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THERMAL RELAY SWITCHING CIRCUIT

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FIG. 1.

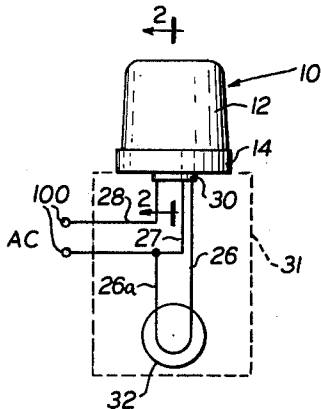


FIG. 2.

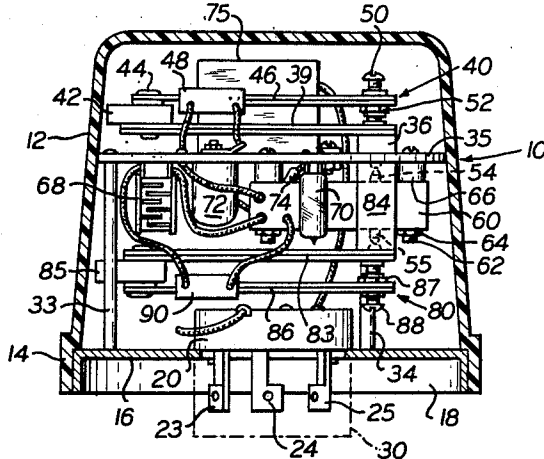


FIG. 4.

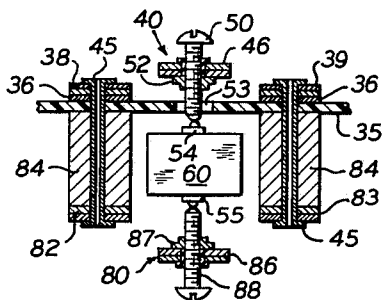


FIG. 3.

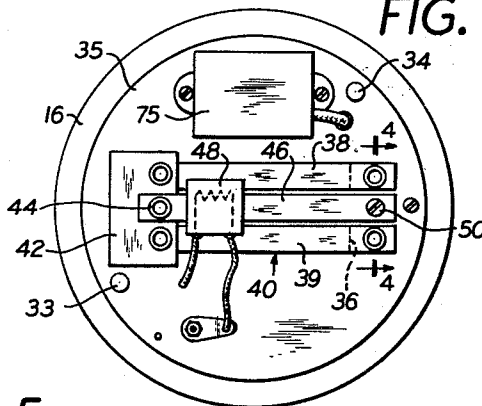
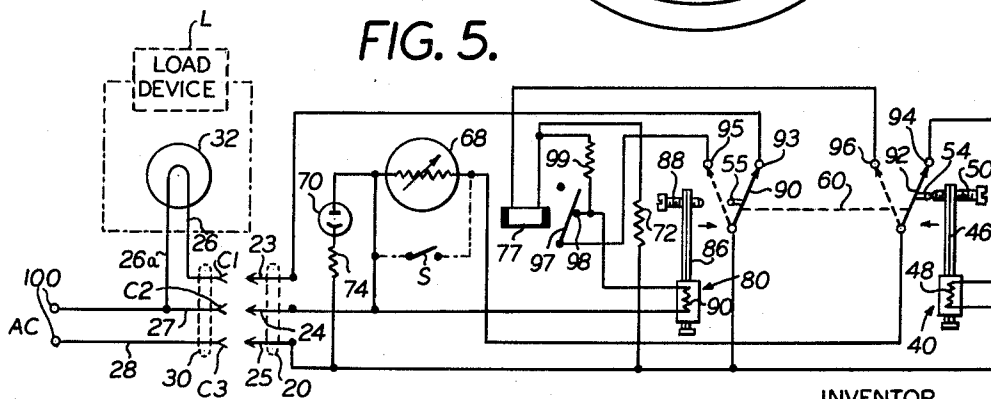


FIG. 5.



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## THERMAL RELAY SWITCHING CIRCUIT

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This invention concerns an improved thermal relay switching circuit.

It has been conventional heretofore to employ thermal relay switching circuits in street lighting control devices. Such devices are controlled by photoconductive types of photoelectric cells. Such photoelectric cells respond to varying conditions of ambient light to actuate the switching circuits for turning street lights on and off at dusk and dawn respectively. The thermal relays in the switching circuits employ bimetallic elements which are heated and bend to contact operating arms of micro-switches for opening and closing the street light load circuits. The devices are housed in closed casings and are mounted on lamp posts which support the street lights. Heretofore it has been the practice to keep the thermal relays in active, heated, current conductive condition, alert for any changes in ambient light conditions requiring turning off or on of the street lights. It has been found in operation that the thermal relays generate a considerable amount of ambient heat. This causes the ambient temperature in the closed housing of the control device to rise quite high. The high ambient temperature has an adverse effect on the sensitive crystalline photoconductive photoelectric cell reducing its responsiveness and even rendering it inactive. The continuous conductive condition of the heater in a thermal relay places the bimetallic element under continuous strain. Metal fatigue occurs so that the bimetallic element assumes a permanent set or warped condition. Responsiveness of the bimetallic element to changes in its heated condition is reduced, lost or changed in an erratic and unpredictable manner. The adverse effects of ambient on the photoconductive cell and on the bimetallic elements are so severe that frequent recalibrations of the device and replacement of damaged parts are required. This type of maintenance is expensive, time consuming and most undesirable, particularly when it is realized that servicing is required for devices mounted at the tops of street lamp posts, so that highly trained servicing crews and special equipment are needed to service light control devices.

The present invention is directed at overcoming the difficulties and disadvantages heretofore encountered in devices actuated by thermal relay switching circuits, as described above.

In the circuit embodying the present invention, the bimetallic elements are utilized only for a few seconds at a time, and they are in an unheated state the remainder of the time, so that they retain their sensitivity, responsiveness and calibration for indefinitely long periods of time.

A further advantage obtained is the substantial elimination of ambient heating of the photoconductive cell. This prolongs the sensitivity and useful life of the cell. Still another advantage is obtained according to the present invention, in that the photoconductive cell is kept continuously in substantially a non-conductive and internally unheated condition, except during the few seconds at dawn and at dusk when it is required to operate the lamp or load switching components. This is accomplished during the daytime when the photoconductive cell normally has low electrical resistance by keeping the cell connected in series with the coil of an electromagnetic relay. This coil has such a high impedance and/or resistance that it holds the alternating current passing through the photoconductive cell down to a negligibly small magnitude.

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By night, the cell itself has a very high resistance so that substantially no current passes through it. Thus the photoconductive cell is doubly protected in being continuously maintained in cool, unheated ambient surroundings and in an internally unheated, substantially, non-conductive condition. This arrangement of the circuit according to the invention results in prolonging the useful life of the photoconductive cell since no effective change in its responsiveness occurs due to internal or external heating as has heretofore been experienced in prior photoelectrically controlled thermal switching circuits.

A particular object of the invention is therefore to provide an improved thermal relay switching circuit in which thermal relays are held in an inactive condition except when required to operate circuit switches.

A further object is to provide a street lighting control device in which ambient heat within the device derived from heaters of thermal relays is substantially eliminated.

Another object is to provide a street lighting circuit or device controlled by a photoconductive photocell, and electro magnetic relay and switching means to maintain heaters of bimetallic elements in thermal relays in continuous unheated condition except when the thermal relays are required to operate the switch.

Another object is to provide two thermal relays in a two-position switching circuit, one relay being operative at one time to set the circuit to one position and the other relay being operative at another time, both relays being inactive except when required to set the circuit to the respective positions.

A further object is to provide a photoelectrically controlled thermal relay switching circuit in which a photoconductive cell is maintained substantially continuously in unheated, substantially non-conductive condition.

The invention will be best understood from the following description taken together with the drawing, wherein:

FIG. 1 is a side elevational view of a device embodying the invention, with a portion of a load circuit shown diagrammatically.

FIG. 2 is a sectional view on an enlarged scale taken on line 2-2 of FIG. 1.

FIG. 3 is a top plan view of a circuit assembly of the device.

FIG. 4 is a sectional view on an enlarged scale taken on line 4-4 of FIG. 3.

FIG. 5 is a diagram of an electrical circuit employed in the device.

In FIGS. 1 and 2 is shown the control device 10, including a translucent canopy 12. The canopy is dome shaped and has an open bottom formed with an annular skirt 14. Seated within the skirt is a circular base 16 made of sheet metal. The base has a cylindrical wall 18 which fits within and abuts skirt 14. A plug 20 having a circular body is secured to the base 16. The plug has three prongs 23-25 extending outwardly for connection to three conductors 26-28 of an external power supply and load circuit, indicated schematically in FIGS. 1 and 5. Conductors 26-28 are connected to a receptacle 30 mounted on a support 31 which also carries the lamp 32 connected to conductors 26, 27. Mounted on base 16 are two posts 33, 34 which support a circular, non-conductive disk 35. This disk fits snugly inside the canopy parallel to the base 16. On the disk is mounted a thermal relay 40 including spacer members 36; see FIGS. 2, 3 and 4. These members carry a pair of spaced ambient temperature compensating bimetallic elements 38, 39. Elements 38, 39 are secured by rivets 45 at one end to the members 36 and at the other end carry a spacer block 42. On the spacer block is secured by rivets 44, one end of another bimetallic element 46. The element 46 has a

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resistance heater 48 mounted thereon. The other free end of the element 46 carries a screw 50 adjustably threaded therein and held by a nut 52. The shank of the screw extends through element 46 and a hole 53 in the disk 35 to contact operating button 54 of a double pole double throw switch 60. The switch is carried under the disk 35 by bolts 62, nuts 64 and spacers 66. Supported underneath the disk 35 is a photoconductive photocell 68, a neon tube 70 and a resistor 72. Another resistor 74 is connected in circuit with the neon tube.

On the disk 35 is mounted a housing 75 containing an electromagnetic relay 77 to be described in connection with FIG. 5. Under the disk is another thermal relay 80. A pair of ambient temperature compensating bimetallic elements 82, 83 is secured by rivets 45 and spacers 84 in alignment with bimetallic elements 38, 39. Block 85 is supported at the other end of elements 82, 83. One end of bimetallic element 86 is secured to block 85. The other end of element 86 carries a screw 88 axially aligned with screw 50 and held by a nut 87. Screw 88 has its end in contact with operating button 55 of switch 60. A resistance heater element 90 is mounted on the bimetallic element 86. The several components of the assembly described are electrically connected in a circuit shown schematically in FIG. 5 to which reference is now made.

Referring to FIG. 5, it will be noted that conductors 27, 28 are the main power supply wires connected to the alternating current terminals 100. Wires 26 and 26a are connected to lamp 32 in the external load circuit. Prongs 23-25 make detachable connection with contacts C1-C3 of receptacle 30. Switch 60 has two poles 90, 92. In one position of the switch, the poles contact fixed contacts 93, 94 respectively. In the alternate position, the poles contact fixed contacts 95, 96 respectively. Insulated operating button 55 contacts pole 90. Insulated operating button 54 contacts pole 92. Heater 48 of relay 40 is connected to prong 25 and contact 94. Heater 90 of relay 80 is connected to contact 98 of relay 77 and to prong 24.

Pole 97 of the relay is connected to contact 95. Contact 93 is connected to prong 23. Contact 96 is connected to one terminal of the coil of relay 77. The other terminal of the coil is connected to resistor 99 and to both heater 48 and prong 25. Photoconductive cell 68 is connected to pole 92 and to prong 24. Pole 90 is connected to both prong 25 and heater 48.

The device is shown in FIG. 5 in the nighttime condition of operation. Contacts 97, 98 are closed and the relay 77 is deenergized. Heaters 48 and 90 are deenergized. Photoconductive cell 68 has a very high resistance and passes practically no current. The lamp 32 is energized and illuminated by its power supply circuit which includes prong 23, contact 93, pole 90 and prong 25. Neon tube 70 is illuminated via resistor 74. Pole 92 is closed with contact 94. Contacts 95 and 96 are open circuited.

At dawn, the photoconductive cell 68 which is exposed to ambient light passing through the canopy 12, will decrease in resistance due to light impinging thereon. Power will then be applied to the resistance heater 48 via the photoconductive cell, pole 92 and contact 94. The relay 40 will be energized and bimetallic element 48 will be heated. The element 46 will bend and move button 54 so that the ganged poles 90, 92 are thrown to the left position indicated in FIG. 5. This opens the power supply circuit of the heater 48 and the bimetallic element 46 cools off. At the same time the power supply circuit of lamp 32 opens as pole 90 moves away from contact 93 and closes with contact 95. Relay 77 becomes energized and contacts 97, 98 open so that the power supply circuit of heater 90 is open. The lamp 32 remains off all day while the resistance of the illuminated photoconductive cell is low. The relay 77 remains energized.

At dusk, ambient light decreases and the resistance of the cell 68 increases. The power supply to the relay 77

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is decreased to so low a magnitude that the relay 77 is effectively deenergized and pole 97 closes with contact 98. As soon as the relay 77 is deenergized the circuit of heater 90 closes and the heater is energized to heat the bimetallic element 86. This element bends and actuates button 55 to move the poles 90, 92 away from their dotted line left position to the solid line right position. Pole 90 closes with contact 93 restoring the power to the lamp 32. Pole 92 closes with contact 94 placing the heater 48 in series with the cell 68. Due to the high resistance of the cell 68, the heater 48 is not heated but the heater circuit is alerted for energization when the resistance of the cell 68 drops again at dawn to repeat the cycle described.

It will be understood that the heaters 48 and 90 remain deenergized except during the few seconds when each heater is energized. The heaters are energized alternately. One heater causes the power supply to the load lamp to be applied and the other heater causes the power supply to the lamp to be cut off when the switch 60 is set from one position to the other, and vice versa.

The circuit has been described in connection with a device for controlling the lighting and extinguishing of a street lamp. It will be understood that the device could be used for turning on and off other types of loads indicated in dotted lines generally by the device L. It is possible to use the circuit in other applications where the photoelectric cell may be replaced by a switch S indicated connected alternatively in place of cell 68. The cell 68 acts in effect like an automatic switch to open and close the power supply circuit to heater 48 and relay 77. Any type of external switching circuit or even a manually operated switch as indicated at S could be used in place of the photoelectric cell. Of course the cell 68 is essential for use in street light control applications. The invention may thus be generally applied in other situations where thermal relay switching is desired. One advantage of employing thermal relay switching is that the thermal relays may be designed to operate with predetermined time delays. The present invention makes use of this desirable characteristic, without the prior disadvantage of keeping the thermal relays in continuous heated condition.

The neon tube 70 serves a monitoring function. If at night the lamp 32 should fail to light due to inoperativeness of the lamp, the neon tube will light to indicate that power is being applied to the circuit so that the lamp may require replacement. Resistor 72 serves as a current limiting device for relay 77. Resistor 99 is a protective resistor for preventing sparking at contacts 97, 98 when the relay 77 is energized.

The invention described makes possible a thermal relay switching circuit which requires no servicing for recalibration or replacement of bimetallic elements, thus insuring uninterrupted service of the device in which it is installed. Turn-on and turn-off of the load circuit is effected at predetermined ambient light levels. The high power line of the load circuit is independent of the circuits including the photoconductive cell, heaters and relay coil. The thermal relays provide desired time delays on switching the load circuit on and off to prevent response of the circuit to transient, ambient light changes. The device is readily assembled at low cost and at minimum expense for labor. Once assembled and calibrated, the device remains in calibration to insure long, trouble-free service.

What is claimed and sought to be protected by Letters Patent of the United States is:

1. A switching circuit for a load device, comprising a double-pole, double throw switch, two thermal relays each including a heater and a bimetallic element, the bimetallic elements of the relays respectively being disposed to set the switch alternately to two positions, a switching member in circuit with one pole of said switch, with one of the heaters and with a power supply in one position of

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the switch to energize the one heater when said switching member passes sufficient current, an electromagnetic relay having normally closed contacts when the relay is deenergized, the other heater being connected through the closed contacts, the power supply and the other pole of said switch in the other position of the switch to energize the other heater, the bimetallic elements being alternately heated by its energized heater in the respective positions of the switch, said relay having a coil connected in circuit with said switching member, a contact element of said switch and said power supply to energize the relay when the one pole contacts said contact element in the other position of the switch, whereby the one heater is deenergized in the other position of the switch and is energized in the one position of the switch only when the switching member passes current, and whereby the other heater is energized independently of the switch and only when the relay is deenergized and the contacts of the relay are closed.

2. A switching circuit according to claim 1, wherein said switching member is a photoconductive photoelectric cell responsive to ambient light to increase and decrease its internal resistance in low and high ambient light levels respectively.

3. A switching circuit according to claim 2, wherein said load device has two terminals, one of the terminals being connected to the power supply and the other of the terminals being connected in circuit with said other pole and said power supply in said one position of the switch to energize the load device.

4. A switching device, comprising a two-position switch having two ganged poles and two pairs of fixed contacts, one contact of each pair of contacts closing with the poles respectively in one position of the switch and the other contact of each pair of contacts closing with the poles respectively in the other position of the switch, a power supply having two terminals, one of the power supply terminals being connected to one of the poles, a switching member connected to the other pole, the other power supply terminal being connected to the switching member,

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two thermal relays having bimetallic elements each carrying a heater, said elements being disposed respectively to throw the switch to one position and the other alternately, one of the heaters being connected to one contact of one pair of contacts and to said one power supply terminal, said other power supply terminal being connected to the other heater, an electromagnetic relay having normally closed contacts, one of said normally closed contacts being connected to the other heater, the other of said normally closed contacts being connected to one of the other contacts of the other pair of fixed contacts, said electromagnetic relay having a coil with two ends the other contact of the one pair of fixed contacts being connected to one end of the coil, the other end of the coil being connected to the one power supply terminal, and an external load circuit connected to the other power supply terminal and to the one fixed contact of the one pair of contacts, whereby the heaters are normally deenergized and are only momentarily energized when said switching member initially passes a high current and initially passes substantially no current.

5. A switching device according to claim 4, wherein said switching member is a photoconductive photoelectric cell responsive to pass high current only under conditions of high ambient light to energize the electromagnetic relay, and to pass substantially no current under conditions of low ambient light, said thermal relays having inherent predetermined time delays in heating, whereby the external load circuit is switched on only when ambient light falls and remains below a predetermined intensity and then is switched off only when ambient light thereafter rises and remains above said predetermined intensity.

6. A switching device according to claim 5, wherein said load circuit includes a lamp.

#### References Cited in the file of this patent

#### UNITED STATES PATENTS

2,900,520 Frank Aug. 18, 1959