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PHOTOELECTRIC LIGHT CONTROL SYSTEM

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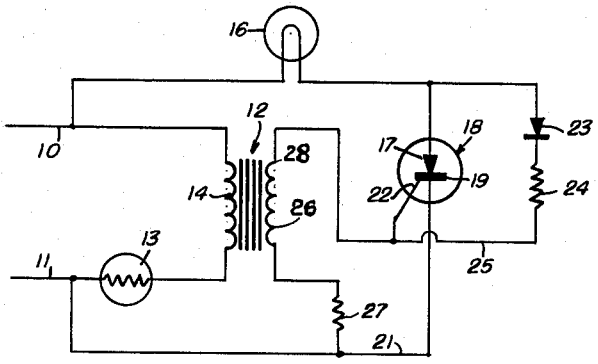

FIG. 1

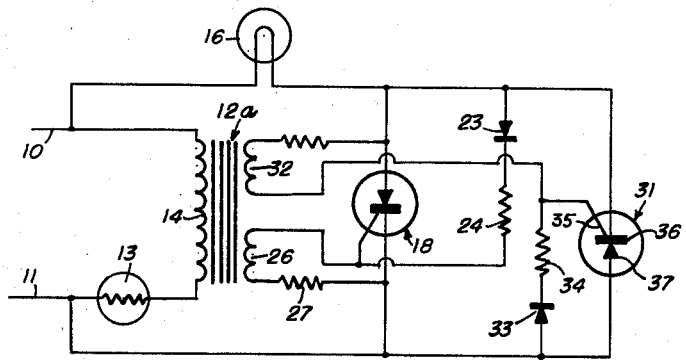

FIG. 2

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PHOTOELECTRIC LIGHT CONTROL SYSTEM

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The present invention relates to semiconductors and circuitry therefor for controlling the energization and deenergization of a load without moving elements such as relays in response to the absence of natural light in the presence of a photoelectric element and in response to natural light above a predetermined intensity in the presence of the photoelectric element and the invention more specifically pertains to the circuits and components associated with a controlled rectifier or rectifiers of semiconductor type for energizing a street lamp or lamps when natural light in the presence of the photoelectric element is below a predetermined level and interrupting the flow of current to the lamp load when the light falling on the photoelectric element rises above a predetermined level.

A conventional scheme for controlling the energization of street lights includes the mounting of a photoelectric control unit on such a lamp fixture or the pole supporting the lamp and such a control unit is provided with a relay having contacts for interrupting the load current to a street lamp or group of lamps with the relay operated in response to the action of the photoelectric element. While such control devices are generally reliable the manufacture and assembly of the relay is costly and tedious adjustments are necessary for the relay to respond to the small electrical differentials resulting from changes in the resistance of the photoelectric element.

It is an object of the present invention to provide a system for controlling the operation of a lamp wherein a semiconductor serves to control the flow of the load current to a load and to provide a control unit wherein a semiconductor is triggered or biased to pass the load current therethrough when the natural light is below a given level and to neutralize such bias when the natural light is above a given level to block the flow of current to the load.

A more specific object is to provide a gate controlled rectifier which serves to control the flow of current to a lamp or group of lamps wherein the gate is biased to render the rectifier operative to pass current during each pulse of an alternating current supply when the light falling on a photoelectric element is below a predetermined level including means responsive to a decrease in resistance of a photoelectric element to provide a current pulse opposing the pulse biasing the gate forwardly to neutralize the gate bias and to render the rectifier non-conductive and interrupt the flow current to the lamp load.

A further object of the invention is to provide a photoelectric control unit operable to energize a lamp during the absence of daylight and to deenergize the lamp during daylight hours with the unit devoid of moving parts and one which may be readily manufactured as a compact unit for mounting on a pole or lamp fixture.

Other objects and features of the invention will be appreciated and become apparent as the present disclosure proceeds and upon consideration the following detailed description taken in conjunction with the accompanying drawing wherein several embodiments of the invention are disclosed.

In the drawing:

FIG. 1 is a circuit diagram for a photoelectric element and a semiconductor for controlling the energization of a lamp and providing a unit embodying the invention.

FIG. 2 is a similar view wherein both waves of an alternating current supply are reconstructed and provide the load current.

In carrying out the invention a source of alternating current is represented as being provided across the supply line 10 and 11. The primary of a transformer 12 is connected across the supply line with a photoelectric element 13 in series relationship with the primary winding 14 of the transformer. The photoelectric element 13 is of a suitable type which is commercially available and which has the characteristic of having a high resistance in the absence of light falling thereon. Under such conditions or at night substantially no current flows in the primary winding 14. When the light falling on the photoelectric element 13 is above a predetermined level such as occurs during daylight hours the resistance of the photoelectric element 13 decreases so that current at an operable level flows in the primary winding 14.

The load is represented as a lamp 16 and control system or unit serves without relays or moving parts to supply current to the lamp 16 when natural light falls below a predetermined level and to continue such energization until the resistance of the photoelectric element 13 decreases to such a level as to permit current to flow in the primary winding 14 and when the natural light has risen to a predetermined level. The lamp 16 is connected to one side 10 of the alternating current supply line and the other terminal of the lamp 16 is connected to the anode 17 of a trigger semiconductor 18 such as a gate controlled rectifier having a capacity to handle load currents and which may be a silicon controlled rectifier. The cathode 19 of the rectifier 18 is connected to the other side 11 of the supply line by means of a conductor 21. The gate 22 is connected to the side 10 of the line and this circuit includes a diode 23 and a resistor 24 in series circuit relationship therewith.

The secondary winding 26 of the transformer 12 has such a number of turns that the voltage developed thereacross when the maximum current flows in the primary winding 14 is substantially equal to the potential of the wave pulse supplied through the diode 23 and the resistor 24. One terminal of the secondary winding 26 is connected to the gate 22 and to the conductor 25 and the other terminal of the secondary winding 26 is connected through a resistance 27 to the side 11 of the supply line.

In operation and when alternating current such as at sixty cycles forms the source of the supply line 10 and 11 and when there is an absence of light falling on the photoelectric element 13 its resistance is high and virtually no current flows in the primary winding 14 of the transformer 12. Under these conditions when a positive pulse arrives at the anode 17 of the rectifier 18 the same positive pulse is applied through the diode 23 and the resistance 24 to produce a gate voltage biasing the rectifier into the conductive state. The biasing current is limited by the resistor 24. The forwardly biasing pulse is in timed relationship with the alternating current supply and current flows to energize the lamp or load 16. During the next half cycle and when a negative pulse arrives on the anode 17 there is an absence of a positive pulse at the gate 22 of the rectifier and it regains its forward blocking capability but upon the occurrence of the next positive pulse the semiconductor device 18 again passes current to maintain energization of the load or lamp 16.

When the natural light in the presence of the photoelectric element 13 rises above a predetermined level its resistance decreases so that signficant current then flows in the primary winding 14 of the transformer. An alternating current voltage is then developed across the terminals of the secondary winding 26. The secondary winding 26 is so connected with regard to polarity that when a positive pulse appears on the anode 17 and on the gate 22 a negative pulse is developed at the terminal 28 of the secondary winding which has substantially the same potential value as the positive pulse supplied through

the diode 23 to reduce the forward biasing current to substantialy zero or to a level below that required for triggering the rectifier 18 to the forwardly conducting state. Under such conditions the rectifier 18 blocks the flow of current in the load circuit and the lamp 16 is deenergized. This condition continues until natural light in the presence of the photoelectric element 13 falls which causes its resistance to increase and reduce the current flowing in the primary winding 14. The voltage produced at the terminals of the secondary winding 25 then drops whereby the forward biasing of the rectifier is reestablished.

If it is desired to supply the load with substantially full voltage of the supply line a second trigger type semiconductor such as a controlled silicon rectifier 31 is employed in association with a transformer 12a having two secondary windings 26 and 32. In this embodiment a diode 33 and a resistor 34 apply a positive pulse to the gate 35 of the rectifier 31 when a positive pulse of the supply is impressed on the anode 37. The transformer secondary windings 26 and 32 each supply a negative pulse in timed relationship with the frequency of the supply line to neutralize the forward bias of semiconductor devices 18 and 31 which then attain their blocking characteristics and no current flows in the load circuit when the light falling on the photoelectric element 13 is above a predetermined level.

While the invention has been described with reference to particular components and specific circuit arrangements for biasing a particular semiconductor into a forward conducting state and particular components for rendering the forward biasing inoperative it will be appreciated that other elements and circuit arrangements may be employed. Such modifications and others may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A system for controlling the energization and deenergization of a lamp load comprising in combination, a photoelectric element, a transformer having a primary winding and two secondary windings, a source of alternating current, means connecting said photoelectric element in series circuit relationship with said primary winding across said source, a lamp load, a semiconductor having an anode and a cathode and a gate, means connecting said load in series circuit relationship with said anode and said cathode across said source, a second semiconductor having an anode and a cathode and a gate, means connecting the anode and the cathode of the second semiconductor in reversed relationship across the cathode and the anode of the first semiconductor, a rectifier, means connecting one of said secondary windings and said rectifier in series circuit relationship across said source, means connecting said rectifier to the gate of the first semiconductor to apply a positive pulse thereto in timed relation with the positive pulse applied to the anode of the first semiconductor to energize said load through a half cycle of said source, a second rectifier, means connecting the other of said secondary windings to said second rectifier in series circuit relationship across said source, means connecting said second rectifier to the gate of the second semiconductor to apply a positive pulse thereto in timed relation with a positive pulse applied to the anode of the second semiconductor to energize the load through the next half cycle of said source whereby the load remains energized until the resistance of said photoelectric element because of natural light falling thereon decreases to a value that the current through said primary winding induces voltages in said secondary windings for neutralizing the pulses applied to said gates to block the flow of current to said load.

2. A system for controlling the energization and deenergization of a load comprising in combination, a photoelectric element, a transformer having a primary winding and two secondary windings, a source of alternating current, means connecting said photoelectric element in series circuit relationship with said primary winding across said source, a load, a semiconductor having an anode and a cathode and a gate, means connecting said load in series circuit relationship with said anode and said cathode across said source, a second semiconductor having an anode and a cathode and a gate, means connecting the cathode and the anode of said second semiconductor in reversed relationship across the anode and cathode of the first semiconductor, a rectifier, means connecting one of said secondary windings and said rectifier in series circuit relationship across said source, means connecting said rectifier to the gate of the first semiconductor to apply forward conducting bias thereto to energize said load through a half cycle of said source, a second rectifier, means connecting the other of said secondary windings to said second rectifier in series circuit relationship across said source, means connecting said second rectifier to the gate of the second semiconductor to apply forward conducting bias thereto to energize the load through the next half cycle of said source whereby the load remains energized until the resistance of said photoelectric element drops to a level permitting sufficient current through said primary winding to induce a voltage across each secondary winding for neutralizing the forward bias applied to said gates to deenergize said load.

3. A system for controlling the energization and deenergization of a load comprising in combination, a photoelectric element, a transformer having a primary winding and a secondary winding, a source of alternating current, means connecting said photoelectric element in series circuit relationship with said primary winding across said source, a load, a semiconductor having an anode and a cathode and a gate, means connecting said load in series circuit relationship with said anode and said cathode across said source, a rectifier, means connecting said secondary winding and said rectifier in series circuit relationship across said source, means connecting the rectifier to said gate to apply a positive pulse to said gate in timed relation with the positive pulse applied to said anode whereby the semiconductor is rendered forwardly conductive to energize said load until the resistance of said photoelectric element attains such a low value as a consequence of light falling thereon that said secondary winding develops a voltage pulse of such phase and polarity as to neutralize the pulse applied to the gate through said rectifier to thereby deenergize the load.

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