Dec. 27, 1932. W. E. PORTER 1,891,946

TIME SWITCH

Filed Aug. 24, 1931

Fig. 1.

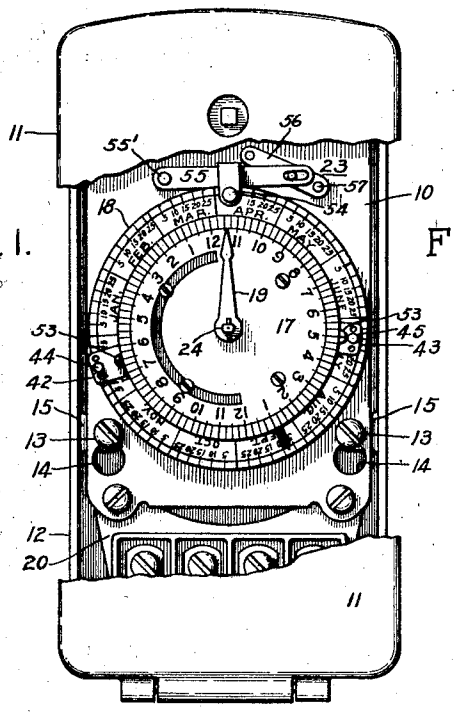


Fig. 2.

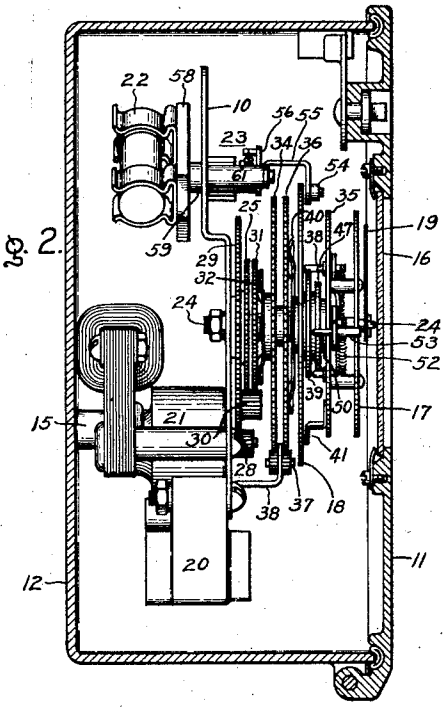


Fig. 3.

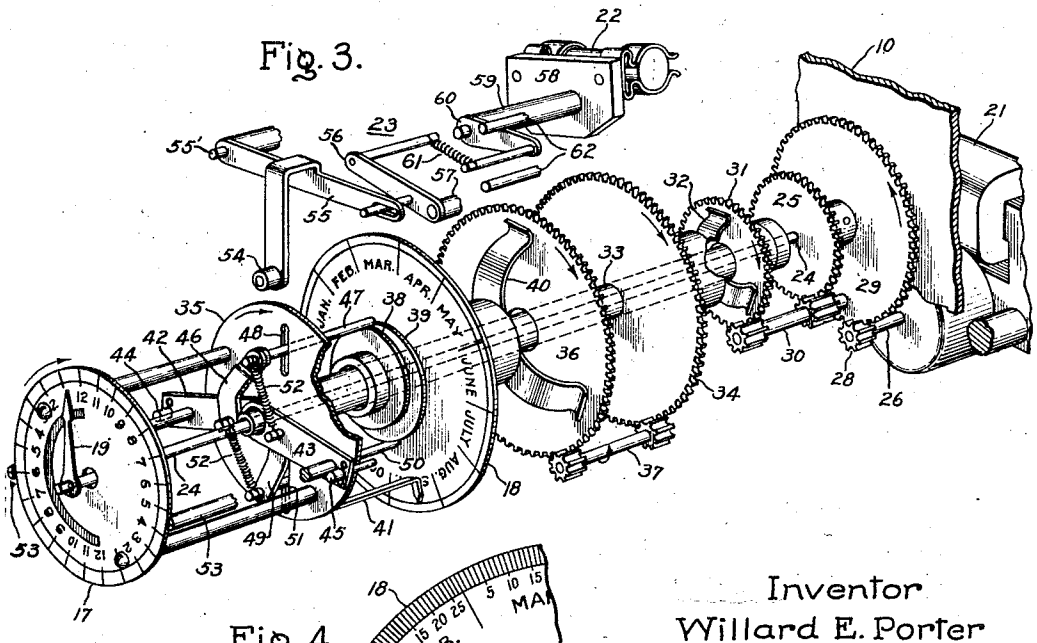


Fig. 4.

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UNITED STATES PATENT OFFICE

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TIME SWITCH

Application filed August 24, 1931. Serial No. 558,950.

My invention relates to time switches. One aspect of the invention relates to improvements in astronomical time switches or switches which are commonly used to turn on and off street lights and which automatically adjust themselves for different "on" and "off" periods in accordance with variations in the length of daylight at different seasons of the year. Another aspect of the present invention is applicable to time switches generally and relates to a novel lever arrangement whereby a switch may be operated with a snap action to two different positions at predetermined adjustable times, which times may be set somewhat closer together than has heretofore been practicable with a single operating lever.

The features of my invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of my invention reference is made in the following description to the accompanying drawing.

In the drawing, Figs. 1 and 2 represent front and side views, respectively, of a commercial form of my time switch, together with portions of the casing structure in which the switch is assembled. Fig. 3 is a perspective exploded view of the time switch mechanism shown in Figs. 1 and 2, and Fig. 4 is an enlarged view of a portion of the astronomical dial of such a switch.

In the astronomical time switch it is necessary to provide a member which rotates at the rate of once per year, as well as a member which rotates once per day. The former varies the time of setting for different seasons of the year in accordance with daylight variations, and the latter establishes the "off" and "on" operations from day to day. This wide variation in speed has usually resulted in constructions which were somewhat complicated and cumbersome with respect to the reduction gearing, even in switches employing an ordinary slow moving spring-operated clock for the timing and driving element. In the form of my invention illustrated, I may, and preferably do, employ a high speed synchronous motor as the timing and driving element. For the usual 60 cycle alternating current circuit this motor operates at 3600 revolutions per minute. Thus, I obtain a total speed reduction from 3600 revolutions per minute to one revolution per year, or a reduction ratio of

$$\frac{3600\times60\times24\times365}{1}.$$

The commercial switch represented in Figs. 1 and 2 is contained in a casing of the form shown, measuring 7½" in length by 3½" in breadth and depth. This extremely large gear reduction in an operable time switch of the size and compact construction mentioned and illustrated indicates what is believed to be a considerable improvement with respect to simplicity, compactness, and cost of this type of device, and while I do not claim mere speed reducing means as a novel feature of my invention, it is believed that certain features of the particular arrangement and assembly of speed reducing means as here employed and combined with the necessary switch adjusting and setting parts is novel and patentable.

The entire switch structure is assembled on a rigid supporting plate 10. When the cover 11 of the casing 12 is unlocked and opened the entire switch structure may be removed by loosening two screws 13, raising the switch assembly slightly until the screw heads 13 can pass through the enlarged lower ends of two slots 14 cut in plate 10 through which screws 13 extend. The plate 10 and the switch assembly secured thereto may then be removed from the casing. Screws 13 are threaded into lugs 15 in the inner side walls of the casing.

The door of the casing is provided with a window 16, through which the hour and month dials 17 and 18 and the various indicating hands may be seen.

To the lower back side of the supporting plate 10 is secured a terminal board 20 for the various circuit connections. Just above the terminal board 10 is a self-starting synchronous motor 21 of the general type described in United States Patent No. 1,495,936, May 27, 1924, Warren. Above the motor is one or more mercury tube switches 22. At the

front of plate 10 opposite the mercury switch is a motion multiplying lever system 23 for tilting the mercury switch with a mild snap action at predetermined times, and from the central front portion of the plate is secured the various parts of the astronomical switch operating mechanism comprising the greater portion of the assembly shown in the exploded perspective view of Fig. 3.

The parts last referred to are assembled and supported on a stationary steel rod 24 rigidly secured to the plate 10 and extending towards the front therefrom. This rod appears too slim and long to properly support the parts carried thereby as illustrated in Fig. 3, but as a matter of fact this rod is only about 1½ inches in length and is about ⅛ inch in diameter, so that it is amply rigid for the purpose. To the front end of this rod is secured the pointer 19, which remains stationary and indicates time on the 24 hour time dial 17 as the latter rotates in a clockwise direction. The only other part shown on rod 24 which is rigidly secured thereto and is therefore stationary is gear wheel 25. The remaining parts have rotation in the directions of the various arrows shown adjacent thereto and at speeds which will be mentioned later.

The driving and timing motor 21 has its speed reduced to one revolution per minute at the terminal shaft 26 by means of reduction gearing contained within the gear casing shown and which constitutes no part of my invention. A different form of motor and a different terminal speed might be employed. A pinion 28 on the motor terminal shaft 26 drives a large gear 29 having a bearing on rod 24. The speed reduction here accomplished in the modification shown is in the ratio of 12 to 1 such that gear 29 makes five revolutions per hour. Integral with gear 29 and at some distance off from its center of rotation is a pinion shaft 30, free to rotate and having rigidly connected pinions meshing with stationary gear 25 and a gear 31. As shown in Fig. 2, the gears 30 and 31 are close together and mesh with a single pinion equivalent to the pinion shaft 30. Pinion shaft 30 is carried around with gear 29, and stationary gear 25 causes the pinion shaft to rotate. Gear 31 has a greater number of teeth than gear 25, so that it is driven in a clockwise direction. The relative number of teeth in gears 25 and 30 is such that gear 31 makes one revolution per 24 hour day. This is one form of epicyclic gear arrangement reducing the speed between gears 29 and 31 in the ratio of 120 to 1.

Gear 31 is connected through a friction clutch 32 to a hollow shaft 33, to which shaft is secured gear 34 and a supporting plate 35 for the astronomical cam levers. The 24 hour dial 17 is fastened to plate 35 so that hollow shaft 33, gear 34, plate 35, and dial 17 rotate together in a clockwise direction at one revolution in a 24 hour day. Dial 17 is graduated in A.M. and P.M. divisions, in hour divisions, and each hour division is graduated into 15 minute division marks, so that it is possible to tell the approximate time from the stationary pointer 19 and dial 17.

Gear 34 has 364 teeth and drives a gear 36 having 365 teeth through a pinion shaft 37. As shown in Fig. 2, the pinion shaft 37 integral with the pinions thereon is rotatively supported in a stationary bearing supported from plate 10 by the arm 38 and the pinions thereon mesh with the peripheries of the two large adjacent gears 34 and 36. Thus, as gear 34 makes a revolution per day in a clockwise direction, gear 36 will make

$$\frac{364}{365}$$

of a revolution per day in the same direction, or rotates in a counter-clockwise direction with respect to gear 34 at the rate of one revolution per year of 365 days. Gear 36 drives a second hollow shaft carrying astronomical dial 18 and astronomical cams 38 and 39. The drive is through a friction clutch 40. The astronomical dial and cams make one revolution per year in a counter-clockwise direction with respect to dial 17 and the cam lever supporting plate 35, which rotate in a clockwise direction one revolution per day. The periphery of the astronomical dial is graduated into 365 day divisions and in the months of the year (see Fig. 4), the month graduation including the correct number of day graduations, with 28 day graduations for the month of February. A pointer 41 secured to the back of plate 35 indicates on dial 18 the day and the month for which the switch is set. Friction clutch 32 permits hollow shaft 33 and all parts carried thereby to be adjusted for correctly setting for the time of day as indicated by pointer 19. Such adjustment automatically takes care of the small relative adjustment of the astronomical dial, since the action of its gear drive is just the same as before. Friction clutch 40 permits the astronomical dial and cams to be adjusted independently of all other adjustments for the day of the year as indicated by pointer 41. This adjustment will ordinarily only be necessary initially and on leap years to account for the extra day in February of such years.

Pivoted to a hub integral with plate 35 is an "on" arm 42 and an "off" arm 43 having axially extending pins 44 and 45 in their outer ends for operating any suitable form of switch mechanism. The rotative position of arm 42 is automatically adjusted with respect to the plate 35 and the 24 hour dial by a lever 46 pivoted to arm 42 and operated by a pin 47 which rides on cam 38 and slides in a slot 48 in plate 35. The shape of cam

38 is such as to change the "on" switch operating time in accordance with the changes in the beginning of darkness during different times of the year. The "off" lever 43 is operated by lever 49 and pin 50, which pin slides in a slot 51 in plate 35 and rides on cam 39. Cam 39 is shaped to vary the "off" switching operation in accordance with the change in the beginning of daylight during different times of the year. The astronomical cams are large enough to be shaped and to perform their functions with good accuracy. Cam 39 is larger than cam 38 and arm 49 is correspondingly longer than arm 46 so that pin 50 extends over but never comes into contact with cam 38. The particular shape of these cams will vary in switches intended for different latitudes, and while it will rarely be necessary to change cams in any particular switch, this may be easily accomplished by removing the pointer 19 and sliding off the unit consisting of dial 17 and plate 35 and the parts carried thereby. Springs 52 are connected between a switch operating arm of one mechanism and a pin of the other mechanism, which springs retain the pins upon the surfaces of their respective cams under all operating conditions. The axially extending pins 47 and 50 are constrained to move in radial directions by reason of the slots 48 and 51. Indicators 53 extend forwardly from the switch operating arms and indicate at all times on the 24 hour dial 17 the times of day for which the "on" and "off" levers are set to operate by the astronomical cams.

The operating pins 44 and 45 which cooperate with the switch operating mechanism are preferably threaded through openings in the ends of the "on" and "off" levers so that the times of switch operation may be manually adjusted to positions corresponding to operations say 15 minutes earlier or later than normal to take care of different rulings relative to the turning on and off of street lights in different cities.

From the foregoing description it will appear that the astronomical mechanism is relatively simple, rugged and compact for the purposes which it accomplishes. The parts are relatively few and easy to assemble. All of the necessary adjustments are provided and are easily accessible to authorized persons. The various desired indications are clearly visible through the window 16.

The form of switch which is used with the mechanism thus far described may vary. In the present embodiment, I have shown a mercury tube switch 22, and the operating mechanism between this switch and the "on" and "off" levers will now be described. As best shown in Fig. 1, the arm 42 is slightly longer than arm 43, and the pins 44 and 45 extending through these arms at their outer ends are located at different radial distances from the axis of rotation. These pins cooperate with a roller 54 on a lever 55, the latter being pivoted at 55'. Roller 54 is positioned between the paths of movement of pins 44 and 45 such that pin 44 comes into contact with the upper surface of the roller and moves it downward as the pin passes, and pin 45 comes into contact with the lower surface of the roller and moves it upward as this pin passes. This up and down movement is conveyed to lever 55 and then to lever 56 through the pin and slot connection shown. Lever 56 is pivoted at 57 and the up and down motion of roller 54 is considerably multiplied at the free end of lever 56. The mercury tube switch is supported on a holding block 58 which is pivoted on a shaft 59 provided with the crank arm 60. Pins extend from the free ends of levers 56 and 60 and are connected together by a spring 61. The up and down movement of arm 56 carries the pin in its end past the axis of rotation of the shaft 59 through a dead center with respect to lever 60 and thus provides a toggle action which gives a mild snap action and quick positive tilting of the switch 22 in both directions. Stop pins 62 limit the movement of the switch in its closed and open or "off" and "on" positions.

The resiliency of spring 61 holds the entire lever arrangement to whichever position it is moved until the next operation, when the pin is again stretched and moved to the opposite side of a dead center, resulting in the reverse operation of the mechanism. Thus, very small up and down movement of the single roller 54 by the operating pins in the ends of the "on" and "off" levers as they pass roller 54 results in the proper tilting action of the mercury switch.

In an ordinary time switch, it might be desirable to place the operating pins 44 and 45 close together so as to obtain a short time interval between the opening and closing of the switch, or vice-versa. The single roller with its small movement and the multiplying arrangement described permits a somewhat shorter time interval setting between two consecutive operations than has heretofore been practicable with a single operating arrangement.

To install and set the astronomical switch described, the necessary circuit connections are made to the switch and electric motor; dial 18 is turned until pointer 41 indicates the day of the year on which the installation is made; then dial 17 is set until pointer 19 indicates the time of day at which the setting is made. The connections of switch 22 are made such as to close the lighting circuit when the "on" lever tilts the switch to the closed position, and to open the circuit when the "off" lever operates the tilting mechanism in the opposite direction. The setting indicated in Fig. 1 shows that the date is September 9th, the hour 11 : 27 a. m., and that

the "on" and "off" settings are for 6:30 p. m. and 5 a. m., respectively.

Having thus described the essential features of the invention and a preferred embodiment thereof, it is my intention to seek claims commensurate with the true spirit and scope of the invention, which are not limited to the particular details of construction shown and described.

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

1. In an astronomical time switch, a 24-hour dial and a 365-day dial spaced apart and rotatively mounted on a common axis of rotation, a pair of astronomical cams rotated with the day dial and "on" and "off" switch operating arms rotated with the hour dial located between said dials, said arms extending radially from and being adjustable about said common axis of rotation with respect to the hour dial, a pair of axially extending pins resting on the cams and connected to the switch arms through links at points intermediate the ends of the arms, means for resiliently holding the pins on the cam surfaces and means rotated with the hour dial for otherwise constraining the movement of the pins to radial directions, said pins and links being rotated as a unit with said hour dial and switch arms while permitting relative adjustment of the positions of the switch arms as the pins are moved over the cam surfaces, and means for rotating the hour dial unit one revolution in 24 hours and the day dial one revolution in 365 days with respect to the hour dial.

2. In an astronomical time switch, a pair of astronomical cams of different size arranged side by side and rotatively mounted together, a plate rotatively mounted adjacent the cams on the same axis of rotation, means for rotating the plate one revolution in 24 hours and the cams one revolution per year with respect to the plate, "on" and "off" switch operating arms rotatively adjustable on the plate about its axis of rotation, said arms extending radially in approximately opposite directions from such axis, a pair of radial slots in said plate, a pair of axially extending pins resting upon the surface of said cams and extending through said slots, a pair of links pivoted between the pins and intermediate points on said arms, said parts constituting two independent sets of mechanisms for individually adjusting the arms astronomically as the pins ride over their respective cams, and springs connected between the pins and the arms of opposite sets for retaining the pins upon the surfaces of the cams.

3. An astronomical time switch mechanism comprising a timing motor having a terminal shaft operating at one revolution per minute, a pinion on said terminal shaft meshing with a larger gear for reducing the speed, a hollow shaft, an epicyclic gear between said hollow shaft and large gear for normally rotating the hollow shaft one revolution in 24 hours, a friction coupling permitting rotary adjustment of the hollow shaft with respect to the timing motor, a second hollow shaft on the first hollow shaft, gearing between said shafts for operating the second hollow shaft one revolution per year with respect to the first hollow shaft, a friction coupling permitting rotary adjustment of the second hollow shaft with respect to the first, an astronomical dial and cams on the second hollow shaft, radial "on" and "off" switch operating levers pivoted on the first hollow shaft, means operated by said cams for adjusting the positions of said switch operating levers in accordance with changes in daylight at the ending and beginning of a day, and a stationary pin for supporting said larger gear, epicyclic gear, hollow shafts, friction couplings, astronomical dial and cams, and switch levers in concentric operating relationship.

4. An astronomical time switch comprising a central supporting plate, a high speed electric timing motor and a mercury tube switch supported on the back of said plate, a stationary pin rigidly secured in said plate and extending to the front thereof between said motor and switch, a stationary pointer on the forward end of said pin, a 24-hour time dial rotatively mounted on said pin directly back of said pointer and cooperating therewith to indicate the time of day, gearing between said dial and motor for rotating the dial one revolution in 24 hours, a 365-day dial of larger diameter than the 24-hour dial rotatively mounted on said pin back of said 24-hour dial, gearing for rotating the 365-day dial one revolution per year with respect to the hour dial, "on" and "off" switch arms rotated with the 24-hour dial, and astronomical cams rotated with the day dial positioned between said dials, means between the cams and switch arms for adjusting the switch arms with respect to the hour dial in accordance with change in the ending and beginning of daylight, means for indicating such positions on the day dial, means for indicating on the year dial the day of the year for which said dial is set, means for adjusting the day and year dials with respect to each other and with respect to the timing motor, and means operated by said "on" and "off" levers for tilting said mercury tube switch in opposite directions.

5. In a time switch, an "on" arm and an "off" arm rotatively mounted about a common axis, said arms having their relative rotative positions adjustable, a timing motor and gear train for rotating said arms, said arms having axially extending pins at different radial distances from the axis of rotation, a lever pivoted at one end and having a

roller at an intermediate point extending into the path of movement of said pins such that said pins pass on opposite sides of said roller but make contact therewith to reciprocate the lever, a second lever pivoted at one end and having a pin and slot connection with the outer end of the first mentioned lever whereby the reciprocating motion of the latter is multiplied in the second lever, a mercury tube switch mounted so as to be tilted to open and closed position, and a toggle mechanism between said second mentioned lever and mercury tube switch for operating the latter.

In witness whereof, I have hereunto set my hand.

WILLARD E. PORTER.