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PHOTOCONTROL DEVICE FOR GASEOUS DISCHARGE LAMPS

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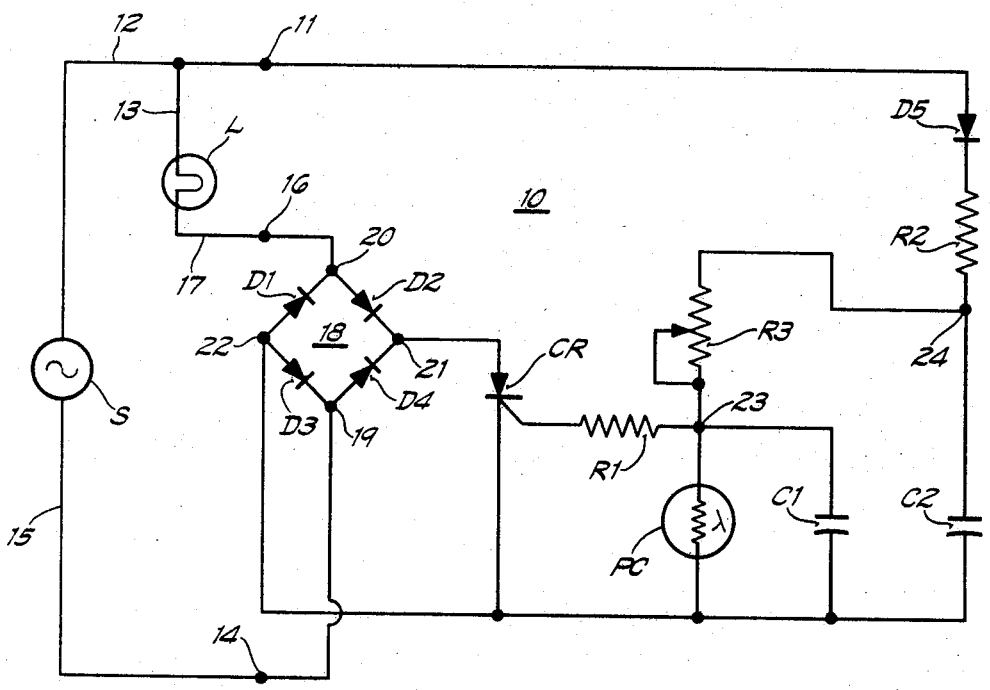

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PHOTOCONTROL DEVICE FOR GASEOUS DISCHARGE LAMPS

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ABSTRACT OF THE DISCLOSURE

A photocontrol for a gaseous discharge type lamp, including a bridge rectifier connected to an alternating current source and a controlled rectifier having anode and cathode terminals in circuit between the bridge rectifier and the lamp. A photocell whose resistance varies with ambient illumination is connected to the controlled rectifier gate, a first capacitive circuit is coupled to the source for providing a substantially constant potential to the photocell and a second capacitor is connected in shunt with the photocell for holding the voltage thereacross at a value which is slightly in excess of the controlled rectifier firing potential once the controlled rectifier has operated.

This invention relates to photocontrol devices and, more particularly, to a completely static photocontrol for outdoor lighting devices.

Prior art photocontrol devices generally employ thermal or magnetic relays which are in circuit wtih a photocell and are constructed and arranged to close contacts to complete a lamp energizing circuit when the ambient light intensity falls below a predetermined level. These relays had contact making and breaking devices which had a tendency to become worn or burn out after repeated operations.

It is an object of the invention to provide a new and improved photocontrol device.

Another object of the invention is to provide a completely static photocontrol.

Yet another object of the invention is to provide a static photocontrol usable with metallic vapor lamps.

A still further object of the invention is to provide a photocontrol which does not employ contact making and breaking devices.

A more specific object of the invention is to provide a solid state switching device having output elements in circuit with the lamp being controlled and a control element in circuit with a photosensitive impedance and circuit means for providing a substantially constant potential to the photosensitive impedance wherein the static switching element will become conductive to pass current to the lamp when the level of ambient illumination reached a predetermined value.

These and other objects and advantages of the instant invention will become more apparent from the detailed description thereof taken with the accompanying drawing which schematically ilustrates the photocontrol according to the instant invention.

Referring to the drawing in greater detail, a photocontrol device **10**, according to the instant invention, is illustrated for connecting and disconnecting a lamp L to an alternating current energy source S. The photocontrol device **10** is provided with a first terminal **11** connected by conductors **12** and **13** to the energy source S and the lamp L, respectively, a second terminal **14** connected by the conductor **15** to the other side of the energy source S and a third terminal **16** connected by conductor **17** to the other side of the lamp L.

The photocontrol **10** also includes a bridge type rectifier **18** comprising diodes D1, D2, D3 and D4 and whose

input terminals **19** and **20** are connected to the photocontrol terminals **14** and **16**, respectively. The positive and negative output terminals **21** and **22** of the rectifier **18** are respectively connected to the anode and cathode of a controlled rectifier CR.

The photocontrol **10** also includes a photocell PC which in the preferred embodiment is of the negative photosensitive resistance type and may be composed of any suitable material whose resistance varies inversely with the intensity of ambient illumination to which the photocell is exposed, such as cadmium sulfide, lead sulfide or selenium. One terminal of the photocell PC is connected to the gate electrode of the controlled rectifier CR by a resistance R1 and its other terminal is connected to the negative output terminal **22** of full wave rectifier **18**. A first capacitor C1 shunts the photocell PC and a second capacitor C2 is connected in series with a resistor R2 and a diode D5 and the combination is connected between the photocontrol terminal **11** and the negative terminal **22** of the rectifier **18**. A potentiometer R3 connects the junction **23** between the photocell PC and the capacitor C1 with the junction **24** between the capacitor C2 and the resistor R2.

It will be recalled that the photocontrol terminals **11** and **14** are connected directly across the source S by conductors **12** and **15** and that capacitor C2 is connected in series with the photocontrol terminals **11** and **14** through a path defined by the diode D5, resistor R2 and diode D3 of the bridge rectifier **18**. During every positive half cycle of the source S, current charging will therefore flow to capacitor C2 through a path defined by conductor **12**, diode D5, resistor R2, capacitor C2, diode D3 and conductor **15**. Diodes D3 and D5 act to block negative current flow to capacitor C2 during the negative half cycle of the source S. As a result, capacitor C2 will be charged to peak line voltage during every positive half cycle of the source S. Although capacitor C2 discharges slightly during the negative half cycle, it will appear as a substantially constant voltage source to the adjustable resistor R3 and the photocell PC. The resulting current flow through resistor R3 and photocell PC will cause a potential to appear at point **23** which is proportional to the resistance of PC.

The current path between the source S and the lamp L during the positive half cycle, taking conductor **12** as a reference point, is defined by the conductors **12**, **13** and **17**, diode D2, controlled rectifier CR, diode D3 and conductor **15**. During the negative half cycle, the current path from the source S through the lamp L is defined by conductor **15**, diode D4, controlled rectifier CR, diode D1 and conductors **17**, **13** and **12**. It can therefore be seen that when the controlled rectifier CR is not conductive, the lamp L is open-circuited.

During daylight hours, the resistance of the photocell PC will be relatively small, so that a relatively low potential will appear at the terminal **23**. The parameters of the various circuit elements are chosen so that this potential will be smaller than the firing potential of the controlled rectifier CR. As a result, the controlled rectifier CR will be nonconductive so that an open circuit will exist between the output terminals **21** and **23** of the bridge-type rectifier **18**.

It will be recalled that the resistance of the photocell PC rises as the level of ambient illumination decreases. At some threshhold value, i.e., the turn-on value for the photocontrol **10**, the resistance of photocell PC will reach the point where the voltage drop across it resulting from the potential at point **24** will be equal to the firing potential of the controlled rectifier CR which will then become highly conductive to complete the circuit between terminals **21** and **22** of bridge rectifier **18**. As those skilled in the art will appreciate, once the controlled rectifier CR

is in its highly conductive state it will remain conductive as long as anode current continues to flow. Since the controlled rectifier CR is connected to the output of the bridge rectifier it will receive a pulsating current which passes through a current zero once every half cycle. In the absence of a sufficient gate signal this would cause the controlled rectifier CR to become nonconductive. However, because junction point **24** presents a substantially constant potential source, the potential at point **23** will be high enough to provide the required gate signal to the controlled rectifier CR during nighttime operation so that the controlled rectifier will be conductive whenever positive voltage appears at its anode.

During each positive half cycle of the source S after controlled rectifier CR has become conductive, current will flow from the conductor **12** through the lamp L, diode D2, controlled rectifier CR and diode D3. During the negative half cycle of the source S, current will flow from the conductor **15** to the lamp L through the diode D4, the controlled rectifier CR and the diode D1. It can be seen, therefore, that after the controlled rectifier CR has become conductive, current will flow through the lamp during each half cycle.

When the level of ambient illumination is just at the turn-on threshold value, the drop across photocell PC will just be sufficient to render controlled rectifier CR conductive. However, because the ambient illumination level may fluctuate as the result of transient conditions, such as drifting clouds, the photocell resistance will also fluctuate slightly. It is necessary, however, to prevent the controlled rectifier from being rendered nonconductive during these fluctuations because if the current to a mercury vapor lamp is interrupted once it has become operative, it cannot be relighted until it has cooled. The capacitor C1 is provided to hold the potential of junction point **23** above that necessary to maintain CR conductive.

When the controlled rectifier CR fires, its gate potential will rise slightly in excess of the gate potential required to render it conductive. This increase in potential causes a current flow from the gate of CR through R1 to charge capacitor C1 to this increased potential. When the pulsating unidirectional current through the anode and cathode of CR goes through a current zero after conduction has begun, therefore, the potential at point **23** will be in excess of the required gate potential so that CR will be rendered conductive as soon as the pulsating current begins rising from the current zero. Thus, the controlled rectifier CR is maintained conductive once the threshold illumination level is reached even though the resistance of the photocell PC may fluctuate slightly.

At dawn the level of ambient illumination will begin rising to decrease the resistance of photocell PC. At the turn-off level of ambient illumination the resistance of PC will have fallen to the point where it will provide a discharge path of sufficiently low resistance for capacitor C1 that at the next zero of the pulsating current through the anode and cathode of controlled rectifier CR, the potential of point **23** will fall below that required to fire CR and it becomes nonconductive.

It can thus be seen that because the controlled rectifier CR remains continuously conductive as long as the photocell resistance is above the threshold turn-off level once it has become conductive, the photocontrol **10** may be employed with metallic vapor-type lamps.

While only a single embodiment of the invention has been shown and described, it is not intended to be limited thereby but only by the scope of the appended claims.

I claim:

1. In a photocontrol device, the combination of a bridge rectifier having a pair of input terminals in circuit between a lamp being controlled and an AC source, a photocell characterized by a resistance which is functionally related to the level of ambient illumination, an electronic switching device having an input element and an output element in circuit between the output terminals of said bridge rectifier and a control element connected to said photocell, said switching device being characterized by a normally nonconductive state and by becoming highly conductive when a predetermined potential is applied to its control element, said switching device also being characterized by a control element voltage during conduction which is higher than said predetermined potential, a substantially constant potential source, reactive impedance means connected in parallel circuit relation with said photocell and the parallel circuit combination connected to said substantially constant potential source, said impedance means being operative for maintaining the potential on said control element at a value higher than said predetermined potential after conduction has commenced.

2. In a photocontrol device, the combination of a bridge rectifier having a pair of input terminals in circuit between a lamp being controlled and an AC source, a controlled rectifier, the anode and cathode of said controlled rectifier being in circuit between the output terminals of said bridge rectifier, a photocell connected to the gate and cathode of said controlled rectifier and being characterized by a resistance which varies with ambient illumination, a first capacitor, circuit means interconnecting said first capacitor and said AC source and constructed and arranged to provide a unidirectional current to said capacitor, an impedance connecting the said capacitor to said photocell and a second capacitor connected in shunt with said photocell.

3. In a photocontrol device, the combination of a bridge rectifier having a pair of input terminals in circuit between a lamp being controlled and a source of alternating electrical energy, a solid state switching circuit element having a pair of output electrodes and a control electrode and being constructed and arranged to go from a nonconductive state to a high conduction state when a predetermined potential is applied to its controlled electrode, the output electrodes of said switching circuit means being in circuit between the output terminals of said bridge rectifier, first circuit means including a resistance and photosensitive resistance means connected to said control electrode, first capacitance means, unidirectional circuit means connecting said first capacitance means to said source, said first capacitance means also being connected to said first circuit means for supplying potential energy thereto, the voltage drop across said photosensitive resistance means being equal to the breakover voltage of said switching circuit means at the threshold level of ambient illumination, and second capacitance means connected to said control electrode for maintaining the firing potential thereacross between alternations of said source once conduction has begun.

4. A photocontrol for connecting and disconnecting a lamp from a source of alternating electrical energy, a controlled rectifier, the anode and cathode of said controlled rectifier being in circuit between said lamp and said source of electrical energy, first circuit means connected between said lamp and said controlled rectifier for maintaining unitary directional current flow through said controlled rectifier as said electrical energy source alternates, second circuit means including photosensitive resistance means connected to the gate electrode of said controlled rectifier, third circuit means connected to said energy source and to said second circuit means for supplying unidirectional potential energy to said second circuit means to provide a voltage drop across said photosensitive resistance means, the voltage drop across said photosensitive resistance means being equal to the breakover voltage of said controlled rectifier at the threshold level of ambient illumination, and fourth circuit means connected to said gate electrode for maintaining the breakover voltage thereon between alternations of said source once conduction of said controlled rectifier has begun regardless of transient variations in the resistance of said photosensitive resistance means.

5. A photocontrol device having first, second and third output terminals, a bridge rectifier having a pair of input

terminals connected to said first and second photocontrol terminals, a controlled rectifier, the anode and cathode of said controlled rectifier being in circuit between the output terminals of said bridge rectifier, a photocell connected to the gate and cathode of said controlled rectifier and characterized by a resistance which varies with ambient illumination, a first capacitor, circuit means including a first resistor and unidirectional current means connecting said first capacitor in series circuit relation between said third photocontrol terminal and one of the output terminals of said bridge rectifier, a second resistor connecting the junction between said first resistor and said first capacitor to said photocell and a second capacitor connected in shunt with said photocell.

6. A photocontrol for connecting and disconnecting a lamp from a source of alternating electrical energy, a solid state switching circuit element having a pair of output electrodes and a control electrode and being constructed and arranged to go from a nonconductive state to a high conduction state when a predetermined potential is applied to its control electrode, the output electrodes of said switching circuit means being in circuit between said lamp and said source of electrical energy, first circuit means connected between said lamp and said switching circuit means for maintaining unitary directional current flow through said switching circuit means as said electrical energy source alternates, second circuit means including photosensitive resistance means connected to said control electrode, third circuit means connected to said energy source and to said photosensitive resistance means for supplying potential energy to said circuit means to provide a voltage drop across said photosensitive resistance means, the voltage drop across said photosensitive resistance means being equal to the breakover voltage of said switching circuit means at the threshold level of ambient illumination and fourth circuit means connected to said control electrode for maintaining the breakover voltage thereat between alternations of said source after conduction of said solid state switching circuit element has begun regardless of transient variations in the resistance of said photosensitive resistance means.

7. A photocontrol for connecting and disconnecting a lamp from a source of alternating electrical energy, a solid state switching circuit element having a pair of output electrodes and a control electrode and being constructed and arranged to go from a nonconductive state to a high conduction state when a predetermined potential is applied to its controlled electrode, the output electrodes of said switching circuit means being in circuit between said lamp and said source of electrical energy, first unidirectional circuit means connected between said lamp and said switching circuit means for maintaining unitary directional current flow through said switching circuit means as said electrical energy source alternates, photosensitive means connected to said control electrode and characterized by a resistance which varies with ambient illumination, first capacitance means, second unidirectional circuit means connecting said first capacitance means to said source, said first capacitance means also being connected to said photosensitive means for supplying current thereto, the voltage drop across said photosensitive means being equal to the breakover voltage of said switching circuit means at the threshold level of ambient illumination and second capacitance means connected to said control electrode means for maintaining the breakover voltage thereat between alternations of said source after conduction has begun.

8. A photocontrol for connecting and disconnecting a lamp from a source of alternating electrical energy, a solid state switching circuit element having a pair of output electrodes and a control electrode and being constructed and arranged to go from a nonconductive state to a high conduction state when a predetermined potential is applied to its control electrode, the output electrodes of said switching circuit means being in circuit between said lamp and said source of electrical energy, unidirectional circuit means connected between said lamp and said switching circuit means for maintaining unitary directional current flow through said switching circuit means as said electrical energy source alternates, photosensitive resistance means connected to said control electrode, first means connected to said photosensitive resistance means for supplying current thereto whereby a voltage drop will appear across said photosensitive resistance which is functionally related to ambient illumination, the voltage drop across said photosensitive resistance means being equal to the breakover voltage of said switching circuit means at the threshold level of ambient illumination whereby said switching circuit means will become conductive, and capacitance means connected to said control electrode for maintaining the breakover voltage thereat after conduction of said switching circuit means has begun regardless of transient variations in the resistance of said photosensitive resistance means.

9. A photocontrol for connecting and disconnecting a lamp from a source of alternating electrical energy, controlled rectifier means, the anode and cathode of said controlled rectifier being in circuit between said lamp and said source of electrical energy, unidirectional circuit means connected between said lamp and said controlled rectifier for maintaining unitary directional current flow through said anode and cathode as said electrical energy source alternates, photosensitive resistance means connected to the gate electrode of said controlled rectifier, first means connected to said photosensitive resistance means for supplying current thereto whereby a voltage drop will appear across said photosensitive resistance means which is functionally related to ambient illumination, the voltage drop across said photosensitive resistance means being equal to the breakover voltage of said switching circuit means at the threshold level of ambient illumination, capacitance means connected to said gate electrode for maintaining the breakover voltage thereat after conduction of said controlled rectifier has begun regardless of transient variations in the resistance of said photosensitive resistance means.

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