

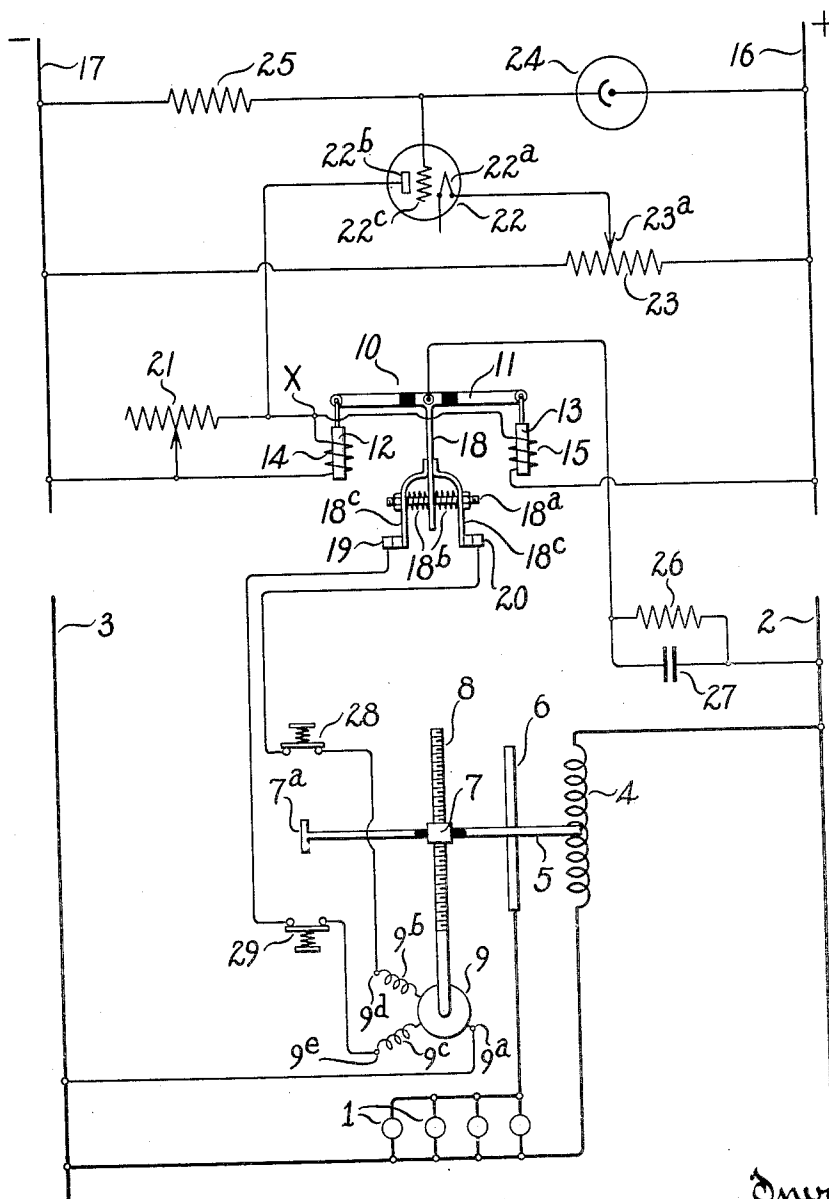
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MOTOR OPERATED AUTOMATIC REGULATOR

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MOTOR OPERATED AUTOMATIC REGULATOR

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The invention relates to motor operated automatic regulators, and while not limited thereto it is particularly adapted to regulators for illuminating systems wherein the light output of electric lamps is to be regulated in accordance with the illumination of a surface, which is subjected to illumination by a second light source of varying intensity.

An object of the invention is to provide a system of the aforementioned type which maintains the illumination of a surface at a given level, if the illumination by a second light source alone is below said level.

Another object is to provide a regulator for an artificial light source which will control the intensity of said source so as to maintain the illumination of a surface, which is simultaneously illuminated by another variable light source, at a given minimum level, unless the intensity of said other source alone results in a higher level of illumination than said minimum.

Another and more specific object is to provide an illumination control system for a classroom, auditorium, or the like, wherein a variable degree of natural light (such as daylight) is utilized to effect illumination thereof—such system affording control of an artificial source of light in such a manner as to insure maintenance of a predetermined degree of illumination in the event that the illumination afforded by the source of natural light falls below said predetermined degree or value.

Another object is to provide a regulator for an artificial light source which responds to the total illumination of a surface and controls said light source to prevent the total illumination from falling below a given level.

Another object is to provide a motor operated regulator of the aforementioned type which is quick and accurate in its response.

Another object is to provide a regulator of the aforementioned type in which the energy supplied to an artificial light source is controlled by an operating mechanism which includes a reversible alternating current driving motor.

Another object of the invention is to provide a reversible controller for an illumination control system, which is quick and accurate in its response to a suitable controlling influence.

Other objects and advantages will hereinafter appear.

The accompanying drawing illustrates schematically and diagrammatically a system of illumination embodying the invention, which will now be described.

In the system a bank of electric lamps 1 may be supplied with current from the alternating current bus bars 2 and 3 of an alternating current source of supply. A variable voltage autotransformer 4 is connected with its input terminals

across the bus bars 2 and 3. It is provided with a sliding brush 5 by means of which its output voltage may be varied in a known manner. The brush 5 is conductively connected to a bus bar 6, which is connected to one terminal of the lamps 1, while their other terminal is connected to the bus bar 3. The brush 5 is also rigidly mechanically connected with but insulated from a nut 7 which engages a threaded shaft 8 which in turn is connected to the armature of a reversible motor 9, so that upon rotation of the motor in one direction or the other, the nut and with it the brush 5 are moved in one direction or the other to vary the voltage impressed on the lamps 1.

The motor 9 has a common terminal 9^a, which is connected to the bus bar 3, and with reversing windings 9^b and 9^c, which latter are provided with reversing terminals 9^d and 9^e, respectively.

The motor 9 is controlled by a center-biased relay 10, comprising a lever 11, which is pivoted at its center to provide for oscillatory movement thereof and which has attached to its ends the magnetic cores 12 and 13, respectively. The cores 12 and 13 cooperate with energizing coils 14 and 15, respectively, which are connected in series across the bus bars 16 and 17 of a direct current source of power supply, and said coils are so wound that normally their pulls balance, so that the lever 11 remains in its central or neutral position. Attached to the lever 11 and oscillatable therewith is a contact arm 18, which is connected to one of the bus bars, 2, of the alternating current supply through an impedance 26, connected in parallel with a condenser 27. A stud or bolt 18^a is fastened at its center to the arm 18 and is provided at both of its transversely projecting ends with heads or nuts, as shown, which serve as abutments to limit the degrees of outward movement of a pair of contact fingers 18^b relatively to the arm 18. Springs 18^c, surrounding the ends of stud 18^a are interposed between the fingers 18^c and the arm 18 and normally bias the fingers 18^c into contact with stationary contacts 19 and 20, respectively. When the lever 11 and arm 18 are oscillated from the center position to one side or the other, the circuit between one of the fingers 18^c and the respective contact 19 or 20 is interrupted. The contact 19 is connected to the motor terminal 9^e and the contact 20 is connected to the motor terminal 9^d.

The coil 14 is shunted by an adjustable resistor 21 by means of which the pull of the two coils 14 and 15 can be balanced.

The system further includes an electron tube 22, having a cathode 22^a, an anode 22^b and a control grid 22^c. The anode 22^b is connected to the point x between the coils 14 and 15, and the cathode 22^a is connected to an adjustable output

contact 23^a of a potentiometer rheostat 23, which is connected across the bus bars 16 and 17.

A photo-electric cell 24 which responds to the intensity of the illumination to be controlled is connected in series with a resistor 25 across the bus bars 16 and 17, and the common terminal of the cell 24 and the resistor 25 is connected to the grid 22^c.

The system described operates as follows: If, with the parts in the respective positions thereof shown in the drawing, the illumination is of the desired, or at least of a predetermined minimum, intensity, the voltage of the lamps 1 is determined by the position of the brush 5. The voltage of the grid 22^c is such, that the current flowing through tube 22 is of such a value, that the pull of the coils 14 and 15 balance, and the relay 10 is in its center position.

If now the degree of illumination to which the cell 24 is subjected decreases, its resistance increases and the potential of the grid 22^c with respect to the cathode 22^a becomes more negative. As a result the current flowing through the tube 22, which also flows through coil 15, decreases and this decreases the total current in the latter, while the current through coil 14 increases, due to the increase of its terminal voltage. This decreases the pull of coil 15 and increases that of coil 14 and effects rotation of the relay lever 11 in a counterclockwise direction to open the circuit at 10, 10^c for the winding 9^c, and maintains the single circuit for winding 9^b from bus bar 2 through impedance 26 and condenser 27, over arm 18, one of the fingers 10^c, contact 20, through winding 9^b and the armature of motor 9, to bus bar 3. The motor is thereby caused to rotate in a direction to move the nut 7 and brush 5 upwardly, to increase the voltage impressed on the lamps 1 which increases their intensity, and thus the total illumination of the cell 24. As the illumination of cell 24 again becomes normal, the potential of the grid 22^c again becomes normal. This rebalances the relay 10, and the motor windings 9^b and 9^c are again connected in parallel through the impedance 26 and condenser 27 to bus bar 2. The opposing torques of the windings 9^b and 9^c afford a strong braking effect which causes the motor to stop quickly with the brush 5 at a point such that the intensity of the lamps 1 corresponds to the desired level of illumination of the lighted surface. If the total illumination increases, the system functions in the opposite sense, in a manner which will be obvious from the foregoing explanation.

It will be observed that the motor windings 9^b and 9^c are normally connected in parallel with each other through the contacts 20 and 19 of the relay 10, and are connected in series with the impedance 26, paralleled by the condenser 27, to the line 2—when relay 10 is in balanced condition, and when nut 7 is in a position between its respective extreme positions. This affords a very strong braking current which flows through the motor windings as long as the relay 10 is in its balanced or center position. As a result, as soon as the contacts 10^c, 10^c simultaneously engage the stationary contacts 19 and 20, the motor is brought to a quick stop, and hunting thereof is prevented. By properly proportioning the impedance 26 and the condenser 27, the braking current which continuously flows through the motor 9 when the same is standing still may be preselected, and the running torque of the motor and its running torque may be similarly predetermined.

It will be apparent that the impedance 26 may be either an ohmic resistance, or an inductance or a combination of both. It will also be apparent that the impedance 26 may be entirely omitted, or, if desired, the condenser 27 may be omitted, and the motor fed through the impedance 26 alone.

The adjustment of the contact 23^a varies the potential of the cathode 22^a with respect to that of the anode 22^b and that of the grid 22^c and thus permits the selection of the illumination of the cell 24 at which the relay 10 is balanced.

In practice we prefer to provide a pair of limit switches 28 and 29 which are spring-biased to their closed positions respectively, and are adapted to be opened selectively by a double-ended extension 7^a on nut 7 when the latter is moved to a position corresponding respectively to maximum or minimum intensity of illumination of lamp or lamps 1.

By this arrangement, it will be apparent to those skilled in the art that when the degree of natural light is above the predetermined minimum the nut 7 will have moved downwardly to its lower extreme position with a resultant reduction to zero of the intensity of illumination afforded by lamps 1—the limit switch 29 being simultaneously opened to interrupt the circuit of winding 9^c (the winding 9^b, as aforesaid, being likewise interrupted under such a condition by the action of relay 10 in disengaging the right-hand relay contact 10^c from stationary contact 20). Similarly, when nut 7 is moved to its upper extreme position to provide full brilliancy of lamps 1, limit switch 28 is opened automatically to interrupt the only live circuit (through winding 9^b) of motor 9—the circuit through winding 9^c having been previously interrupted by disengagement of left-hand contact 10^c from stationary contact 19. Accordingly when no further change is required or is possible in the intensity of illumination of lamps 1 no electric current is used, or wasted, by motor 9 pending a reverse operation of relay 10; but the parts are then preset to automatically perform the reverse functions when the occasion arises.

In practice the number and illuminating power of lamps 1 are preferably such that full brilliancy thereof is seldom or never required, even in the absence of natural light or any other source of light of variable value. Therefore, the limit switch 28 might be omitted, except for its value from a precautionary or safety viewpoint.

When limit switch 29 has been opened it is to be understood that upon rebalancing of relay 10 the circuit of winding 9^b will be completed—but completion of such circuit will only be temporarily effective to cause upward movement of nut 7—the winding 9^c being likewise energized to cause stopping of motor 9 and nut 7 as soon as limit switch 29 has been reclosed; unless in the meantime the relay 10 has become unbalanced in one direction or the other, with obvious results.

If the surface illuminated by the lamps is simultaneously illuminated by another source of light, such as daylight, the cell 24 effects intensity control of the lamps 1 so as to insure a total value of illumination which is not less than a desired or predetermined minimum. In this case the illumination intensity of the lamps may be varied automatically from maximum brilliancy to zero, dependent upon the amount of daylight available, and the intensity of illumination of the lamps remains at zero value as

long as the daylight produces at least the desired minimum illumination.

We claim:

1. A control system for controlling the light output of an electric lamp to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, an electric lamp, a circuit therefor, a photo-electric cell having a characteristic responsive to the degree of the total illumination of said surface, an electron tube connected to a source of energy, adjustable means to effect response of said electron tube to the operation of said photo-electric cell, a relay responsive to the current of said tube, an alternating current motor having a pair of reversing windings normally connected by said relay in parallel with each other and in series with an impedance across an alternating current source for stopping said motor, said relay upon response operating to disconnect one of said reversing windings from circuit to cause said motor to rotate in opposite directions selectively, and a regulator operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamp.
2. A control system for controlling the light output of an electric lamp to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, an electric lamp, a circuit therefor, a photo-electric cell having a characteristic responsive to the degree of the total illumination of said surface, an electron tube connected to a source of energy, adjustable means to effect response of said electron tube to the operation of said photo-electric cell, a reversing relay responsive to the current of said tube and provided with a pair of contacts normally connected by said relay in parallel with each other, an alternating current motor having a pair of reversing windings, each connected to one of said contacts, an impedance connected in series with said windings across a supply of alternating current, said relay being adapted, upon response thereof, to disconnect one of said reversing windings from circuit to cause said motor to rotate in opposite directions selectively, and a regulator operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamp.
3. A control system for controlling the light output of a group of electric lamps to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, a group of electric lamps, a circuit therefor, a pair of direct current terminals, a photo-electric cell, a resistance connected in series with said photo-electric cell across said terminals, a thermionic tube having a cathode, an anode and a grid, means to impress upon said grid a voltage of said cell, means to connect said cathode and anode across said terminals and to impress a variable potential upon said cathode, an electromagnetic relay provided with two opposing windings connected to said terminals, means to impress a potential varying with the voltage between said cathode and anode upon one of said windings, a reversible motor controlled by said relay, and a regulator operable by said motor and adapted to vary the

voltage impressed upon the circuit of said electric lamps.

4. A control system for controlling the light output of a group of electric lamps to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, a group of electric lamps, a circuit therefor, a pair of direct current terminals, a photo-electric cell, a resistance connected in series with said photo-electric cell across said terminals, a thermionic tube having a cathode, an anode and a grid, means to impress upon said grid a voltage of said cell, means to connect said cathode and anode across said terminals and to impress a variable potential upon said cathode, an electromagnetic relay provided with two opposing windings connected to said terminals, means to impress a potential varying with the voltage between said cathode and anode upon one of said windings, a regulator operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamps, said relay being also provided with a pair of contacts normally connected together, an alternating current motor having a pair of reversing windings each connected to one of said contacts of said relay, and in impedance connected in series with said windings, said relay being adapted upon response to disconnect one or the other of said reversing windings from circuit to cause said motor to rotate in opposite directions selectively.

5. A control system for a reversing alternating current single-phase motor having a pair of reversing windings, comprising, a condenser, means operable automatically to connect one or the other of said windings in series with said condenser across an alternating current supply circuit for rotation of said motor in opposite directions selectively, and said means being also operable automatically to connect the two windings in parallel with each other and in series with said condenser across said alternating current source to effect stopping of the motor.

6. A control system for a reversing alternating current single-phase motor having a pair of reversing windings, an impedance comprising an inductance and a parallel condenser, means arranged to connect one or the other of said windings in series with said impedance across an alternating current supply circuit for rotation of said motor in opposite directions selectively, and to connect the two windings in parallel with each other and in series with said impedance across said alternating current source to effect stopping of the motor.

7. A control system for a reversing alternating current single-phase motor having a pair of reversing windings, an impedance comprising an ohmic resistance and a condenser connected in parallel therewith, means operable automatically to connect one or the other of said windings in series with said impedance across an alternating current supply circuit for rotation of said motor in opposite directions selectively, and said means being also operable automatically to connect the two windings in parallel with each other and in series with said impedance across said alternating current source to effect stopping of the motor.

8. A control system for controlling the light output of an electric lamp to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising,

in combination, an electric lamp, a circuit therefor, a photo-electric cell having a characteristic responsive to the degree of the total illumination of said surface, an electron tube connected to a source of energy, adjustable means to effect response of said electron tube to the operation of said photo-electric cell, a relay responsive to the current of said tube, an alternating current motor having a pair of reversing windings normally connected by said relay in parallel with each other and in series with an impedance across an alternating current source for stopping said motor, said relay upon response operating to disconnect one or the other of said reversing windings from circuit to cause the motor to rotate in opposite directions selectively, and a regulator including a variable voltage auto-transformer operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamp.

9. A control system for controlling the light output of an electric lamp to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, an electric lamp, a circuit therefor, a photo-electric cell having a characteristic responsive to the degree of the total illumination of said surface, an electron tube connected to a source of energy, adjustable means to effect response of said electron tube to the operation of said photo-electric cell, a reversing relay responsive to the current of said tube and provided with a pair of contacts normally connected by said relay in parallel with each other, an alternating current motor having a pair of reversing windings, each connected to one of said contacts, an impedance connected in series with said windings across a supply of alternating current, said relay being adapted, upon response thereof, to disconnect one or the other of said reversing windings from circuit to cause said motor to rotate in opposite directions selectively, and a regulator including a variable voltage auto-transformer operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamp.

10. A control system for controlling the light output of a group of electric lamps to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum, comprising, in combination, a group of electric lamps, a circuit therefor, a pair of direct current terminals, a photo-electric cell, a resistance connected in series with said photo-electric cell across said terminals, an electron tube having a cathode, an anode and a grid, means to impress upon said grid a voltage of said photo-electric cell, means to connect said cathode and anode across said terminals and to impress a variable potential upon said cathode, an electromagnetic relay provided with two opposing windings connected to said terminals, means to impress a potential varying with the voltage between said cathode and anode upon one of said windings, a reversible motor controlled by said relay, and a regulator including a variable voltage auto-transformer operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamps.

11. A control system for controlling the light output of a group of electric lamps to maintain the illumination of a surface illuminated thereby and by an uncontrolled light source jointly at a degree of illumination above a given minimum,

comprising, in combination, a group of electric lamps, a circuit therefor, a pair of direct current terminals, a photo-electric cell, a resistance connected in series with said photo-electric cell across said terminals, an electron tube having a cathode, an anode and a grid, means to impress upon said grid a voltage of said photo-electric cell, means to connect said cathode and anode across said terminals and to impress a variable potential upon said cathode, an electromagnetic relay provided with two opposing windings connected to said terminals, means to impress a potential varying with the voltage between said cathode and anode upon one of said windings, a regulator including a variable voltage auto-transformer operable by said motor and adapted to vary the voltage impressed upon the circuit of said electric lamps, said relay being also provided with a pair of contacts normally connected together, an alternating current motor having a pair of reversing windings each connected to one of said contacts of said relay, and an impedance connected in series with said windings, said relay being adapted upon response to disconnect one or the other of said reversing windings from circuit to cause said motor to rotate in opposite directions selectively.

12. A control system comprising, a reversing alternating current single-phase motor having a pair of reversing windings, a condenser, means operable automatically to connect one or the other of said windings in series with said condenser across an alternating current supply circuit for rotation of said motor in opposite directions selectively, said means being also operable automatically to connect the two windings in parallel with each other and in series with said condenser across said alternating current source to effect stopping of the motor, and a regulator including a variable voltage auto-transformer operable by said motor.

13. A control system comprising, a reversing alternating current single-phase motor having a pair of reversing windings, an impedance comprising an inductance and a condenser connected in parallel with the latter, means arranged to connect one or the other of said windings in series with said impedance across an alternating current supply circuit for rotation of said motor in opposite directions selectively, said last mentioned means being alternatively adapted to connect the two windings in parallel with each other and in series with said impedance across said alternating current source to effect stopping of the motor, and a regulator including a variable voltage auto-transformer operable by said motor.

14. A control system comprising, a reversing alternating current single-phase motor having a pair of reversing windings, an impedance comprising an ohmic resistance and a condenser connected in parallel therewith, means operable automatically to connect one or the other of said windings in series with said impedance across an alternating current supply circuit for rotation of said motor in opposite directions selectively, said means being also operable automatically to connect the two windings in parallel with each other and in series with said impedance across said alternating current source to effect stopping of the motor, and a regulator including a variable voltage auto-transformer operable by said motor.

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