactors having 135 volt secondaries, regardless of input voltage, there is usually no need to change component values for different a.c. supply voltages. For those systems employing ballast reactors with secondary voltages different from 135 volts or mercury vapor lamps having wattage ratings that cause changes in the detected voltages during hot start, cold start and normal operation, the mercury vapor lamp and capacitor voltage levels which cause energization of the switching means can be varied by suitably adjusting the values of resistors connected in circuit with the detecting neon bulbs or relay coils.

It is, accordingly, an object of the present invention to provide a new and improved system for energizing an auxiliary lamp in response to a mercury vapor lamp being in either a hot start or cold start condition.

Another object of the present invention is to provide a new and improved system for activating an auxiliary lamp utilized in conjunction with a mercury vapor lamp in response to low voltage conditions existing across the mercury vapor lamp during cold start or low voltage conditions existing across a ballast capacitor during hot start.

A further object of the invention is to provide a system for energizing an auxiliary lamp utilized in conjunction with a mercury vapor lamp by employing a switch means having an a.c. input terminal responsive to a.c. voltages developed across the mercury vapor lamp and a ballast capacitor.

Another object of the invention is to provide a new and improved solid state device for activating an auxiliary lamp utilized in conjunction with a mercury vapor lamp.

An additional object of the invention is to provide a new and improved system for activating an auxiliary lamp utilized in conjunction with a mercury vapor lamp wherein relatively high voltages developed across the lamp during hot start conditions cannot adversely affect operation of the system.

A further object of the invention is to provide a system for activating an auxiliary lamp during hot start and cold start conditions of a mercury vapor lamp, wherein the relatively high voltage developed across the mercury vapor lamp during hot start conditions is effectively decoupled from control circuits for a switch controlling activation of the auxiliary lamp.

Still another object of the invention is to provide a new and improved circuit for activating an auxiliary lamp while a mercury vapor lamp is in a cold start or hot start condition, which system is relatively inexpensive, simple and adapted for extremely widespread use without substantial modification despite the wattage of the mercury vapor lamp or voltage of an a.c. power source powering the lamp.

Yet another object of the invention is to provide a new and improved circuit for energizing an auxiliary lamp while a mercury vapor lamp is in a hot start or cold start condition, which circuit is adaptable for use with ballast saturable reactors having different voltages by adjusting the values of resistors connected in circuit with sensing elements.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of several specific embodiments thereof, especially when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1** and **2** are schematic diagrams of two different solid state embodiments of the present invention; and

FIG. **3** is a circuit diagram of a relay embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIG. **1** of the drawings wherein high pressure mercury vapor lamp **11** is illustrated as being energized by a 120 volt, 60 Hz a.c. source connected to terminals **12**. Terminals **12** are connected to mercury vapor lamp **11** via the usual circuit including saturable reactor transformer **13** and a ballast circuit comprising capacitor **14** and shunt resistor **15**. Capacitor **14** is series resonant with reactor **13** at 60 Hz and lamp **11** exhibits negative impedance properties so that voltages across the various circuit

elements may exceed the voltage applied to the circuit by reactor 13. Saturable reactor 13 includes a saturable core 16, as well as a primary winding 17 connected between terminals 12 and a secondary winding 18, connected in series with winding 17. Typically, the voltage developed across the series combination of windings 17 and 18 is 135 volts a.c. The windings of saturable reactor transformers 13 that might be employed are generally designed so that regardless of the specific input voltage for which it is designed, the 135 volt potential subsists across them when the input voltage is applied to terminals 12.

As is well known, the mercury vapor lamp 11 does not reach full illumination until several minutes, approximately five minutes, after a.c. power is applied to terminals 12. In addition, if power is removed from terminals 12, even instantaneously, when the bulb has been operated for some time and it is hot, there is no light output from the mercury vapor lamp 11 for several minutes. These periods of mercury vapor lamp 11 operation are respectively referred to as cold start and hot start conditions.

For a typical 400 watt mercury vapor lamp, during cold start conditions the voltage across capacitor 14 remains relatively constant, at approximately 420 volts. The voltage across mercury vapor lamp 11, however, is initially approximately 15 volts immediately after an a.c. source is applied to terminals 12. The voltage across mercury vapor lamp 11 gradually and monotonically increases to approximately 135 volts after approximately 5 minutes has elapsed from the time power is applied to terminals 12. With a voltage of 135 volts subsisting across mercury vapor lamp 11 and 5 minutes having elapsed from the time power is initially applied to terminals 12, full illumination is derived from the mercury vapor lamp.

During hot start conditions, immediately after the restoration of power to terminals 12 there is approximately a 270 volt drop across mercury vapor lamp 11 and no voltage across capacitor 14. Approximately 5 minutes after power is reapplied to terminals 12 during the hot start conditions, the voltage across capacitor 14 again reaches a level of approximately 420 volts, while the mercury vapor lamp voltage gradually increases to approximately 135 volts a.c. Each of these voltage variations is monotonic. It is to be understood that the range of voltages may be different for mercury vapor lamps having different wattages but that the principles of operation for these different wattage ratings are the same as described herein for a 400 watt lamp.

To provide illumination while mercury vapor lamp 11 is in either a cold start or hot start condition, auxiliary lamp 21 is provided. Lamp 21 is preferably of the incandescent type although other types of lamps that are energized to full illumination substantially instantaneously can be employed. While only one incandescent lamp is illustrated, it is to be understood that additional incandescent lamps, either connected in series or in parallel with lamp 21, can be employed.

Incandescent lamp 21 is connected between terminals 12 in an energization circuit including an a.c. controlled electronic switch 22, preferably a four layer silicon controlled switch, such as a triac or its equivalent, a pair of back-to-back silicon controlled rectifiers having their gate electrodes connected together. A triac, as is well known, can conduct symmetrically in either direction between electrodes 23 and 24, and therefore, is capable of conducting during each half cycle of the a.c. source connected to terminals 12. Triac 22 includes a gate electrode 25, connected through diac 26 to tap 27 of phase lag network 28 that includes resistor 29 and capacitor 31 connected between terminals 12. Diac 26 is a symmetrically conducting semiconductor device having threshold conducting properties. Thereby during each half cycle of the a.c. voltage applied to terminal 12, diac 26 is capable of conducting and supplying sufficient voltage to electrode 25 to enable triac 22 to be rendered into a conducting state. Triac 22, once energized into a conducting state during each half cycle of the a.c. source, remains in the conducting state until the voltage between electrodes 23 and 24 drops to zero.

Conduction of triac 22 and activation of lamp 21 are in response to the voltages developed across mercury vapor lamp 11 and capacitor 14. In response to the voltage across mercury vapor lamp 11 indicating that the mercury vapor lamp is in a cold start condition or in response to the voltage across capacitor 14 indicating that the mercury vapor lamp is in a hot start condition, the voltage at tap 27 is coupled to gate electrode 25 to activate triac 22 into a conducting state and energize incandescent lamp 21 to illumination.

To these ends, the voltages across mercury vapor lamp 11 and capacitor 14 are detected by neon bulb circuits 32 and 33. Circuits 32 and 33 include virtually identical neon bulbs 34 and 35, respectively, connected in series with resistors 36 and 37. The values of resistors 36 and 37 are selected to control the ionization voltages of neon lamps 34 and 35. With a 400 watt mercury vapor lamp, neon bulb 34 is triggered into a conducting state in response to at least 90 volts a.c. subsisting across mercury vapor lamp 11, while neon bulb 35 is triggered into a conducting state in response to at least 400 a.c. subsisting across capacitor 14. Thereby, during each half cycle of a.c. source 12 while lamp 11 is activated to full illumination and the voltages across lamp 11 and capacitor 14 are greater than 90 volts a.c. and 400 volts a.c., neon bulbs 34 and 35 are triggered into a conducting state.

During cold start conditions, the a.c. voltage across lamp 11 is insufficient to cause ignition of neon bulb 34 during either of the half cycles of a.c. source 12. During hot start conditions, the relatively high voltage of approximately 270 volts that subsists across mercury vapor lamp 11 has virtually no effect on the operation of neon bulb 34 relative to the operation of the neon bulb during normal operation. In contrast, the low voltage across capacitor 14 during hot start conditions causes neon bulb 35 to become extinguished and remain extinguished until full illumination of mercury vapor lamp 11 occurs, at which time the a.c. voltage across capacitor 14 again reaches a level of approximately 420 volts. During cold start conditions, neon bulb 35 is ionized during each half cycle of the a.c. source connected to terminals 12 because the voltage across capacitor 14 remains relatively constant at approximately 420 volts.

The light emitting characteristics of neon bulbs 34 and 35 are utilized to control conduction of triac 22 and energization of incandescent lamp 21. In the em-

bodiment of FIG. 1, this result is achieved by connecting photoresistors 38 and 39, respectively coupled by separate optical paths to neon bulbs 34 and 35, in series circuit with each other and in shunt with capacitor 31. By optically coupling the voltage indicating glow conditions of neon bulbs 34 and 35 to photoresistors 38 and 39 the need for voltage transformation devices is completely obviated.

Photoresistors 38 and 39 are extremely high impedances when not illuminated by optical energy. In response to optical energy being coupled to one of photoresistors 38 and 39 in response to ionization of one of neon bulbs 34 and 35, the impedance of the illuminated photoresistor drops materially so that it becomes a relatively highly conductive device. Thereby, in response to both neon bulbs 34 and 35 being activated into an ionized state during each half cycle of the a.c. source connected to terminals 12, as exists during normal operation of mercury vapor lamp 11, a low impedance path is provided across capacitor 31 so that the voltage across capacitor 31 is maintained at a relatively low level during each half cycle of the a.c. source. The ionization times of neon bulbs 34 and 35 are such that the phase shifted voltage across capacitor 31 never has sufficient potential to be coupled through diac 26 to control electrode 25 at a time when the voltage between electrodes 23 and 24 permits energization of triac 22 into a low impedance state. Thereby, during normal operation, triac 22 is never fired so that incandescent lamp 21 does not consume power and does not serve as a source of illumination.

In response to either a cold start or hot start condition occuring, as detected by one of neon bulbs 34 or 35 being in a deionized state for a complete half cycle, the impedance of one of photoresistors 38 or 39 is maintained at a high level during each half cycle of the a.c. source connected to terminals 12. The high impedance of one of photoresistors 38 or 39 enables the voltage across capacitor 31 to be maintained at a relatively high level during each half cycle of the a.c. source. The relatively high voltage level across capacitor 31, at tap 27, is coupled during each half cycle through diac 26 to gate electrode 25 of triac 22 to ignite the triac into a conducting state. Triac 22 remains in a conducting state until the half cycle of the a.c. source has been completed, at which time the voltage between electrodes 23 and 24 changes polarity and the triac cuts off. Due to the phase shifting properties of network 28, triac 22 is rendered into a conducting state with a relatively high duty cycle, to enable maximum illumination to be derived from incandescent lamp 21.

Reference is now made to FIG. 2 of the drawing wherein the circuit of FIG. 1 is modified to provide an alternative connection for the photoresistors responsive to voltage detecting neon bulbs 34 and 35. In the circuit of FIG. 2, photoresistor 41, optically coupled to neon bulb 34, is connected in shunt with capacitor 31, while photoresistor 42, optically coupled with neon bulb 35, is connected in series with neon bulb 34 and resistor 36. This circuit enables the a.c. potential across mercury vapor lamp 11 during hot start conditions, which may be as high as 270 volts, to be decoupled from neon bulb 35.

In normal operation, neon bulb 35 is energized to an ionized condition during each half cycle of the a.c. source to provide a low impedance for photoresistor 42, whereby neon bulb 34 can become ionized during each half cycle of the a.c. source. In response to ionization of neon bulb 34 during each half cycle of the a.c. source, photoresistor 41 is activated into a low impedance state to prevent triggering of triac 22, whereby incandescent lamp 21 is deenergized. During cold start conditions, neon bulb 35 is activated to an ionized state during each half cycle of the a.c. source whereby the impedance of photoresistor 42 is sufficiently low to enable ionization of neon bulb 34. Neon bulb 34, however, is not ionized during cold start conditions because of the low voltage subsisting across the terminals of mercury vapor lamp 11. Thereby, photoresistor 41 is in a high impedance state and the substantial a.c. voltage developed across capacitor 31 is coupled through diac 26 to gate electrode 25 of triac 22. Hence, during each half cycle of the a.c. source applied to terminals 12, triac 22 is rendered into a conducting state and lamp 21 is energized to illumination. During hot start conditions, the voltage across capacitor 14 is insufficient to enable neon lamp 35 to become ionized whereby photoresistor 42 has such a high impedance that substantial current cannot flow through neon bulb 34, so the bulb cannot be ionized despite the high voltage of approximately 270 volts a.c. subsisting across mercury vapor lamp 11. Since neon lamp 34 is deionized, the impedance of photoresistor 41 remains at a relatively high level and triac 22 is energized.

Reference is now made to FIG. 3 of the drawings wherein still another embodiment of the invention is disclosed. In FIG. 3, detectors for the magnitudes of the a.c. voltages across mercury vapor lamp 11 and capacitor 14 comprise coil 51 of a.c. relay 52 and a series circuit comprising voltage dropping resistor 53 and coil 54 of a.c. relay 55. Resistor 53 determines the a.c. voltage of capacitor 14 required to trip relay 55 into an energized state. Preferably, relays 52 and 54 are of the type that do not chatter despite gradually increasing a.c. voltages; such relays are manufactured by Essex International. Relay 52 is of the single pole, single throw type and includes normally closed contacts 56. Relay 55 is of the single pole, double throw type including normally closed contacts 57 and 58, as well as normally open circuited contacts 58 and 59. In response to energization of relay coil 51, contacts 56 are open circuited; in response to energization of coil 54, normally closed contacts 57 and 58 are open circuited, and a closed circuit is formed between contacts 58 and 59.

Contacts 56–59 of the a.c. relay circuit are connected in an energization circuit for auxiliary lamp 21 in a manner analogous to the connection of triac 22 to lamp 21 in FIGS. 1 and 2. The use of the single pole, double throw relay 55 has a particular advantage of preventing excessively high voltages from being applied to coil 51 of relay 52 during hot start conditions whereby the life of relay 52 is prolonged.

In normal operation, when the a.c. voltage across mercury vapor lamp 11 exceeds 90 volts and the a.c. voltage across capacitor 14 exceeds 400 volts, while full illumination from lamp 11 occurs, the voltages applied to coils 51 and 54 are sufficient to enable both relays 52 and 55 to be energized. In response to the voltage across capacitor 14 being approximately 420 volts a.c. (as occurs during normal operation), the a.c.

voltage across coil 54 causes relay 55 to be energized whereby contacts 58 and 59 are closed and contacts 57 and 58 are open circuited. With contacts 58 and 59 closed, coil 51 senses the voltage across mercury vapor lamp 11 as being greater than 90 volts to energize relay 52 and open circuit contacts 56. Thereby, incandescent lamp 21 is open circuited from the a.c. source connected to terminals 12 and is not energized to illumination.

During cold start conditions the voltage across capacitor 14 is about 420 volts so relay 55 is energized to close contacts 58 and 59. The voltage across mercury vapor lamp 11, however, during cold start conditions, is insufficient to enable relay 52 to be energized, whereby, contacts 56 are activated to their normally closed state. In response to contacts 56 being closed, as well as contacts 58 and 59 being closed, current from the a.c. source connected to terminals 12 flows through incandescent lamp 21 and the lamp is energized to full illumination, as a substitute fro mercury vapor lamp 11.

During hot start conditions, the voltage across relay coil 54 is insufficient to cause energization of relay 55, whereby contacts 57 and 58 are closed. In response to closure of contacts 57 and 58, relay coil 51 is disconnected from the terminals of mercury vapor lamp 11 whereby the relatively high voltage of 270 volts that exists across the mercury vapor lamp is decoupled from coil 51. Thereby, the flow of current through coil 51 is prevented and the coil is not subjected to voltages exceeding its voltage rating during hot start conditions. During hot start conditions, incandescent lamp 21 is energized to illumination by virtue of contacts 57 and 58 being closed.

While there has been described and illustrated several specific embodiments of the invention, it will be clear that variations in the details of the embodiments specifically illustrated and described may be made without departing from the true spirit and scope of the invention as defined in the appended claims. For example, for mercury vapor lamps having ratings other than 400 watts the values of resistors 36 and 37 are selected in a manner to provide desired voltage detection levels for mercury vapor lamp 11 and capacitor 14 in the embodiments of FIGS. 1 and 2. In the embodiment of FIG. 3, a dropping resistor can be connected in circuit with coil 51 and the value of resistor 53 can be appropriately adjusted to provide desired detection voltages for mercury vapor lamp 11 and capacitor 14.

I claim:

1. A system for activating an auxiliary lamp to illumination in response to a mercury vapor lamp being supplied with power from an a.c. source but not energized to full illumination because of either a cold start or hot start condition thereof, said mercury vapor lamp being energized from said a.c. source by a ballast circuit including a capacitor connected between the a.c. source and mercury vapor lamp, said auxiliary lamp being activated to full illumination substantially immediately after energizing voltage being applied thereto, comprising an energization circuit for connecting said auxiliary lamp to said a.c. source, switch means having a path in said energization circuit in series between the source and auxiliary lamp for selectively connecting the auxiliary lamp to the a.c. voltage source, said switch means including control circuitry activating the switch means in response to the amplitude of the voltage applied thereto exceeding a predetermined level, said control circuitry including means for activating the switch means to an open circuit condition in response to the mercury vapor lamp being energized by the a.c. source to full illumination and to a closed circuit condition in response to the mercury vapor lamp being supplied by the a.c. source but not energized to full illumination because of hot and cold start conditions, said last named means comprising: first voltage detection means responsive to the a.c. voltage magnitude across the mercury vapor lamp for closing the switch means in response to the a.c. voltage magnitude across the mercury vapor lamp being less than a first predetermined level, said first predetermined level being less than the mercury vapor lamp voltage during full illumination of the mercury vapor lamp, and second voltage detection means responsive to the a.c. voltage magnitude across the capacitor for closing the switch means in response to the a.c. voltage magnitude across the capacitor dropping below a second predetermined level, said second predetermined level being less than the voltage across the capacitor during full illumination of the mercury vapor lamp, and means for providing a substantially open circuit to the flow of current through the first voltage detection means in response to a hot start condition being sensed.

2. The system of claim 1 wherein the open circuit providing means includes means responsive to the a.c. voltage magnitude across the capacitor dropping below the first predetermined level.

3. The system of claim 2 wherein the open circuit providing means includes means having high and low impedance states connected in series with the first voltage detection means, said high and low impedance states respectively occurring in response to the capacitor voltage being below and above the first predetermined level.

4. The system of claim 3 wherein the means having high and low impedance states comprises a first pair of contacts of a first relay having a voltage sensing coil connected in circuit across the capacitor.

5. The system of claim 3 wherein the first and second voltage detection means comprises first and second neon bulbs connected in different circuits across the mercury vapor lamp and capacitor to be activated to an ionized state in response to the mercury vapor lamp capacitor voltages respectively exceeding the first and second predetermined levels, and said means having high and low impedance states comprises a photoresistor connected in series with the first neon bulb and optically coupled to the second neon bulb.

6. The system of claim 4 wherein the first relay includes a second pair of contacts closed only while the first pair of contacts is open circuited, said first and second pairs of contacts being selectively connected in said energization circuit.

7. The system of claim 5 wherein the first voltage detection means comprises a voltage sensing coil of a second relay having a third pair of normally closed contacts, said third pair of contacts being connected in circuit with the first pair of contacts.

8. A system for activating an auxiliary lamp to illumination in response to a mercury vapor lamp being

supplied with power from an a.c. source but not energized to illumination because of either a cold start or a hot start condition thereof, said mercury vapor lamp being energized from said a.c. source by a ballast circuit including a capacitor connected between the a.c. source and mercury vapor lamp, said auxiliary lamp being energized to full illumination substantially immediately after application of power thereto, comprising an energization circuit for connecting said auxiliary lamp to said a.c. source, switch means having a path in said energization circuit in series between the source and auxiliary lamp for selectively connecting the auxiliary lamp to the a.c. voltage source, said switch means including a control terminal for activating the switch means into a conducting state in response to the amplitude of the voltage applied thereto exceeding a predetermined level, a first neon bulb circuit connected in parallel with said mercury vapor lamp, a second neon bulb circuit connected in parallel with the ballast circuit capacitor, the neon bulbs of said first and second neon bulb circuits being triggered into an ionized condition in response to the a.c. voltages across the mercury vapor lamp and ballast capacitor, respectively, exceeding predetermined voltage levels, and means responsive to ionization of either one of said neon bulbs for enabling a voltage exceeding the predetermined level to be applied to the control electrode of the switch means.

9. The system of claim **8** wherein the means for enabling includes photoresistor means optically coupled to said neon bulbs and in circuit with the control electrode of the switch means for controlling the voltage applied to the control electrode.

10. The system of claim **9** wherein the photoresistor means includes first and second photoresistors respectively optically coupled to said first and second neon bulbs.

11. The system of claim **10** wherein the first and second photoresistors are connected in series with each other.

12. The system of claim **10** wherein the first photoresistor is connected in circuit with the control electrode, and the second photoresistor is connected in series circuit with first neon bulb.

13. The system of claim **11** wherein the series connected photoresistors are connected in shunt with the control electrode.

14. The system of claim **12** wherein the first photoresistor is connected in shunt with the control electrode.

15. The system of claim **8** wherein the switch means is a silicon controlled switch, the control terminal of the switch being connected to the a.c. source by a phase lag circuit.

16. The system of claim **15** further including a voltage threshold switching element connected in circuit with the control terminal to be responsive to a.c. voltage derived from the phase lag circuit.

17. The system of claim **16** wherein the means for enabling includes photoresistor means optically coupled to said neon bulbs and in shunt with the control electrode of the switch means for controlling the voltage applied to the control electrode.

18. The system of claim **17** wherein the silicon controlled switch is a symmetrical conductor.

19. A system for activating an auxiliary lamp to illumination in response to a mercury vapor lamp being supplied with power from an a.c. source but not energized to illumination because of either a cold start or a hot start condition thereof, said mercury vapor lamp being energized from said a.c. source by a ballast circuit including a capacitor connected between the a.c. source and mercury vapor lamp, said auxiliary lamp being energized to full illumination substantially immediately after application of power thereto, comprising an energization circuit for connecting said auxiliary lamp to said a.c. source, switch means having a path in said energization circuit in series between the source and auxiliary lamp for selectively connecting the auxiliary lamp to the a.c. voltage source, said switch means including a single control terminal for activating the switch means into a conducting state in response to the amplitude of the voltage applied thereto exceeding a predetermined level, means for normally maintaining the control terminal bias at a voltage less than the predetermined level, means responsive to the a.c. voltage magnitude across the mercury vapor lamp for increasing the bias level applied to the control terminal above the predetermined level in response to the a.c. voltage magnitude across the mercury vapor lamp dropping below a predetermined level associated with cold start conditions, and means responsive to the a.c. voltage magnitude across the capacitor for increasing the bias level applied to the control terminal above the predetermined level in response to the a.c. voltage magnitude across the capacitor dropping below a predetermined level associated with hot start conditions.

20. A system for activating an auxiliary lamp to illumination in response to a mercury vapor lamp being supplied with power from an a.c. source but not energized to full illumination because of either a cold start or hot start condition thereof, said mercury vapor lamp being energized from said a.c. source by a ballast circuit including a capacitor connected between the a.c. source and mercury vapor lamp, said auxiliary lamp being activated to full illumination substantially immediately after energizing voltage being applied thereto, comprising an energization circuit for connecting said auxiliary lamp to said a.c. source, an a.c. activated switch having a path in said energization circuit in series between the source and auxiliary lamp for selectively connecting the auxiliary lamp to the a.c. voltage source, control circuitry for said switch responsive to both polarities of the a.c. source for activating the switch in response to the amplitude of the a.c. voltage applied thereto exceeding a predetermined level, said control circuitry including means for activating the switch means to an open circuit condition in response to the mercury vapor lamp being energized by the a.c. source to full illumination and to a closed circuit condition in response to the mercury vapor lamp being supplied by the a.c. source but not energized to full illumination because of hot and cold start conditions, said last named means comprising: first a.c. voltage detection means responsive to the a.c. voltage magnitude across the mercury vapor lamp for closing the switch in response to the a.c. voltage magnitude across the mercury vapor lamp being less than a first predetermined level, said first predetermined level being less than the

mercury vapor lamp voltage during full illumination of the mercury vapor lamp, and second a.c. voltage detection means responsive to the a.c. voltage magnitude across the capacitor for closing the switch in response to the a.c. voltage magnitude across the capacitor dropping below a second predetermined level, said second predetermined level being less than the capacitor voltage during full illumination of the mercury vapor lamp.

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