Aug. 27, 1935. W. R. KING 2,012,821

AUTOMATIC CONTROL OF ARTIFICIAL ILLUMINATION

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Fig. 1.

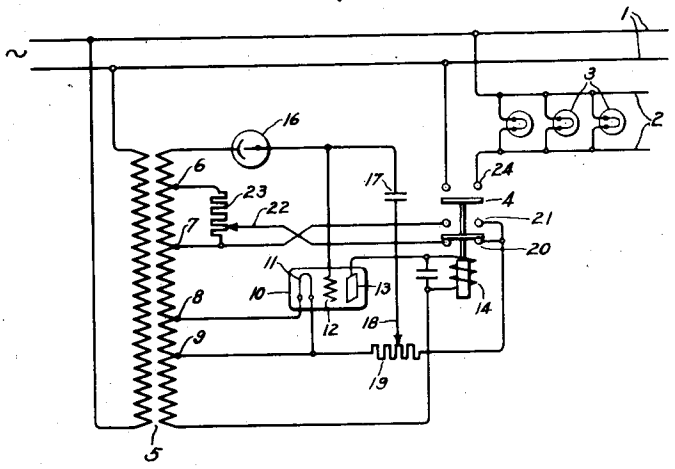
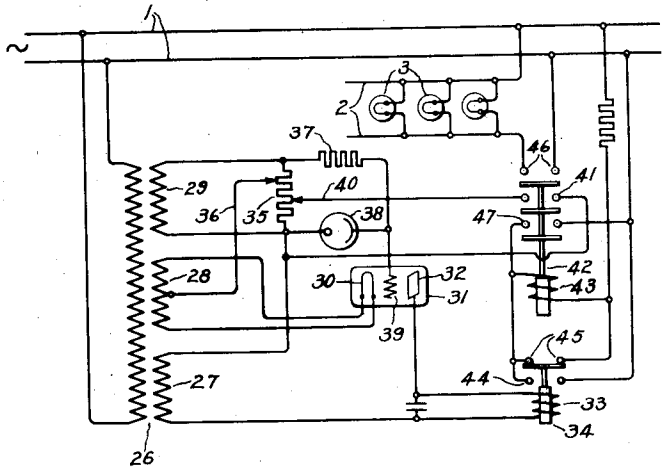


Fig. 2.



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AUTOMATIC CONTROL OF ARTIFICIAL ILLUMINATION

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14 Claims. (Cl. 250—41.5)

My invention relates to the automatic control of artificial illumination. Where photo-electric devices are employed to control the turning on or off of lighting equipment in response to variations in daylight, as for example in interior illumination, difficulty has been experienced in obtaining a satisfactory operation of the apparatus due to the fact that the photo-electric device is affected by the artificial illumination as well as by daylight, with the result that the device in responding to the effect of the artificial illumination has caused the immediate turning off of the same. It is the object of my invention to overcome this difficulty by providing an arrangement whereby compensation is made for the effect of the artificial illumination on the photo-electric device.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

Referring to the drawing, Figs. 1 and 2 are circuit diagrams illustrating two embodiments of my invention. In Fig. 1, reference number 1 represents an alternating current supply line, which for example may be a 60 cycle commercial lighting circuit. I have shown connected to this line the lighting circuit 2 having lamps 3 providing for the artificial illumination, this lighting circuit being controlled by the electromagnetic switch 4. The source of supply 1 also furnishes current to the control apparatus by which the lights 3 are turned on and off. Transformer 5 has its primary connected to the supply circuit 1 and has its secondary provided with taps 6, 7, 8, and 9 dividing the secondary winding into a number of sections. At 10 I have shown an electron discharge device having the cathode 11, grid 12, and the plate 13. The cathode 11 connects with the transformer secondary at points 8 and 9. The plate 13 connects through the winding 14 of the switch 4 with one end of the secondary winding. The photo-electric device 16 has its cathode connected to the opposite end of the secondary and its anode connected with the grid 12 and with one side of the condenser 17, the opposite side of which connects with the arm 18 of the potentiometer 19. One end of the latter connects with the tap 9, while the other end connects through the front contacts 21 of switch 4 with tap 7, and through the back contacts 20 of the switch with arm 22 of potentiometer 23, whose two ends connect with taps 6 and 7 respectively. Two other front contacts 24 of switch 4 are in the lighting circuit 2.

During the daylight hours when photo-electric device 16 is rendered conducting by the daylight, the grid 12 is maintained sufficiently negative to prevent the flow of any plate current or to allow an insufficient plate current to cause the operation of switch 4. When the daylight fades to such a degree that artificial illumination is desirable the resulting decreased conductivity of the photo-electric device 16 results in the grid 12 becoming sufficiently positive or acquiring a sufficiently small negative charge by reason of its connection through condenser 17 with arm 18 of potentiometer 19 that the plate current increases an amount sufficient to cause the operation of the switch 4. The lighting circuit 2 thereupon is closed, the circuit through the back contacts 20 is opened, and the circuit through the front contacts 21 is closed. By the latter change the connection of the potentiometer 19 is shifted from the arm 22 of potentiometer 23 to the point 7, thereby causing the arm 18 of the potentiometer to become slightly less negative or slightly more positive than before and therefore varying the bias applied through potentiometer 19 and condenser 17 to the grid 12. This change in potential of arm 18 raises the potential of the grid an amount which is sufficient to compensate for the effect on the photo-electric device 16 of the added illumination coming from the lamps 3. Were it not for the change in bias which is produced by the operation of the switch 4, the increased light stimulus due to the turning on of the lamps 3 would cause the photo-electric device 16 immediately to produce a deenergization of switch 4 and there would result a rapidly recurring closing and opening movement of the switch.

Upon the return of daylight the resulting increase in conductivity of the photo-electric device causes the grid 12 to swing negative to such an extent that the energizing current in the winding of switch 4 allows the switch to drop open, hence the lighting circuit 2 is opened and the bias on the grid is restored to that which originally obtained.

By varying the position of the arm 18 of potentiometer 19 the grid bias can be adjusted for various amounts of daylight and by varying the position of the arm 22 of potentiometer 23 the degree of compensation made for the effect of the artificial illumination can be adjusted.

It will be noted that during the day time the discharge device 10 has been inoperative, or at least operative to an insufficient degree to cause the closing of the switch 4. In the form of my

invention shown in Fig. 2, and which I shall now describe, the corresponding electron discharge device is operative during the daylight hours, but is inoperative, or substantially so, during the hours when the artificial illumination is required. The lighting circuit and the operating mechanism are shown in this form of my invention as supplied from the same alternating current supply circuit 1 as in Fig. 1. Transformer 26, like transformer 5, has its primary connected across the supply circuit 1, but the secondary in this case comprises the three windings 27, 28, and 29. The cathode 30 of the electron discharge device 31 is connected across the winding 28. The plate 32 connects through the winding 33 of the relay 34 with one end of the winding 27, the opposite end of which connects with the cathode 30 through the potentiometer 35 and arm 36 to the midpoint of the winding 28. Potentiometer 35 connects across winding 29 and in conjunction with the resistance 37 and the photo-electric device 38 keeps the grid 39 of device 31 at the desired potential. Potentiometer 35 is provided also with a second adjustable arm 40 which connects through forward contacts 41 of switch 42 with one end of the potentiometer. The winding 43 of switch 42 is connected to receive current from the supply circuit 1 through the back contacts 44 of relay 33, the front contacts 45 being provided to short circuit this winding to cause the switch to drop open. Switch 42 has the front contacts 46 by which the lighting circuit 2 is closed, and is also provided with front contacts 47 by which the switch is locked in closed circuit position.

In the operation of this form of my invention, during the daylight hours when the conductivity of the photo-electric device 38 is relatively high, the potential of the grid 39 is maintained sufficiently positive to operate the device 31, thereby maintaining the relay 34 energized. Being energized as shown, relay 34 short circuits the winding 43 of switch 42; hence the lighting circuit remains open. As daylight fades, the conductivity of the photo-electric device 38 decreases; hence the potential of the grid 39 becomes more negative until the device 31 cuts off and the armature of relay 34 drops away from the front contacts 45 to the rear contacts 44. Thus, winding 43 becomes energized to operate switch 42 to close the lighting circuit. Switch 42 also locks itself into closed position and closes the circuit of the potentiometer arm 40, thereby short circuiting one end portion of the potentiometer 35, thus changing the bias on the photo-electric device 38 an amount sufficient to compensate for the effect of the light coming from the artificial illumination. Upon return of daylight, the resulting increased conductivity of the photo-electric device causes the grid 39 to become less negative until the device 31 operates sufficiently to energize relay 34, whereupon the switch 42 is deenergized and the lighting circuit is opened. In this form of my invention an adjustment in the amount of grid bias for various amounts of artificial illumination may be made by shifting the arm 40 of potentiometer 35, and adjustment in the response of the photo-electric device to daylight may be made by shifting the arm 36 of the same potentiometer.

It will be understood that while I have illustrated the photo-electric devices 16 and 38 diagrammatically as electron discharge devices or photo-electric tubes, my invention is not limited to the use of any particular type of photo-electric device, but is equally applicable to apparatus employing any other form of photo-electric device than that illustrated, such, for example, as a selenium cell. It will also be understood that the lighting circuit 2 may be connected to be supplied from any other desired source and may comprise any form of artificial illumination.

I have chosen the particular embodiments described above as illustrative of my invention, and it will be apparent that various other modifications may be made without departing from the spirit and scope of my invention, which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. Apparatus for controlling artificial illumination comprising a source of light, means including an electron discharge device having a grid for controlling said source, a plurality of circuits connected with said grid, one of said circuits including a photo-electric device arranged to receive light from said source and from another source and another of said circuits including means for supplying a biasing potential, circuit changing means for controlling the biasing potential supplied by said biasing means to said grid and means responsive to the operation of said controlling means for operating said circuit changing means.

2. Apparatus for controlling artificial illumination in accordance with daylight comprising a source of current, means connected therewith for controlling a light source, a photo-electric device arranged to receive both daylight and light from said source, an electron discharge device having a grid responsive to said photo-electric device for controlling the operation of said means, a circuit having a variable connection with said source for supplying a bias to said grid and means responsive to the operation of said light controlling means for varying said connection to cause a variation in the bias on said grid.

3. Apparatus for the control of artificial illumination in accordance with daylight comprising switching means arranged to control an illumination circuit, a photo-electric device arranged to be affected by both daylight and said illumination, an electron discharge device having an output circuit operatively connected with said switching means and having a grid controlled by said photo-electric device, grid biasing means comprising a plurality of circuits for supplying different amounts of bias respectively to said grid and means operated by said switching means for controlling the connections of said circuits to compensate for the effect of the artificial illumination on the photo-electric device.

4. Apparatus for the control of artificial illumination in accordance with daylight comprising switching means arranged to control an illumination circuit, a photo-electric device arranged to be affected by both daylight and said illumination, an electron discharge device having an output circuit operatively connected with said switching means and having a grid controlled by said photo-electric device, grid biasing means comprising a potentiometer, means operated by said switching means for changing the connections of said potentiometer to compensate for the effect of the artificial illumination on the photo-electric device, means for adjusting the degree of said compensation, and means for adjusting the response made by said photo-electric device to daylight.

5. Apparatus for controlling artificial illumination comprising a source of light, means in-

cluding an electron discharge device having a grid for controlling said source, a photo-electric device connected with said grid and arranged to receive light from said source and from another source, means connected with said grid for supplying a grid biasing potential which is independent of the illumination to which said photo-electric device is subjected and means responsive to the operation of said controlling device for changing the grid biasing potential supplied by said means.

6. Apparatus for controlling artificial illumination in accordance with daylight, comprising means for controlling a light source, a grid controlled electron discharge device for controlling the operation of said means, a photo-electric device connected with said grid and arranged to receive both daylight and light from said source and separate means controlled by said light controlling means for supplying a bias to said grid which is independent of the illumination to which said photo-electric device is subjected.

7. Apparatus for controlling artificial illumination comprising a source of light, a source of current, means including a grid controlled electron discharge device for controlling said source of light, a photo-electric device arranged to receive light from said source of light and from another source and connected with said source of current for supplying a controlling voltage to said grid, means having a variable connection with said source for supplying a biasing voltage to said grid and means responsive to the operation of said controlling means for varying the connection of the means for supplying said biasing voltage.

8. Apparatus for controlling artificial illumination comprising means including an electron discharge device having a grid for controlling a light source, a photo-electric device connected with said grid, a potentiometer connected with said grid to supply a bias thereto and means responsive to said light controlling means for changing the connection of the grid with the potentiometer to change the grid bias.

9. Apparatus for controlling artificial illumination comprising a source of light, a source of current, means including a grid controlled electron discharge device for controlling said source of light, a photo-electric device arranged to receive light from said source of light and from another light source and connected with said source of current for supplying a negative potential to said grid, a variable connection between the grid and said source of current for supplying to said grid potentials less negative than said negative potential and means responsive to the operation of said controlling means for varying said connection.

10. Apparatus for controlling artificial illumination comprising a source of light, means including a grid controlled electron discharge device for controlling said source of light, a photo-electric device arranged to receive light from said source and from another source for supplying a potential to said grid, means including a potentiometer for supplying a negative biasing potential to said grid and switching means responsive to said light controlling means for controlling said potential supplying means.

11. In combination, a source of illumination, an electron discharge device having a grid, a photoelectric device connected with said grid for controlling the same, means responsive to said discharge device for varying the illumination, and means also connected with said grid and controlled by said illumination varying means for supplying a bias to said grid which is independent of the illumination to which the photo-electric device is subjected.

12. In combination, an electron discharge device having a grid, a photoelectric device connected with said grid for controlling the same, means responsive to said discharge device for varying the illumination and means also connected with said grid for supplying thereto either one of a plurality of different bias voltages, said last means including circuit controlling means responsive to said illumination controlling means.

13. Apparatus for controlling the artificial illumination in a region comprising means to respond to the illumination in said region, said means including a photo-sensitive device to be subjected to said illumination, an electric discharge device having a control electrode and a plurality of principal electrodes cooperating with said photo-sensitive device to amplify the output thereof, means to be actuated by said electric discharge device for energizing said artificial illumination when the natural illumination in said region attains a predetermined minimum value, and to be actuated by said electric discharge device when said illumination in said region attains a predetermined maximum value to deenergize said artifical illumination and means independent of said photo-sensitive device for applying predetermined biasing potentials on the control electrode of said electric discharge device to predetermine the minimum illumination at which said electric discharge device actuates said energizing and deenergizing means to energize said artificial illumination and the maximum illumination at which said electric discharge device actuates said energizing and deenergizing means to deenergize said artificial illumination.

14. Apparatus for controlling the artificial illumination in a region comprising means to respond to the illumination in said region, said means including a photo-sensitive device to be subjected to said illumination, an electric discharge device having a control electrode and a plurality of principal electrodes cooperating with said photo-sensitive device to amplify the output thereof, means to be actuated by said electric discharge device for energizing said artificial illumination when the natural illumination in said region attains a predetermined minimum value, and to be actuated by said electric discharge device when said illumination in said region attains a predetermined maximum value to deenergize said artificial illumination, means for applying a biasing potential on the control electrode of said electric discharge device to predetermine the minimum illumination at which said electric discharge device actuates said energizing and deenergizing means to energize said artificial illumination and means for applying another biasing potential on the control electrode of said electric discharge device, that is independent of said biasing potential applied by said above-named predetermining means, to predetermine the maximum illumination at which said electric discharge device actuates said energizing and deenergizing means to deenergize said artificial illumination.

WILLIAM R. KING.