Aug. 28, 1945. R. S. GREGORY 2,383,644

PHOTOELECTRIC RELAY WITH AUTOMATIC ADJUSTER

Filed Aug. 17, 1944

Fig. 1.

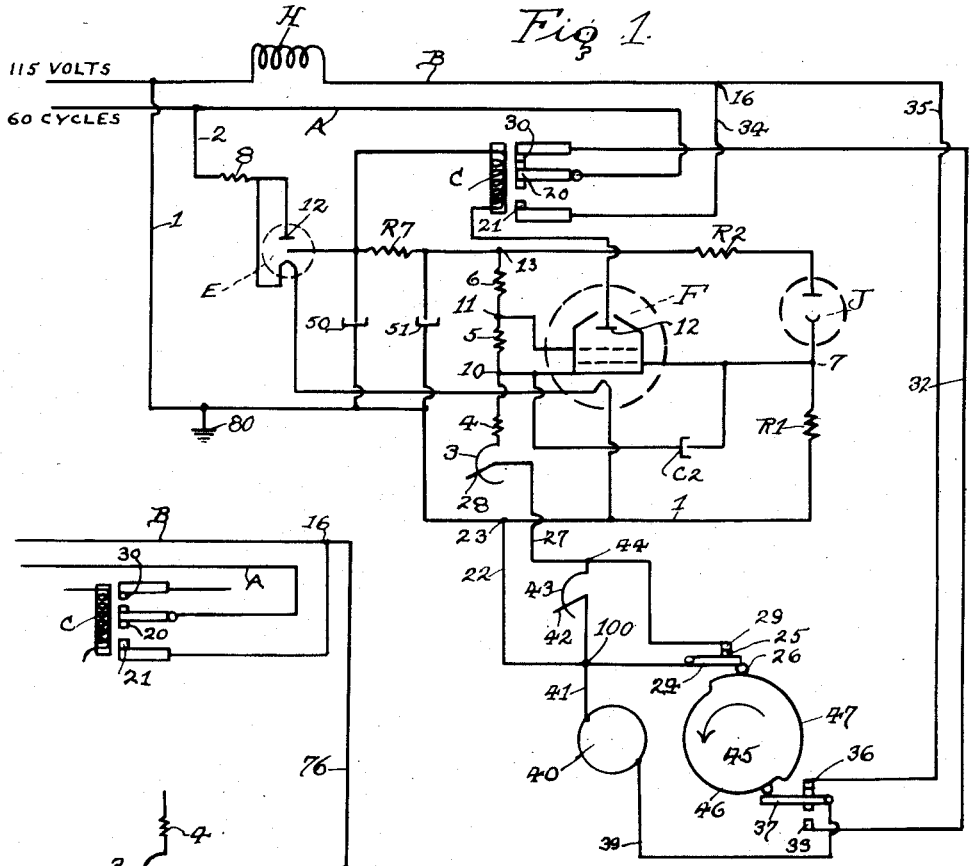
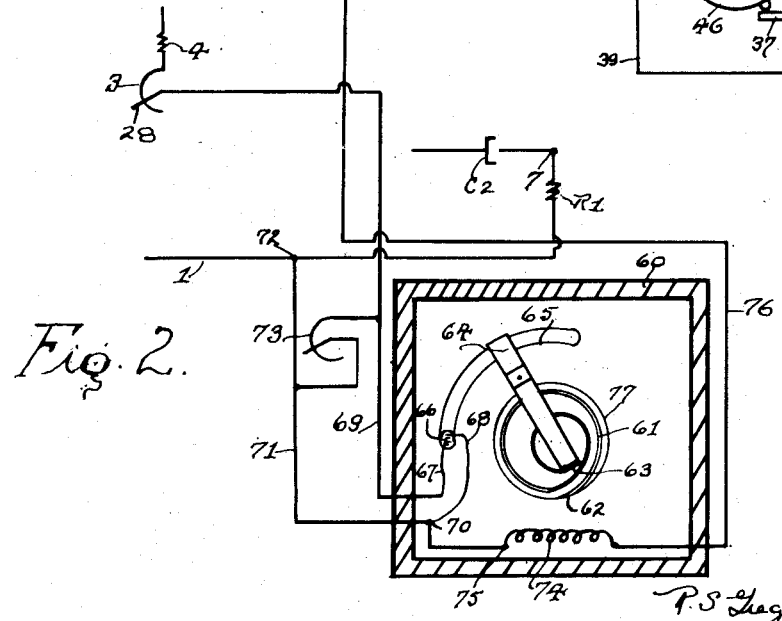


Fig. 2.



Inventor

P. S. Gregory

By

Cattison, Wright & Cattison

Attorneys

Patented Aug. 28, 1945 2,383,644

UNITED STATES PATENT OFFICE

2,383,644

PHOTOELECTRIC RELAY WITH AUTOMATIC ADJUSTER

Richard S. Gregory, Princeton, Ky.

Application August 17, 1944, Serial No. 549,928

13 Claims. (Cl. 315—15.6)

This invention pertains to an improvement in photo-electric relays and more particularly and specifically to such a device for turning on and off electric lights as for instance the lights of a street lighting system or the lights in some other similar electric circuit.

A photo-electric relay for turning on and off the lights in a street lighting system is not broadly new as relays for such purpose have been in use for a number of years. Such relays as have been manufactured and put into use for turning on and off the electric current supply to street lighting circuits have however an inherent fault, which is that the level of light required to actuate the circuits in the mornings to turn off the current in the circuit and extinguish the lights is higher than the light level required to actuate the relay to turn on the current in the circuit to the lights at night. This difference in the light levels required to turn on and off the circuit has resulted in the lights burning in the morning for a longer period than required, that is, the lights have remained on beyond that period where artificial illumination is necessary with a resultant wastage of electrical energy.

Broadly the invention comprises means for automatically adjusting the resistance of the rheostat or other resistor in the relay circuit. This adjustment of resistance takes place after the relay has operated in the evening to turn the lights on and the adjustment is one which increases the resistance of the rheostat or the relay circuit to thereby decrease the light level at which the relay will operate the following morning to turn the lights off. This will result in turning the lights off promptly after there is sufficient natural light for visibility and will overcome the wastage of electric energy incident to relays now in use.

With the foregoing statement of the object of the invention and description of the broad inventive concept, description will now be given of specific arrangements which will accomplish the desired result and provide a photo-electric relay control which will extinguish and turn on the street lights at exactly the same light level, that is to say, a relay which will operate in the evening and in the morning at the same light level.

Description of two forms which the invention may take is given and in the accompanying drawing illustrative of the invention,

Fig. 1 is a diagrammatic illustration of a relay embodying my invention, and

Fig. 2 is a similar illustration of a modified form of the invention.

The present invention comprises an improvement, which I call an adjusting relay, to be used in combination with a photoelectric relay manufactured by the General Electric Company. A photoelectric relay as manufactured and sold by the General Electric Co. is schematically illustrated in Fig. 1 of the drawing and my improved adjusting relay is illustrated in combination therewith.

The photoelectric relay circuit includes a beam power rectifier-amplifier tube which is a multipurpose tube containing a beam power amplifier and a diode rectifier within the same envelope. For the purpose of clarity this tube in the schematic illustration of Fig. 1 is shown as two separate tubes. The rectifier tube being designated E and the amplifier tube F.

Referring to Fig. 1, A and B designate the main power lines for supplying 115 volt 60 cycle electric current. To the power line B a take-off wire 1 is connected and a take-off wire 2 is connected to the power line A. Wire 1 is grounded as at 80. The wire 2 has in it a resistor 8 to limit the magnitude of current which will flow through the tubes in case of a fault at any point in the circuit. The cathode heaters are connected in series with their free ends across the full potential of the main power supply except as limited by resistance 8. Further respecting the rectifier E, the resistor R7 and the two capacitators 50 and 51 comprise a half-wave rectifier and resistor type "Pi" filter, as it is known to the art, for supplying the remainder of the circuit with the required potential of direct current. The voltage divider consists of a variable resistor 3, which may be in the form of a rheostat and resistors 4, 5 and 6. The variable resistor 3 is for regulating the bias potential of the cathode to the desired value. The value of this bias potential as determined by the setting of the rheostat 3 will control or determine the level of day light at which the relay will function and particularly the level of light required for the relay to turn on the circuit. This variable resistor or rheostat is provided so that when in use the relay can optionally be set so that the relay will cause the circuit to be closed, that is turn on the circuit, at any selected level of light within the range of the relay.

The beam power amplifier F is an electronic tube construction or arrangement well known to the art. The beam forming plate of this amplifier is at cathode potential, being connected inside the envelope to a thorium-coated cathode (not shown in the diagram) which cathode

and beam forming plate are connected to the voltage divider as indicated at 10. The control grid is connected to the light-sensitive photo tube J and its circuit at 7. The screen grid is connected to the voltage divider at 11 and therefore is held at a potential somewhat less than the full anode potential but above the cathode potential. The anode or plate 12 of the amplifier is connected to the full output positive potential of the rectifier through a coil forming a part of the magnetically operated circuit maker or breaker C.

This circuit maker or breaker C is a high sensitive telephone type relay such as is common and well known in the art.

The signal or trigger circuit has therein the photo tube J which is a device well known to the art and needs no specific description. Suffice to say that it consists of the usual light sensitive cathode and a blackened anode enclosed within an evacuated glass envelope. As has been previously mentioned, the cathode of this photo tube is connected to the control grid of the amplifier by a wire connected at the point 7. It is connected through the resistor R1 to the grounded conductor 1 of the circuit. The anode of the photo tube is connected through a limiting resistor R2 to the positive output of the filter circuit as indicated at 13. A capacitor C2 is connected across the amplifier cathode and control grid and protects against very short transient light or electrical surges that might cause false operation or chattering of the circuit maker and breaker or relay C.

It is thought that the invention will be better understood if a description of the operation of the commercial photo relay control circuit is given prior to a description of my improvement thereof and the modified operation resulting from my improvement of the standard photoelectric relay circuit.

The standard and in this case the General Electric photoelectric control circuit or device operates as follows: When there is no light falling upon or striking the photoelectric tube J there will be no current flowing through it and there consequently will be no potential across the resistor R1 and the grid of the amplifier will be at negative bus potential. The rheostat or adjustable resistor 3 will be adjusted to produce a cathode bias such that insufficient current will flow through the relay contact maker and breaker C to cause it to operate. When however light falls upon or strikes the phototube the electron flow through it and resistor R1 will raise the potential of the amplifier grid and permit sufficient current to flow to cause the operation of the circuit maker and breaker relay C. The setting of the variable resistor or rheostat 3, this is the cathode bias control, determines the photo tube current and the voltage drop across resistor R1 which is necessary to raise the amplifier grid potential sufficiently to cause operation of the circuit maker and breaker relay C.

From the foregoing it will be seen that the circuit maker and breaker or relay C, which is magnetic in nature, is energized in daylight hours when light falls upon the photo tube and is deenergized during the hours of darkness which are at night. When deenergized the circuit maker and breaker relay C causes electrical contacts or terminals 20 and 21 to engage which closes the circuit to complete the supply of current to the street lighting system or to some auxiliary contacting device of a street lighting system, such as for instance the coil H.

In most applications of this control relay for street lighting systems the contacts 20 and 21 are not capable to handling the currents and voltages usually encountered in street lighting circuits and consequently the relay is made to operate a still further contact or relaying device which has the capacity to handle these heavier circuits. Hence the illustration of the coil H which is associated with other instrumentalities, not shown because they form no part of the present invention, which are capable of handling the heavier currents and cause the closing of the street light circuit when the coil H is energized. Under certain conditions coil H and instrumentalities with which it is associated could be eliminated and the street lighting circuit opened and closed directly by the opening and closing of the circuit through the contacts 20 and 21.

From the foregoing it will be seen that in the commercial photoelectric relays described above the particular light level at which the circuit will be closed through the contacts 20 and 21 is determined by the setting of the resistor or variable rheostat 3 due to its control of the magnitude of the cathode bias potential. Increasing the resistance of the rheostat 3 will lower the bias of the cathode and likewise lower the light level required to cause the operation of the circuit maker and breaker C to open the contacts 20 and 21. A decrease in the resistance of the rheostat 3 will raise the light level required to energize and cause the operation of the circuit maker and breaker C. The difference between the light level required to deenergize the circuit maker and breaker C and the light level required to energize it is a fixed value of light due to the inherent characteristic of the circuit maker and breaker C which characteristic is that a higher magnitude of current is required to cause it to pick-up, that is cause engagement of the contacts 20 and 21, than is required to cause the circuit maker and breaker to release these contacts. This difference may be, as previously mentioned, desirable to prevent erratic operation but this difference in operating light level results in causing the relay to maintain the street lighting circuit "on," that is, closed longer than is required by usual street lighting schedules. It is to overcome this defect that the present invention has been conceived and perfected, and specific description of the improvement which accomplishes the elimination of this fault will now be described.

My improvement might be well called an adjusting relay in that it adjusts the internal resistance of the main relay circuit during the night with the result, as will hereinafter appear, that the relay circuit will cause the lights to be extinguished in the morning at exactly the same light level at which the relay will cause the lights to be turned on in the evening.

I have devised two forms of adjusting relays, for the accomplishment of the foregoing. One form appears in Fig. 1 of the drawing and the other in Fig. 2. In both instances my adjusting relay is used in combination with a commercial General Electric photoelectric relay circuit.

Describing my improved device as it is illustrated in Fig. 1 of the drawing, a current conducting line 22 is connected in the main relay circuit as indicated at 23 and terminates in a pivotally mounted arm 24 having on its upper face an electrical contact 25 and on its outer free

end a roller 26. A second conductor 27 is connected into the main relay circuit by connection to one side of the rheostat 3 and particularly to the adjustable contact element 28 of said rheostat. The opposite end of the conductor 27 terminates in a contact 29 positioned immediately above and adapted for contact with the aforementioned contact 25.

In the particular commercial relay with which my invention is associated there is a contact 30 which is associated with the previously mentioned and described contact 20. The commercial relay is quite evidently provided with the contact 30 so that the relay could be operated to function in reverse to the usual manner, by which we mean, the relay could be used to energize a street lighting or other circuit in the daytime rather than to deenergize it. In my improvement I make use of the contact 30 extending from it a line or conductor 32 the opposite end of which terminates in an electrical contact 33. The main current supply conductor B is extended beyond the point 16 at which it is met by the conductor 34 running to the contact 21. This extension of the supply line B beyond the point 16 is designated by 35 and terminates in a contact 36 above but in spaced relationship to the aforementioned contact 33. Intermediate the contacts 33 and 36 is a pivoted arm 37 carrying on its opposite sides contact points adapted for engagement with the contacts 33 and 36. The free end of this arm is provided with a roller 38. The contacts on the arm 37 are electrically connected to a conductor 39 which is electrically connected to one terminal of a motor 40. A conductor 41 is connected to the other terminal of the motor and terminates in a movable contact 42 of an adjustable resistor or rheostat 43 which rheostat is connected to the aforementioned conductor 27 at the point 44. Wires 41 and 22 are connected at point 100.

The motor 40 is a synchronous motor such as may be found on the open market and is there put to many uses as for instance in electric clocks and other electrical timing devices. This motor is mechanically connected to a cam 45 for revolving it at a speed of one-half revolution per hour. The rollers of the cam or contact arms 24 and 37 are in engagement with the cam face of this cam.

From the foregoing it will be seen that the contacts 25 and 29 are connected in parallel with the rheostat 43 and that the rheostat in turn is connected in series with the control rheostat 3 of the main photoelectric relay control. As a consequence when the contacts 25 and 29 are open the resistance or rheostat 43 is added to the resistance of rheostat 3 and serves to lower the operating light level of the main photoelectric relay. The rheostat 43 is shunted out of the circuit when the contacts 25 and 29 are closed and thus the affect of the rheostat 43, under these conditions, on the main photoelectric relay control circuit is removed with the result that the resistance of the grid circuit of the photoelectric relay and therefore the operating light level of the relay is dependent on the setting of the rheostat 3 alone. This would be a setting suitable for evening operation.

The operation of my improved device is as follows. The motor 40 is put into operation immediately after the evening operation, that is the turn-on operation of the photoelectric relay, the electric circuit to the motor being established through the closing of the contacts 20 and 21 by the operation of the relay or circuit maker and breaker C. The operation of the motor causes the cam 45 to be revolved in the direction indicated by arrow. The circuit passes or travels through the contact 36 to the contact on the upper side of the arm 37 by reason of the fact that the cam roller 38 of the cam arm 37 is resting on the low dwell portion 46 of the cam. Concurrently the contact 29 is closed by being in engagement with the contact 25, these contacts being held in position due to the fact that the cam roller 26 of the cam arm 24 is on the high dwell portion 47 of the cam.

As the cam is turned at a speed of one-half revolution an hour in the direction indicated by arrow the cam arm 24 upon the passage of one hour will drop off of the upper dwell to the lower dwell portion of the cam which will cause separation of the contacts 25 and 29 and will thereby insert the resistance or rheostat 43 in the circuit of the photoelectric relay, as has been described.

The high and low dwell portions of the cam and the positioning of the cam arms 24 and 37 is such that some two or three minutes after the opening of the circuit by the separation of the contacts 25 and 29 the roller 38 of the cam arm 37 will enter upon the upper dwell portion of the cam causing a breaking of the circuit to the synchronous motor 40 through the contact 36. This will cause the motor and the cam to come to rest.

The photoelectric relay upon the arrival of dawn of the following morning operating at the proper and desired light level by reason of the added resistance in the circuit of the rheostat 43 extinguishes the street lighting circuit by opening contacts 20 and 21 and closing contact 30 with contact 20 by reason of the operation of the relay circuit maker and breaker C. Upon the closing of the contacts 20 and 30 a new circuit is established to the synchronous motor 40. This circuit is through the contact on the under side of the cam arm 37 having engagement with the contact 33. The motor 40 will be put into operation to again revolve the cam 45 and after the passage of one hour the outer dwell portion of the cam will be under the roller 26 of the cam arm 24 to bring about the closing of the contacts 25 and 29 thus shunting the rheostat 43 out of the circuit. As before, after the passage of two or three minutes the cam arm 37 will drop off of the outer dwell portion of the cam thereby moving the contact at the under side of the cam arm out of engagement with the contact 33 thereby opening the circuit to the motor. Immediately this circuit is broken the motor stops and the adjustment of the photoelectric relay, for the next, that is, the evening operation, has been accomplished.

At this point attention is directed to the fact that although the cam arms 24 and 37 are positioned at opposite sides of the cam 45 they are not diametrically opposed to one another but are disposed at a distance of a few degrees less than 180. This arrangement is to assure full and positive opening and closing of the contacts 25 and 29 prior to the opening of the contacts 33 and 36 which latter contacts upon being opened stop the operation of the motor. The mechanical construction should be such that there is a snap action in respect to the contacts 33 and 36 so that one or the other of them is always closed in respect to the contacts on the cam arm 37.

The second or alternate form of my improvement for accomplishing the aforementioned modified operation of the photoelectric relay circuit

is illustrated in Fig. 2 of the drawing and operates on a thermal principle.

Inasmuch as the main photoelectric relay circuit in this instance is identical with that already described and appearing in Fig. 1 of the drawing only so much of the commercial relay circuit is illustrated as to enable an understanding of the connection of my improvement to the photoelectric circuit.

It will be seen that there is the same photoelectric relay circuit rheostat 3 and the same current conductor 1 of that circuit. A suitable and comparatively air-tight chamber 60 preferably constructed of low heat transmitting material such as asbestos, cement or molded diatomaceous earth is provided and has therein a bi-metallic spiral strip 61 having one end anchored as at 62 and a free end 63 attached to the lower end of a rocker arm 64 which carries a mercury switch designated as an entirety by 65. This mercury switch is internally provided with a mercury drop 66 which is adapted to close the circuit between a pair of spaced contacts 67, 68.

The contact 67 is provided with a lead or conductor 69 which is connected to the movable arm 28 of the photoelectric relay circuit rheostat 3. The second mercury switch contact 68 is connected at 70 to a conductor 71 which is connected as at 72 to the photoelectric circuit relay conductor 1. A rheostat or other suitable adjustable resistor 73 is connected across the conductors 69, 71.

An electrical heating element 74 is positioned within the housing or chamber 60 below and closely adjacent the bi-metallic spiral strip 61. This heating element is connected as at 75 to the conductor 71 and is connected by a wire 76 which extends to and is electrically connected to the point 16 of the main photoelectric relay circuit main current conductor B.

The operation of this device is as follows. The daytime position or condition of the circuit is illustrated in the drawing. The mercury drop is positioned to close the contacts 67, 68 which has shunted or short-circuited the rheostat 73 out of the circuit. At night or at dusk upon the operation of the photoelectric relay circuit and with the consequent closing of the contacts 20 and 21 the circuit is closed to the heating element 74 in the housing 60. The heat generated by this heater will slowly accumulate within the housing or chamber and will after the passage of sufficient time cause the bi-metallic thermo-responsive spiral strip 61 to expand and move the rocker arm 64 through the arc of a circle and a distance sufficient that the mercury switch will be tilted to a position such that the mercury drop 66 therein will run toward the opposite end of the mercury tube and away from the contacts 67 and 68. This movement of the mercury drop will route the circuit through the rheostat 73, that is the rheostat will no longer be short-circuited or shunted out, and the resistance of this rheostat will now be inserted into the grid circuit of the photoelectric circuit and will function to accomplish the exact same results as has been described in respect to the first form of the invention.

It is contemplated that the heat generated by the electric heater 64 and the interior area of the chamber 60 will be coördinated or so correlated that the time required to cause sufficient heating of the bi-metallic strip to bring about the movement of the mercury switch to break the circuit at the contacts 67 and 68 will require about one hour or possibly a slightly longer period.

In so long as the photoelectric relay circuit remains in an ON position or condition so that current is being delivered to the lighting circuit the heating element 74 remains in the circuit and remains heated and the mercury switch 65 remains in an open position.

At dawn upon the operation of the photoelectric relay circuit to turn off the circuit to the street lights through the breaking of the circuit through the contacts 20 and 21 the electric circuit to the heating element 74 is broken and the apparatus immediately begins to cool off. Eventually the cooling is sufficient that the mercury switch will return to the position illustrated in Fig. 2 of the drawing so that the circuit will be re-established through the contacts 67 and 68 and will thereby again shunt the rheostat 73 out of the circuit. When this occurs the original setting of the photoelectric relay for daytime position is reestablished.

For the purpose of increasing the heat inertia of the device the bi-metallic coil 61 is shown as being backed at one side by a metal disc 77 which is suitably secured to the free end of the bi-metallic coil.

In this form of the invention no use is made of the contact 30 of the photoelectric relay circuit. It will be noted that no electrical connection is made with this particular contact of the circuit maker and breaker C.

From the foregoing description it will be seen that in both forms the invention provides a photoelectric relay which will operate to accomplish the recited desired results. It is to be understood that the invention is limited only by the scope of the hereinafter appended claims.

I claim:

1. For use in turning on and off the current to the electric lights of a street or other like illuminating system, a photoelectric control circuit having a current supply to turn on the current at a predetermined light level and to turn off the current at a predetermined but higher light level and in which the light level at which said operations occur is determined by an electric current resistor in said photoelectric control circuit, and in combination therewith, means for increasing the internal resistance of said photoelectric control circuit above that caused by said resistor, said increase of internal resistance being such as to cause the photoelectric control circuit to turn off the current to the illumination system at the same light level at which the control circuit operates to turn on the current, means operable to bring a second resistance into and thereby increase the internal resistance of said photoelectric control circuit, and additional means acting upon the operation of the photoelectric circuit to turn on the current to the illumination system to bring said first named means into operation.

2. For use in turning on and off the current to the electric lights of a street or other like illuminating system, a photoelectric control circuit having a current supply to turn on the current at a predetermined light level and to turn off the current at a predetermined but higher light level and in which the light level at which said operations occur is determined by an electric current resistor in said photoelectric control circuit, and in combination therewith, means for increasing the internal resistance of said photoelectric control circuit above that caused by said resistor, said increase of internal resistance being such as to cause the photoelectric control circuit to turn off the current to the illumination system

at the same light level at which the control circuit operates to turn on the current, means operable to bring a second resistance into and thereby increase the internal resistance of said photoelectric control circuit, additional means acting upon the operation of the photoelectric circuit to turn on the current to the illumination system to bring said first named means into operation, and said first named means acting to return the internal resistance of said photoelectric circuit to normal after said photoelectric circuit has acted to turn off the current to the illuminating system.

3. An arrangement as defined in claim 1, wherein, the automatic insertion of the additional resistance into the photoelectric control circuit occurs after the passage of a predetermined time interval following the turning on of the current to the illumination system.

4. An arrangement as defined in claim 2 wherein, the insertion of the increased resistance and the removal of said increase of resistance from the photoelectric control circuit occurs after the passage of a predetermined time interval following respectively the turning on and turning off of the current to the illumination system.

5. An arrangement as defined in claim 1 wherein, the means operating automatically to insert the increase of internal resistance into the photoelectric control circuit is thermally controlled and causes the insertion of said additional resistance only after the passage of a considerable amount of time following the turning on of the current to the illumination system.

6. An arrangement as defined in claim 2 wherein, thermostatic means is provided and constitutes the means for inserting and removing the increase to the internal resistance of the photoelectric control circuit, and said thermo responsive means operating to cause said increase and decrease of circuit internal resistance only after the passage of a considerable interval of time following respectively the turning on and turning off of the current to the illumination system and maintaining said increase of circuit resistance insolong as the current remains turned on to the illumination system.

7. For use in turning on and off the current to the electric lights of a street or other like illuminating system, a photoelectric control circuit having a current supply to turn on the current at a predetermined light level and to turn off the current at a predetermined but higher light level and in which the light level at which said operations occur is determined by an electric current resistor in said photoelectric control circuit, and in combination therewith, a second resistor adapted to be placed in circuit with the first resistor, a switch for placing said second resistor in and removing it from said circuit, an electric motor operable to open and close said switch, means to deliver current to said motor when said photoelectric circuit operates to either turn on or turn off the current to the illumination system, and said electric motor operating to open said switch and thereby place the second resistor in the circuit when the photoelectric circuit turns on the current to the illumination system and operating to close said switch and remove said second resistor from the circuit after the photoelectric circuit is operated to turn off the current to the illumination system.

8. An arrangement as defined in claim 7 wherein a second switch is provided for secondarily controlling the delivery of current to the electric motor, and said second switch operating to stop the delivery of current to said motor after the passage of a predetermined time interval following each opening and closing of the first named switch by the motor.

9. For use in turning on and off the current to the electric lights of a street or other like illuminating system, a photoelectric control circuit having a current supply to turn on the current at a predetermined light level and to turn off the current at a predetermined but higher light level and in which the light level at which said operations occur is determined by an electric current resistor in said photoelectric control circuit, and in combination therewith, a second resistor adapted to be placed in and removed from the photoelectric control circuit, a thermo-responsive device for inserting and removing said second resistor from said circuit, and means causing the operation of said thermo device to place said second resistor in said circuit and maintain the same in said circuit after the current to the illumination system has been turned on and as long as said current to the illumination system remains turned on.

10. For turning lights on and off, a source of electric supply, a photoelectric supply, a photoelectric circuit connected to said current source, a circuit maker and breaker controlled by said photoelectric circuit, a pair of individual resistors in said photoelectric circuit and controlling the light level at which said circuit will operate to open and close said circuit maker and breaker, a switch for cutting one of said resistors into and out of said photoelectric circuit, an electric motor, a rotatable cam driven by said motor for opening and closing said switch, an electric connection between said motor and the source of current supply under the control of said circuit maker and breaker, said cam being associated with said switch to close the same when said circuit maker and breaker is in an open position, and said circuit maker and breaker causing the delivery of current to said motor to rotate said cam to cause said switch to open and place the second resistor in said photoelectric circuit when said circuit maker and breaker is moved to a closed position by said photoelectric circuit.

11. An arrangement as defined in claim 10 wherein, a second switch is provided and is in the electrical connection between said motor and said source of current supply, said second switch being actuated by said cam, and said cam causing the opening of said second circuit and the stoppage of current delivery to said motor an appreciable length of time after the cam has caused the opening of said first named switch.

12. For turning lights on and off, a source of electric supply, a photoelectric supply, a photoelectric circuit connected to said current source, a circuit maker and breaker controlled by said photoelectric circuit, a pair of individual resistors in said photoelectric circuit and controlling the light level at which said circuit will operate to open and close said circuit maker and breaker, a switch for cutting one of said resistors into and out of said photoelectric circuit, a comparatively airtight chamber having therein a thermo-responsive device operatively connected to said switch for opening and closing the same, an electric heater in said chamber, an electrical connection between said heater and said source of current supply, means causing the delivery of current to said heater upon the closing of said

circuit maker and breaker by said photoelectric circuit, and said thermo-responsive device upon being actuated by an accumulation of heat in said chamber operating to close said switch and place said second resistor in said photoelectric circuit.

13. An arrangement as defined in claim 12 wherein, the thermo device for operating the switch is in the form of a coiled bi-metallic strip, said switch being a mercury switch pivotally mounted and normally being open, and said thermo device upon being heated swinging said switch about its pivotal support and moving it to a closed position.

RICHARD S. GREGORY.