June 6, 1933. E. F. HOLINGER 1,912,368

ELECTRIC TIME SWITCH AND SELF WINDING CLOCK MECHANISM FOR OPERATING SAME

Filed July 18, 1929 2 Sheets-Sheet 1

FIG. 2

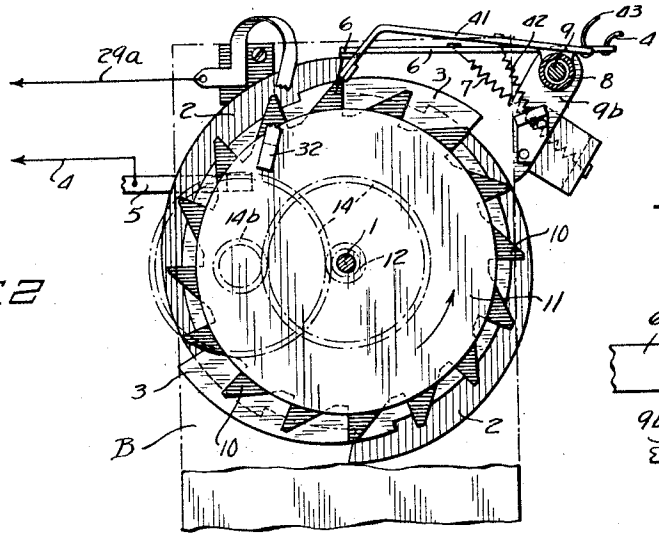


FIG. 3

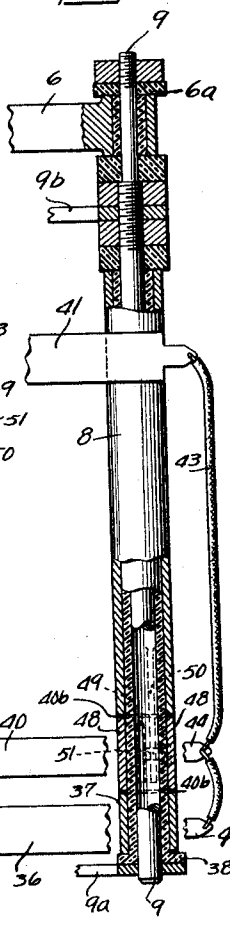
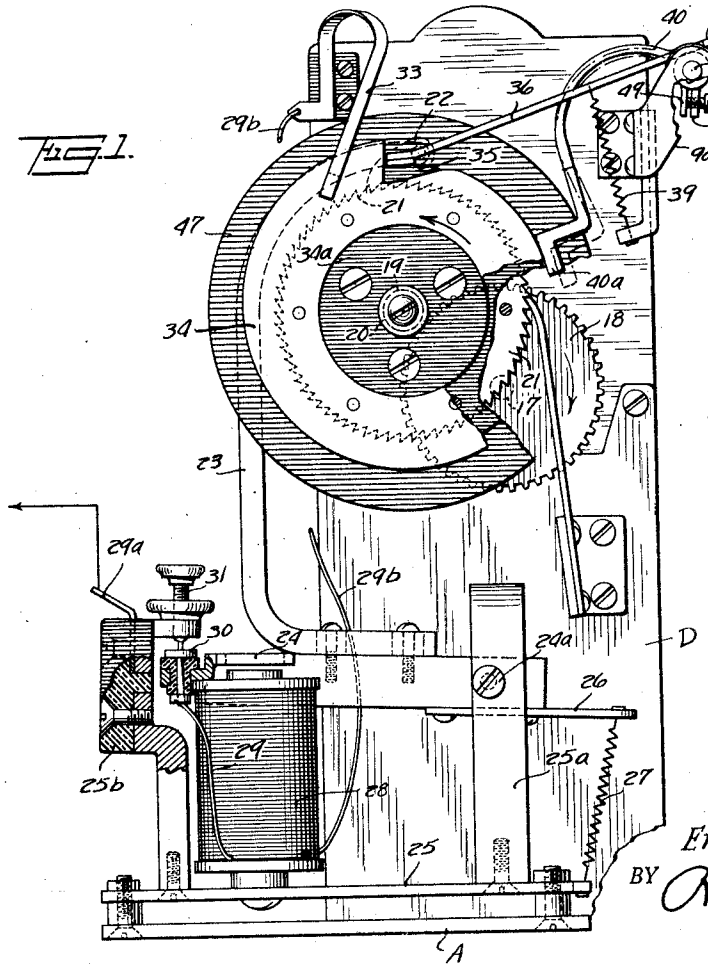


FIG. 1



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FIG. 4.

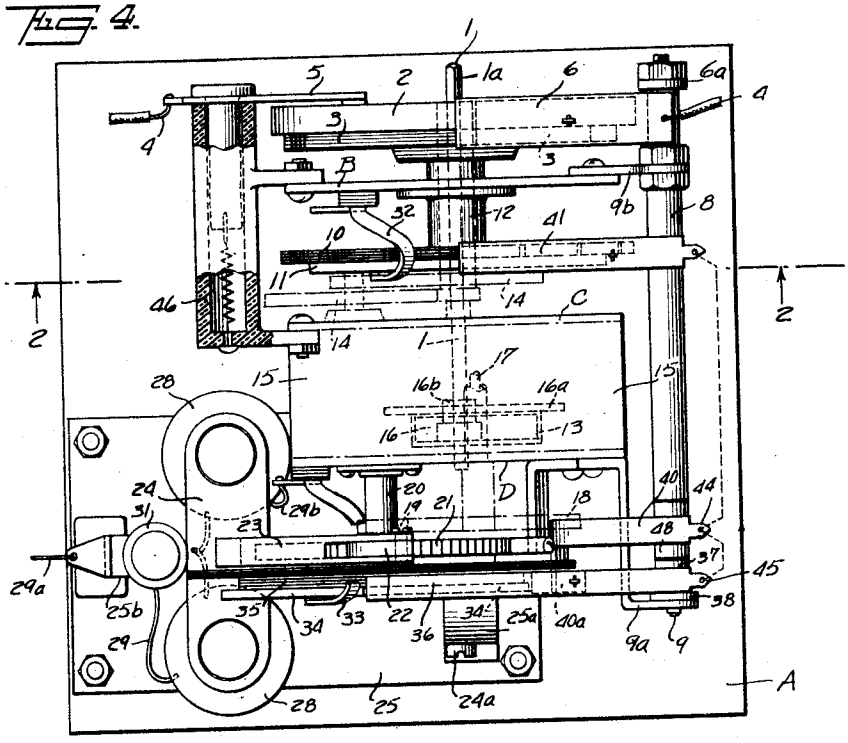
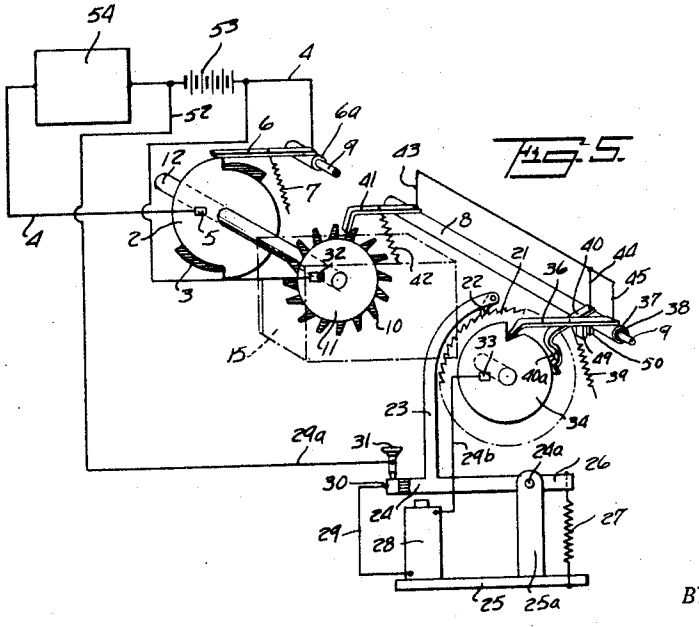


FIG. 5.



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UNITED STATES PATENT OFFICE

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ELECTRIC TIME SWITCH AND SELF-WINDING CLOCK MECHANISM FOR OPERATING SAME

Application filed July 18, 1929. Serial No. 379,152.

This invention relates generally to mechanisms periodically set in operation by clockwork to partially or wholly re-wind the main spring which drives said clockwork, said re-winding being performed to an extent equal to that by which the clockwork mainspring has been unwound during the period of time intervening between two given re-windings. The principal objects of the invention are to produce a mechanism which shall be simple and cheap in construction, can be applied to any standard clock movement, and is easily adjustable while prompt and positive in operation. Another object is to produce such mechanism which will wind up the clock spring to an amount which will exactly compensate for its unwinding during a given period of operation of the clock movement.

As illustrated specifically the invention is applied to the periodic operation of an electric switch or work circuit controller which controls the supply of current to one or more electric heaters to the end that said heaters may be cut out of the supply circuit during the portion or portions of the day when said circuit is called upon to deliver the maximum current necessary to carry the peak load imposed thereon by other consuming devices, such as a transportation, lighting, or other industrial power system, and it has particular specific advantages in the combination thus illustrated, but the invention may obviously be used for other purposes.

Broadly stated, the invention in the embodiment here illustrated, comprises a work circuit controlling mechanism, mounted on the hour hand carrying sleeve, or similar element, of an ordinary clock mechanism, and a self-winding apparatus for said clockwork comprising an electric motor geared to the winding shaft of the clockwork, and two winding circuit controllers connected in series in said motor circuit. One of the latter is opened and closed periodically by movement of the hour hand carrying element and the other, which has two vibrating members in shunt relation one with another, is operated successively by the clockwork and by the winding mechanism. That is to say, one shunt controlling member is moved into closed position by actuation of the hour hand carrying element, while the other is thereafter moved into closed position by movement of the winding mechanism, and both are moved into open position by rotation of the winding shaft in its periodic clock-winding operation, such opening of the clock-winding circuit, of course, terminating each periodic winding operation.

The best form of apparatus at present known to me embodying my invention is illustrated in the accompanying two sheets of drawings in which

Fig. 1 is a general rear elevation, with parts broken away and others shown in section, disclosing the circuit controller operated by the winding mechanism.

Fig. 2 is a detail vertical section on line 2—2 of Fig. 4 disclosing the circuit controller operated by the clockwork.

Fig. 3 is a detail plan view on an enlarged scale of the vibrating contact assembly, parts being broken away and others shown in section.

Fig. 4 is a general plan view, parts being shown in section or broken away, and

Fig. 5 is a diagrammatic partial assembly of the apparatus.

Throughout the drawings the same reference character has been applied to the same parts.

A is the base plate supporting the front frame plate B, on which the work circuit controller is mounted. D is the rear frame plate between which and the front plate B is supported an ordinary clock mechanism 15, partly shown in outline and having a front frame plate C. Between B and C is a winding circuit controller operated by the element which would carry the hour hand of the clockwork if it were used to form an ordinary clock, and to the rear of plate D is located the circuit controller operated by the winding mechanism and the electric motor apparatus for revolving the winding arbor.

Other portions of the clock mechanism shown in the drawings are the shaft 1, which would carry the minute hand of the clock, said shaft having the squared end 1*a* to which an adjusting key may be applied for

purposes to be hereinafter described, said shaft being connected by suitable reducing gearing 14 to the hour hand carrying sleeve 12, which is loosely mounted upon it. Shaft 1 is also connected to mainspring 16, coiled in drum 13, which is fast on winding arbor 17. The inner end of the main spring is connected to the clock driving gear wheel 16*a*, meshing with the lantern gear 16*b*, which is frictionally mounted on shaft 1. The outer end of the main spring is fastened to the interior of drum 13. Within the clockwork compartment, represented generally by rectangle 15, is located the usual clock train (not shown) conveying motion to the usual escapement. When spring 16 is wound up the clockwork will be set in operation, rotating shaft 1 once every hour, and the hour hand carrying sleeve once in every period of hours determined by the gear ratio of gear 14.

3 is a cam disk of insulating material, mounted on hour hand sleeve 12, and carrying a generally similar cam disk 2, of conducting material, which latter is thus insulated from all other parts of the apparatus except spring contact fingers 5 and 6, the former of which bears on its side, while the latter bears on its periphery, when not prevented from so doing by the projecting portions of insulating cam disk 3, finger 6 being wide enough to bear on either 2 or 3. Finger 6 is loosely mounted on shaft 9 but insulated therefrom by bushing 6*a* (see Fig. 3) and pulled downwardly by the spring 7. Shaft 9 is supported on housings 9*a* and 9*b*, carried respectively by frame plates D and B. 46 is an insulating housing for supporting spring contact finger 5. The contact fingers 5 and 6, thus insulated, form the terminals of any suitable work circuit 4 (see Fig. 5) which may include an electric heater or any other translating device indicated at 54. Obviously when sleeve 12 is rotated by the clockwork, circuit 4 will be opened during those portions of every period of time consumed by its revolution during which finger 6 rests on the edge of insulating disk 3, and closed during the rest of the time while said finger rests on the periphery of conducting disk 2. By making one of these disks circumferentially adjustable with reference to the other, the periods of open circuit during which the heater will be cut out of operation may be varied in length, without otherwise modifying the apparatus.

The clockwinding arbor 17 is periodically rotated in clockwise direction (looking at Fig. 1) to wind up spring 16. This rotation is produced by gear wheel 18 fast on said shaft and driven by pinion 19 on shaft 20 which is rotated by ratchet wheel 21 under the action of reciprocating pawl 22, carried by arm 23 extending from vibrating armature 24 of the make-and-break mechanism best shown in Figs. 1 and 5. Any other suitable electrically driven mechanism could be substituted for this form of motor, however. As shown this motive mechanism comprises electromagnet 28, mounted on base 25, which also supports housing 25*a* to which vibrating armature 25 is pivoted at 24*a*, and insulating housing 25*b*, carrying the adjustable contact screw 31 with which cooperates insulated contact 30, carried by the free end of vibrating armature 24. A spring 27 connected to the rearwardly projecting arm 26 on 24, normally maintains contact between 30 and 31, except when magnet 28 is energized by current flowing through circuit 29, 29*b*. This circuit is dominated by the winding circuit controllers heretofore referred to, which are connected in series therein.

The winding circuit controller, operated by the hour-hand-carrying element, sleeve 12, and therefore driven by the clockwork, comprises the disk 11, of conducting material and the ratchet-like wheel 10 of insulating material mounted by its side and both carried by sleeve 12, and the spring contact 32 mounted on front plate B and bearing on the side of 11, together with spring finger 41, bearing on the periphery of 11, or on one of the teeth of the wheel 10, according to the angular position of sleeve 12, finger 41 being wide enough to overhang both. Said finger 41 is fast on metal sleeve 8, which is loose on bushing 38, carried by shaft 9. Spring 42 constantly pulls finger 41 downwardly. Wire 29*a* from the fixed make-and-break contact 31 is connected to spring contact 32 and finger 41 may be intermittently connected to the other magnet terminal 29*b*, through the other winding circuit controller, which is partly operated by the winding mechanism. This second winding circuit controller comprises the following apparatus, best shown in Figs. 1, 3 and 5.

Cam disk 34 of conducting material is fast on shaft 20, which, in the rewinding operation, is rotated by pawl and ratchet wheel mechanism 22, 21, before described. Cam disk 34 is carried by insulating hub 34*a* and separated from ratchet wheel 21 by insulating disk 47. Contact finger 36 rests on the periphery of this cam disk and forms an electrical connection therewith, except when it drops onto the non-conducting segment 35, located at the bottom of the cam drop. Spring contact finger 33, connected to wire 29*b* from one of the terminals of magnet 28, presses continuously on the side face of 34. Finger 36 is loosely mounted by means of short sleeve 37 on insulating bushing 38, carried by shaft 9 (see Figs. 3 and 5) and is pressed downwardly by spring 39. Finger 41, bearing on the rotary member of the first winding circuit controller, and being mounted on sleeve 8, which is loose on bushing 38, slowly oscillates said sleeve, as said finger rides up and down over the teeth of the fibre wheel 10, under the pull of spring 42, as

said wheel is slowly rotated by the clockwork. A third contact finger 40 is fast on short sleeve 48, which is loosely mounted on bushing 38 and insulated from sleeves 8 and 37 by insulating rings 40*b*, these forming a friction bearing for sleeve 48. Sleeve 48 has a downwardly projecting lug 49 which cooperates with adjustable screw 51 carried by lug 50 projecting from sleeve 8 and forming a lost motion connection between sleeves 8 and 48. The free end of finger 40 has a lateral extension 40*a* (see Figs. 1 and 5) adapted to bear on the periphery of cam disk 34, when said finger is swung upwardly through operation of the lost motion connection when finger 41 has ridden up nearly to the top of one of the teeth on 10, as shown in Fig. 2. When finger 41 falls from the top of any of these teeth, finger 40 is not moved thereby, but remains in contact with 34 as the result of the opening of the lost motion connection. Finger 41 is electrically connected to both fingers 36 and 40 by shunt connections, 44, 45 (see Figs. 3 and 5) so that these two fingers which cooperate with cam disk 34 are in multiple connection with finger 41 and in shunt relation one with another. The operation of this particular multiple circuit breaker is as follows:

When the winding mechanism has come to rest at the end of any re-winding operation, finger 36 is left resting on insulating segment 35, and finger 40 is withdrawn from contact with cam disk 34, as shown in dotted lines in Fig. 1, and in full lines in Fig. 5. This withdrawn position of finger 40 has been caused by cam disk 34 pushing it back during the preceding winding operation. This position of the parts leaves open the winding circuit through magnet coils 28, and that is the reason why the preceding rewinding operation ceased, although finger 41 of the other winding circuit controller was then still resting on the periphery of contact disk 11, between two teeth of the insulating ratchet-like wheel 10. With the lapse of time rotation of 10 by the clockwork causes finger 41 to ride upon on the next fibre tooth of 10 and so break the winding circuit also at that point. Further rotation, which causes finger 41 to reach the tip of the tooth, oscillates sleeves 8 and 48 (screw 51 engaging lug 49) sufficiently to swing finger 40, 40*a*, against cam disk 34, thus reestablishing one shunt of the winding circuit at that point, as indicated in full lines in Fig. 1. Consequently, when finger 41 drops off the fiber tooth onto the edge of conducting disk 11, the circuit through finger 40 is completed and magnet 28 is energized, finger 40 not being withdrawn from such contact by the downward motion of 41, sleeve 48 having a frictional bearing on the bushing 38 and the lost motion connection before described merely opening. As the result the make-and-break mechanism is energized and actuates pawl 22, rotating the winding shaft 17 to wind up main spring 16. As cam disk 34 is rotated by this winding operation, it gradually pushes back finger 40 which yields by reason of its frictional mounting on bushing 38, and, when the high portion of cam disk 34 passes from under finger 40, the latter is left in its retracted position shown in Fig. 5 and in dotted lines in Fig. 1, thus opening one shunt of the winding circuit. Further rotation of cam disk 34 in the same direction indicated by the arrow in Fig. 1 causes finger 36 (at the end of one complete revolution of the cam disk) to drop off the high point of the cam onto insulating segment 35, thus opening the other shunt of the winding circuit and bringing the re-winding operation to a stop, as both shunts 36 and 40 are opened, although finger 41 may still be resting on conducting disk 11. This completes the re-winding cycle and thereafter finger 41 gradually leaves conducting disk 11, (as 10 and 11 continue to be rotated by the clock mechanism) and begins to mount another fiber tooth on 10, thus opening the circuit at that point also and before finger 40 has been forced back into contact with 34 by the lost motion connection between sleeves 8 and 48.

Both the closing and breaking of the winding circuit are instantaneous and positive so that no sparking occurs because the spring finger 41 snaps off of and away from the apex of each insulating tooth of the ratchet-like wheel 10, and down upon the conducting element 11, to instantaneously close the circuit, while the spring finger 36 snaps down and away from the high point of cam 34 upon the non-conducting member 35 to instantaneously break the circuit. The slow moving shunt controlling finger 40 makes and breaks contact with cam 34 only after the circuit has been already closed or opened through the shunt around it by action of fingers 41 and 36, as above described.

If it were not for the necessity of producing a quick break of the winding circuit, finger 36 might be dispensed with and the action of cam disk 34 when its high point leaves finger 40 relied upon to produce such breaking of the circuit. Obviously if some other mechanism were added for insuring the desired quick breaking of the circuit, only one contact finger such as 40 might be employed.

In practical operation of my invention the parts may be so proportioned as to produce a rewinding action of any desired extent and with any selected frequency. As shown, the insulating ratchet wheel 10 has 16 teeth and consequently the winding circuit will be closed and opened sixteen times during each revolution of the main circuit controller disks 2 and 3. The reducing gearing 14 between shaft 1 and sleeve 12 has a ratio of one to twenty-four, instead of one to twelve, as in a standard clock mechanism. Consequently the re-winding will occur every ninety min-

utes with the apparatus illustrated. At each closing of the circuit the electro motor apparatus quite rapidly produces one rotation of cam disk 34 and is then cut out of circuit as previously described. As the work circuit controller disks 2 and 3 make one revolution every twenty-four hours, the heater will be cut out twice a day for periods of about three hours each, morning and evening, which could be adjusted to correspond to the peak load periods of a transportation system.

An important point to be taken care of in designing apparatus of this character is to make sure preferably that at each re-winding operation the main spring is wound up to an extent substantially equal to that by which it has unwound in the last period of running the clockwork since the previous rewinding, or, in any event, that the amount of re-winding during some reasonably short period, such as that required for one complete revolution of the work circuit controller, shall be exactly equal to the amount of unwinding of the mainspring required to drive the clockwork that far. Unless this is done, the clockwork would in time run down and stop, or the spring will be wound to the limit before some re-winding operation is completed (i. e. before cam disk 34 has effected a complete revolution) and the motor will then stall and probably burn out. This complete balance of the winding and unwinding operation can be easily secured in my invention by so designing the various trains of gearing that during each revolution of the sleeve 12, carrying the clock-driven circuit controller 10, 11, which will, of course, cause as many revolutions of winding circuit controller cam disk 34 as there are teeth on wheel 10, the unwinding movement of spring driven gear 16*a* shall be exactly equal to the winding-up movement of drum 13. This result evidently can be secured by properly proportioning the gear ratios of the winding gearing and of the clock driven gearing. For example, if the revolution ratio of winding gears 19, 18, is eight to one, and that of the reducing gearing 14 is twenty-four to one, then the revolution ratio of the clock driving gearing 16*a*, 16*b*, should be one to twelve, since sixteen revolutions of the cam disk 34 (which would occur in every twenty-four hours because wheel 10 has sixteen teeth) would then produce two complete revolutions of spring drum 13, tending to wind up spring 16 to that extent, and the contemporaneous one complete revolution of wheel 10 and sleeve 12 would have resulted from twenty-four revolutions of shaft 1, which would have permitted one-twelfth as many revolutions of spring gear 16*a*, i. e. two complete revolutions thereof tending to unwind spring 16, which exactly equals the two revolutions of spring drum 13 occurring during the same twenty-four hours. As a result the final tension of mainspring 16 would be identical with its initial tension and thus the apparatus could continue to run as long as current was supplied to the motor without the clockwork running down or the mainspring being wound up any tighter than it was at the beginning of operations.

If the sixteen teeth on 10 were spaced apart evenly and with exactness, each re-winding operation would also exactly equal the unwinding of the spring during the interval of time since the beginning of the previous re-winding cycle, but this is not essential. The teeth might be quite irregularly spaced so long as their total is sixteen (assuming the gear ratios above described) because the total re-winding for each complete revolution of the toothed wheel 10 would be the same whatever the relative spacing of the sixteen teeth, and it would be equal to the total unwinding of the main spring occurring during that twenty-four hour period. Even though certain of the unwinding operations would then exceed the immediately previous re-winds, others would fall short, and the total plus and minus differences would cancel out at the end of each complete revolution of wheel 10, i. e. at the end of every twenty-four hours.

Obviously other forms of gearing and motion transmission mechanism could be substituted for those shown in the drawings without departing from the principle of my invention, so long as the general mode of operation and results described were the same. Also other forms of motor, including those using power other than electricity, could be substituted for the make-and-break apparatus shown, and proper means for controlling the application of such other kinds of power could be substituted for the electrical apparatus here shown as embodying the invention.

By applying a key to the squared end 1*a* of shaft 1, the positions of sleeve 12, switch disks 2, 3, and controller members 10, 11, can be adjusted at will, the shaft turning in the friction coupling by which it is connected to the lantern gear 16*b*, the same as when the hands of a clock are set forward or backward. In this way the time of day at which work circuit 4 is cut out by the apparatus can be varied.

The current for the winding circuit may be supplied from any source, as by means of the shunt circuit 52 from the work circuit 4 as indicated in Fig. 5. The source of current is conventionally represented by battery 53.

As the winding operation occurs sixteen times during each revolution of the hour hand sleeve 12, or at intervals of an hour and a half, it is evident that the mainspring, which would usually be of an expansion capacity sufficient to drive the clock mechanism thirty hours in a one-day movement, will be alternately first wound up and then allowed to unwind through one twentieth of its expan-

sion capacity, and to secure the most uniform operation of the time mechanism it is well to set up the apparatus originally so that the mainspring 16, is about one half or one third expanded, as it is well known that the force of a clock spring is most uniformly exerted throughout that zone of its unwinding.

As a result the mainspring will be kept continually operating at medium tension, and it is well known that its force is most evenly expended throughout that period, rather than near either extreme of tight winding on the one hand, or a nearly run down condition, on the other.

Having described my invention, I claim:

1. In an automatic winding attachment for clock mechanism comprising a clock train, a motor geared to the clock winding arbor and a source of power for said motor, the combination, with said above recited elements, of means participating in the control of the application of said power adapted to be operated by said clock train, and two devices also adapted to participate in said power control severally arranged in series operatively with said means and in shunt relation one with the other, one of which devices is adapted to be controlled in operation by the said motor, while the other is adapted to be partly controlled in operation by said clock train and partly by said motor.

2. In an electrically controlled automatic winding attachment for clock mechanism comprising a clock train, an electric motor geared to the winding arbor of said clock mechanism and a power circuit for said motor, the combination, with said above recited elements, of a controller for said circuit adapted to be periodically actuated by said clock train, and a second controller comprising two circuit controlling devices each connected in series with said first mentioned circuit controller but in shunt relation one with another, one of which last mentioned devices is adapted to be both opened and closed by the operation of said motor while the other is adapted to be opened by operation of the motor but closed by operation of the clock train.

3. In an electrically controlled automatic winding attachment for clock mechanism comprising a clock train, an electric motor geared to the winding arbor of said clock mechanism and a power circuit for said motor, the combination, with said above recited elements, of a member adapted to be rotated by the clock train and having a serrated periphery, the projecting portions of which are of non-conducting material while the intervening, depressed portions are of conducting material, a vibrating conducting finger yieldingly pressed against said periphery, a member of conducting material adapted to be rotated by said motor and having a short, non-conducting segment in its periphery, a spring pressed conducting finger resting on said periphery, and a third conducting finger pivoted on a friction bearing and also adapted to bear on said periphery, together with means operated by said motor to force said last mentioned finger away from said periphery, and a train of mechanism having a lost-motion link adapted to be operated by the first above mentioned finger to force said last mentioned finger back into contact with said periphery, said two last mentioned fingers being in multiple connection with the first above mentioned finger, and each in series therewith and with the conducting portion of said rotary members in said power circuit.

4. In an electrically controlled automatic winding attachment for clock mechanism comprising a clock train, an electric motor geared to the winding arbor of said clock mechanism and a power circuit for said motor, the combination, with said above recited elements, of a controller for said circuit adapted to be operated wholly by said clock train, a second controller for said circuit in series with the first mentioned one and adapted to be partially operated by said motor, and an apparatus mechanically actuated by movement of an element of said first mentioned controller to complete each cycle of operation of said second controller.

5. An automatic winding attachment adapted to be mounted on a standard clock mechanism, which attachment comprises, in combination, an electric motor and a rotary circuit controlling member therefor adapted to be supported at the rear of the clock frame and geared to the winding arbor of said clock mechanism, another rotary circuit controlling member adapted to be supported at the front of the clock frame and connected to the hour-hand-carrying sleeve of said clock mechanism, a shaft adapted to extend from the front to the rear of the clock frame and circuit controlling fingers mounted thereon and cooperating with the above mentioned rotary circuit controlling members, said circuit controlling device being connected in series in the motor supply circuit and said last mentioned circuit controlling device being adapted to close the motor circuit at the end of a predetermined period of operation of the clock mechanism while said first mentioned circuit controlling device is adapted to open said circuit at the end of a predetermined amount of rewinding of the main spring of said clock mechanism.

6. In an electrically controlled automatic winding attachment for clock mechanism comprising a clock train, an electric motor geared to the winding arbor of said clock mechanism and a power circuit for said motor, the combination, with said above recited elements, of two rotary circuit controllers connected in series in said circuit, the rotat-

ing contact member of one controller being driven by the clockwork while the rotary contact member of the other is driven by the rewinding gearing, and a vibrating member for each circuit controller connected together by a lost motion mechanism, the vibrating contact member for the first controller being adapted to be actuated in both directions by the clockwork, while that of the second controller is adapted to be actuated in one direction by the winding gearing and in the other by the rotating member of the first controller through said lost motion mechanism.

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