Dec. 10, 1957 R. M. MANNING ET AL 2,816,184

TIME SWITCH

Filed Dec. 20, 1955 6 Sheets-Sheet 1

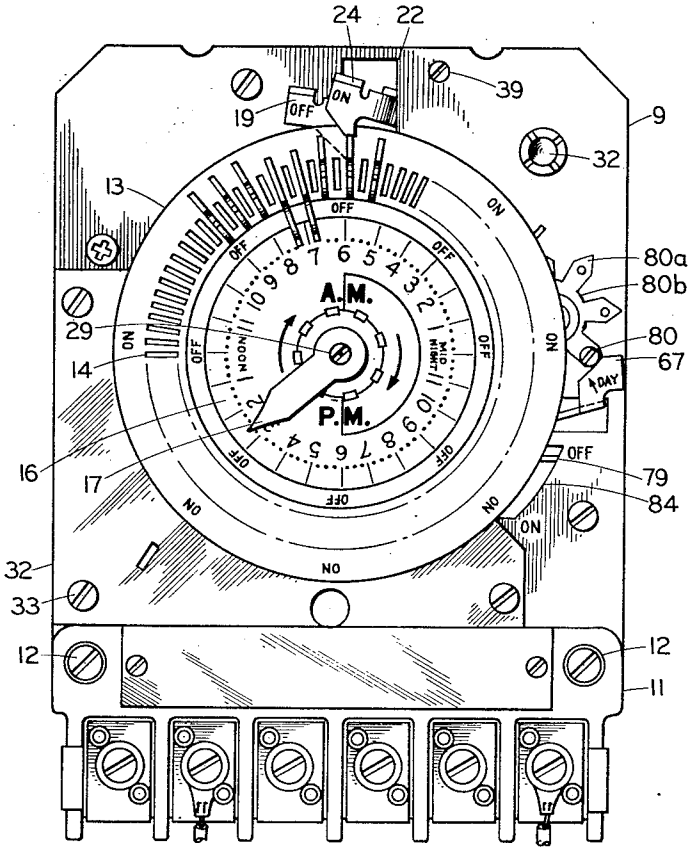


Fig. 1

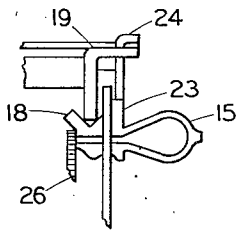


Fig. 2

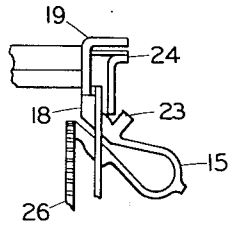


Fig. 3

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TIME SWITCH

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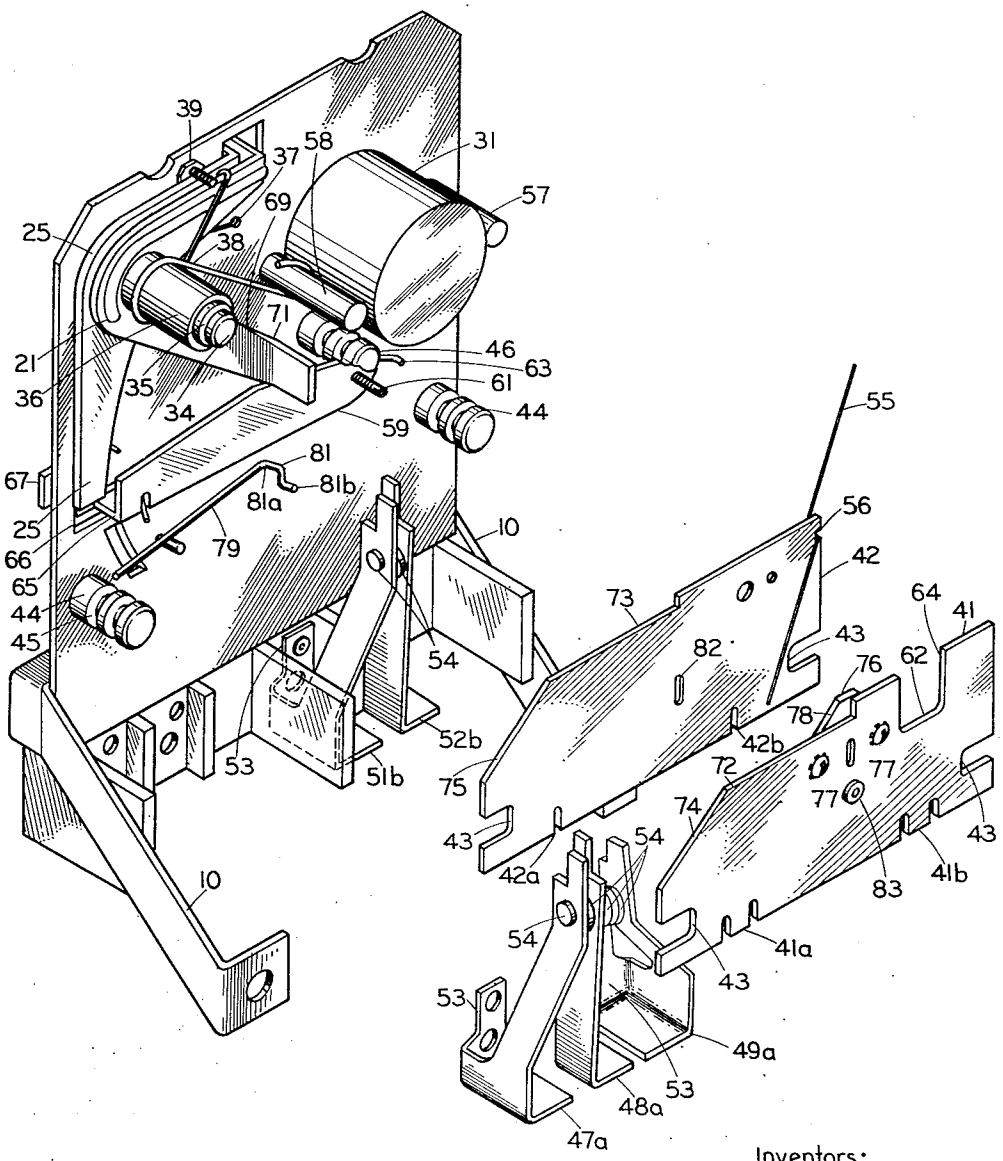


Fig. 4

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TIME SWITCH

Filed Dec. 20, 1955 6 Sheets-Sheet 3

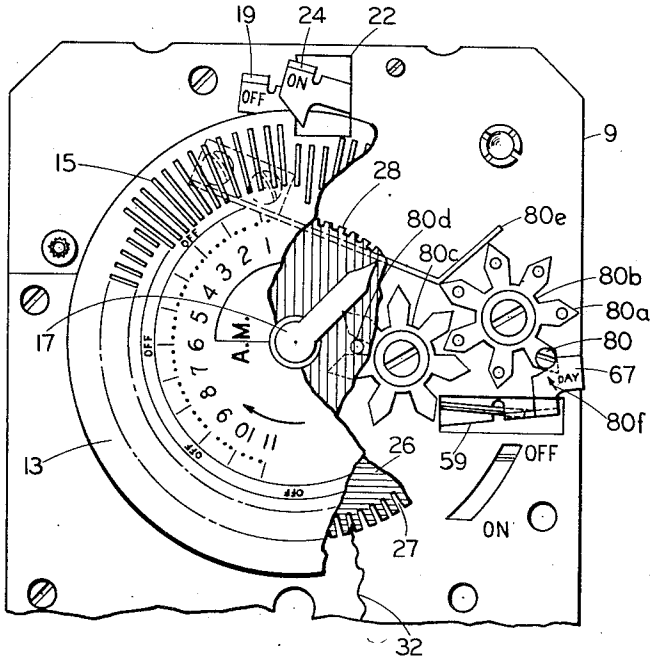


Fig. 5

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TIME SWITCH

Filed Dec. 20, 1955 6 Sheets-Sheet 4

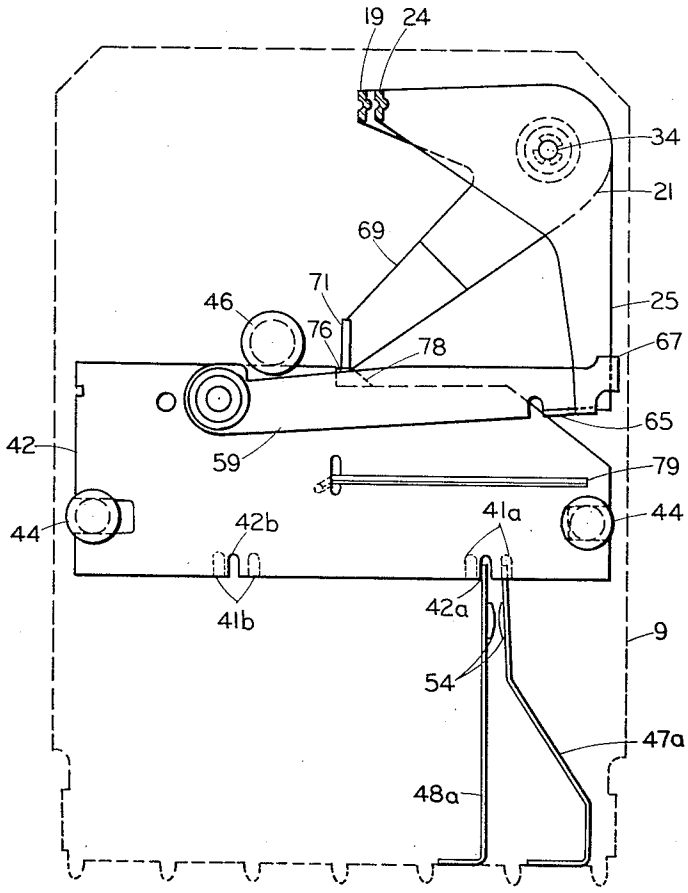


Fig.6

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TIME SWITCH

Filed Dec. 20, 1955 6 Sheets-Sheet 5

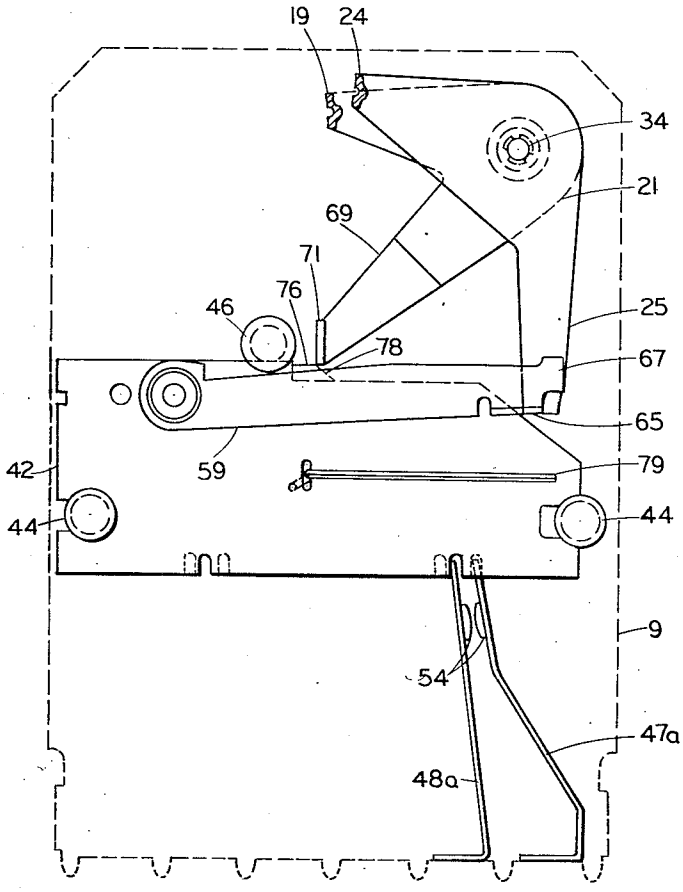


Fig.7

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TIME SWITCH

Filed Dec. 20, 1955 6 Sheets-Sheet 6

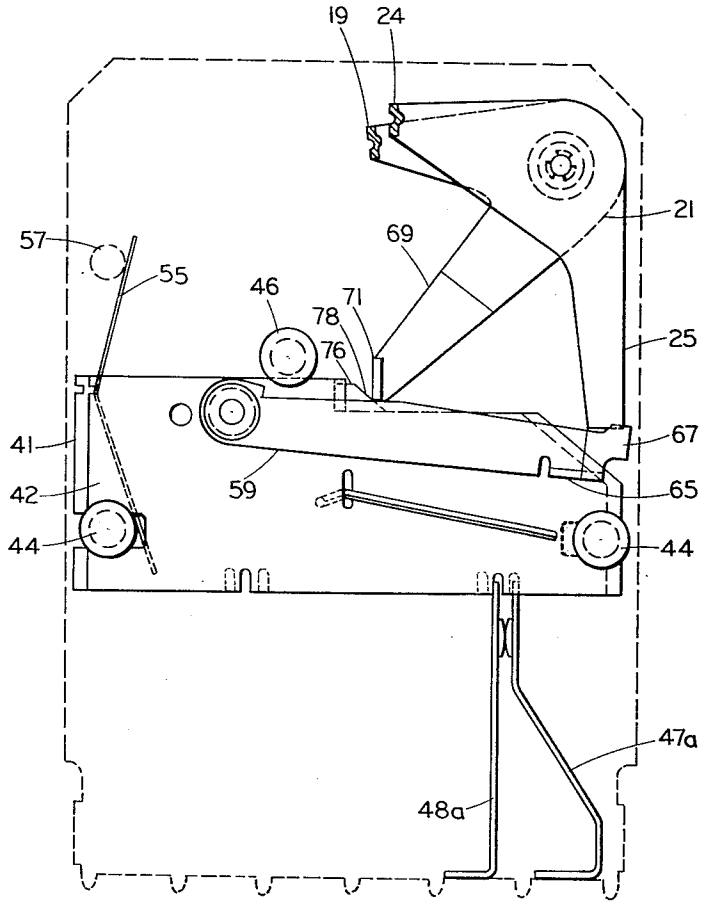


Fig. 8

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United States Patent Office 2,816,184 Patented Dec. 10, 1957

2,816,184

TIME SWITCH

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Application December 20, 1955, Serial No. 554,201

17 Claims. (Cl. 200—38)

The present invention relates generally to time switches and more particularly to improvements in time switches that can automatically and regularly control electric circuits on a schedule related to the time of day.

Such time switches normally include some form of timing dial, which may be arranged to complete one revolution every twenty-four hours, on which may be mounted a plurality of switch position selectors. In its simplest form, the time switch may have only one single-pole, single-throw switch, arranged to be opened and closed once a day by a pair of suitable switch position selectors appropriately arranged on the timing dial.

In this form of the time switch, it can only perform a very limited function and in some applications, such limited functioning is sufficient. However, there are many electric circuit arrangements requiring a far more flexible and versatile time switch than the simple form described above wherein it may be necessary to have a plurality of complete switching operations in each day for a plurality of switches functioning as either single-pole, single-throw switches; single-pole, double-throw switches; double-pole, single-throw switches; or double-pole, double-throw switches. Naturally, such more versatile time switches require the use of a great many switch position selectors, as well as a number of individual switches, both of which features add significantly to the complexity of the time switch.

Such complexity not only adds to the size and cost of the time switch, but it creates additional problems which must be overcome in the attainment of a reliable and satisfactory time switch. For example, it has been found that one major problem is encountered when the time switch is set to perform a repetitive series of "on-off" switching operations.

Thus, one pair of switch position selectors may be set to close an associated single-pole, single-throw switch at 8 a. m. and open the switch at 9 a. m., and another pair of selectors may be set to close the switch again at 11 a. m. and to then open it again at 12 a. m. If the time switch remains set in this position, no difficulties will be normally encountered in the performance of the switch. However, the user of the switch may wish to eliminate the intermediate opening and closing of the switch and thus convert the switch cycle to a closing at 8 a. m. and an opening at 12 a. m. The natural impulse of the user of the switch will be to merely disengage or otherwise render inoperative the intermediate "off" selector set to open the switch at 9 a. m., leaving the intermediate "on" selector at 11 a. m., and thus assuming that the intermediate selector will have no effect on the circuit being controlled, since it has already been closed at 8 a. m. Unfortunately, some prior structures have been found to be deficient in this regard, for experience has shown that the intermediate "on" selector may actually produce a momentary opening of the switch at 11 a. m., in which event the time switch would be entirely unreliable unless great care were taken to positively disengage all switch position selectors not being used for a particular switching cycle.

The above problem is further complicated if the switch mechanism is arranged to provide single-pole, double-throw action for in this instance, one set of switch contacts will be opening while another set is closing, and vice-versa, which, of course, means that successive "off" selectors should not cause momentary opening of the additional set of contacts normally closed by these selectors. For that matter, successive "off" selectors should not cause momentary closing of the switch contacts normally opened by these selectors.

Other important problems encountered with the more versatile time switches, in addition to those discussed above, relate to the supporting arrangements for the switch members, as well as the other parts of the time switch, the wiring and insulation for the switches, the arrangement of properly functioning omitting devices, and the accessibility of the various parts for adjustment, maintenance, and repair.

It is therefore a primary object of the invention to provide an improved time switch, capable of functioning reliably to automatically and regularly perform a plurality of switching operations on a presettable timed schedule.

It is another object of the invention to provide a time switch having a plurality of switch position selectors in which a series of successive selectors arranged to select the same switch position will have no effect on the switch controlled thereby once the switch position has been established by the first selector in the series.

It is yet another object of the invention to provide a time switch having a new and improved switch actuating mechanism functioning to produce extremely reliable switching action.

It is a further object of the invention to provide a time switch having a new and improved arrangement of switch members and their associated supporting means.

It is a still further object of the invention to provide a time switch wherein its cooperating parts are compactly and efficiently arranged to keep its size to a minimum, its internal wiring and insulation has been materially simplified, its manufacturing costs are reduced, its parts are rugged, heavy duty members capable of continuous uninterrupted use over extended periods of time, and its overall design is such that adjustment and servicing is significantly simplified.

Briefly, in one aspect thereof, the invention comprises a main support plate on which all of the parts of the time switch are carried, including a timing motor on the rear thereof coupled to a rotatably mounted timing dial carried on the front of the plate, the dial in turn being adapted to carry a plurality of switch position selectors. A terminal block is mounted at the bottom of the support plate from which may project a plurality of contact carrying cantilever spring blades. A pair of such blades may function to provide single-pole, single-throw switch action; three of such blades can function together to provide single-pole, double-throw switch action; and another two or three blade group can duplicate the action of the first group or combine with it to produce double-pole, single-throw action or double-pole, double-throw action. All of the blades have their free ends confined within notches along the lower edges of a pair of relatively movable, spaced slides adapted to move transversely with respect to the blades to provide switch action.

A first switch position is established by the biasing action of the spring blades themselves whereas a second switch is established by means of a pivoted driving arm mounted on one of the slides, coupled to the other, and adapted to be selectively actuated by one group of switch position selectors. The driving arm is positively disengaged from its actuating means after it has moved to es-

tablish the second switch position and is held so disengaged until the other group of selectors function to release the holding means. The holding means for the driving arm in addition to disengaging the arm also holds one of the slides while the other slide returns to its first position upon disengagement of the driving arm. During the holding cycle, the slides maintain the contacts in their second switch position.

When the holding means is released, the slide held thereby moves to its first position to re-establish the first switch position.

Additionally, the driving arm may be positively disengaged from its actuating means for any given day of the week, through the cooperation of an extension on the driving arm with an omitting device driven by the timing motor.

Moreover, a simple "on-off" indicator is actuated by the relative motion between the slides to give a position, visual indication of the switch position.

The invention will be more fully understood, as well as its objects and advantages, upon reference to the detailed description set forth below, particularly when taken in conjunction with the drawings annexed hereto, in which:

Figure 1 is a front view in elevation of a time switch illustrating one form of the invention;

Figure 2 is a partial side view of the time switch in Figure 1 showing a switch position selector in one position;

Figure 3 is a view similar to Figure 2 showing the switch position selector in another position;

Figure 4 is an exploded rear view, in perspective, of the time switch shown in Figure 1;

Figure 5 is a partial front view of the arrangement shown in Figure 1, with portions of the time switch cut away to illustrate the parts underneath;

Figure 6 is a simplified view of a portion of the time switch, taken from the front of the switch with the support plate removed, illustrating a first position of the switch;

Figure 7 is a view similar to the view shown in Figure 6, illustrating an intermediate position of the switch; and

Figure 8 is a view similar to the view shown in Figure 6, illustrating a second position of the switch.

Referring first to Figure 1 wherein there is shown a front view of the time switch forming the subject invention, it is seen that the time switch includes a main support plate 9 on which all of the component parts of the time switch are carried, there being a pair of external mounting brackets 10 (see Figure 2) and a molded terminal block 11 formed of a suitable electrical insulating material mounted at the bottom of plate 9 by a pair of suitable screws 12.

A timing dial 13 is rotatably mounted on the front of plate 9 and the dial has an annular series of slots 14 arranged therein in which may be carried switch position selectors 15. The dial also has a suitable clock face 16 covering a 24-hour period and cooperating with a fixed pointer 17 whereby the arrangement provides a visual indication of time.

The switch position selectors 15 are in the form of resilient keys adapted to be inserted within the slots 14 and pivotally mounted therein such that in one position of the selector a first switch position is set and in the other position of the selector a second switch position is set.

The two positions of the selectors are illustrated in Figures 2 and 3, the first position being shown in Figure 2 wherein the inner tripper section 18 has been moved up by downward pivotal motion of the selector to coact with the cammed end 19 of a first crank 21 pivotally mounted on the rear of plate 9, the plate having a cutout 22 through which the cammed end 19 extends. As the dial 13 rotates in a clockwise direction, the tripper 18 contacts the cammed end 19 and raises it to thereby impart pivotal action to the crank 21.

In Figure 3 the selector 15 is shown in a second position wherein the outer tripper section 23 has been moved upwardly by the upper pivotal motion of selector 15 to cooperate with the cammed end 24 of a second crank 25 also pivotally mounted on the rear of plate 9 and having its cammed end extending through slot 22. Here again, as the dial 13 rotates in a clockwise direction, the tripper 23 lifts the cammed end 24 and thus imparts pivotal motion to crank 25.

For convenience in the use of the switch, the crank 21 is designated as the "off" crank and crank 25 is designated as the "on" crank, the legends "off-on" being suitably indicated on the front surface of the respective cam ends 19, 24. In addition, the legends "off-on" are also indicated at spaced points around the slots 14 to further facilitate the use of the switch by indicating the direction in which the selectors must be moved to achieve the desired switch action.

As is seen in Figures 2, 3, and 5, an auxiliary supporting dial 26 is affixed to the dial 13 and spaced therefrom to the rear thereof. This auxiliary dial has a plurality of notches 27 surrounding its periphery and these notches are adapted to receive, guide and support the inner end of the switch selectors.

The arrangement of the dial 13, the auxiliary supporting dial 26, the selectors 15 and the cam ends 19, 24 are described and claimed in the co-pending application of Ralph M. Manning, Serial No. 477,903, filed December 27, 1954 and assigned to the same assignee to which the subject application is assigned, and reference will be made to the aforementioned Manning application for a more complete description of the structural details of the selectors 15.

As is seen in Figure 5, a driving gear 28 is arranged coaxially with dial 13, being attached to the dial and spaced therefrom behind the auxiliary dial 26. In the form of time switch illustrated, the two dials and the drive gear are staked to a sleeved bushing rotatably mounted on a suitable stud shaft rigidly attached to the main support plate. This shaft extends through the bushing to the front thereof and is threaded to receive a screw 29 passing through the hub of pointer 17, this hub serving to retain the dial and its associated parts properly in place on the time switch. These arrangements are conventional and understood by those skilled in the art and a detailed illustration thereof has been omitted in the interests of brevity.

The gear 28 is adapted to be driven by a timing motor, the gear box of which is shown in Figure 4 as comprising the sealed cylindrical body 31 mounted on the rear wall of plate 9. Such a motor may be one of the well known Telechron timing motors, comprising a field structure, armature, and sealed unit 31, the details of which are well understood by those skilled in the art and as such, need not be shown in detail herein.

It is to be understood that the motor has a suitable pinion extending from its gear box 31, through an aperture provided in the plate, after which it is operatively coupled to the gear 28 through a suitable gear train journalled for rotation between the plate 9 and an auxiliary plate 32 mounted on the front of plate 9 and spaced therefrom by means of suitable screws 33 passing through the auxiliary plate and cooperating with suitable threaded spacers rigidly attached to the main plate. The auxiliary plate lies between the auxiliary dial 26 and the gear 28 and may be substantially L-shaped, being thus formed to provide clearance for gear 28.

Thus, it is apparent that the timing motor will turn the dial 13 in a regular manner so that the selectors on the dial can function to perform switching actions at any preselected times during an entire 24-hour period. In the arrangement shown, the dial has 96 slots spaced at 15-minute intervals and the completed time switch may be sold with as many as 96 selectors mounted within the slots, although in the usual application, no more than

half of the total number of selectors will be used in which event half of the selectors may be removed.

The cranks **21** and **25** are arranged coaxially with respect to a stud shaft **34** extending rearwardly from plate **9** and staked thereto at the front thereof. A pair of inner and outer bushings **35** and **36** surround the stud shaft; the inner bushing **35** extends through the crank **21**, and is rigidly attached to crank **25** by suitable means such as staking or the like; the outer bushing **36** is staked to the crank **21**. The dimensions of the bushings are such that the two cranks are slightly spaced with respect to each other along the shaft **34**. The bushings may be retained on the shaft by means of a conventional snap ring (not shown) adapted to fit over the end of the shaft.

Cranks **25** and **29** are biased by springs **37** and **38** respectively in such a way that their outer cammed ends are urged downwardly toward the spring selectors, a stop screw **39** being provided on the plate to limit upward motion of the cranks. The edge of the dial **13** serves as a stop limiting downward motion of crank **25** and the crank **21** also has its downward motion limited in a manner to be more fully described hereinafter.

Cooperating with the cranks **21** and **25** are first and second novel switch actuators in the form of the substantially rectangular first and second slides **41**, **42** respectively, formed of electrical insulating material, each of which is provided with mounting slots **43** at the opposite ends thereof intended to cooperate with a pair of spaced grooved bushings **44** extending rearwardly from the plate **9** and staked thereto at the front face thereof. The slots **43** are intended to embrace the grooves **45** and it is thus seen that the two slides are supported on the plate and slidable with respect thereto and with respect to each other. A third grooved bushing **46**, which is shown as partially cut away in Figure 4, is mounted proximate to the top edge of the two slides to further support these slides on the plate. As with the bushings **44**, the bushing **46** extends from the rear of plate **9** and is staked to the inner face thereof. The first slide **41**, which is mounted in the outer groove of the bushing **44**, has two sets of spaced notches **41***a* and **41***b* along its lower edge and the second slide has a pair of similar notches **42***a* and **42***b* spaced along its lower edge.

Mounted below the slides may be a plurality of sets of cantilever spring blades, a first set comprising the blades **47***a*, **48***a* and **49***a*, and a second set comprising the blades **51***b* and **52***b*. All of these spring blades have suitable identical mounting extensions **53** formed as an integral part of their bases, certain of these mounting extensions being shown in Figure 4, all of which are adapted to be rigidly secured to the terminal block **11** by means of rivets or the like. Thus, all of the blades are rigidly attached at their bases to the terminal block and their free ends extend upwardly toward the lower edges of the slides **41**, **42**. Each of the blades carries at its free end a suitable electrical contact **54** and in the case of blade **48***a*, there are two contacts carried thereby mounted on opposite sides thereof. The free ends of all of the contact blades are suitably notched, some having their notches facing inwardly toward the plate and some having their notches facing outwardly away from the plate.

Thus, the blades **47***a*, **49***a* and **51***b* have their notches facing inwardly and the outer tips of these blades are adapted to be received by the notches **41***a* and **41***b*, respectively, and retained thereby. The blades **48***a* and **52***b* have their notches facing outwardly and their outer tips are received in the notches **42***a* and **42***b*, respectively, and retained thereby.

All of the spring blades are formed from a suitable electrical conducting material and as their names imply, they are resilient and each blade is provided with spring tension which creates in the blade a biasing force which urges the blades to the left as viewed in Figure 4, which effect urges the slides **41** and **42** to the left, against the sides of the grooves in the bushing, and serves to establish a first switch position in a manner to be more fully described below.

An auxiliary biasing spring **55** is hooked around a notch **56**, provided in one edge of slide **42**, and is arranged in such a way that the slide is urged to the left as viewed in Figure 4. The upper extremity of spring **55** rests against a portion of a stud **57**, extending rearwardly from plate **9** and staked thereto, and the lower extremity of spring **55** rests against a corresponding portion of bushing **44**.

The stud **57** along with a stud **58**, mounted on the other side of the timing motor gear box **31**, is provided as a support for the field structure of the motor, the field structure in turn carrying the remainder of the motor.

From the above, it is seen that the slides **41**, **42** have a first relative position established by the biasing action developed by the spring blades and, as will be more fully discussed hereinafter, this first position establishes a first position for the various switches formed by the spring blades and their associated contacts. In the embodiment illustrated, the set of blades **47***a*, **48***a* and **49***a*, together with their associated contacts **54**, form a single-pole, double-throw switch, whereas the blades **51***b* and **52***b*, with their associated contacts **54**, form a single-pole, single-throw switch.

In the arrangements of the parts illustrated in Figure 4, their position is such that the contacts carried by blades **47***a*, **48***a* and **51***b* and **52***b* are closed or, as may be conveniently designated, these switches are in the "on" position. At the same time the contacts carried by blades **48***a* and **49***a* are open and the switch formed thereby is open, this position being conveniently designated as the "off" position of the switch. Thus, when the contacts are closed, they are in a first switch position and when the contacts are open, they are in a second switch position, these positions being designated as the "on-off" positions respectively.

To move the slides against the biasing action therein, a driving arm **59** is pivotally mounted on the slide **42** by means of a shouldered screw **61**, the end of which extends beyond the slide **42** within a notch **62** provided at the upper edge of slide **41**. A suitable spring **63** is connected to the driving arm **59** in such a way that this arm is biased upwardly as viewed in Figure 4. The inner end of screw **61** is adapted to rest against the edge **64** formed by the notch **62**, the arrangement being such that when the driving arm is actuated to move the slide **42** to the right as viewed in Figure 4, slide **41** will be carried therewith. In other words, the slides will move together when the driving arm is actuated.

The driving arm lies between plate **9** and slide **42** and extends along the upper edge of the slide, its outer end terminating in a substantially L-shaped extremity **65**, the base of this extremity extending through an aperture **66** formed in plate **9** such that the upstanding portion **67** of the L-shaped end lies in front of the plate **9** slightly spaced therefrom.

The driving arm is adapted to assume either a first operative or a second inoperative angular position with respect to its pivotal mounting and in its first position, the base of its extension **67** is contiguous to the lower extremity of crank **25** and is adapted to be driven by the crank upon actuation thereof. In the second position of the driving arm, its base will no longer be in alignment with the lower extremity of crank **25**, but it will have been moved downwardly with respect thereto in response to actuation of crank **21**, the lower edge of aperture **66** serving as a stop to limit its downward motion. Although it is not too clear in Figure 4, because of the exploded nature of the illustration, the driving arm is intended to be in its first operative position, corresponding to the arrangement shown in Figure 6.

The outer upstanding portion **67** of arm **59**, which lies in front of plate **9**, has a cam surface **70** thereon intended to cooperate with an omitting device which includes

the head of a screw 80 that may be selectively carried in one of the threaded points 80*a* of the seven-point star wheel 80*b* suitably journalled for rotation on plate 9.

As is best shown in Figure 5, star wheel 80*b* is adapted to be driven by the seven-point idler star wheel 80*c*, also suitably journalled for rotation on plate, the wheel 80*c* being in turn driven by a pin 80*d* attached to main driving gear 28. The arrangement is such that the pin will advance one point of star wheel 80*b* relative to the cam surface 70 for each complete revolution of the timing dial. A biasing spring 80*e*, attached to plate 9, holds the star wheel 80*b* against rotation for any part of the timing cycle that the star wheel is not being driven by its idler.

As the star wheel point moves past the cam surface, the head of screw 80 will engage the cam surface and move the driving arm downwardly to its inoperative position, the arm remaining in this position for 24 hours, the completion of which sees another advancement of star wheel 80*b*, the screw 80 moving off of the cam surface 70 to thereby permit the driving arm to function in the normal manner.

The screw 80 may be inserted in any one of the seven points 80*a*, each one of which may be marked to correspond to a particular day of the week, the seven together covering an entire week. An arrow 80*f* together with the legend "Day," carried on the front face of the portion 67, cooperates with the star-wheel points 80*a* to give a visual indication of the day of the week corresponding to the position of the star wheel. If required, additional screws 80 could be provided to permit deactivation of the switch for more than one day.

The lower end of crank 21 is in the form of a pawl 69 having its extreme tip 71 turned at right angles with respect to the balance of the crank and extending transversely over the upper edges of the slides 41 and 42 and the driving arm 59.

The slides 41, 42 are both cut away along a portion of their upper edges, as at 72, 73 respectively, and have corresponding corners cut away, as at 74, 75 respectively. In addition, slide 41 has a cam member 76 attached thereto by screws 77, the cam member having an inclined cam surface 78 extending between the upper edge of the cam and the upper edge of the slide in the region of the cut-away section 72. The upper edge of the cam may be conveniently designated as a cam high and the upper edge of the slide, in the region of the cut-away section 73, may be conveniently designated as a cam low.

Thus, the slide 41 has its upper edge in the form of a stepped cam, formed so by the addition of cam 76 thereto, it being understood, though, that the stepped cam effect could also be achieved by initially forming the slide in this shape, the arrangement shown being selected for reasons of manufacturing expediency.

A switch position indicator is provided for the time switch in the form of an elongated indicator arm 79 having one extremity in the form of an off-set shaft portion 81 turned at right angles to the arm and extending through a slot 82 provided in slide 42, the slot being elongated in a direction perpendicular to the direction of travel of the slide. The off-set shaft has its inner end 81*a* retained within the slot 82 and its outer end 81*b* pivotally mounted in a bearing 83 carried by slide 41. The arrangement is such that relative movement between the slides 41, 42 causes the arm 79 to rock about its shaft, assuming either one of two angular positions, one corresponding to the "on" switch position and the other corresponding to the "off" switch position. The outer end of arm 79 is visible through a slot 84 provided in plate 9 and the front of the plate has the designations "on," "off" opposite the lower and upper edges of slot 84 to cooperate with the arm 79 and provide a visual indication of switch position.

With the above arrangement of parts in mind, reference will now be made to Figures 6, 7 and 8 for a further understanding of the operation of the time switch. Bearing in mind that a first group of selectors 15 may be set to actuate the "off" crank 21 and a second group of selectors may be set to actuate the "on" crank 25, and remembering that the "off" crank operates to open the contacts and the "on" crank operates to close the contacts, it is seen that Figure 6 depicts a time switch having a single-pole, single-throw switch in its "off" position.

In Figure 6, as well as in Figures 7 and 8, the views are taken from the front of the time switch with the plate and the terminal block removed so that the switch actuating mechanism can be more clearly seen. The guide bushings 44 and 46 have been retained and portions of the cranks 21, 25 and their front ends are shown. The switches have been simplified in these views by the elimination of the blades 51*b*, 52*b*, and 49*a*, leaving the blades 47*a* and 48*a* which by themselves form the single-pole, single-throw switch illustrated.

Referring first to Figure 6, the contacts 54 are open and the switch is in the "off" position, corresponding to a first relative position of slides 41 and 42. In this position, the slides are aligned and urged to the right against their stops by the biasing forces in the spring blades 47*a* and 48*a*. Additionally, the indicator arm 79 is in its upper or "off" position.

The pawl tip 71 is resting on the upper edge of cam 76 being thus on the cam high and the driving arm 59 has been moved up by its biasing spring to its first operative angular position, its end 65 being contiguous to the driving end of crank 25, ready to be engaged thereby upon actuation of the crank.

With the parts in the position shown in Figure 6, it is important to note that any further actuation of the crank 21 will have no effect on the switch, for the end of the pawl is resting on its cam high, and actuation of the crank 21 will only serve to lift it higher. In other words, the pawl is inoperative in this position; and any number of successive "off" selectors could move past the crank inner end 19 without in any way disturbing the switch.

This feature of the time switch is important for the simple single-pole, single-throw switch shown in Figure 6, and is doubly important should there be another switch blade arranged beside blade 48*a* to achieve double-throw action. For example, with blade 49*a* in place, as shown in Figure 4, the switch formed by blades 48*a* and 49*a* would be closed, or in the "on" position, being positioned that way by an "off" selector and it is important that the switch remain closed upon continued operation of the "off" crank.

In connection with the aforementioned double-throw action, the arrangement shown in Figure 6 best illustrates how the blades 49*a* and 48*a* will have their contacts closed when the blades 47*a* and 48*a* have their contacts open. Thus, with the slides 41, 42 aligned, it is to be noted that the pair of notches 41*a* and the pair of notches 41*b* straddle the notches 42*a* and 42*b*, respectively, but in an off-set manner. That is, the individual notches forming the pairs are unequally spaced from the common notch in the other slide, and from this arrangement, it is obvious how the double-throw action occurs.

Now, with the switch in the position shown in Figure 6, and assuming that one of the "on" selectors has been moved by the timing dial to contact and raise the cammed end 24 of the "on" crank 25, the lower end of crank 25 will be driven against the actuating arm 59 and move this arm against the biasing forces of the spring blades of the switch.

Figure 7 shows the position of the switch components after the crank 25 has been partially moved, and it is important to note that both slides have been moved to the left, as viewed in Figure 7, by the action of the crank. When the slides were together, in the position shown in Figure 6, the end of screw 61 was abutting edge 64 of slide 41, and upon motion of the driving arm 59, this screw moves both of the slides to the left. The contacts

on the switch remain open during this motion but the cam high on slide **41** has moved relative to the pawl tip, bringing the tip to the edge of the cam drop-off, as shown.

Bearing in mind that the pawl tip is biased toward the slides and the driving arm, and that considerable energy is stored in its biasing spring **38** when the pawl tip is on the cam high, when the crank **25** moves the slides slightly further to the left, from their position shown in Figure 7, the pawl tip will drop off of the cam high and move downwardly along the inclined cam surface **78** with a snap action.

When this occurs, the pawl tip first holds the slide **42** and then strikes the upper edge of driving arm **59**, moving it down rapidly to its second angular position against its stop. When the driving arm is so moved, it is rendered inoperative, being disengaged from the driving end of crank **25**.

As soon as the driving arm is rendered inoperative, the biasing force in the spring blades of the switch, being no longer overcome by the driving action of the arm **59**, will tend to return both slides to their first switch position, i. e., to the right, as viewed in Figure 7, against their stops.

However, slide **42** is now held by pawl tip **71** and cannot return to its original position, but since slide **41** is free to move, it will return to its original position, against its stop.

When this action is completed, the switch components will be in the position shown in Figure 8. The slides are no longer aligned, but off-set as shown, and the relative motion that has occurred between the slides has established a second switch position wherein the contacts are closed. The indicator arm **79** has rocked down to its "on" position and, by this time, the crank end **24** has passed completely over the tripper section of its cooperating selector and returned to its original position.

In this position of the switch, the auxiliary spring **55** adds to the biasing action of spring blade **48***a* to positively drive the slide **41** against its stop, which not only insures that the indicator arm moves to its full "on" position but it also enables the spring blade **48***a* to maintain the maximum pressure at the contacts **54**. Without the auxiliary spring present, the existence of friction forces in the slide structure would detract from optimum switch performance but with the spring in place as shown, such friction forces can be readily overcome.

The driving arm is held down by the pawl tip **71**, out of engagement with the driving end of crank **25**, and it is thus apparent that any further actuation of crank **25** by successive "on" selectors will not in any way disturb the position of the switch contacts.

If the time switch were arranged for double-throw action, the alternate contacts would be open when the contacts on blades **47***a* and **48***a* are closed, and would remain open upon any further actuation of the crank **25**.

To return the switch to its first switch position, it is now necessary for an "off" selector to move the crank **21**, in which event the pawl tip **71** will be lifted out of its holding position, permitting the slide **42** and the driving arm to move to their original positions shown in Figure 6.

The cam surface **78** is disposed tangentially with respect to the radius of the pawl **69** when the pawl tip **71** is in its cam low position, and as the pawl tip **71** is lifted, the slide **42** will thus move continuously to the right until it comes to rest against its stop.

From the above, it is seen that the switch action is positive and reliable, and that a series of successive "on" or "off" selectors will not in any way affect the switch position once it has been established by the first selector in the series. That is, once the switch position has been established by an "on" selector, succeeding "on" selectors will have no effect on switch position until such time as the switch position is changed by an "off" selector. In the same manner, once the switch position has been established by an "off" selector, succeeding "off" selectors will have no effect on switch position until such time as the switch position has been changed by an "on" selector. Of added significance is the fact that the arrangement of the switch actuating mechanism more nearly balances forces required to actuate the cranks **21**, **25**, which promotes more efficient operation while at the same time more evenly distributing the wear and tear on the moving parts of the entire structure.

In addition, the use of closely spaced slides makes the time switch a very compact unit and, with the slides formed of electrical insulating material having their lower edges notched to cooperate with the cantilever spring blades, vibration of the switch contacts is minimized, versatility and flexibility of switch action is attained and all internal wiring has been eliminated for the switch members per se. The only internal wiring necessary is for the timing motor, and all external leads may be conveniently affixed to the terminal block **11**.

Moreover, the slides permit the use of very simple but effective switch position indicating means, and the arrangement of the driving arm with its L-shaped outer end extending through the plate **9** provides for a very convenient arrangement of the setting means used to deactivate the switch for any predetermined day or days of the week.

And furthermore, all of the important parts of the time switch are ruggedly made, those requiring adjustment or service being readily accessible and nicely arranged, and the overall arrangement of the switch, as well as the design of its component parts, are well suited to low-cost manufacturing techniques.

Therefore while a particular embodiment of the subject invention has been shown and described herein, it is in the nature of description rather than limitation, and it will occur to those skilled in the art that various changes, modifications, and combinations may be made within the province of the appended claims, and without departing either in spirit or scope from this invention in its broader aspects.

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

1. A time switch comprising, in combination: an electric switch having a pair of electrical contacts, said contacts being movable relative to each other to establish first and second switch positions, first contact moving means biasing said contacts to establish said first switch position, second contact moving means including a driving arm for driving said contacts to establish said second switch position, holding means operative upon operation of said driving arm to retain said contacts in said second switch position, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, said holding means being released by selectors in said first group to allow said first contact moving means to move said contacts to said first switch position, said second contact moving means being controlled by selectors in said second group, said driving arm being inoperative to move said contacts when said contacts are being retained in said second switch position by said holding means.

2. A time switch comprising, in combination: an electric switch having a pair of electrical contacts, said contacts being movable relative to each other to establish first and second switch positions, first contact moving means biasing said contacts to establish said first switch position, second contact moving means including a driving arm for driving said contacts to establish said second switch position, holding means operative upon operation of said driving arm to retain said contacts in said second switch position, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning

to select said first switch position, a second group of said selectors functioning to select said second switch position, said holding means being released by selectors in said first group to allow said first contact moving means to move said contacts to said first switch position, said first contact moving means being inoperative to move said contacts when said contacts are in said first switch position, said second contact moving means being controlled by selectors in said second group, said driving arm being inoperative to move said contacts when said contacts are being retained in said second switch position by said holding means.

3. A time switch comprising, in combination: an electric switch having a pair of electrical contacts, said contacts being movable relative to each other to establish first and second switch positions, first contact moving means biasing said contacts to establish said first switch position, second contact moving means including a driving arm for driving said contacts in opposition to the biasing action of said first contact moving means to establish said second switch position, holding means including a pawl operative upon operation of said driving arm to retain said contacts in said second switch position and to render said driving arm inoperative, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, said pawl being released by selectors in said first group to allow said first contact moving means to move said contacts to said first switch position, said second contact moving means being controlled by selectors in said second group, said driving arm being rendered operative only upon release of said pawl.

4. A time switch, comprising, in combination: an electric switch having a pair of electrical contacts, a first movably mounted slide operatively coupled to one of said contacts, a second movably mounted slide contiguous to said first slide and operatively coupled to the other of said contacts, said slides being movable relative to each other to have first and second relative positions whereby said contacts are movable relative to each other to establish first and second switch positions, first contact moving means operatively coupled to said slides and biasing said slides to their first relative position to establish said first switch position, second contact moving means including a driving arm operatively coupled to said slides for driving said slides in opposition to said biasing means, holding means including a pawl operative upon operation of said driving arm to first retain one of said slides and to then render said driving arm inoperative, the other of said slides moving relative to the slide retained to establish said second relative position of said slides whereby said second switch position is established, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, said pawl being released by selectors in said first group to allow said first contact moving means to move said slides to their first relative position to establish said first switch position, said second contact moving means being actuated by selectors in said second group, said driving arm being rendered operative only upon release of said pawl.

5. A time switch, comprising, in combination: an electric switch having a pair of electrical contacts, a first movably mounted slide operatively coupled to one of said contacts, a second movably mounted slide contiguous to said first slide and operatively coupled to the other of said contacts, said slides being movable relative to each other to have first and second relative positions whereby said contacts are movable relative to each other to establish first and second switch positions, first contact moving means operatively coupled to said slides and biasing said slides to their first relative position to establish said first switch position, second contact moving means including a driving arm operatively coupled to said slides for driving said slides in opposition to said biasing means, holding means including a pawl operative upon operation of said driving arm to first retain one of said slides and to then render said driving arm inoperative, the other of said slides moving relative to the slide retained to establish said second relative position of said slides whereby said second switch position is established, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, said pawl being released by selectors in said first group to allow said first contact moving means to move said slides to their first relative position to establish said first switch position, said first contact moving means being inoperative to move said contacts when said contacts are in said first switch position, said second contact moving means being actuated by selectors in said second group, said driving arm being rendered operative only upon release of said pawl.

6. A time switch comprising, in combination: an electric switch having a pair of electrical contacts, a first movably mounted slide operatively coupled to one of said contacts, a second movably mounted slide contiguous to said first slide and operatively coupled to the other of said contacts, said slides being movable relative to each other to have first and second relative positions whereby said contacts are movable relative to each other to establish first and second switch positions, first contact moving means operatively coupled to said slides and biasing said slides to their first relative position to establish said first switch position, second contact moving means including a pivotally mounted driving arm operatively coupled to said slides for driving said slides in opposition to said slide biasing means, means biasing said driving arm in a first angular postion, holding means including a pivotally mounted pawl operative upon operation of said driving arm to first retain one of said slides and to then render said driving arm inoperative, the other of said slides moving relative to the slide retained to establish said second relative position of said slides whereby said second switch position is established, means biasing said pawl toward said driving arm and said slides, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, said pawl being movable by selectors in said first group to release said slide retained and allow it to be moved by said first contact moving means to establish said first switch position, said pawl being moved to a first angular position against its biasing means when released, said driving arm moving to its first angular position upon release of said pawl, said second contact moving means being actuated by selectors in said second group, said driving arm being operative only when it is in said first angular position, said pawl moving with a snap action to strike said driving arm and move it away from its first angular position each time said driving arm has been moved a predetermined distance by said second contact moving means.

7. The combination defined by claim 6 wherein said first contact moving means comprise a pair of cantilever spring blades on which said contacts are mounted, each of said slides has a notch for receiving and retaining respective free ends of said blades, and stop means are provided for said slides, said blades being arranged to bias said slides against said stop means to establish said first switching position.

8. The combination defined by claim 7 wherein the slide retained by said pawl is said first slide, and auxiliary

biasing means are coupled to said second slide adding to the biasing action of said spring blade.

9. A time switch comprising, in combination: an electric switch including a pair of electrical contacts and a pair of cantilever spring blades on which said contacts are mounted, a first movably mounted slide operatively coupled to the free end of one of said blades, a second movably mounted slide contiguous to said first slide operatively coupled to the free end of the other of said blades, said slides being movable relative to each other to establish first and second switching positions, said slides being biased in a first relative position by said spring blades to establish a first switching position, an elongated driving arm pivotally mounted on said second slide and extending contiguous thereto along the upper edge thereof, said arm being adapted to have either first and second angular positions, means coupling said second slide to said first slide whereby said slides move together whenever said arm is driving said second slide, a first pivotally mounted member in the form of a pawl having a portion thereof extending transversely over the upper edges of said slides and said driving arm, said first member being biased whereby said transverse portion is urged in a direction toward said slides and said driving arm, said first slide having its upper edge in the form of a stepped cam having high and low cam portions whereby in one position of the slide said transverse portion is urged against the cam high and in another position of the slide the transverse portion is urged against the cam low, said transverse portion cooperating with said first slide to hold it against the biasing action of its associated spring blade whenever said transverse portion is against said cam low, a second pivotally mounted member having one of its ends adapted to engage one end of said driving arm only when said driving arm is in its first angular position, said driving arm being biased toward said transverse portion and assuming said first angular position when said transverse portion is against said cam high, said transverse portion cooperating with said driving arm to hold it in its second angular position when said transverse portion is against said cam low, a timing motor, and a plurality of switch position selectors moving in timed sequence in response to operation of said motor, a first group of said selectors functioning to select said first switch position, a second group of said selectors functioning to select said second switch position, selectors in said first group operating to move said first member and thereby move said transverse portion to said cam high whereby said driving arm moves to its first angular position and said first slide moves to establish said first switch position, selectors in said second group operating to move said second member and thereby move said driving arm whereby said slides are moved together against the biasing action of said spring blades, said cam high moving relative to said transverse portion upon movement of said first slide by said driving arm, said transverse portion dropping off of said cam high to said cam low to first hold said first slide and to then move said driving arm to its second angular position, said second slide moving relative to said first slide to establish said second switch position.

10. A time switch as defined in claim 9 wherein a single plate comprises the main supporting means for all of said parts, said switch position selectors being mounted on the front of said plate, the remainder of said parts being mounted on the rear of said plate, said plate having apertures through which said timing motor and said first and second members can be coupled to said selectors.

11. A time switch as defined in claim 10 wherein the lower edge of each of said slides is provided with a notch to receive and retain the free end of its associated cantilever spring blades, said blades are formed of resilient electrically conducting material and a terminal block is detachably secured to the lower portion of said plate, the fixed ends of said blades being secured to said terminal block.

12. A time switch as defined in claim 11 wherein each of said slides is substantially rectangular, said second slide is adjacent the rear surface of said plate and is cut away along a portion of its upper edge to provide clearance for said transverse portion, and the means coupling said slides comprises a stud arranged in said second slide coaxially with said driving arm and having its free end extending within a slot provided in said first slide.

13. A time switch as defined in claim 11 wherein a third contact carrying cantilever spring blade is mounted on said terminal block adjacent to said pair of spring blades, one of said pair of blades being between the other of said pair of blades and said third blade and having an additional contact thereon adapted to cooperate with the contact on said third blade, one of said slides has an additional notch in its lower edge spaced from the other notch therein for receiving and retaining the free end of said third blade, said notches being on opposite sides and at unequal distances from the notch in said other slide when said slides are in said first switch position, said additional contact and the contact on said third blade being in the second switch position whereby said three blades and their associated contacts function to provide single pole-double throw action for said switch.

14. A time switch as defined in claim 13 wherein said slides have additional sets of notches in their lower edges and said block has additional sets of contact carrying cantilever spring blades mounted thereon, said additional sets of blades having their free ends retained within said additional notches, all of said sets of blades functioning in a similar manner.

15. A time switch as defined in claim 12 wherein an off-set shaft extends between said slides, one end of said shaft being pivotally mounted in said first slide and the other end of said shaft extending through an elongated slot in said second slide, said slot being disposed at right angles with respect to the direction of motion of said slides whereby said shaft rocks upon relative motion of said slides, said other end of said shaft having an elongated indicating arm integral therewith and lying between said second slide and said plate, said plate having a cut-out section proximate to the outer end of said indicating arm whereby the position of said arm is visible from the front of said plate, said indicating arm having first and second positions to indicate first and second switch positions.

16. A time switch as defined in claim 12 wherein said driving arm has an off-set extension at its outer end and said plate has a cut-out section through which the off-set extension projects, and an omitting device is rotatably mounted on the front of the plate proximate to said extension, said omitting device being coupled to said timing motor and adapted to advance through a predetermined angular distance each day said timing motor functions, said omitting device including a removably mounted cam follower and portions cooperating therewith whereby said cam follower can be selectively mounted in a position corresponding to any predetermined day of a week, said extension having a cam section cooperating with said cam follower whereby said cam follower is adapted to move said driving arm to render it inoperative for any selected day of the week.

17. A time switch as defined in claim 12 wherein said omitting device is in the form of a seven point star wheel, each of said points corresponds to a different day of the week, and said cam follower is in the form of a screw adapted to threadably engage said star wheel points, said screw having an enlarged head cooperating with the cam section on the extension of said driving arm.

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