

Jan. 30, 1968

J. J. EVERARD

3,366,800

AUTOMATIC RECYCLING TIME SWITCH WITH COMPENSATING MECHANISM

Filed Feb. 19, 1965

7 Sheets-Sheet 1

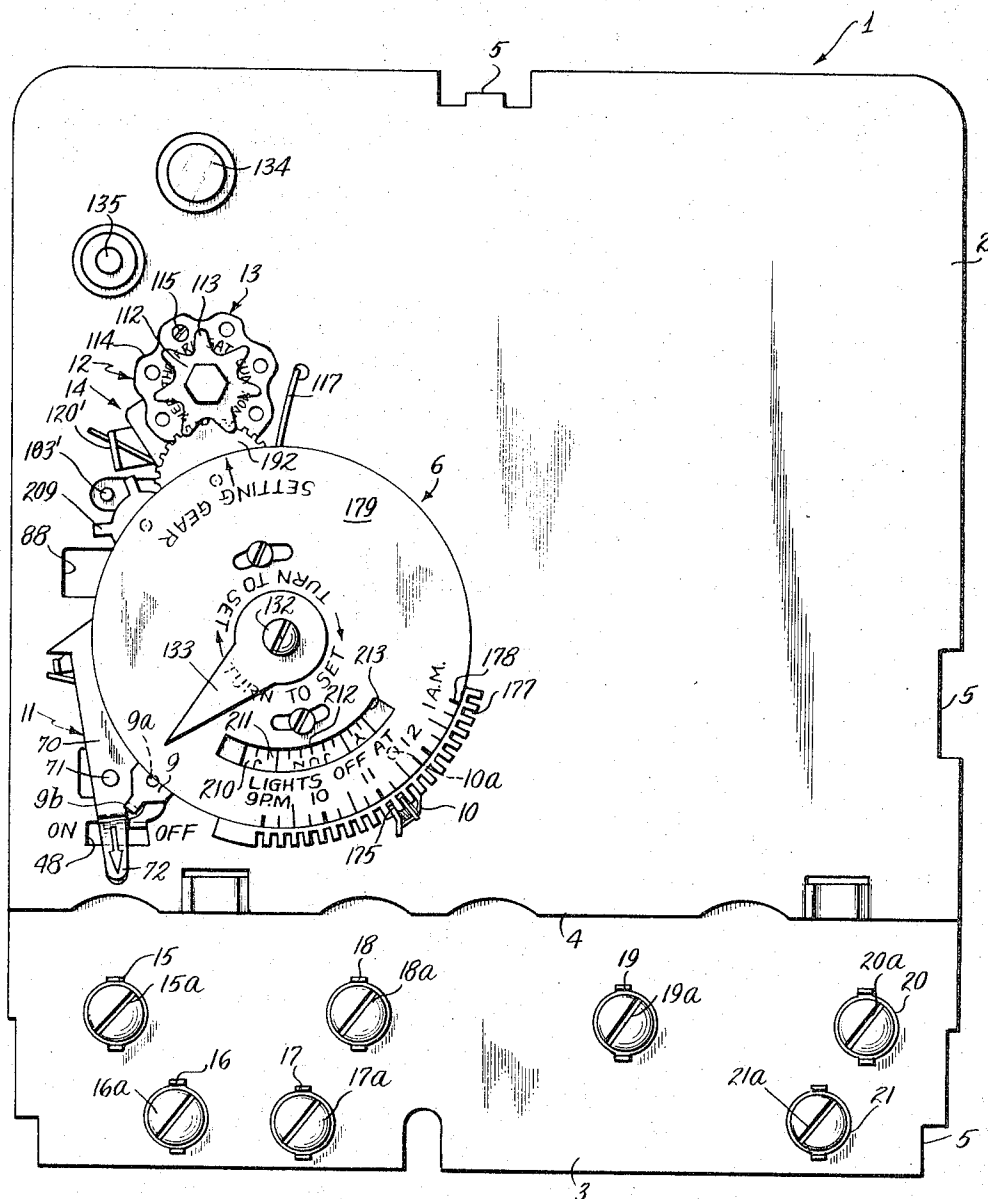


Fig. 1.

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7 Sheets-Sheet 2

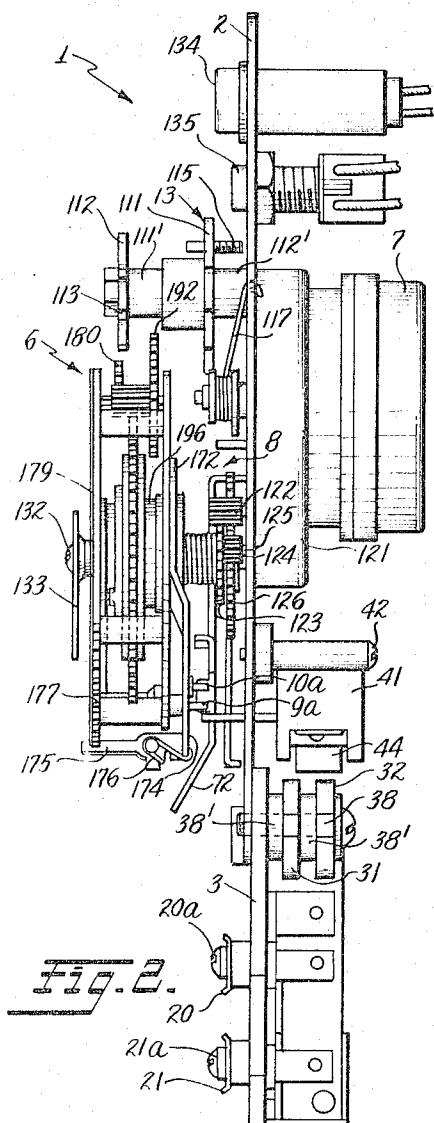


Fig. 2.

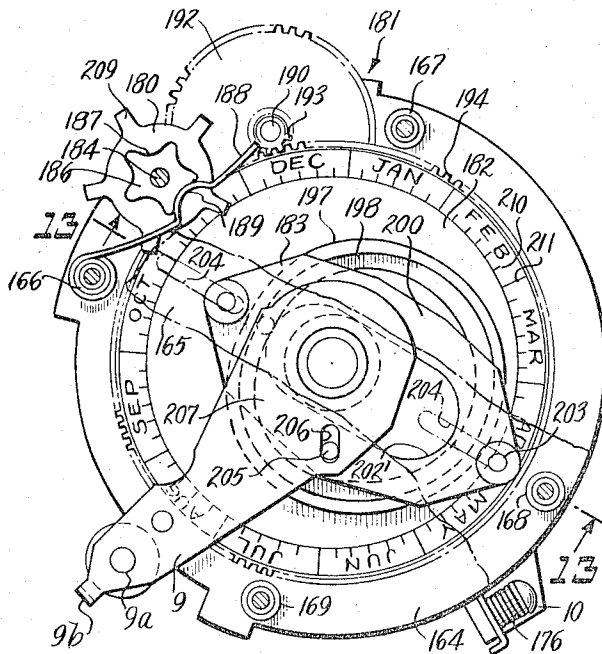


Fig. 12.

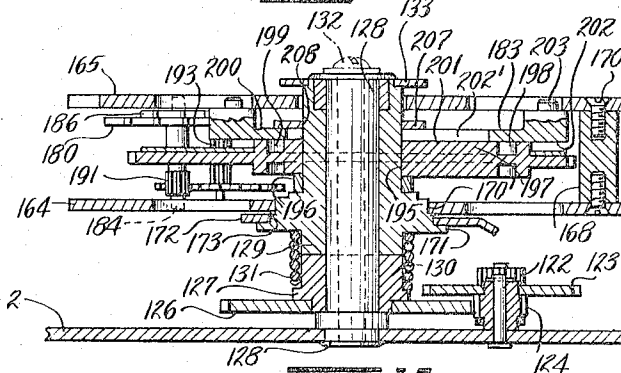


Fig. 13.

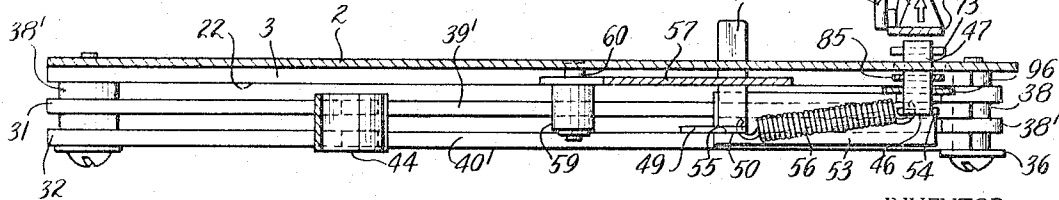


Fig. 2A.

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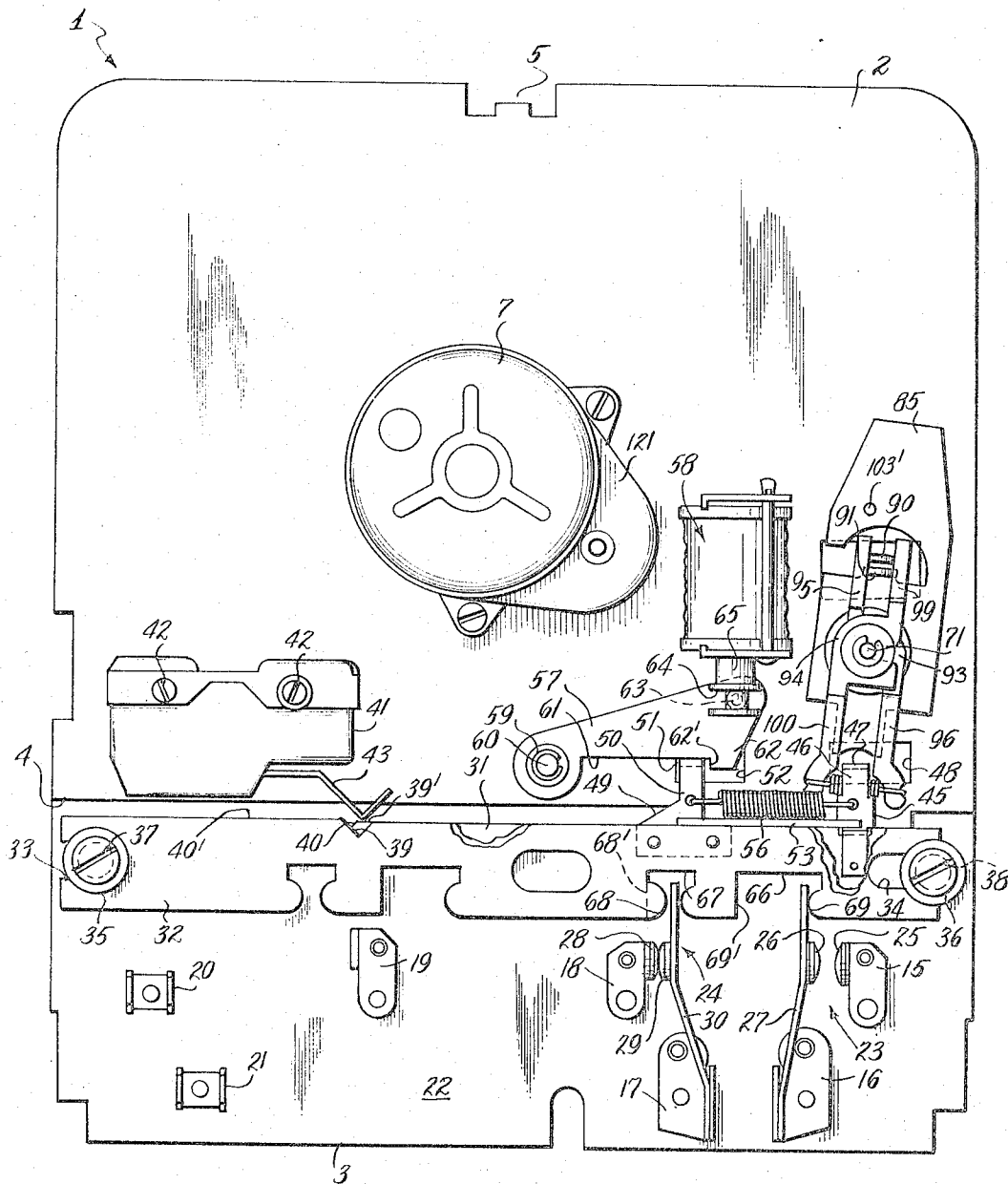


Fig. 3.

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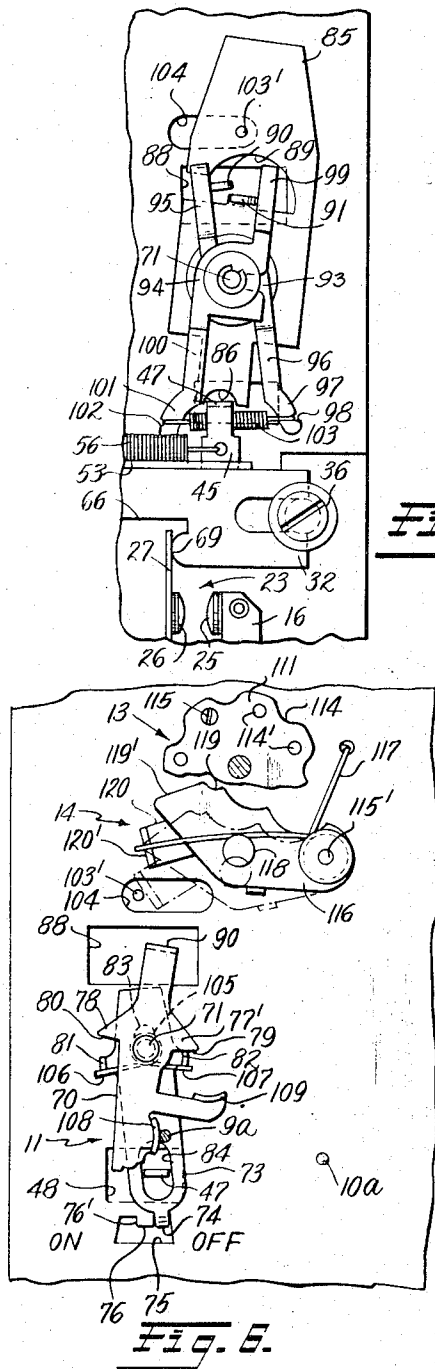
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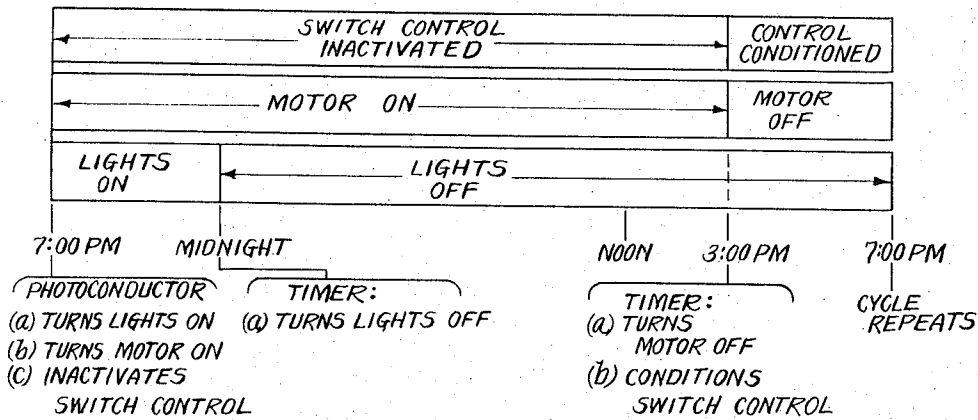


Fig. 11.

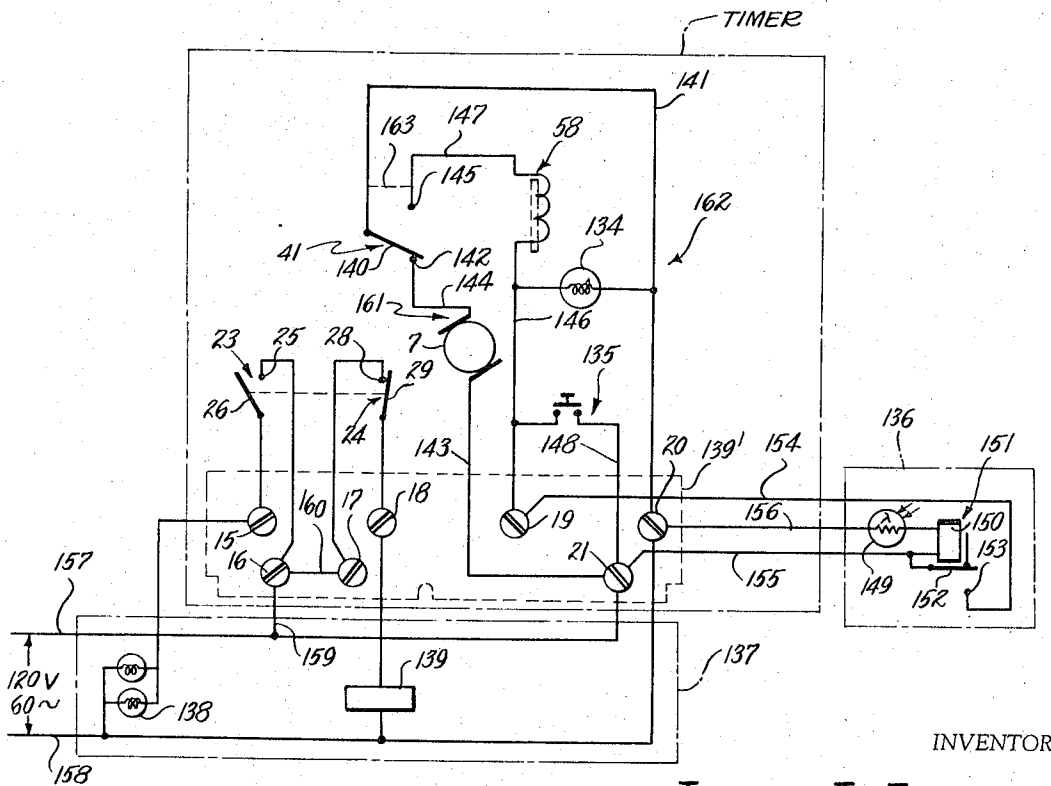


Fig. 10.

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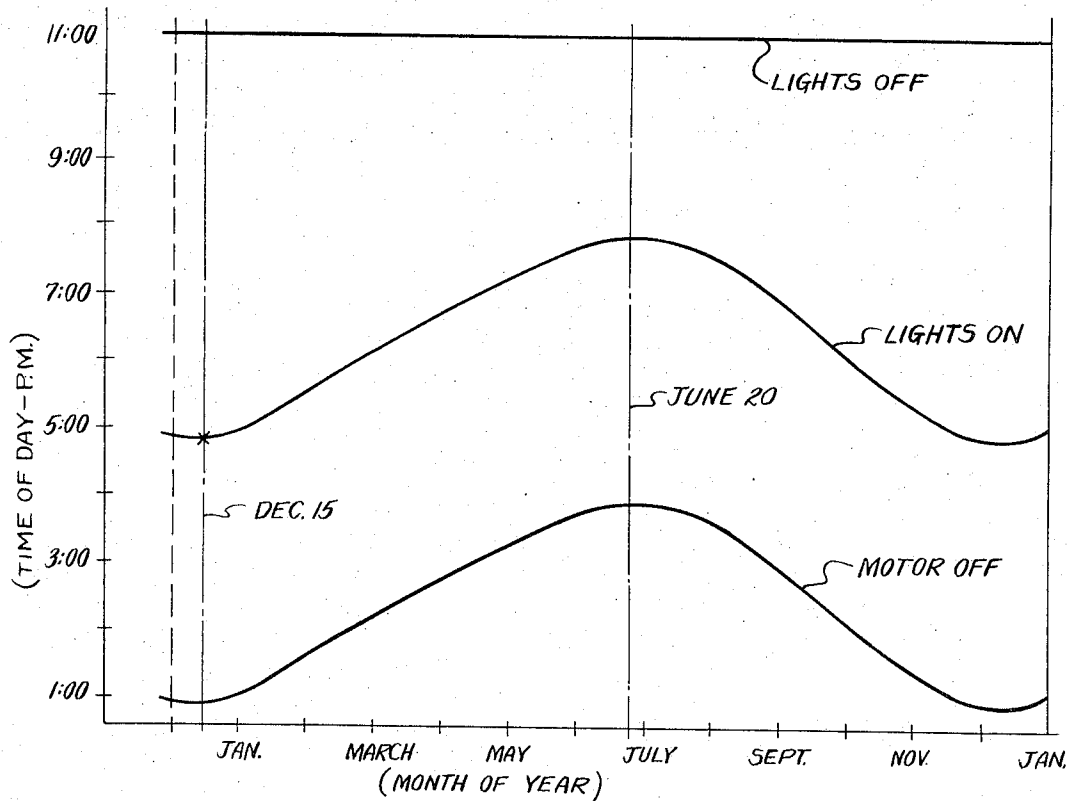


Fig. 14.

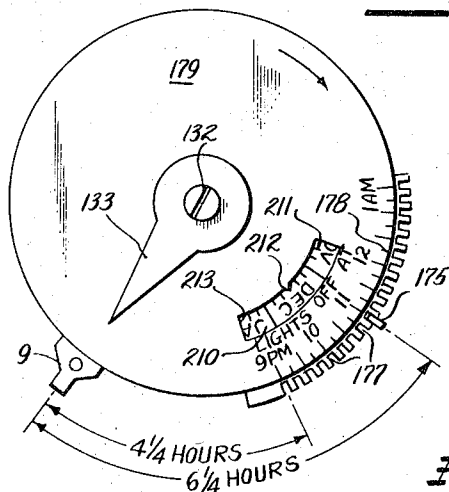


Fig. 15.

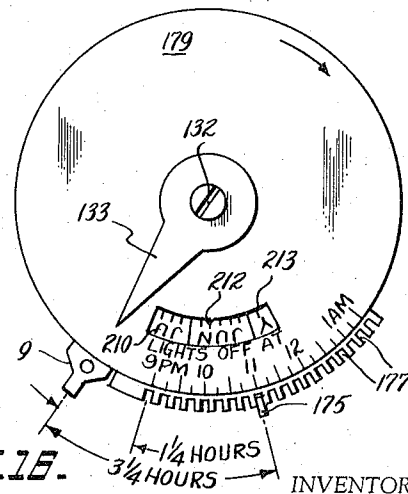


Fig. 16.

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AUTOMATIC RECYCLING TIME SWITCH WITH COMPENSATING MECHANISM

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Filed Feb. 19, 1965, Ser. No. 433,915

13 Claims. (Cl. 307—117)

ABSTRACT OF THE DISCLOSURE

A timer which automatically resets after a power failure having a motor and a dial driven by the motor to make a complete revolution in less than twenty four hours whereupon the motor is turned Off, the timer is conditioned for subsequent operation, and the remaining time until subsequent operation is a pause period provided for resetting. A photoelectric circuit is provided to turn the motor On, and to operate a load switch to a first state which at a predetermined time period, regardless of seasonal variations of time related natural light levels, is returned to its original state by compensating means operatively associated with the driven dial.

This invention relates generally to timers of the automatically retiming type with a control device responsive to a recurring natural condition, and particularly to timers of this type which automatically compensate for seasonal variations in the time of the daily occurrence of the natural condition.

More particularly, this invention relates to an automatically retiming timer driven by an electric motor and operated once each day by a photocell or other light responsive switch, responsive to a predetermined value of natural light intensity, to automatically operate a switch to a first condition in response to operation of the light responsive switch (LRS), and to operate the switch to a second condition at a predetermined time of day regardless of variations in the time of operation of the LRS by reason of seasonal changes in the time of sunset and dusk.

In the geographic regions of the earth at latitudes 25° north or south of the equator, and beyond, there is a significant difference in the time of sunrise and sunset throughout the several seasons of a year. Hence, if it is desired to turn lights on at sunset a photocell has been used to accomplish the function. Where the lights are to remain on until sunrise of the following day a photocell alone is normally sufficient. However, where it is desired to turn the lights out at a predetermined hour during the night a time switch is also used. The most common arrangement is to combine the photocell and time switch in such a manner that the photocell turns the lights on at dusk and the continuously running time switch turns the lights off at a predetermined hour of the night or the following day. The disadvantage of this arrangement is that during a power failure the timer stops and hence, turns the lights off at a later time each day than the time at which the timer is originally set to do so. Therefore, when a power failure occurs it is necessary to manually reset the timer to turn the lights off at the proper time.

In the copending application Ser. No. 433,916 entitled Automatically Retiming Timer and filed of even day herewith by Roger Rulseh there is disclosed a timer so combined with a LRS as to automatically reset the timer after a power failure. The operation of the timer is such that an electric timer motor runs only about 20 hours a day and a dial of the timer is driven only when the motor is running. A trip finger carried by the driven dial operates to turn the motor off about 20 hours after a previous actuation of the LRS. Simultaneous with the turning of the motor off, the timer conditions itself for operation by the

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LRS. About 4 hours later, when the LRS operates, the timer motor is re-energized and the electric lighting or other controlled load is turned on. A second trip finger on the driven dial then operates the timer to turn the lights off a predetermined number of hours after they and the motor are turned on. Such a timer works extremely well in latitudes close to the equator where variations in the hour of sunset and dusk for the several seasons of the year are very slight. However, at latitudes beyond about 25° from the equator, where the seasonal variation in the time of sunset and dusk is several hours the Rulseh timer has not proven completely satisfactory in all instances because the lights can only be turned off a predetermined number of hours after they are turned on. Hence, in the summertime when darkness sufficient to operate the LRS occurs between 7:30 and 8:00 p.m. (standard time), and it is desired that the lights turn off at midnight it is necessary that the timer motor run for 4 hours after operation of the LRS, before the trip member of the driven dial turns the lights off. In the wintertime however darkness sufficient to operate the LRS occurs at about 5 o'clock. Since the timer turns the lights off 4 hours after they are turned on the lights will then be turned off at 9 o'clock. This of course is a disadvantage since the lights are then operated off at a substantially different hour in the winter than in the summer.

With the timer of this invention applicant has solved the shortcomings of the known prior timers. Applicant's timer arrangement is quite similar to that of the above mentioned Rulseh type. However, in applicant's invention the lighting can be turned off at the same hour of the day, evening, or night regardless of seasonal variations in the time of sunset and dusk at which the LRS operates. Such operation of the lights off at a predetermined time is accomplished by automatically varying the number of hours between the time that the photocell operates and the time the lights are turned off, in accordance with the variations in the hour of dusk and sunset throughout the several seasons of the year, while still retaining the automatically resetting features of the timer. In the preferred embodiment which will subsequently be described in detail, this compensation for the difference in time of sunset and dusk throughout the seasons is effected by automatically adjusting the on trip circumferentially of a driven dial in accordance with variations of dusk and sunset.

In view of the foregoing an object of this invention is a time switch of the automatically resetting type which automatically operates a load at a predetermined hour each day.

Another object of this invention is a time switch which has the advantages of an automatically resetting timer which runs less than 24 hours a day, and in which the electrical load is turned on by a LRS, and turned off by the timer at a predetermined hour each day regardless of the time at which the load is turned on.

Another object is a timer of the type described in which the number of hours that the load is on varies in accordance with the seasons of the year.

A further object is a timer of the type described having a cam mechanism automatically operated by the timer itself to vary the position of an off trip lever relative to the position of an on trip lever so that the electric load is operated at a predetermined hour each day regardless of seasonal variations of sunset and dusk.

A further object is a timer of the type described having the advantages set forth above and which is reliable, is capable of controlling electrical loads with high current requirements, and which is very inexpensive to manufacture.

The following specification, of which the accompanying drawings form a part, explains the manner in which

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the foregoing objects are attained in accordance with this invention. In the drawings:

FIG. 1 is a plan view of the timer of this invention;

FIG. 2 is a view in side elevation looking from right to left at the timer of FIG. 1;

FIG. 2A is a sectional view taken horizontally through the timer of FIG. 1 illustrating, in plan, switch operating slide bar members with latching and biasing means therefor and indicated by line 2A—2A of FIG. 4;

FIGS. 3—5 are each views in plan looking at the back of the timer of FIG. 1 and showing the positions of the various switches and operating elements for an operating cycle of the timer with:

FIG. 3 showing the timer with motor off and light sensitive device conditioned;

FIG. 4 showing the timer with motor on and primary electrical load on; and

FIG. 5 showing the timer with motor on and primary electrical load off;

FIG. 6 is a fragmentary view of the front of the timer showing the switch operating assembly an instant before snap operation from off to on, with the driven dial removed for clarity of illustration;

FIG. 7 is a fragmentary view of the back of the timer showing the switch operating assembly an instant before snap operation from off to on;

FIG. 8 is a view corresponding to FIG. 7 showing the switch operating assembly after snap operation to its on condition;

Corresponding FIG. 9 is a view corresponding to FIG. 6 showing the switch operating assembly after snap operation to its on position;

FIG. 10 is a schematic diagram showing the electrical wiring of the timer, light sensitive switch, and electrical loads controlled by the timer;

FIG. 11 is a graph showing a complete cycle of operation of the timer and light sensitive switch during a 24 hour period of time;

FIG. 12 is an enlarged fragmentary view in plan of the dial mechanism which compensates for seasonal variations in the time of dusk, with portions of the dial cut away for clarity;

FIG. 13 is a fragmentary view in section looking along lines 13—13 of FIG. 12;

FIG. 14 is a graph showing the variations in the time of the several events of a cycle of operation of the timer for the several months of a year;

FIG. 15 is a partial view in plan showing the position of the on trip lever relative to the off trip lever on Dec. 15, at a latitude of approximately 40° north; and

FIG. 16 is a view corresponding to FIG. 15 showing the position of the on trip lever relative to the off trip lever on June 20, at a latitude of approximately 40° north.

Referring now to the drawings in detail and particularly to FIGS. 1 and 2 there is shown a timer assembly 1 having a mounting panel in the form of a flat plate 2 and a flat terminal board 3 of insulating material generally coplanar with plate 2 and secured to and projecting below its bottom edge 4. Plate 2 and terminal board 3 are provided with suitable notches 5 to enable removably securing timer assembly 1 in a protective box type housing (not shown) when in use. A dial assembly 6 is mounted for rotation about an axis perpendicular to the plane of plate 2, this axis being offset toward the left side of the plate as seen in FIG. 1. Dial assembly 6 is driven by an electric motor 7 (FIG. 2) via suitable reduction gearing indicated generally at 8 to turn the dial one complete revolution in 20 hours.

Mounted on dial assembly 6 for rotation therewith is an on trip lever 9 having an on trip finger 9a and a lug 9b, and an off trip lever 10 having an off trip finger 10a, the off trip lever being spaced circumferentially from the on trip lever.

Pivotaly mounted on plate 2 adjacent dial assembly 6

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is a snap acting switch operator assembly 11 which is operated from the off position of FIG. 1 to the on position of FIG. 8 by on trip lever 9, and from the on position of FIG. 8 to the off position of FIG. 1 by off trip lever 10, however, such operation can also be done manually.

At a location slightly above dial assembly 6 is a day omit mechanism indicated generally at 12, and mounted on plate 2. The purpose of day omit mechanism is to prevent a cycle of operation of the timer on any particular day or days of a week. This purpose is accomplished by day selector dial 13 and blocking lever 14 to prevent operation of switch operator assembly 11 from off to on during any preselected day or days of the week.

Fixed to terminal board 3 are a plurality of terminals 15—21 having terminal screws 15a—21a respectively to facilitate making electrical connections.

As shown in FIG. 3 terminals 15—21 project from the back face 22 of terminal board 3 and terminal screws 15a—21a extend through threaded portions of the respective terminals. A primary load switch 23, and an auxiliary load switch 24 are secured to the back of the terminal board. Primary load switch 23 includes a stationary contact 25 fixed to terminal 15, and a movable contact 26 aligned with contact 25, and fixed to a flat leaf spring arm 27 of conducting material having an end secured to terminal 16 and which normally biases contact 26 to engage contact 25. Auxiliary load switch 24 is of similar construction having a stationary contact 28 fixed to terminal 18 and a movable contact 29 carried by a flat leaf spring arm 30 secured to terminal 17 and which normally biases contact 29 to engage contact 28. With switch operator assembly 11 in the off position as seen in FIG. 3, primary load switch 23 is open and auxiliary load switch 24 is closed. Terminals 19—21 at the left hand side of the terminal board (FIG. 3) are provided to facilitate making the necessary connections for the internal wiring (omitted in this view for purposes of clarity) for the timer.

Mounted on the back of terminal board 3 are a pair of switch actuators in the form of an inner slide bar 31, and an outer slide bar 32, the slide bars cooperating to operate the several switches of the timer in a manner which will subsequently be described in detail.

Each slide bar is generally rectangular, is formed from insulating material, and has a pair of aligned outwardly facing slots 33 and 34 at the ends thereof to mount the slide bars for sliding movement independently of each other on identical bushings 35 and 36 secured to opposite sides of the terminal board by screws 37. As best seen in FIG. 2 each bushing includes two reduced diameter portions 38, which receive the ends of slide bars 31, 32, and larger diameter bosses 38' on each side to mount the slide bars in spaced apart relation parallel to each other and parallel with the plane of terminal board 3. Such mounting of the slide bars permits them to slide in a direction generally parallel with edge 4 of plate 2.

Slide bars 31 and 32 are identical save that a V-shaped notch 39 in top edge 40' of outer slide bar 32 is offset slightly to the right of V-shaped notched 40 in the top edge 39' of slide bar 31. Mounted on plate 2 immediately above the slide bars and secured thereto with screws 42 is a single pole double throw microswitch 41 having an operating arm 43 with a V-shaped end 44 of sufficient width to extend across the top edges of both slide bars (FIG. 2A).

Arm 43 is spring biased to normally rest against top edges 39' or 40' of the slide bars, whereupon the switch is in a first position, and switches to its second position when notches 39 and 40 are aligned and end 44 drops into the notches, as shown in FIG. 4.

Secured to inner slide bar 31 is a rigid motion transmitting member 45 that has a leg 46 which projects upwardly beyond edge 39' of the slide bar and has a rectangular end which extends perpendicular to plate 2 and through an opening 48 in the plate. Secured to outer slide

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bar 32 is a similar member 49 having a leg 50 and an end 51 that extends perpendicularly through opening 52 of plate 2. Extending between members 45 and 49, as best seen in FIGS. 2A and 3, is a flat relatively thin stop plate 53 having outwardly opening slots 54 and 55 at opposite ends thereof. Stop plate 53 lies flat on top edges 39' and 40' and is of sufficient width to extend across both slide bars. The slots 54 and 55 are parallel with each other but are in spaced apart planes so that the leg 46 extends into slot 54 and leg 50 extends into slot 55. The ends of a helically wound tension spring 56 are connected respectively to legs 46 and 50 by passing the ends of the spring through openings in the legs.

Mounted for pivotal movement about an axis perpendicular to plate 2 and spaced laterally of the slide bars is a latch arm 57 operated by a solenoid 58. One end of latch arm 57 has a bushing 59 secured thereto which is journaled on pin 60 fixed to plate 2 and extending perpendicularly therefrom. Latch arm 57 diverges in a direction away from pin 60 and has a flat lower edge 61 with a latch finger 62 having an edge 62' that projects downwardly at a right angle from edge 61 and faces toward pin 60. Above latch finger 62 and spaced therefrom is a pin 63 which is disposed within a groove 64 of plunger 65 of solenoid 58. Within solenoid 58, immediately above plunger 65 is a compression spring (not shown) which urges the plunger downwardly when the coil of the solenoid is unenergized and correspondingly urges latch arm 57 downwardly against end 51 of member 49.

As best seen in FIGS. 3 and 4 slide bars 31 and 32 each have a pair of spaced apart downwardly facing openings 66 and 67 formed therein into which the ends of spring arms 27 and 30 extend. Opening 67 of outer slide bar 32 has a rounded switch operating projection 68 extending from its left hand edge. The left hand side of opening 67 of slide bar 31 has a flat face 68' in the plane of the left hand edge of the opening and is spaced from the end of contact arm 30 when slide bar 31 is in the position shown in FIG. 4. Hence, slide bar 31 does not operate switch 24. Opening 66 of both slide bars is identical and has at its right hand side a rounded switch operating projection 69 which functions to open switch 23 when the slide bars are in the FIG. 3 or FIG. 4 position. Opening 66 of both slide bars is of sufficient width that its flat left hand edge 69' does not engage contact arm 27.

As seen in FIGS. 3-5 slide bars 31 and 32 are operable sequentially to three different positions. With switch operator assembly 11 in its off position both slide bars are in the extreme left hand positions of FIG. 3. When so positioned the contacts of switch 24 are closed since switch operating projection 68 is spaced from contact arm 30, and the contacts of switch 23 are open due to the engagement of projection 69 with the end of movable contact arm 27. It is also to be noted that the side edge of end 51 of member 49 is spaced slightly from edge 62' of latch finger 62. When switch operator assembly 11 is operated to its on position member 45 is moved to the right with corresponding movement of slide bar 31, to the position of FIG. 4. Although inner slide bar 31 moves the same distance as member 45, outer slide bar 32 is moved by the action of tension spring 56, only far enough for end 51 to engage edge 62' of latch finger 62 and further movement of outer slide bar 32 in a direction to the right is prevented by the latch finger. With the slide bars in this position notches 39 and 40 are aligned and V-shaped end 44 of microswitch 41 is disposed in the notches and the microswitch is switched to its second position. Neither switches 23 nor 24 are operated by the movement of inner slide bar 32 when the switch operator assembly 11 is moved from its off position to its on position.

Operation of switches 23 and 24 occurs when the winding of solenoid 58 is energized. Solenoid 58 energized in a manner that will subsequently be described in detail.

When the solenoid is energized plunger 65 is pulled upwardly and lifts pin 63 thereby pivoting latch arm 57 to release member 49 and permit outer slide bar 32 to slide to the right under the action of tension spring 56, the extent of movement of the slide bar to the right being limited by the engagement of leg 50 with the bottom edge of slot 55 of stop plate 53. Such movement of slide bar 32 to the position of FIG. 5, moves operating projection 69 a sufficient distance away from contact arm 27 to permit the contacts of switch 23 to close and opens the contacts of switch 24 by the engagement of operating projection 68 with contact arm 30. Also, notch 39 is moved to the right which forces V-shaped end 44 of microswitch 41 upwardly onto edge 40' and thus returns the switch to its first position. When switch operating assembly 11 is again returned to its off position, either manually or under the action of off trip lever 10 the several elements of the timer are returned to the FIG. 3 positions. It is to be noted that during such movement of switch operating assembly 11 from on to off, inner slide bar 31 is moved to the left from the position of FIG. 5 by the action of switch operator assembly 11 on leg 47 of member 45. Leg 45 moves stop plate 53 which engages and moves leg 50 of member 49. Since member 49 is connected to outer slide bar 32, the outer slide bar is also moved to the left as switch operating assembly pivots from on to off, but such movement is via inner slide bar 31.

It is extremely important that movement of the slide bars occurs with a snap action to avoid arcing of the contacts of switches 23 and 24. As just described, movement of under slide bar 32 to the right occurs with a snap action under the influence of tension spring 56 when slide bar 32 is released by operating the solenoid. Movement of both slide bars 31 and 32 to the left also occurs with a snap action under the influence of switch operator assembly 11 in a manner which will later be described in detail.

Referring now to FIG. 6, switch operator assembly 11 includes operating lever 70 mounted for pivotal movement on a pin 71 fixed to and projecting beyond both faces of plate 2. Operating lever 70 is formed from flat sheet metal and has a manual operating tab 72 (FIGS. 1, 2 and 2A) bent at an angle to the body of the operating lever to facilitate operating the lever from one position to another manually. Mounted between operating lever 70 and plate 2 is a slider member 73 also formed from rigid sheet metal. The bottom end of slider member 73 has a tab 74 bent inwardly to extend through opening 75 in plate 2. Projecting from the top edge of opening 75 is a finger 76 with side edges 76' and 77 and tab 74 normally rests on one side or the other of finger 76.

Operating lever 70 has wing-like projections 77' and 78 extending from opposite sides thereof to provide edges 79 and 80 arranged to engage respectively tabs 81 and 82 which project from slider member 73 in a direction away from plate 2 to underlie edges 79 and 80. Slider member 73 as an elongated closed slot 83 with curved ends, and through which pin 71 extends. Spaced longitudinally from slot 83 is a slot 84 located between lug 74 and slot 83. Slot 84 receives rectangular end 47 of member 45 so that movement of slider member 73 from a position on one side of finger 76 to the other moves member 45 and correspondingly inner slide bar 31 which is secured thereto. It is to be noted that the sides of slot 84 are closely adjacent the side edges of end 47 and hence, slide member 73 determines the precise position of inner slide bar 31.

Switch operating assembly 11 also includes a mechanism mounted on the back of plate 2, as shown in FIG. 7. Mounted on the back of plate 2 for pivotal movement about pin 71 is a pivot plate 85 having a U-shaped cut out 86 at its lower end to provide clearance for end 47 of member 45. Above pin 71 and adjacent an opening 88 of plate 2 pivot plate 85 is cut away to provide a generally arcuate slot 89 into which a rectangular tip 90 of operating lever 70 extends from the other side of plate 2 via

opening 88. Formed from the material of pivot plate 85 is a tab 91 located slightly radially inwardly of tip 90, relative to pin 71, tab 91 being bent to project in a direction away from plate 2.

Mounted for pivotal movement on a bushing 92 concentric with pin 71 and on which pivot plate 85 also pivots, are a pair of offset lever arms 93 and 94 each formed of flat sheet metal and superposed one on the other. Lever arm 93 includes a leg 95 projecting upwardly from bushing 92 and a parallel offset leg 96 projecting downwardly and terminating at an outwardly curved end 97 having a notch 98 at its outer edge. Lever arm 94 is identical to lever arm 93 inverted relative to the plane of plate 2 so that leg 99 projects upwardly, and a leg 100 projects downwardly and terminates in an outwardly curved end 101 with notch 102 in its outer edge. A helically wound tension spring 103 has its ends retained in notches 98 and 102 to normally maintain the inner side edges of legs 95 and 99 respectively in engagement with the side edges of tip 90 and tab 91. A pin 103' is secured to plate 86 at a location slightly above cut out 89, the pin extending through an opening 104 of plate 2 and projecting beyond its front face. A torsion spring 105 (FIG. 6), mounted on pin 71 has ends 106 and 107 that engage beneath tabs 81 and 82 to normally bias slider member 73 upwardly so that lug 74 is urged against the upper edge of opening 75 on one side or the other of finger 76.

Operation of the switch operator assembly will now be described in detail. Operation of switch operator assembly 11 from one position to the other is accomplished by moving operating lever 70 in the appropriate direction either manually or by the action of on trip finger 9a or off trip finger 10a. As shown in FIG. 6 operating lever 70 has already been pivoted somewhat in a clockwise direction by the operation of on trip finger 9a which projects from on trip lever 9 and engages a curved on operating lug 108 formed from the material of operating lever 70 and which is disposed in the path of travel of on trip finger 9a whenever switch operator assembly 11 is in its off position. With operating lever 70 initially pivoted by on trip lever 9, tip 90 of the operating lever engages the inner edge of leg 95 to pivot lever arm 93 in a counterclockwise direction as seen in FIG. 7 from the back of the timer. Such pivotal motion tensions spring 103 since lever arm 94 is restrained from movement in a counterclockwise direction by the engagement of leg 99 with tab 91 of pivot plate 85. (Pivot plate 85 is restrained from movement by the engagement of U-shaped opening 87 with a side edge of end 47 of member 45.) As viewed from the front of the timer in FIG. 6, engagement of end 47 with the side edges of slot 84 restrains end 47 against movement. The slider member 73 is prevented from pivotal movement at this time by the engagement of lug 74 with the side edge 77 of finger 76. As operating lever 70 is further pivoted in a clockwise direction (FIG. 6) edge 79 engages tab 82 of slider member 73 and pushes the slider member downwardly as operating arm 70 pivots. During such movement the slider member is guided by slot 83 which encircles pin 71 and slot 84 which encircles end 47. When operating lever 70 is pivoted enough to move slider member 73 a sufficient distance downwardly so that lug 74 clears finger 76, switch operator assembly 11 snaps over to its on position as shown in FIG. 8. The snap action occurs as the results of the rapid release of energy stored in tension spring 103 during the pivotal movement of operating lever 70 toward the snap over position. As slider member 73 pivots from its off position to its on position tab 82 likewise pivots away from edge 79 and hence, when slider member 73 reaches the on position of FIG. 8 ends 106 and 107 of torsion spring 105 bias the slider member upwardly so that lug 74 engages in the notch adjacent side edge 76' of finger 76.

The operation from on to off of switch operating assembly 11 takes place in an identical manner as off to on save that the snap operation is in the opposite direction.

Operation from on to off can be accomplished either manually or by the action of off trip pin 10a, of off trip lever 10, against off operating lug 109 integral with an arm 110 and extending from the side of operating lever 70. When operating lever 70 is pivoted in a counterclockwise direction from the position of FIG. 8 edge 80 engages a tab 81 to push slider member 73 downwardly against the action of torsion spring 105 until lug 74 clears side edge 76' of finger 76, whereupon the entire switch operator assembly snaps over to the off position, the snap action again being the result of the sudden release of the energy stored in spring 103 when tensioned by the initial movement of operating lever 70.

Day omit mechanism 12 prevents operation of switch operator assembly 11 from its off position to its on position, during any selected day of a week. This result is effected by the cooperation of blocking lever 14 with day selector dial 13.

Referring now to FIGS. 1, 2 and 6, day selector dial 13 includes an indicator wheel 111 fixed to one end of a bushing 111', and an index wheel 112 fixed to the other end of bushing 111'. Bushing 111' is mounted for rotation on shaft 112' projecting perpendicularly from plate 2. Index wheel 112 is flat and has seven equally spaced projecting arms 113. Indicator wheel 111 has seven equally spaced rounded bottom recesses 114 formed at the periphery of the wheel. Between each pair of adjacent recesses 114 is a threaded opening 114' adapted to receive a selector pin 115 which is similarly threaded to project beneath wheel 111 when in position, as shown in FIG. 2.

Blocking lever 14 is mounted for pivotal movement about a pin 115' projecting perpendicularly from plate 2 (FIG. 6). Main body 116 of blocking lever 14 is formed of flat sheet metal and is located in a plane below indicator wheel 111 so that a torsion spring 117 normally biases main body 116 partially beneath indicator wheel 111. Projecting from main body 116 in a direction away from plate 2 is a stop pin 118 which normally engages one of recesses 114 due to the bias of spring 117, and prevents free rotation of day selector dial 13. As best seen in FIG. 6, the upper edge of body 116 is provided with a shallow U-shaped recess 119 which faces toward the axis about which day selector dial 13 rotates. Adjacent recess 119 is an edge 119' disposed in the path of travel of a pin 115 when the pin is inserted in one of the threaded openings 114' of indicator wheel 111. Projecting laterally from the side of main body 116 opposite the side where body 115 is pivoted is an end lever 120 having an upwardly extending end which presents a flat blocking face 120'. As best seen in FIG. 1, one of arms 113 of day selector dial 13 is disposed in the path of travel of lug 9b of on trip lever 9. During each revolution of dial assembly 6 lug 9b engages a side edge of one of arms 113 to index day selector dial 13 one-seventh of a revolution. Since dial assembly 6 makes only one revolution each day, day selector dial 13 is correspondingly indexed only $\frac{1}{7}$ of a revolution each day. Lug 9b operates to rotate day selector dial 13 in a counterclockwise direction. Rotation of the day selector dial pivots blocking lever 14 in a direction away from indicator wheel 111 by virtue of the engagement of the periphery of the indicator wheel with pin stop 118. Continued movement of day selector dial 13 under the action of lug 9b permits pin 118 to enter the next adjacent recess 114 of the indicator wheel, simultaneously with movement of arm 113 beyond the path of travel of lug 9b. The cooperation of pin 118 with one of recesses 114 maintains day selector dial 13 in the proper position to be indexed by lug 9b the next time the lug passes the day selector dial. If it is desired to omit a cycle of operation of the timer on any particular day of the week a selector pin 115 is threaded into an opening 114' corresponding to the day of the week when operation is to be omitted. With a selector pin 115 so mounted edge 119' of blocking lever 14 extends into the

path of travel of the selector pin. Referring now to FIG. 6, as indicator wheel 111 is indexed on the preselected day the selector pin will engage edge 119' thus pivoting blocking lever 14 to the dotted line position, whereupon selector pin 115 enters recess 119 at the edge of body 116 just as the arm 113 engaged by lug 96 moves out of the path of travel of the lug. Blocking face 120' is then disposed in the path of travel of pin 103' fixed to pivot plate 85. In this position the blocking lever prevents pivot plate 85 from moving from its FIG. 7 position to its FIG. 9 position. Hence, pivotal movement of operating lever 70 in a counterclockwise direction under the action of on trip pin 9a is effective to merely pivot the operating lever and the remainder of switch operating assembly 11 is held in its off position because pivot plate 85 is blocked against movement. When operating lever 70 is released by on trip pin 9a the lever merely snaps back to its original off position under the action of tension spring 103. When day selector dial is again indexed the following day, selector pin 115 moves out of recess 119 to a new position to release blocking lever 14 whereupon the timer resumes its normal cycle of operation. As previously stated dial assembly 6 is driven one revolution in 20 hours by motor 7 via reduction gearing 8. Motor 7 is a standard synchronous type timer motor with self-contained gearing within housing 121 to rotate motor pinion 122 at the rate of $\frac{1}{60}$ revolution per minute. With motor 7 mounted on the back of plate 2 as shown in FIG. 2 pinion 122 extends through an opening in the plate to mesh with and drive spur gear 123. Gear 123 is fixed to and thus drives a smaller diameter gear 124, both gears being mounted for rotation on a shaft 125 fixed to plate 2. Gear 124 drives a larger diameter gear 126 fixed to a bushing 127 mounted for rotation on a shaft 128 fixed to plate 2. Fixed to dial assembly 6 is a bushing having a sleeve 129 of similar outside diameter to a sleeve 130 of bushing 127. The sleeves 129 and 130 are each mounted for rotation on shaft 128 with their end faces in abutting relation. Encircling sleeves 129 and 130 is a helically wound torsion spring 131 which cooperates with the sleeves to provide a conventional one way clutch which permits manually rotating dial assembly 6 and sleeve 129 in a clockwise direction only, relative to bushing 127.

Since dial assembly 6 is to rotate only once in the 20 hours and since pinion 122 makes $\frac{1}{60}$ revolution per minute the gear train comprised of gears 123, 124 and 126 are appropriately selected to provide a reduction ratio of 24:1. Shaft 128 extends completely through dial assembly 6 and terminates at an end which is internally threaded to receive a screw 132 which secures setting pointer 133 in a fixed position. In practice setting pointer 133 is pre-set to the proper circumferential position at which the on and off trip levers operate the switch operator assembly 11.

Also mounted on plate 2 adjacent the upper edge thereof is an indicator light 134 and a momentary contact push button switch 135, the purposes of which will subsequently be described in detail.

For purposes of clarity of illustration the internal wiring of the timer is not shown in detail in FIGS. 1-5. FIG. 10 shows the wiring for the timer in schematic, as well as the wiring of a light response switch 136, and external wiring 137 for a primary load 138, in the form of a bank of electric light bulbs, and an auxiliary load 139. Terminal board 3 is shown in dotted lines 139' and terminals 15-21 are shown in their appropriate positions as viewed from the front of the timer to facilitate explanation.

The internal wiring is as follows. Movable contact arm 140 of single pole double throw switch 41 is connected to terminal 20 by line 141. Motor 7 is connected between terminal 21 and stationary contact 142 of switch 41 by lines 143 and 144. The winding of solenoid 58 is connected between terminal 19 and the other stationary contact 145 of switch 41 by lines 146 and 147 respec-

tively. As previously described, movable contact 26 of switch 23 has its spring arm 27 fixed to terminal 15 and stationary contact 25 of switch 23 is fixed to terminal 16. Similarly, movable contact 29 of switch 24 has its spring arm 30 fixed to terminal 18 and stationary contact 28 of switch 24 is fixed to terminal 17. Indicator light 134 is connected between terminals 19 and 20 via lines 146 and 141. Push button switch 135 is connected between terminals 19 and 21 via line 147 and line 148.

Light responsive switch 136 is external to the timer and includes a cadmium sulphide photoconductor 149 connected in series with a winding 150 of a relay 151. Relay 151 has a movable contact 152 which is spring biased to engage its stationary contact 153 when winding 150 is unenergized. In the position shown in FIG. 10 winding 150 is energized and hence, the contacts of relay 151 are open. Stationary contact 153 is connected to terminal 19 by line 154. Movable contact 152 and one side of winding 150 are connected to terminal 21 via line 155, and line 156 completes the series connection of photocell and relay between terminals 20 and 21.

The several electrical components of timer assembly 1, light responsive switch 136, and external wiring 137 are powered by standard 120 volt 60 cycle current from leads 157 and 158 of a power line. Electricity to operate both the timer and light sensitive switch 136 is supplied by power leads 157 and 158 connected to terminals 21 and 20 respectively. Lamps 138 controlled by the timer, are connected between power lead 158 and terminal 15 and lamps 138 light when switch 23 is closed. Auxiliary load 139 is connected between power lead 158 and terminal 18. Power lead 157 is also connected to both terminals 16 and 17 via lines 159 and 160.

Power for photocell 149 and relay 151 is thus supplied from power leads 157 and 158 via terminals 21 and 20 and lines 156 and 155. Photoconductor 149 is of the cadmium sulphide type that has a low resistance when exposed to light and a very high resistance when dark. Relay 151 is selected to pull in and maintain contacts 152 and 153 open when photoconductor 149 is exposed to a daylight value of natural light. When the light to which photoconductor 149 is exposed diminishes to a predetermined value the resistance of the photoconductor increases and the voltage at winding 150 decreases to below the drop out voltage of the relay, whereupon the armature of the relay drops out and contacts 152 and 153 close. When contacts 152 and 153 are closed terminal 19 is connected to terminal 21 and indicator lamp 134 lights. However, solenoid 58 is operated only when contact arm 140 is switched to its second position to engage fixed contact 145. It is to be noted that pushbutton switch 135 is connected in parallel with light responsive switch 136 so that closing switch 135 has the same effect as closing contacts 152, 153 by the operation of photoconductor 149.

Motor 7 is energized only when microswitch 41 is in its first position with contact arm 140 engaging contact 142, and the motor stops whenever switch 41 is in its second position in which solenoid 58 can be energized. It is thus apparent that the circuit indicated generally at 161, including motor 7, contacts 140 and 142 of switch 41, and line 141 may aptly be termed a motor control circuit. Also, line 141, contacts 140 and 145 of switch 41, line 146, and light responsive switch 136 form a load switch control circuit indicated generally at 162, since energization of solenoid 58 can operate load switches 23 and 24 from one condition to another.

It is to be noted that solenoid 58 when operated has no effect on the condition of switches 23 and 24 unless outer slide bar 32 is biased toward the right under the action of spring 56 as shown in FIG. 4. With the outer slide bar in this position the timer is termed "conditioned" since operation of solenoid 58 is then effective to lift latch finger 62 to release slide bar 32 and operate the several switches of the timer. When outer slide bar 32 is not biased by spring 56, as is the case when the slide bar oc-

cupies the positions of either FIGS. 3 or 5, operation of the solenoid merely functions to lift latch finger 62, but the position of outer slide bar 32 remains unchanged since there is no force acting to move the slide bar.

Referring now to FIG. 10, it seems apparent that switch 41 could be a single throw switch and that contact 145 of control circuit 162 could be eliminated merely by connecting a lead 163 (shown in dotted line in FIG. 10) between line 141 and line 147, without affecting the basic operation of the timer. With lead 163 so connected control circuit 162 operates solenoid 58 whenever light sensitive switch operates to close contacts 152 and 153. However, such operation has no effect on the timer unless slide bar 32 is in its FIG. 4 position and biased to the right under the action of tension spring 56, this "conditioned" position occurring by the action of on trip lever 9, or alternatively by manual movement of switch operator assembly 11 from its off position to its on position.

Movable contact 140 and fixed contact 145 of switch 41 do however, accomplish an important function. Considering FIG. 10 with lead 163 is eliminated, solenoid 58 can be energized only when switch 41 is in its second position in which contact 140 engages contact 145. With switch 41 in the FIG. 10 position and lead 163 eliminated contacts 152 and 153 may open and close several times each day due to clouds in the day time or lightening at night time, for example, without any danger of arcing or pitting at the contacts since no current is carried by circuit 162 because contacts 140 and 145 are open. Hence, switch 41 is provided in the form of a double throw switch to prevent damage to contacts 152 and 153 because of unwanted operation of light sensitive switch 136. It is to be understood however, that contact 145 is not absolutely necessary and could be eliminated by the use of lead 163. However, if a different operator is substituted for outer slide bar 32 to operate switches 23 and 24, and is so arranged that the switches are operated each time solenoid 58 is energized the same end result of conditioning the timer for operation would be provided by contacts 140 and 145. Hence, where the load to be controlled requires only several amperes of current, high current carrying switches such as 23 and 24 need not be used and a relay with appropriately connected contacts could be substituted for solenoid 58.

The operation of the timer can be best visualized by reference to FIG. 11 which shows a complete cycle of operation of the timer for any particular day. For purposes of explanation it is assumed that the time of year is such that the light sensitive switch operates at approximately 7 p.m., the controlled load is a lighting circuit, the lights are to be turned off at 11 p.m., four hours after they are turned on, and the timer motor is on only 20 hours a day. During the hours between 11 p.m. and 3 p.m. the several elements of the timer are in their FIG. 3 position in which the motor is on to drive dial assembly 6, the lights are off, and the switch control operator (slide bar 32) is not conditioned. At approximately 3 p.m., on trip finger 9a of the dial assembly operates switch operator assembly 11 from its off position to its on position, with corresponding operation of slide bars 31 and 32 to the FIG. 4 position. As shown in FIG. 4 slide bar 32 is biased to the right by the action of tension spring 56, but the slide bar is held against movement by latch arm 57 which engages end 51 of member 49. Primary load switch 23 is open, auxiliary load switch 24 is closed, and double throw switch 41 is in its second position, since notches 39 and 40 of the slide bars are aligned to permit end 44 to pivot counterclockwise into the notches. With switch 41 in this position movable contact 140 engages fixed contact 145 and circuit 162 will be energized when contacts 152 and 153 of light responsive switch close. Since contacts 140 and 142 are now open motor 7 is off and dial assembly 6 is thus stopped. At dusk (which it is assumed occurs at 7 p.m.) the intensity of light received by photoconductor 149 has reduced to a value to

cause relay 151 to drop out thereby closing contacts 152 and 153. Solenoid 58 is then energized and pivots latch arm 57 counterclockwise to release outer slide bar 32 whereupon the slide bar is snapped to the position of FIG. 5 under the action of tension spring 56. Such operation of the slide bar closes the contacts of primary load switch 23, opens the contacts of auxiliary load switch 24, and switches switch 41 back to its first position by moving operating arm 43 counterclockwise out of notch 39 so that the arm rests on edge 40' of slide bar 32. Operation of the primary load switch 23 turns the lights on and turns the motor on. At the same time control circuit 162 is disconnected from the power supply at terminal 20 and outer slide bar 32 is in an unconditioned state. Obviously any extraneous light reaching the photoconductor, due to accidental illumination by lightening or automobile headlights, has no effect on the timer since the timer is not conditioned for operation.

Four hours after the lights are turned on, off trip lever 10 of the dial assembly reaches off operating lug 109 of operating lever 70 and pivots switch operator assembly 11 back to its off position. As previously explained movement of switch operator assembly 11 from on to off returns slide bars 31 and 32 to the FIGS. 3 position wherein primary load switch 23 is open and auxiliary load switch 24 is closed. End 44 of operating arm 43 of switch 41 rests on edge 39' of slide bar 31 and hence, circuit 162 cannot be energized by light responsive switch 136. Since motor 7 is off from 3 p.m. to 7 p.m. it is apparent that dial assembly 6 is driven by the motor to make a complete cycle of operation between the hours of 7 p.m. of one day and 3 p.m., of the following day, a period of 20 hours.

Automatic retiming takes place in the following manner. The time interval of four hours during which the motor is off is termed a "pause period," for convenience. During this pause period motor 7 is off and the dial assembly 6 is stopped. In the event of power failure the timer can gain as much as four hours each day, i.e. the duration of the pause period until a proper cycle of operation is resumed. Assume for example that a power failure occurs and that the power is off for three hours. Also assume that the power failure occurs at about 8 p.m. Since the motor is normally on between the hours of 7 p.m. of one day and 3 p.m. of the following day the effect of the power failure is to shut the motor off for a period of 3 hours, and the lights also go off. When power is resumed the motor starts again and the lights go on. The lights remain on for an extra 3 hours and are thus not turned off until 2 a.m. by the operation of off trip lever 10. On the following day on trip lever 9 turns the motor off and conditions the switch control for operation but not until 6 p.m. because the driven dial has been retarded 3 hours by the failure of power on the preceding day. At 7 p.m. however, light responsive switch operates in the normal manner and the lights are turned on and the motor is turned on. Hence, the light responsive switch has operated to decrease the duration of the pause period when the motor is off and the dial assembly has thus regained the three hours lost during the power failure on the previous day. Had the three hour power failure occurred during the pause period the lights may have been turned on later and turned off later depending on the exact time of the power failure. However, the time lost if any, during the power failure would have been regained on the following day.

Now consider the automatic retiming of the timer, set to turn lights off at 11 p.m., as before, when a power failure of extensive duration occurs. Assume that the power failure again occurs at 8 p.m. but that power is off for 12 hours. Because of the operation of the timer at 8 p.m. the parts of the timer are in the FIG. 5 position, with primary load switch 23 closed. When power is resumed at 8 a.m. the following day the lights go on since switch 23 is still closed. Three hours later the motor has

driven the dial assembly to a position to operate primary load switch 23 and turn the lights off. Since the power failure was of 12 hours duration the timer motor is not turned off again until 3 a.m. and the switch control is simultaneously conditioned for operation. Since it is dark at 3 a.m. light responsive switch immediately operates to turn the lights on and turn the motor on. Hence, four hours of the 12 hours lost during the power failure has been regained. The lights remain on for four hours and are turned off at 7 a.m. by operation of the off trip lever. The following day the motor is turned off and the switch control conditioned for operation at 11 p.m. and the light responsive switch immediately operates to turn the lights on and turn the motor back on. Hence, another four hours is gained. The lights are then on from 11 p.m. until 3 a.m. On the next day the on trip lever turns the motor off and conditions the switch control at 7 p.m., and the light sensitive switch immediately operates to turn the lights on and turn the motor back on. Thus, another four hours is gained and since the light sensitive switch was originally set to turn the lights on at 7 p.m. the proper cycle of operation of the timer is resumed. Even in the worst possible situation a proper cycle of operation will be resumed within 3 or at most 4 days after the power failure.

Compensating mechanism

Dial assembly 6 includes a compensating mechanism to automatically turn the primary load switch off at approximately the same time each day regardless of seasonal variations in the hour of dusk at which the lights are turned on by light responsive switch 136. Referring now to FIG. 14, the curve designated "lights on" is a plot of the time at which the lights are turned on by light responsive switch 136 vs. the several months of the year at a latitude of approximately 40° north. Hence, it can be seen that there is approximately three hours variations; namely 4:45 p.m. to 7:45 p.m., in the time at which the light sensitive device turns the lights on during the several seasons of the year. If the relative positions of on trip lever 9 and off trip lever 10 were fixed the time interval between lights on and lights off would be the same throughout the year. Therefore, it is necessary to adjust one of the trip levers throughout the year to turn the lights off at approximately the same hour each day. As can be seen from FIG. 14 the time interval during which the lights are on at Dec. 15 of a year is 6¼ hours if it is desired that the lights turn off at 11 p.m. During the summer when the lights do not go on until approximately 7:45 p.m. (at dusk) the lights need remain on only 3¼ hours if they are to be turned off at 11 p.m.

Variation of the interval during which the load switch is on is automatically effected by adjusting the on trip lever to the proper circumferential position relative to the off trip lever to turn the load switch off at the same hour each day regardless of the season of the year.

On trip lever 9 is adjusted circumferentially relative to off trip lever 10 by a solar compensating mechanism mounted on dial assembly 6. As best seen in FIGS. 12 and 13 the compensating mechanism is mounted between a flat lower plate 164 and a flat upper plate 165. Upper plate 165 is maintained in spaced parallel relation to lower plate 164 and is secured thereto by four spaced apart support bushings 166-169 fixed to lower plate 164 adjacent its periphery. Upper plate 165 is secured to the support bushings with screws 170. Lower plate 164 is fixed to a cylindrical portion 170' of bushing 129 which extends through the lower plate the bushing having a flange 171 thereon spaced below lower plate 164. Mounted for rotation on bushing 129 between flange 171 and lower plate 164 is a flat body 172 of off trip lever 10 having a bore 173 which encircles the bushing. Bore 173 is slightly larger than the outside diameter of the bushing to permit circumferential adjustment of the off trip lever manually relative to the periphery of dial assem-

bly 6. The extremity of arm 174 of off trip lever 10 is provided with a rectangular latch finger 175 biased inwardly by spring 176 to normally engage the periphery of upper plate 165. Finger 175 is of appropriate width to fit into any of the identical shallow evenly spaced slots 177 formed in the peripheral edge of upper plate 165. When finger 175 is aligned with one of slots 177 and released, spring 176 pivots the finger inwardly into one of the slots of off trip lever 10 is thus prevented from movement circumferentially of dial assembly 6. Indicia 178 are provided on dial face 179 adjacent slots 177 to facilitate setting latch finger 175 in the proper slot to turn the lights off at the desired time. In the embodiment shown the latch finger can be set so that off trip lever 10 turns the lights off at a desired time between the hours of 9 p.m. and 1 a.m. However, the circumferential length of the member in which slots 177 are formed could be increased to permit setting the off trip lever to turn the lights off at a later hour if necessary for example at 4 a.m. It is to be appreciated that off trip lever 10, since it is mounted below lower plate 164, has a clear path of travel for manual adjustment of at least 180° relative to on trip lever 9.

The solar compensating mechanism (FIGS. 2, 12 and 13) includes a star wheel 180, reduction gearing designated generally at 181, a cam wheel 182, and a follower member 183. Star wheel 180 is fixed to shaft 184 having reduced diameter ends supported in bearings provided by a pair of aligned openings in upper plate 165 and lower plate 164 respectively. Formed integral with star wheel 180 is a smaller diameter star wheel 186 having arcuately curved steps 187. A leaf spring 188 having an arcuately curved center portion 189 has one end extending around the reduced diameter end of support bushing 166 and its other end supported by a shaft 190, portion 189 of the spring normally seating in one of steps 187. The spring is sufficiently flexible to enable center portion 189 to be forced out of one step 187, when star wheel 180 is rotated, and then seat in the next adjacent step.

Reduction gearing 181 includes a pinion gear 191 fixed to the lower end of shaft 184, and setting gear 192 and pinion gear 193 fixed to shaft 190 disposed in spaced parallel relation to shaft 184, and having reduced diameter ends which extend into bearing openings in the upper and lower plates respectively. Pinion 191 drives setting gear 192 which in turn drives pinion 193 that meshes with a gear 194 formed in the periphery of cam wheel 182. Cam wheel 182 has a bore 195 concentric with gear 194, bore 195 being of a diameter sufficient to permit rotation of cam wheel 182 relative to the portion of bushing 129 which extends through the dial assembly. A spacer bushing 196 is provided between cam wheel 182 and lower plate 164 to maintain the cam wheel at the proper elevation for engagement by pinion 193. Formed in a projecting annular portion 197 of cam wheel 182 is a cam groove 198. A follower pin 199 depending from body 200 of follower member 183 is dimensioned to ride in cam groove 198. A face 201 of annular portion 197 is substantially flat to support flat bottom face 202 of follower member 183. Body 200 has a generally elliptical configuration with an elongated opening 202' therein to provide clearance for bushing 129. Projecting upwardly from body 200 at opposite sides thereof are a pair of guide pins 203 which slide in elongated aligned openings 204 formed in upper plate 165. Also projecting upwardly from body 200 is a drive pin 205 which extends into a slot 206 of on trip lever 10 and terminates below plate 165. Slot 206 is formed in the material of flat body portion 207 of on trip lever 10, the body portion 207 also having a bore 208 through which bushing 129 extends, to permit angular movement of the on trip arm about the bushing.

The reduction gearing is so selected that on step of movement of star wheel 180 is effective to drive cam wheel 182 1/365 of a revolution relative to the dial assem-

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bly. Rotation of cam wheel 182 correspondingly rotates cam groove 198 which drives follower member 183 via the engagement of follower pin 199 with cam groove 198. Due to the engagement of guide pins 203 with openings 204, movement of follower member 183 is restrained to a path parallel with longitudinal center line of openings 204. Hence, follower member 183 moves laterally of the dial assembly but does not rotate relative to the dial assembly. Movement of follower member 183 laterally correspondingly varies the position of drive pin 205 relative to the axis of shaft 123. As the position of drive pin 205 changes, engagement of the pin with the sides of slot 206 pivots on trip lever 9 about bushing 129 and relative to the dial assembly. Hence, the circumferential position of on trip lever 9 is varied within predetermined limits relative to the preset position of off trip lever 10.

The shape of cam groove 198 is selected in accordance with the latitude at which the timer is to be used. The cam groove shown and described is designed for use at a latitude of approximately 40° north where there is approximately a 3 hour variation in the time of sunset and dusk throughout the seasons of the year. For latitudes closer to the equator for example, 35° north, a cam wheel 182 is provided which imparts less lateral movement to follower member 183 than the cam designated for use at 40° north latitude. When the several parts of the timer are assembled as shown in FIG. 1 arms 209 of star wheel 180 are coplanar with arms 113 of index wheel 112. Star wheel 180 is so dimensioned that one arm 209 of the star wheel engages an arm 113 of the index wheel during each revolution of dial assembly 6. Spring 188 is sufficiently flexible to permit star wheel 180 to index one step each time arm 209 engages an arm 113 without indexing index wheel 112. The reduction gearing 181 is such that movement of star wheel 180 one step rotates cam wheel 182 $\frac{1}{365}$ revolution. Since dial assembly 6 makes 365 revolutions per year cam wheel 182 is rotated one complete revolution relative to the dial assembly each year. Mounted on cam wheel 182 is an indicator plate having indicia 210 representative of each of the several months of a year. Each graduation 211 represents 5 days and there are seventy-three graduations.

The effect of automatically adjusting on trip lever 9 relative to a preselected position of off trip lever 10 is to decrease the length of time that the load switch is on during the summer and increase the length of time that the load switch is on during the winter for a particular setting of the off trip lever. Hence, when cam wheel 182 is rotated to a position to align graduation 211 for Dec. 15 of a year with pointer 212 at viewing window 213 of dial face 179, the relative circumferential distance between on trip lever 9 and off trip lever 10 is such that 6¼ hours of rotation of dial assembly 6 is necessary to turn the lights off at 11 p.m. (see FIG. 15). However, during the summer on June 20 the circumferential position of on trip lever 9 is such that only 3¼ hours rotation of dial assembly 6 turns the lights off at 11 p.m. (FIG. 16).

To set the timer for operation is a relatively simple matter. After the light responsive switch is connected to the appropriate terminals and the loads to be controlled by primary load switch 23 and auxiliary load switch 24 are also connected the proper terminals the timer is set in the following manner. Setting gear 192 is purposely positioned to extend beyond the periphery of upper and lower plates 164 and 165 to permit manual adjustment of the cam wheel. Hence, the first step in setting the timer is to rotate setting gear 192 until the day of the year on which the timer is placed in operation corresponds with the indicia at pointer 213. Dial assembly 6 is then manually rotated in a clockwise direction, which is permitted by the clutching operation of

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spring 131, until the on trip lever is in approximately the proper position relative to the setting pointer. If the setting is done during the daylight hours it is merely necessary to manually rotate dial assembly 6 counterclockwise until on trip lever 9 operates switch operator assembly 11 to its on position. The dial assembly then remains inactive until light sensitive switch 136 operates to turn motor 7 on and thus drive the dial assembly. Even if the timer is improperly set it will automatically assume a proper cycle of operation within several days, in the manner previously described.

Since the on trip lever is adjusted relative to the off trip lever, the pause period of four hours during which motor 7 is off remains constant throughout the year and automatic retiming in the event of power failure takes place as previously described. As shown in FIG. 14, the time of day at which the motor turns off varies with the seasons in the same manner as the time at which the lights are turned on.

Although a preferred embodiment of the timer is shown and described it is to be understood that numerous changes can be made without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In an automatically retiming timer, the combination comprising; a motor, a driven device driven by the motor to make a complete cycle of operation in less than 24 hours; means responsive to the completion of said cycle of operation to stop said driven device and condition said timer for operation by a light sensitive device, said light sensitive device operating in response to a predetermined value of natural light; a load switch operable to a first state and a second state; means responsive to operation of said light sensitive device, but only when said timer is conditioned, to start said driven device and to place said load switch in one of said states; and means carried by said driven device and effective to automatically operate said load switch to said second state at the same time each day regardless of seasonal variations in the time of day at which said predetermined level of natural light occurs to operate said light sensitive device; and said means carried by said driven device being automatically adjusted during each complete cycle of operation of said driven device.

2. A timer in accordance with claim 1 in which said driven means is a dial driven one complete revolution to complete a cycle of operation; and said means carried by said dial includes an On trip lever and an Off trip lever; one of said levers being automatically adjusted relative to the other, circumferentially of the dial to operate said load switch to said second state at the same time each day.

3. In an automatically retiming timer, the combination comprising; a motor, a driven device driven by said motor to make one complete revolution in less than 24 hours; means responsive to the completion of said one complete revolution to stop said driven device, means responsive to said driven device to condition said timer for operation by a light sensitive device during a predetermined time interval, said light sensitive device operating in response to a predetermined value of natural light; a load switch operable to a first state and a second state; means responsive to operation of said light sensitive device to start said driven device and to place said load switch in one of said states; and means responsive to rotation of said driven device to place said load switch in said second state at the same time each day regardless of seasonal variations in the time of day at which said predetermined level of natural light occurs to operate said light sensitive device; and said means responsive to rotation of said driven device is a compensating mechanism carried by said driven device and movable relative to the driven device to vary the time interval during which said load switch is in said first state.

4. A timer in accordance with claim 3 in which said driven device includes an On trip lever, and an Off trip lever each projecting from said driven device and said compensating mechanism includes a cam for adjusting the

position of one of said levers relative to the other to vary said time interval during which said load switch is in said first state.

5. A timer in accordance with claim 3 in which said compensating mechanism includes an index wheel which is indexed at least once during each complete revolution of said driven device by engagement of said wheel with an arm extending into the path of travel of said wheel.

6. In an automatically retiming timer, the combination comprising; a motor, a driven dial driven by the motor to complete a cycle of operation in less than 24 hours; an On trip lever and an Off trip lever each carried by said dial; a load switch operable to a first state and a second state; a light sensitive device, said light sensitive device operating in response to a predetermined value of natural light; means operated by said On trip lever to stop said driven dial and condition said timer for operation by said light sensitive device; means responsive to operation of said light sensitive device, only when said timer is conditioned for operation, to start said dial and to operate said load switch to said first state; means responsive to said Off trip lever to place said load switch in said second state; and compensating means responsive to rotation of said dial for automatically adjusting the position of one of said trip levers relative to the other to cause said Off trip lever to place said load switch in said second state at the same time each day regardless of seasonal variations throughout the year in the time of occurrence of said predetermined value of natural light.

7. A timer in accordance with claim 6 in which said compensating means is carried by said dial and includes a cam rotatable relative to said dial to automatically adjust said one of said trip levers.

8. A timer in accordance with claim 7 in which said one of said trip levers adjusted by said compensating mechanism is the On trip lever, and said Off trip lever remains at a fixed position relative to the circumference of said dial for a particular setting of the Off trip lever.

9. A timer in accordance with claim 7 in which said compensating mechanism further includes a follower member connected between said cam and said one trip lever to adjust the position of said one trip lever in response to rotation of said cam relative to said dial.

10. A timer in accordance with claim 7 in which said timer further includes day omit means for automatically eliminating a cycle of operation of said timer on any preselected day of a predetermined period of time by preventing operation of said load switch, said day omit means having an index wheel with arms projecting there-

from; and in which said compensating means includes a cam rotated relative to said dial by a star wheel carried by the dial; said star wheel being indexed by engagement of one of its arms with one of said arms of said index wheel during each revolution of said dial.

11. A timer in accordance with claim 7 in which said cam is rotated by a gear train including a gear, a portion of which is exposed relative to said dial to permit manual adjustment of said cam; and further includes cooperating indicia on said cam and said dial to indicate the proper initial setting of said cam for a particular day of a year.

12. In an automatically retiming timer of the type described, the combination comprising; an electric motor; a dial mounted for rotation about a fixed axis and driven by said motor to make one complete revolution in a time period less than twenty-four hours; an On trip lever and an Off trip lever each carried by and rotatable with said dial about said axis; a load switch operable to a first state and a second state; a light sensitive device, said light sensitive device operating in response to a predetermined value of natural light; means operated by said On trip lever, to stop said driven dial by disconnecting said motor from a source of electric power, and to condition said timer for operation by said light sensitive device; means responsive to operation of said light sensitive device, only when said timer is conditioned for operation, to start said dial and to place said load switch in said first state; means responsive to said Off trip lever to place said load switch in said second state; and compensating means responsive to rotation of said dial to adjust one of said trip levers relative to the other by moving same about said axis; such adjustment being effective to cause said Off trip lever to place said load switch in said second state at the same time each day regardless of variations in the time of occurrence of said predetermined value of natural light.

13. A timer in accordance with claim 12 which further includes a manual switch to place said load switch in said first state in response to manual operation when said timer is conditioned.

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