Feb. 20, 1951 W. J. KELLEIGH 2,542,085

ELECTRICAL TIMER

Filed Jan. 22, 1949 3 Sheets-Sheet 1

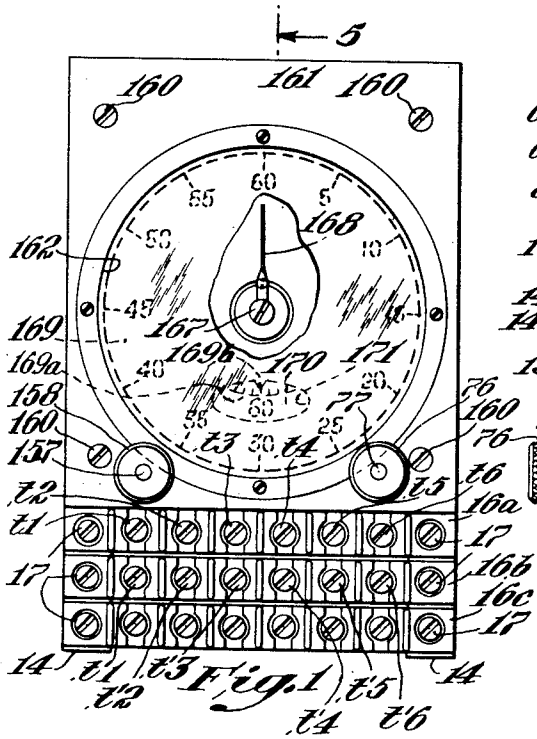


Fig. 1

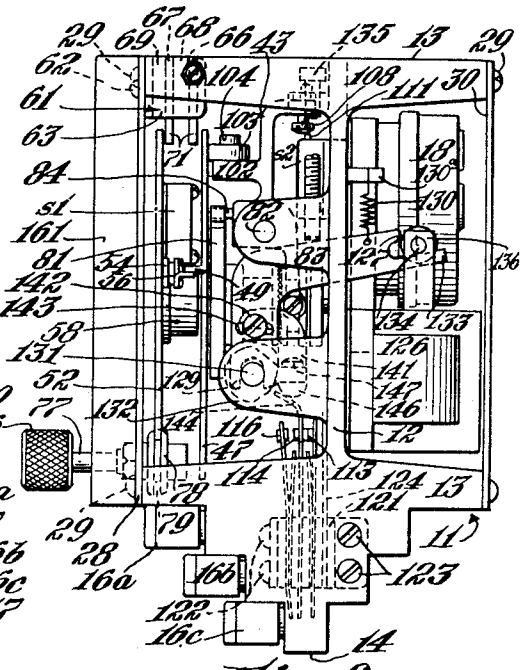


Fig. 2

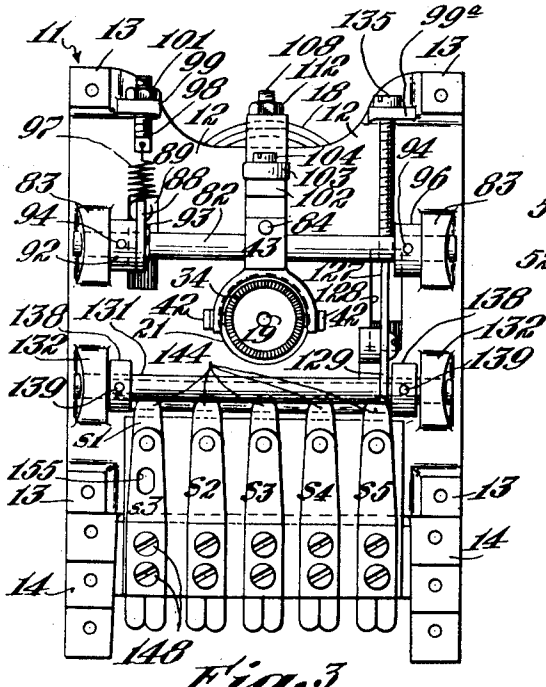


Fig. 3

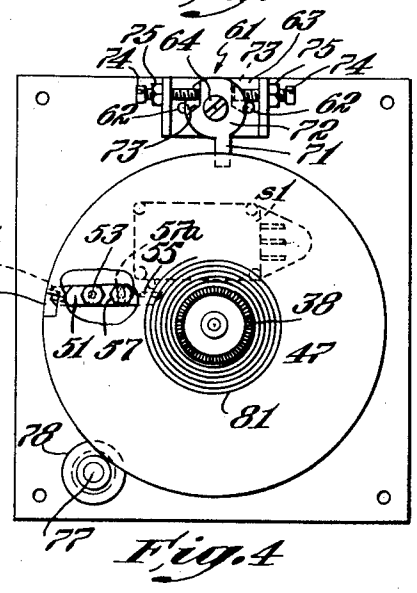


Fig. 4

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ELECTRICAL TIMER

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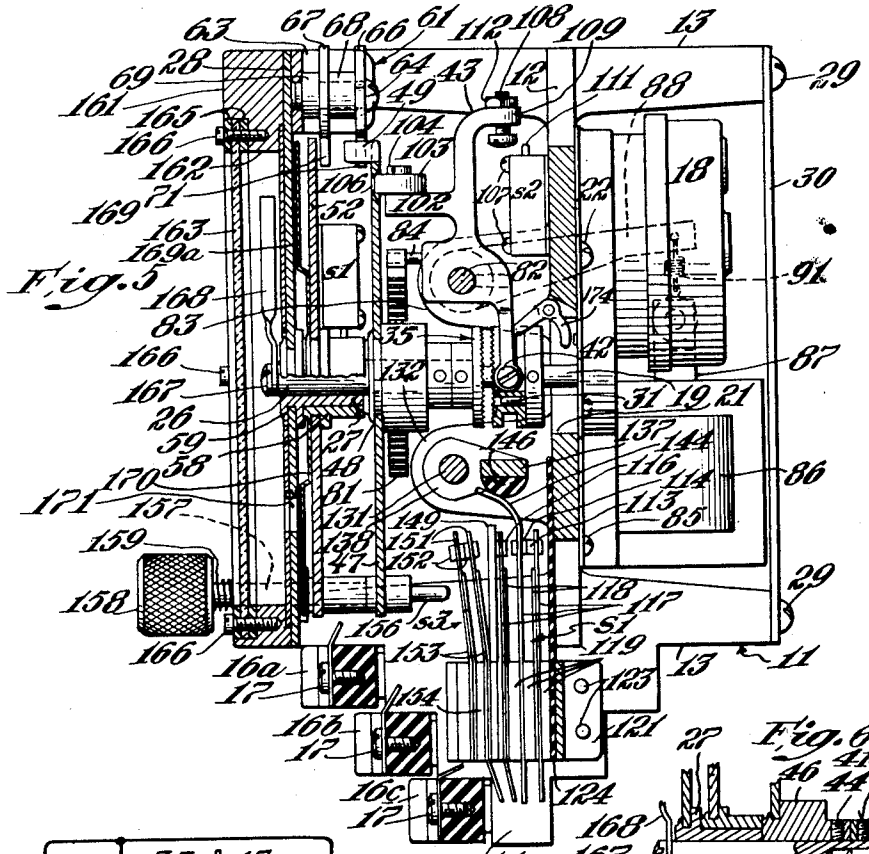


Fig. 5

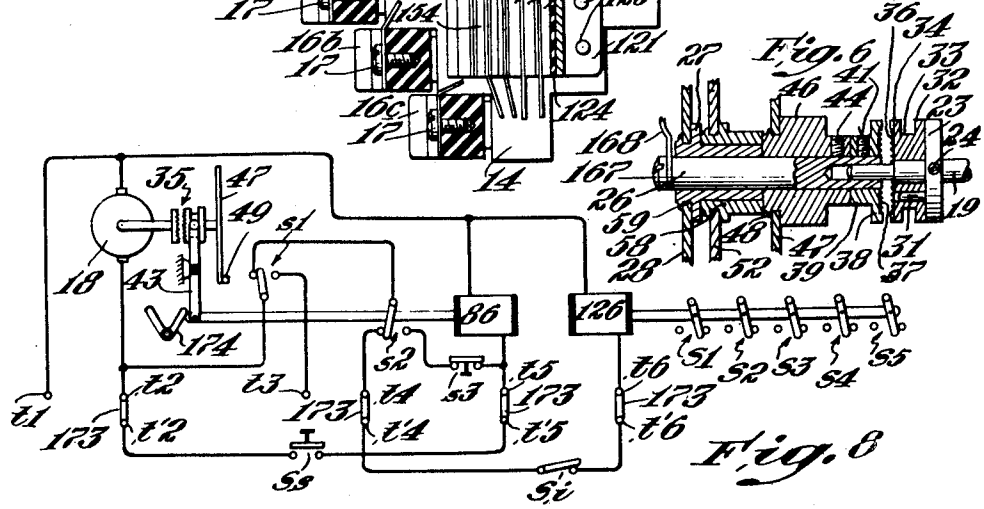


Fig. 6

Fig. 8

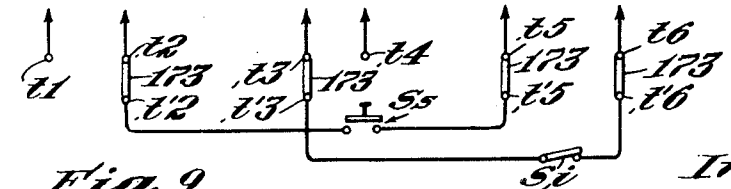


Fig. 9

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ELECTRICAL TIMER

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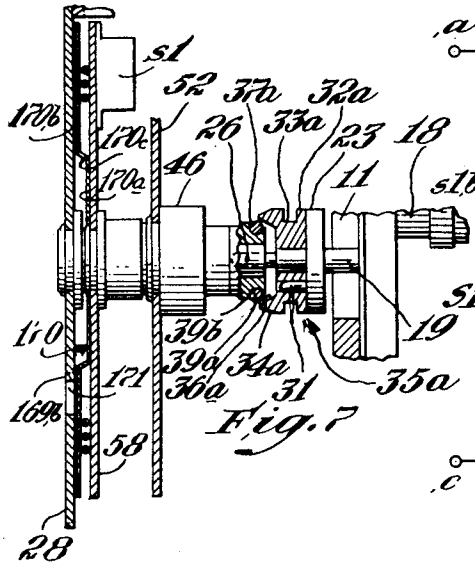


Fig. 7

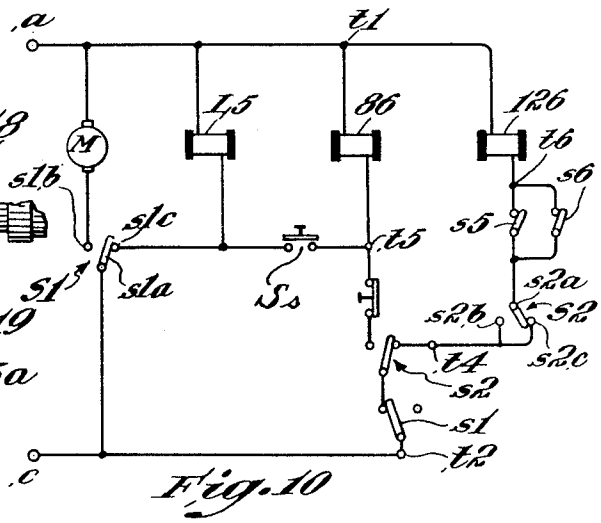


Fig. 10

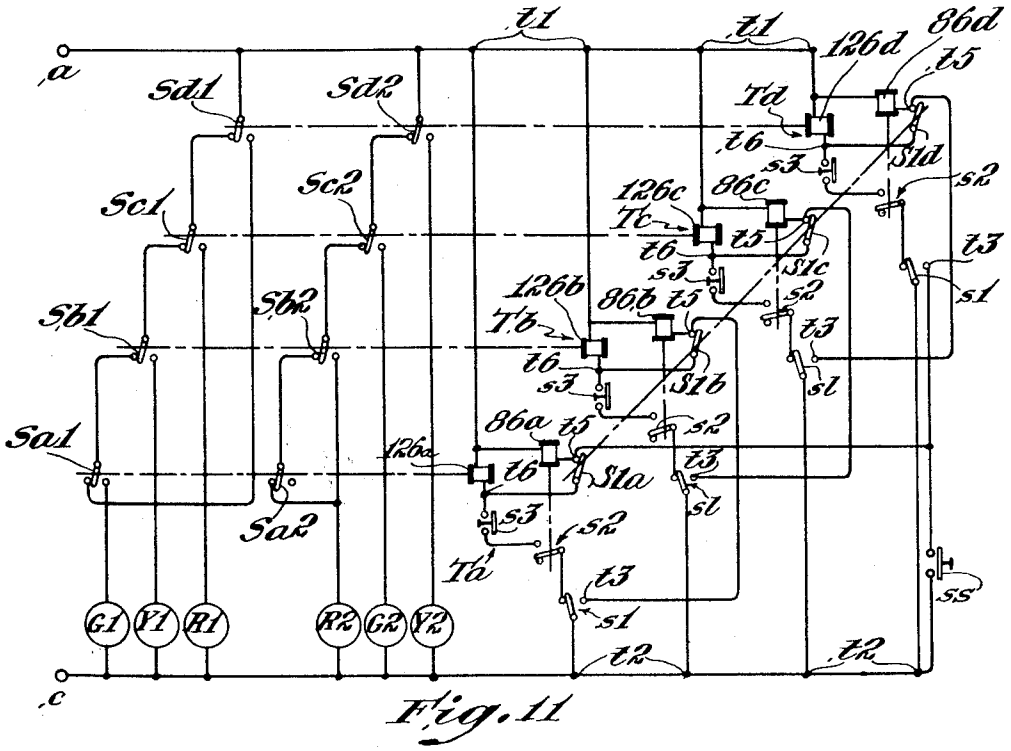


Fig. 11

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UNITED STATES PATENT OFFICE

2,542,085

ELECTRICAL TIMER

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Application January 22, 1949, Serial No. 72,118

22 Claims. (Cl. 175—320)

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This invention relates to switches for controlling an electrical circuit and more particularly to switches of the timer type for modifying a controlled circuit after the elapse of a predetermined time interval.

Objects of this invention are to provide an electrical timer which modifies a controlled circuit after an elapse of a predetermined time interval, which is accurate and dependable, which is simple and rugged, which is easily adjustable to obtain any desired timing interval, which can be reset during any portion of the timing cycle, which can be mounted on the surface or flush with a supporting panel, which is simple to connect, which can be readily adapted for use with a variety of circuits, which is attractive in appearance, and which advances the art of time switch manufacture generally.

In a broad aspect the invention contemplates a timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time. Such timer comprises an electric motor which is connected between the terminals so that the motor is continuously operated by the power supply, a member having a time opening switch with a normally closed contact, and a switch operating member. Means are provided for manually shifting the position of one of the members from a zero index position, the other member being biased to the zero index position by a spring. A solenoid operated clutch selectively engages the motor thereby to move the biased member against the force of the spring to operate the time opening switch after an elapse of time determined by the selected position of the manually shifted member. A holding switch is operated by the clutch solenoid concomitantly with the engagement of the clutch. This holding switch has a normally open contact for completing a holding circuit to connect the clutch solenoid and the normally closed contact of the time opening switch in series between the terminals of the power supply. A load solenoid of a load relay is adapted to be connected in parallel with a portion of the holding circuit. The solenoid operates a plurality of load contacts connected in the distribution circuit whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch after the elapse of the predetermined time interval operates the load solenoid to transfer the load contacts.

In another aspect the members are coaxially arranged discs, one of which carries a time opening switch. The other disc has an operating member, such as a projecting finger, for operating the time opening switch either directly or through a switch operating lever having a lever ratio (for example 2:1), such that the rotation of the disc required to operate the switch, after the projecting finger contacts the switch actuating member is considerably reduced thereby to minimize the timing error.

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In another aspect the invention contemplates a solenoid operated lever which performs four distinct functions. This lever conjointly engages the clutch to drive the spring biased disc, operates the holding switch and withdraws a roller from an aperture in the spring biased disc. When the solenoid is de-energized the lever forces the roller against the disc thereby acting as a brake to retard the return of the disc to its zero index position. As the disc reaches the zero index position, it is positively centered therein by the roller again engaging the aperture.

In a specific aspect the timer comprises a frame having a stepped bracket on each side thereof for mounting a plurality of terminal blocks, each of which has a plurality of terminals. An electric motor is mounted on the frame and connected between two of the terminals which are adapted to be coupled to the power supply so that the motor shaft is continuously rotated thereby. A time opening switch with a normally open contact connected to a third of said terminals is mounted upon an index disc adjacent a switch operating lever. A timing disc is arranged coaxially with the index disc so that a projecting finger contacts the switch lever when the timing disc is rotated, the lever ratio being such that the rotation of the timing disc required to operate the switch is considerably reduced thereby to minimize the timing error. Each of the discs mounts a respective stop contacting member thereupon to cooperate with a respective stop assembly. Each of the stop assemblies includes a rotatable cylindrical body having a cam sector therein and a finger projecting therefrom to contact the respective disc stop contacting member. A pin is positioned to contact one side of the cam sector thereby restraining further movement of the body when the finger is located to contact the stop contacting member and preventing further counterclockwise rotation of the respective disc beyond the zero index position. The cam sector is shaped to allow movement of the body as the stop contacting member meets the finger upon clockwise rotation of the respec-

tive disc so that the finger is moved out of the way by the stop contacting member thereby permitting a full 360 degree rotation of the disc. The index disc is rotated from the zero index position by a friction drive including an operating knob and a grommet, for example of rubber, with an annular groove for engaging the edge of the disc. A scale divided in chronometric units is carried up on the face of the index disc, the zero scale position corresponding to the zero index position of the disc. The setting of the timer is shown by a fiducial indicator having an aperture exposing the portion of the scale corresponding to the time setting selected by the amount the index disc has been manually rotated from the zero index position. The timing disc is biased to the zero index position against the correlated stop finger by means of a spring. A clutch selectively engages the motor thereby moving the timing disc against the force of the spring to operate the time opening switch after an elapse of time determined by the selected position of the index disc. The clutch is engaged by a lever which also operates a holding switch having a normally closed contact connected to a fourth of the terminals and a normally open contact for completing a holding circuit to connect a clutch operating solenoid and a normally closed contact of the time opening switch in series between the power supply terminals, one end of the solenoid being connected to a power supply terminal, the other end being connected to a fifth of the terminals. A roller is also carried by the clutch lever so that it acts as a brake retarding the return of the timing disc when the clutch is disengaged. The roller also engages an aperture in the timing disc thereby to positively center the disc in the zero index position. The roller is withdrawn from the aperture by the movement of the clutch lever, the clutch engaging, the holding switch closing and roller withdrawing operations being performed conjointly. A load solenoid of a load relay has one end linked to a terminal of the power supply and the other end linked with a sixth of said terminals which is adapted to be connected by means of an external circuit with one of the other terminals, such as the terminal of the normally open contact of the holding switch, the terminal of the normally closed contact of the time opening switch or the terminal linked with end of the clutch solenoid so that the load solenoid is in parallel with a portion of the holding circuit. The energization of the load solenoid operates a plurality of load contacts which are connected in the distribution circuit. The interruption of the holding solenoid circuit by the opening of the normally closed contact of the time opening switch after the elapse of the predetermined time interval operates the load relay to transfer the load contacts.

These and other objects and aspects will be apparent from the following description of an illustrative specific embodiment of the invention referring to drawings in which:

Figs. 1 and 2 are front and side elevation views respectively of the embodiment;

Fig. 3 is a front elevation view with the front plate removed;

Fig. 4 is an elevation view of the removed front plate;

Fig. 5 is a cross-sectional view on line 5—5 of Fig. 1;

Fig. 6 is an enlarged cross-sectional fragmentary view of one embodiment of the clutch assembly;

Fig. 7 is an enlarged cross-sectional fragmentary embodiment of a second embodiment of the clutch assembly;

Fig. 8 is a wiring diagram of the timer and an external circuit for normally energizing the load solenoid;

Fig. 9 is a wiring diagram of an external circuit for momentarily energizing the load solenoid at the end of the timing cycle;

Fig. 10 is a wiring diagram illustrating a pump motor control circuit which incorporates the timer; and

Fig. 11 is a wiring diagram of a control circuit for a traffic signal using three timers.

The timer comprises an integral frame 11, preferably cast from aluminum, having a substantially square central web 12 with a traverse member 13 extending normally from each of the respective corners thereof. A bracket 14 for supporting the terminal blocks 16*a*, 16*b* and 16*c* projects downwardly from the bottom of each of the respective lower transverse members 13. Both the front and rear of the brackets 14 are stepped so that the terminal blocks 16 mounted thereupon by means of the screws 17 are in different vertical planes thus simplifying the external wiring to the timer.

Mounted on the rear of the center web 12 is a synchronous electric motor 18. The motor 18 is supported with its shaft 19 projecting through a centrically located aperture 21 in the frame web 12 by means of the screws 22 which engage threads tapped into the web. One disc 23 (Fig. 6) of a coupling is fastened to the projecting motor shaft 19 by means of a set screw 24. The shaft 19 extends through the disc 23 into a recess centrically located in the end of a coaxially disposed extension shaft 26. The opposite end of the shaft is supported by a long sleeve bearing 27. The bearing 27 is secured in an aperture in a dial plate 28 which is fastened to the front ends of the respective transverse frame members 13 by the screws 29 (Fig. 2). Four similar screws 29 fasten a rear plate 30 to the rear ends of the respective transverse members 13.

Two diametrically located pins 31 project axially from the coupling disc 23 to engage respective apertures in a mating disc 32. The mating disc 32 is integrally connected by an annular piece 33 with a circular plate 34 having a serrated outer face 36 for engaging a similar serrated face 37 of a second circular plate 38. The plate 38 has a hub 39 which is secured to the extension shaft by a set screw 41.

The serrated plates 34 and 38 comprise respectively the movable and stationary members of a clutch 35. The plate 34 is moved axially by the screws 42 (Fig. 5) which project radially into the groove between the disc 32 and plate 34 from the respective bifurcated ends of a clutch lever 43 whose mode of operation will be described in detail hereinafter.

Fig. 7 shows a second embodiment 35*a* of the clutch assembly 35 above described. This embodiment is preferably used in long period timers wherein the pitch of the serrations of the plates 34 and 38 of the clutch 35 introduce an appreciable timing error. Clutch 35*a* incorporates an annular member of resilient plastic material, commonly referred to as an O-ring, as a friction member. A mating disc 32*a* has as an

annular groove 33a and ends in a circular member 34a having a conical bearing surface 36a for engaging the O-ring 37a. The ring 37a is secured in a groove 39a in the hub 39b carried by the extension shaft 26. The circular member 34a is moved axially by the clutch lever 43 (Fig. 3) so that its conical surface 34a frictionally engages the O-ring 37a thereby driving the shaft 26 as described below.

Also fixed to the extension shaft 26 by a set screw 44 is a hub 46 which bears against the end of the bearing 27. The end of the hub 46 adjacent the bearing 27 is reduced in diameter to engage an aperture in the center of a member such as the timing disc 47; the disc being held against the shoulder of the hub by peening over the ends thereof in a number of places as at 48.

A small tab is cut from the material at the outer circumference of the disc 47 and bent to form an axially projecting operating member such as the finger 49 for contacting one end of a switch operating lever 51 (Fig. 4) carried by a member such as the index disc 52. The finger 49 also acts as a stop contact member as will be described below. The lever 51 has a circular aperture therein through which projects a screw 53 engaging threads tapped in aligned holes in the index disc 52, a stop contacting member or plate 54 whose use will be described below, and a switch actuating face 55. A washer 56 is inserted between the lever 51 and the plate 54 so that the lever moves freely with respect thereto; the screw 53 acting as a fulcrum allowing the lever to contact with face 55 the actuating member of a time opening switch s1 which is also carried by the index disc 52. It will be noted that the lever ratio is approximately 2:1 thus reducing the travel required after the disc finger 49 contacts the end of the lever 51 to trip the switch s1 thereby making the exact point of tripping less critical, a distinct advantage which increases the accuracy of the timer. To protect the switch s1 from overtravel of the disc 47, a screw 57 projects through a slotted aperture 57a in the lever 51 to act as a stop.

The index disc 52 is supported upon a sleeve 58 (Fig. 6) having one end reduced in diameter to engage an aperture in the disc center. The disc 52 is held against the sleeve shoulder by peening in a number of places as at 59. The inner surface of the sleeve 58 rotatably engages the outer surface of the bearing 27 so that the disc 52 can be turned with respect to the bearing 27 as will be described below.

An adjustable stop assembly 61 (Figs. 4 and 5) is mounted at the top of the dial plate 28 by means of the screws 62 to provide a zero indexing point for the discs 47 and 52. This assembly 61 includes a U-shaped frame 63 having a pivot screw 64 projecting normally from the center of the cross piece thereof. The screw 64 carries two rotatable stops 66 and 67 thereupon which are maintained in spaced relationship by means of the washers 68 and 69. Each stop has a finger 71 extending from a rotatable cylindrical body 72 with an aperture therein for the pivot screw 64 and a sector shaped portion 73 cut from the body 72 to provide a cam surface against which bears a pin such as the screw 74 projecting from one side of the stop frame 63. The screw 74 is adjusted to contact the vertical surface of the cam sector 73 when the extended finger 71 is positioned vertically thereby preventing the disc finger 49 (or stop plate 54) from rotating counterclockwise beyond the zero index position. The screws 74 are maintained in adjusted position by the respective lock nuts 75.

When the disc finger 49 contacts finger 71 from the opposite side upon clockwise rotation of the disc 47, the stop body 72 turns about the pivot screw 64 until the end of the screw 74 contacts the opposite sector surface whereupon the finger 71 prevents further rotation. It is apparent that by proper proportioning of the cam sector 73, the stop body 72 will turn sufficiently to provide a full 360 degree rotation of the disc, further rotation then being prevented by the bearing of the screw against the cam surface. The stop for the index disc 52 is similar in construction and operates in an analogous manner by contacting the stop plate 54 which also acts as a mounting base for the lever 51.

The index disc 52 is rotated manually by means of a friction drive including a knob 76 located upon the outer end of the shaft 77 which projects through the lower right hand corner of the dial plate 28. Fixed to the opposite end of the shaft 77 is a rubber grommet 78 having an annular groove 79 in its outer surface for engaging the edge of the index disc 52. The timing disc 47 is rotated in a clockwise direction by the engagement of the clutch 35 as will be decribed in detail below. With the clutch disengaged, a restoring force provided by a clock spring 81 maintains the timing disc 47 in the zero index position with the finger 49 against the finger 71 of the rotatable stop 67.

The clutch lever 43 is rotatably supported upon a shaft 82 the ends of which are journaled in the bosses 83 which project from the frame web 12. A cap screw 84 acts as a set screw to prevent relative motion between the lever 43 and the shaft 81. The screw 84 is made of sufficient length so that the end thereof projects to hold the stationary end of the clock spring 81. A clutch solenoid 86 (Fig. 5) is mounted on the rear of the web 12 adjacent the motor 18 by the screws 85 to provide, as its first function, a means of operating the clutch lever 43 so that the screws 42 threaded in its bifurcated end move the circular plate 34 to bring the serrated clutch surfaces 35 and 37 into engagement.

The translational force of the solenoid armature 87 is converted into torque by an arm 88 (Fig. 3) which extends through an aperture 89 in the frame web 12. One end of the arm 88 is connected to the solenoid armature 87 by a spring 91 which provides an elastic link between the arm and armature so that the armature is certain to seat thus eliminating chattering and vibration. The other end of the arm 88 engages the threaded end of a collar 92 being secured thereto by prick punching of the exposed threads as at 93. A set screw 94 fastens the collar 92 upon the shaft 82 adjacent the boss 83. A second collar 96 is similarly secured to the shaft 81 adjacent the other boss 83 thereby preventing axial movement of the shaft 82. Restoration torque is provided by a spring 97 connected between an aperture in the arm 88 and an eye in the end of an adjustable screw 98 which engages threads in a boss 99 at the junction of a web 12 and the upper transverse member 13. The screw 98 is locked in adjusted position by means of a nut 101.

A second function of the clutch lever 43 is to act as a brake retarding the return of the timing disc 47 to the index or zero position. The portion of the clutch lever 43 extending above the shaft 82 has an arm 102 projecting normally

therefrom to carry a roller such as the outer race ring 103 of a small ball bearing which is secured to the arm by a screw 104. The spring 97 forces the roller 103 against the side of the timing disc 47, the drag exerted thereby decelerating the return of the disc so that the third function, the positive "zeroing" of the disc 47 can be accomplished by the lever 43. When the index disc 52 is in the exact zero index position, the roller 103 drops into a slotted aperture 106 cut in the disc as is shown in Fig. 5. If the disc 52 is not held precisely in the zero index position by the finger 71 of the rotatable stop 66 as described heretofore, the roller 103 will tend to be partially out of the aperture 106; but because of the force exerted by the spring 97 the roller 103 is forced into the slotted aperture 106 so that the disc 52 is moved to the zero position. It will thus be seen that roller 103 provides a braking member when contacting the side of timing disc 47, and that it provides a zeroing latch when it contacts the zeroing deformation of the disc constituted by aperture 106.

The fourth function of the clutch lever 43 is the operation of a holding switch *s2* which is mounted on the front of the web 12 by the screws 107. This operation is accomplished by a cap screw 108 threaded into the underside of the bent end 109 of the clutch lever 43 so that the head thereof contacts the actuating member 111 of the switch *s2*. The screw 108 is locked in adjusted position by means of a nut 112.

The timer is provided with a load relay having five load switches S1, S2, S3, S4 and S5 each of which has a normally closed contact 113, a moving contact 114 and a normally open contact 116. As is best shown in Fig. 5, these contacts are supported near the end of respective leaf springs 117 so that the opening (or closing) of the contacts provides some relative sliding or "wipe" to prevent sticking and poor electrical contact. An auxiliary leaf spring 118 is provided adjacent each of the respective stationary contact springs 117 to limit the movement thereof. The contact carrying leaf springs 117 are separated by plastic blocks 119, the blocks and springs comprising each respective switch S being fastened to a switch support bar 121 by means of two screws 122 which thread into the bar. The ends of the support bar 121 are bent at right angles thereto and fastened to the respective terminal block brackets 14 by the screws 123 so that the switches S are positioned in front of the lower portion of the frame web 12. A barrier 124 of plastic or other insulating material is fastened between the switches S and the support bar 121 so that the switches are insulated from the frame web 12.

The load switches S are operated by a load solenoid 126 (Fig. 2), mounted on the back of the frame web 12 on the opposite side of the motor 18 from the clutch solenoid 86, through a bent lever 127 extending through an aperture 128 (Fig. 3) in the web 12. One end 129 of the lever 127 is bifurcated to engage a shaft 131 which is journaled in the bosses 132 extending from the frame web 12. The opposite end of the lever 127 terminates in a finger 133 which engages a pin 134 in the solenoid armature 136 so that the lever pivots about the shaft 131 when the solenoid 126 is energized. Sufficient restoring torque is ordinarily supplied by the elasticity of the bent portions 144 of the leaf springs 177 of the switches S. If additional torque is required, it may be supplied by a spring 130, one end of which engages an aperture in the lever 127, the other end being secured by a pin 130*a* which projects from the rear of the web 12. The upward movement of the lever 127 is restrained by an adjustable stop such as the screw 135 engaging a threaded aperture in a boss 99*a* located at the junction of the web 12 and an upper transverse member 13.

An actuating bar 137 is maintained in parallel relationship with the shaft 131 by two support members 138 located at the respective ends thereof. Each member 138 has an aperture therein through which passes the shaft 131, relative motion therebetween being prevented by a set screw 139. Also extending from the bar 137 is a bent rotating arm 141 which projects upwardly to lie adjacent the bent lever 127 near the bifurcated end 129 thereof. The lever 127 and arm 141 are connected by a screw 142 which projects through a slotted aperture 143 in the lever to engage a thread tapped in the arm.

It is apparent from the above that energizing of the solenoid 126 moves the armature 136 downwardly to pivot the bent lever 127 about the shaft 131 as a fulcrum point so that the arm moves the support bar 137 in a path having a locus describing a partial arc of a circle with a center coinciding with the axis of the shaft and a radius equal to the distance between the axis of the shaft 131 and the support bar 137. By means of the slotted aperture 143 the relationship between the lever 127 and the arm 141 can be made such that the arc described by the bar 137 intersects the bent portion 144 of the respective moving contact leaf springs 117 thereby to conjointly operate the switches S upon energization of the solenoid 126. To electrically isolate the respective switches S from each other, the portion of the bar 137 which would otherwise come in contact with the leaf springs 117 is insulated by a semicircular plastic rod 146 secured to the bar by means of the screws 147.

A reset switch *s3* is also provided in the timer, the normally closed contacts thereof being mounted in front of the end load switch S1 by means of the screws 148 which are also used to secure the load switch S1 to the support bar 121. The switch *s3* (Fig. 5) comprises two leaf springs 151, each having an electrical contact 152 and an adjacent auxiliary leaf spring 153, separated by a plastic block 154. Electrical interconnection between the switches *s3* and S1 is prevented by positioning a nonconducting barrier 149 therebetween. An aperture 155 (Fig. 3) is provided in the front leaf springs 151 and 153 to provide clearance for an operating finger 156 of nonconducting material which is threaded upon one end of a rod 157 projecting outwardly through the lower left hand corner of the dial plate 28. An operating knob 158 is attached to the other end of the rod 157. The switch *s3* is operated by pushing the knob 158 inwardly against the force of a spring 159 compressed between the knob and the face of a front panel 161, so that the finger 156 projects through the aperture 155 to push the rear leaf spring 151 thereby to open the contacts 152.

The front panel 161 is secured to the dial plate 28 by the screws 160 (Fig. 1). A large circular aperture 162 is cut in the front panel 161 so as to be coaxially located with respect to the extension shaft 26. The aperture 162 is enclosed by a plate of transparent material 163 which is secured between two gaskets 165 by the screws 166.

The end of the extension shaft 26 projecting out through the dial plate 28 is tapped to re-

ceive a screw 167 which secures a pointer 168 to the shaft end. A dial 169 is fastened to the dial plate 28 so that it is visible through the transparent plate 163. The dial 169 is divided into chronometric units correlated with the rotational speed of the motor 18 so that the pointer 168 indicates the time interval which has elapsed from the starting of the timing cycle.

A scale bearing member 170 is coaxially attached by means of its inner portion 170*a* to the index disc 58. The outer portion 170*b* of the member 170 being axially disposed with respect to the inner portion as at 170c so that the front face thereof which has a chronometrically divided scale 169*a* embossed thereupon is positioned immediately behind an aperture 171 in the dial plate 28. The scale 169*a* is correlated with a fiducial indicator or pointer 169*b* whereby the portion of the scale corresponding in time units to the time setting selected by the degrees the disc has been manually rotated from the zero index position by means of the knob 76 is exposed in the aperture 171, see Figs. 1 and 7.

The wiring diagram of the timer is shown in Fig. 8. The motor 18 is permanently coupled to the terminals *t1* and *t2* which are connected to a power supply (not shown) thereby causing the motor shaft 19 to rotate continuously in a clockwise direction. A holding circuit for energizing the clutch solenoid 86 includes the normally closed contact of the time opening switch *s1*, the normally open contact of the holding switch *s2* and the normally closed contact of the reset switch *s3* which contacts are connected in series with the solenoid 86 between the power supply terminals *t1* and *t2*. The normally open contact of the time opening switch *s1* and the normally closed contact of the holding switch *s2* are linked with the terminals *t3* and *t4* respectively. One end of the load relay solenoid 126 is connected with the power supply terminal *t1*, the other solenoid end being connected to a terminal *t6*. For convenience when connecting the timer to an external circuit, the terminals *t1*—*t6* are preferably located upon the top terminal block 16*a* as is shown in Fig. 1.

In Fig. 8 the timer is shown connected to an external circuit linking the terminals *t4* and *t6* whereby the load solenoid 126 is normally energized. If desired the link between the terminals *t4* and *t6* may include an interlocking switch *Si* which is associated with the distribution circuits connected to the switches S1—S5 as will be described in detail below.

The timer operation is started by momentarily closing a normally open switch or starting push button *Ss* to conductively connect the terminals *t2* and *t5* thereby energizing the clutch solenoid 86 from the power supply terminals *t1* and *t2*. The energization of the solenoid 86 engages the clutch 35 to start the rotation of the timing disc 47 and concomitantly closes the normally open contacts of the holding switch *s2* to complete the holding circuit including the switches *s1* and *s3*, which shunts the push button *Ss*. The normally closed contacts of the switch *s2* conjointly open to de-energize the load solenoid 126 thereby transferring the load switches S1—S5.

After the elapse of a time interval determined by the manual setting of the index disc 52, the finger 49 on the disc 47 moves the switch operating lever 51 momentarily to transfer both the normally closed and normally open contacts of the time opening switch *s1*, a characteristic feature which is of importance in certain practical applications such as described below with reference to Fig. 11. The interruption of the holding circuit by the switch *s1* de-energizes the solenoid thereby releasing the clutch 35 so that the timing disc 47 is returned to the zero index position by the spring 81. The switch actuating mechanism 111 is conjointly released by the clutch lever 43 thus closing the normally closed contacts of the holding switch *s2* to energize the load solenoid 126 and transfer the load switches S1—S5.

The timer can be reset before the end of the timing cycle by opening the holding circuit of the clutch solenoid 86 by means of the reset switch *s3*. The switch *Si* is opened either manually or in response to an electrical or mechanical signal from the apparatus being timed to de-energize the load solenoid 126 and transfer the switches S1—S5 without starting the timing cycle. In case of failure of the power supply, an armature element in the field of the motor 18 moves forward to actuate a bell crank 174 which contacts the clutch lever 43 so that the clutch 35 is maintained in engagement and the holding switch *s2* remains closed thereby to continue the timing cycle upon the restoration of the power supply, the total length of the cycle being the same as if no interruption had occurred.

In Fig. 9 is shown another external circuit by means of which the load solenoid is energized momentarily at the end of the timing cycle. The terminals *t2* and *t5* are again connected by a starting push button *Ss*. The terminal *t6* is linked to the terminal *t3* so that the load solenoid 126 is energized by the normally open contacts of the time opening switch *s1* only when the switch is operated at the end of the timing cycle.

In the preferred method of connecting the timer, the leads from the external circuit or circuits are brought to the terminals in the lower terminal blocks 16*b* and 16c as, for example, the terminals *t'2*—*t'6* are used for the circuits shown in Figs. 7 and 8. The connections to the timer are then completed by connecting the correlated terminals by short leads or conducting metal straps such as the jumpers 173. The use of the jumpers 173 greatly facilitates the wiring, and provides a quick convenient means of changing the manner in which the timer is connected to the external circuits. The auxiliary terminal block 16*b* and 16c also provide a plurality of junctions for the connections to the load switches S1—S5.

A practical use for the timer is illustrated by the schematic wiring diagram in Fig. 10 of the power and control circuits for a motor M driving a pump (not shown) for emptying a tank. A pump motor M is connected to the terminals *a* and *c* of a power source (not shown) by the normally closed contacts *s1a* and *s1b* of the load switch S1. The timer clutch solenoid 86, the reset switch *s3*, the normally open contacts of the holding switch *s2* and the normally closed contacts of the switch *s1* are connected in series with the power supply by linking the timer terminals *t1* and *t2* with the supply terminals *a* and *c* respectively.

One end of the load solenoid 126 is coupled to the power supply terminal *a* through the timer terminal *t1*. The other end of the solenoid 126 is linked by the terminal *t6* to a normally open relay contact *s5*, a normally energized circuit for the solenoid 126 being completed to the power

terminal *c* through the normally open contacts *s2a* and *s2c* of the load switch S2, the terminal *t4* and the normally closed contacts of the timer holding switch *s2*, the time opening switch *s1* and the terminal *t2*. The normally closed contact *s2b* is also connected to the terminal *t4* thereby completing the solenoid energizing circuit in either position of the load switch S2.

Connected in parallel with the contact *s5* is a switch *s6* controlled by the level of liquid in the tank (not shown) emptied by the pump motor M, such control being accomplished for example, by a float and associated mechanism which is arranged to close the switch *s6* only when the tank is empty. The relay contact *s5* is operated by solenoid L5 which is energized from the power supply terminals *a* and *c* through the normally open contacts *s1a* and *s1c* of the load switch S1. The closing of the contacts *s1a* and *s1c* also connects the starting switch Ss between the power terminal *c* and the solenoid terminal *t5*.

The tank pump motor M is started by closing the starting switch Ss either manually or automatically by means of a signal from other apparatus used in connection with the tank emptying operation. The closing of switch Ss energized the clutch solenoid 86 from the power supply terminals through the load switch contacts *s1a* and *s1c* thereby starting the timer cycle. The holding switch *s2* is operated by the solenoid 86 to complete the holding circuit shunting the starting switch Ss and concomitantly to interrupt the circuit energizing the load solenoid 126. The de-energization of the solenoid 126 completes a circuit through the contacts *s1a* and *s1b* of the load switch S1 to connect the pump motor M across the power terminals *a* and *c* and concomitantly opens the contacts *s1a* and *s1b* to de-energize the relay solenoid L5. The load switch S2 transfers conjointly to close the contacts *s2a* and *s2b*.

Under normal operating conditions the pump empties the tank during the timing cycle of the timer. Upon the interruption of the holding circuit by the timing switch *s1* the normally closed contact of the holding switch *s2* completes a circuit through the load contacts *s2a* and *s2b* and the tank switch *s6* (closed by the emptying of the tank) to energize the load solenoid 126 thereby to open the contacts *s1a* and *s1c* of the switch S1 to stop the pump motor M. The contacts *s1a* and *s1b* concomitantly energize the solenoid L5 to close the contact *s5* thereby to shunt the tank switch *s6* which opens upon the subsequent filling of the tank by any conventional means (not shown). If because of sediment, pump wear or for any other reason the tank is not emptied during the cycle of the timer, the tank switch *s6* remains open so that the solenoid 126 is not energized to stop the motor M until the completion of the pumping cycle.

In Fig. 11 four timers T*a*, T*b*, T*c* and T*d* of the type described above are used to control the sequence of illumination of the lamps of a traffic signal installation. The red, yellow and green lamps on one street are designated R1, Y1 and G1, those on the intersecting street R2, Y2 and G2. It being understood that the indicia R, Y and G may represent a plurality of lamps of the same color connected in parallel.

This installation is energized from the terminals *a* and *c* of the conventional single phase alternating power supply (not shown). The terminals *t1* of the respective timers T*a*, T*b*, T*c* and T*d* are connected to the power supply terminal *a* so that one end of the respective solenoids 86 and 126 are linked to the terminal *a*. The terminals *t2* of the respective timers T*a*, T*b*, T*c* and T*d* are connected to the power supply terminal *c* thereby linking the movable contacts of the time opening switches *s1* thereto and connecting the respective motors 18 (eliminated from Fig. 11 to simplify the diagram) to the power supply. The terminals *t5* and *t6* for the timer T*a* are linked by a normally closed external switch S1*a* thereby connecting the solenoids 86*a* and 126*a* in parallel. The terminals *t5* and *t6* of the timers T*b*, T*c* and T*d* are linked in an analogous manner by the switches S1*b*, S1*c* and S1*d*. The switches S1*a*, S1*b*, S1*c* and S1*d* are mechanically linked together so that the solenoids 126*a*, 126*b*, 126*c* and 126*d* can be de-energized conjointly without interrupting the timing sequence of the system.

The timer T*a* is initially energized by a momentary contact starting switch Ss which is connected between the power supply terminal *c* and the timer terminal *t5*. The closing of the switch Ss energizes the solenoid 86*a* to close the holding switch *s2* and start the timing cycle as described in detail heretofore. Upon the elapse of the predetermined timing period the contacts of the time opening switch *s1* momentarily transfer, interrupting the timer cycle and energizing the timer terminal *t3*. The terminal *t3* of the timer T*a* is linked to the terminal *t5* of the timer T*b* so that the switch *s1* of the timer T*a* acts as a starting switch for the timer T*b*. By means of a similar connection the interrupting of the timing period of the timer T*b* starts the timer T*c*. The timer T*c* after the elapse of its timing period energizes the timer T*d* which in turn energizes timer T*a* thereby causing the above described sequence of operations to be repeated.

Upon the energization of the solenoid 126*a*, the load switches Sa1, Sa2 of the timer T*a* transfers so that the green lamp G1 is connected between the power source terminals *a* and *c* by a circuit including the normally closed contacts of the load switches Sb1, Sc1 and Sd1 of the timer T*b*, T*c* and T*d* respectively and the normally open contact of the switch Sa1 which is closed by such energization of the solenoid 126*a*. Simultaneously the normally open contacts of the switch Sb2 energize the red lamp R2 on the cross street by a circuit also including the normally closed contacts of the switches Sb2, Sc2 and Sd2 of the timers T*b*, T*c* and T*d* respectively.

At the end of the timing period of the timer T*a* the switches Sa1 and Sa2 return to their normal position, thereby extinguishing the lamp G1. The timer T*b* concomitantly energizes as described above so that its switches Sb1 and Sb2 transfer. The closing of the normally open contact of the switch Sb1 illuminates the yellow lamp Y1 by means of a circuit completed between the terminals *a* and *c* by the normally closed contact of the switches Sc1 and Sd1. The concomitant transfer of the switch Sb2 causes a circuit to be completed through its normally open contact to maintain the illumination of the lamp R2.

The timer T*c* is energized at the termination of the timing period of the timer T*b* thereby to transfer the contacts Sc1 and Sc2, the normally closed contacts thereof interrupting the circuits to the lamps Y1 and G2 respectively. The normally open contact of the switch Sc1 connects the lamp R1 in series with the normally closed contact of the switch Sd1 between the power supply terminals *a* and *c*. The normally open contact of the switch Sc2 and the normally closed

contact of the switch Sd2 concomitantly connect the lamp G2 to the power source terminals *a* and *c*.

The fourth step of the sequence is initiated by the transfer of the switches Sd1 and Sd2 of the timer Td at the conclusion of the timing period of the timer Tc whereupon the normally open contact thereof connects the lamps R1 and Y2 directly between the terminals *a* and *c*. These lamps remain illuminated during the timing period of the timer Td. At the end of such period the timer Td energizes the timer Ta so that the above described sequence of operation is repeated.

If as described heretofore the switches *S1a*, *S1b*, *S1c* and *S1d* are open conjointly either mechanically or by a solenoid so that the solenoids *126a*, *126b*, *126c* and *126d* are not energized it will be noted as is shown in Fig. 11 that with all the load switches in their normal positions the red lamps R1 and R2 are both illuminated. This feature allows traffic on both streets to be stopped in the case of emergency for example when it is necessary to provide a right of way for an ambulance or a fire engine. After the emergency has passed, the closing of the switches *S1a*, *S1b*, *S1c* and *S1d* continues the cycle as if the emergency had not interrupted the sequence thereof.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a member having a time opening switch with a normally closed contact, a switch operating member, means for manually shifting the position of one of said members from a zero index position, a spring for biasing the other member to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit, and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the timing switch after the elapse of the predetermined time interval operates the load solenoid to transfer the load contacts.

2. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a member having a time opening switch with a normally closed contact, a switch operating member, means for manually shifting the position of one of said members from a zero index position, a spring for biasing the other member to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for connecting said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid with one end linked to a terminal of the power supply and the other end adapted to be coupled with the normally open contact of the time opening switch and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the deenergization of the clutch solenoid by the opening of the normally closed contact of the timing opening switch after the elapse of the predetermined time interval energizes the load solenoid to transfer the load contacts.

3. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a member having a time opening switch with a normally closed contact, a switch operating member, means for manually shifting the position of one of said members from a zero index position, a spring for biasing the other member to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally closed contact and a normally open contact for connecting said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid with one end linked to a terminal of the power supply and the other end adapted to be coupled with the normally closed contact of the holding switch and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the deenergization of the clutch solenoid by the opening of the normally closed contact of the timing opening switch after the elapse of the predetermined time interval deenergizes the load solenoid to transfer the load contacts.

4. A timer operated from the terminals of a power supply to modify after the elapse of a predetermined time an external circuit having an interlocking switch responsive to a change in a selected operating condition, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a member having a time opening switch with a normally closed contact, a switch operating member, means for manually shifting the position of one of said members from a zero index position, a spring for biasing the other member to the zero index position, a solenoid

operated clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit by means of the interlocking switch and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the change in the selected operating condition overrides the timed operation of the load relay to transfer the load contacts.

5. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a member having a time opening switch with a normally closed contact, a switch operating member, a friction drive having an operating knob for manually shifting the position of one of said members from a zero index position, a spring for biasing the other member to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the timing opening switch after the elapse of the predetermined time interval operates the load relay to transfer the load contacts.

6. A timer operated from a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising a terminal block having a plurality of terminals; an electric motor connected between two of said terminals adapted to be coupled to the power supply so that said motor is continuously operated thereby; a member having a time opening switch with a normally open contact connected to a third of said terminals and a normally closed contact; a switch operating member; means for manually shifting the position of one of said members from a zero index position; a spring for biasing the other member to the zero index position; a clutch for selectively engaging said motor thereby to move the biased member against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted member; a solenoid for operating said clutch having one end connected

to one of the power supply terminals and the other end connected to a fourth of said terminals; a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally closed contact connected to a fifth of said terminals and a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply; and a load relay having a load solenoid with one end linked to a terminal of the power supply and the other end linked with a sixth of said terminals, said sixth terminal being adapted to be coupled externally with one of the other terminals so that the load solenoid is connected in parallel with a portion of the holding circuit, and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the deenergization of the clutch solenoid by the opening of the normally closed contact of the timing opening switch after the elapse of the predetermined time interval operates the load solenoid to transfer the load contacts.

7. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for manually shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

8. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, an index disc carrying a time opening switch having a normally closed contact, a timing disc arranged coaxially with the index disc and having an operating member for said switch, means for manually shifting the position of index disc from a zero index position, a spring for biasing the timing disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the timing disc against the force of the spring to operate

said switch after an elapse of time determined by the selected position of the index disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

9. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, an index disc carrying a time opening switch having a normally closed contact and a switch operating lever, a timing disc arranged coaxially with the index disc and having a projecting finger to contact said switch lever when the timing disc is rotated, the lever ratio being such that the rotation of the timing disc required to operate the switch is considerably reduced thereby minimizing the timing error, means for manually shifting the position of index disc from a zero index position, a spring for biasing the timing disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the timing disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the index disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

10. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, a friction drive having an operating knob and a grommet with an annular groove for engaging the edge of one of said discs, thereby to rotate manually the engaged disc from a zero index position, a spring for biasing the other disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

11. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc having a time opening switch with a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for manually rotating the position of one of said discs from a zero index position, a scale divided in chronometric units carried by the manually rotated disc, the zero scale position corresponding to the zero index position of the disc, a fiducial indicator having an aperture exposing the portion of the scale corresponding in time units to the time setting selected by the amount the disc has been manually rotated from the zero index position, a spring for biasing the other disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually rotated disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

12. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals for continuous operation by said power supply, a disc, a time opening switch mounted on said disc and having a normally open contact and a normally closed contact with flexible conductors leading therefrom, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for rotating the position of one of said discs from a zero index position, a dial plate positioned parallel said switch carrying disc in spaced relationship therewith and having a fiducial aperture therein, a scale bear-

ing member having an inner portion fastened to said switch carrying disc and an outer portion axially disposed with respect to said inner portion so that the scale is immediately behind said dial plate aperture, said outer portion and said switch carrying disc thereby defining a passageway for said flexible switch conductors, said scale being divided in chronometric units and having a zero scale position corresponding to the zero index position of the switch carrying disc whereby the aperture exposes the portion of the scale corresponding in time units to the time setting selected by the amount the disc has been manually rotated from the zero index position, a spring for biasing the other disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually rotated disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

13. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc having a time opening switch with a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, a friction drive having an operating knob and a grommet with an annular groove for engaging the edge of one of said discs thereby to rotate manually the engaged disc from a zero index position, a scale divided in chronometric units carried on the face of the manually rotated disc, the zero scale position corresponding to the zero index position of the disc, a fiducial indicator having an aperture exposing the portion of the scale corresponding in time units to the time setting selected by the degrees the disc has been manually rotated from the zero index position, a spring for biasing the other disc to the zero index position, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

14. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for manually shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position, a clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a solenoid operated lever for throwing said clutch, a holding switch operated by the lever conjointly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

15. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for manually shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position, said spring biased disc having a zero positioning deformation therein, a clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a solenoid operated lever for engaging said clutch, a zeroing latch carried by said lever and engaging the deformation in the spring biased disc thereby to center the disc in the zero index position when the solenoid is deenergized, said latch being withdrawn from the deformation conjointly with the engaging of said clutch, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the inter-

ruption of the holding circuit by the opening of the normally closed contact of the timing opening switch operates the load relay to transfer the load contacts.

16. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load circuit after the elapse of a predetermined time, comprising an electric motor connected between said terminals so that said motor is continuously operated by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for manually shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position, a clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a solenoid operated lever for engaging said clutch, a brake extension carried by said lever to engage the side of the spring biased disc thereby to retard the return of the disc to the zero index position when the solenoid is deenergized, said extension being withdrawn from the side of the disc conjointly with the engaging of said clutch, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the timing opening switch operates the load relay to transfer the load contacts.

17. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between said terminals for continuous operation by said power supply, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, means for shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position, said spring biased disc having a zero positioning deformation therein, a clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a lever for operating said clutch, a holding switch operated by the lever, a zeroing and braking latch extension carried by said lever to engage the side of the spring biased disc thereby to retard the return of the disc to the zero index position when the clutch is disengaged, said extension subsequently engaging the deformation in the spring biased disc thereby to center the disc in the zero index position, said extension being withdrawn from the deformation by the movement of the lever to engage the clutch, a solenoid for moving the lever, the clutch engaging operation, the holding switch operation and the extension withdrawing operation being performed conjointly thereby, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contacts.

18. A timer operated from a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising a frame having a stepped bracket on each side thereof; a plurality of terminal blocks mounted on said steps, each of said blocks having a plurality of terminals; an electric motor mounted on said frame and connected between two of said terminals adapted to be connected to the power supply so that said motor is continuously operated thereby; a disc having a time opening switch with a normally open contact connected to a third of said terminals and a normally closed contact; a disc arranged coaxially with the switch disc and having an operating member for said switch; means for manually shifting the position of one of said discs from a zero index position; a spring for biasing the other disc to the zero index position; a clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc; a solenoid for operating said clutch having one end connected to one of said power supply terminals and the other end connected to a fourth of said terminals; a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally closed contact connected to a fifth of said terminals and a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply; and a load relay having a load solenoid with one end linked to a terminal of the power supply and the other end linked with a sixth of said terminals, said sixth terminal being adapted to be coupled externally with one of the other terminals so that the load solenoid is connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid, the remaining terminals being open so that they can be used as junctions for the distribution circuit connections when the timer is installed.

19. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between terminals of said power supply and having a shaft continuously rotated thereby, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, a stop to prevent each of the respective discs from being rotated beyond a zero index position in a direction

counter to the direction of rotation of said motor shaft, means for manually shifting the position of one of said discs from the zero index position, a spring for biasing the other disc to the zero index position against the correlated stop, a solenoid operated clutch for selectively engaging said motor shaft thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally contact of the time opening switch operates the load relay to transfer the load contacts.

20. A timer operated from the terminals of a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising an electric motor connected between terminals of said power supply and having a shaft continuously rotated in a clockwise direction thereby, a disc carrying a time opening switch having a normally closed contact, a disc arranged coaxially with the switch carrying disc and having an operating member for said switch, a stop contacting member mounted on each of said respective discs, a stop assembly cooperating with each of the respective stop contacting members, each of said stop assemblies including a rotatable cylindrical body having a cam sector therein and a finger projecting therefrom to contact the respective disc stop contacting member and a pin positioned to contact one side of the cam sector thus restraining further movement of the body when the finger is positioned to contact the stop contacting member thereby to prevent further counterclockwise rotation of the respective disc beyond the zero index position, the cam sector being shaped to allow movement of the body as the stop contacting member meets the finger upon clockwise rotation of the disc so that the finger is moved by the stop contacting member thereby permitting a full 360 degree rotation of said disc, means for manually shifting the position of one of said discs from a zero index position, a spring for biasing the other disc to the zero index position against the correlated stop finger, a solenoid operated clutch for selectively engaging said motor thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc, a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the terminals of said power supply, and a load relay having a load solenoid adapted to be connected in parallel with a portion of the holding circuit and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch operates the load relay to transfer the load contents.

21. A timer operated from a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising a terminal block having a plurality of terminals; an electric motor connected between two of said terminals adapted to be coupled to the power supply and having a shaft continuously rotated thereby; a disc having a time opening switch with a normally open contact connected to a third of said terminals and a normally closed contact; a disc arranged coaxially with the switch disc and having an operating member for said switch; a stop to prevent each of the respective discs from being rotated beyond a zero index position in a direction counter to the direction of rotation of said motor shaft; a friction drive having an operating knob for manually shifting the position of one of said members from the zero index position; a spring for biasing the other disc to the zero index position against the correlated stop; a clutch for selectively engaging the motor shaft thereby to move the biased disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the manually shifted disc; a solenoid for operating said clutch having one end connected to one of the power supply terminals and the other end connected to a fourth of said terminals; a holding switch operated by the clutch solenoid concomitantly with the engagement of said clutch, said holding switch having a normally closed contact connected to a fifth of said terminals and a normally open contact for connecting said solenoid and the normally closed contact of the time opening switch in series between the power supply terminals; and a load relay having a load solenoid with one end linked with a sixth of said terminals, said sixth terminal being adapted to be externally connected to one of the other terminals so that the load solenoid is connected in parallel with a portion of the holding circuit, and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding circuit by the opening of the normally closed contact of the time opening switch after the elapse of the predetermined time interval operates the load relay to transfer the load contacts.

22. A timer operated from a power supply to modify a distribution circuit to an electrical load after the elapse of a predetermined time, comprising a frame having a stepped bracket on each side thereof; a plurality of terminal blocks mounted on said steps, each of said blocks having a plurality of terminals; an electric motor mounted on said frame and connected between two terminals adapted to be coupled to the power supply and having a shaft continuously rotated thereby; an index disc having a time opening switch with a normally open contact connected to a third of said terminals and a normally closed contact and a switch operating lever; a timing disc arranged coaxially with the index disc and having a projecting finger to contact said switch lever when the timing disc is rotated thereby momentarily to transfer said switch contacts, the lever ratio being such that the rotation of the timing disc required to operate the switch is considerably reduced thereby to minimize the timing error; a stop contacting member mounted on each of said respective discs, a stop assembly co-

operating with each of the respective stop contacting members, each of said stop assemblies including a rotatable cylindrical body having a cam sector therein and a finger projecting therefrom to contact the respective disc stop contacting member and a pin positioned to contact one side of the cam sector restraining further movement of the body when the finger is positioned to contact the stop contacting member thereby to prevent further counterclockwise rotation of the respective disc beyond the zero index position, the cam sector being shaped to allow movement of the body as the stop contacting member meets the finger upon clockwise rotation of the disc so that the finger is moved by the stop contacting member thereby permitting a full 360 degree rotation of said disc; a friction drive having an operating knob and a grommet with an annular groove for engaging the edge of the index disc to rotate the disc from the zero index position; a scale divided in chronometric units carried on the face of the manually shifted disc, the zero scale position corresponding to the zero index position of the disc; a fiducial indicator having an aperture exposing the portion of the scale corresponding in time units to the time setting selected by the degrees the disc has been manually rotated from the zero index position; a spring for biasing the timing disc to the zero index position against the correlated stop finger, said timing disc having an aperture therein for positively determining the zero position thereof; a clutch for selectively engaging the motor shaft thereby to move the timing disc against the force of the spring to operate said switch after an elapse of time determined by the selected position of the index disc; a clutch solenoid having one end connected to one of the power supply terminals, the other end being connected to a fourth of said terminals; a lever for operating by said solenoid to engage said clutch; a holding switch operated by the lever, said holding switch having a normally closed contact connected to a fifth of said terminals and a normally open contact for completing a holding circuit to connect said solenoid and the normally closed contact of the time opening switch in series between the power supply terminals; a roller carried by said lever to engage the side of the timing disc thereby to retard the return of the disc to the zero position when the clutch is disengaged which roller subsequently engages the aperture in the timing disc thereby to center the disc in the zero index position, said roller being withdrawn from the aperture by the movement of the lever to engage the clutch, the clutch engaging the holding switch and roller withdrawing operations being performed conjointly; and a load relay having a load solenoid with one end linked to a terminal of the power supply and the other end linked with a sixth of said terminals, said sixth terminal being adapted to be connected externally with one of the other terminals so that the load solenoid is connected in parallel with a portion of the holding circuit, and a plurality of load contacts connected in the distribution circuit and operated by the load solenoid whereby the interruption of the holding solenoid circuit by the opening of the normally closed contact of the time opening switch after the elapse of the predetermined time interval operates the load relay to transfer the load contacts.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,902,508	Kearsley	Mar. 21, 1933
2,103,907	Kearsley	Dec. 28, 1937
2,468,855	Abrahamse	May 3, 1949
2,500,956	Mershon	Mar. 21, 1950

FOREIGN PATENTS

Number	Country	Date
558,726	Germany	Sept. 10, 1932