July 3, 1956 C. D. PIGMAN 2,753,406

ELECTRIC SWITCH MECHANISM

Filed Feb. 17, 1954

FIG. 1

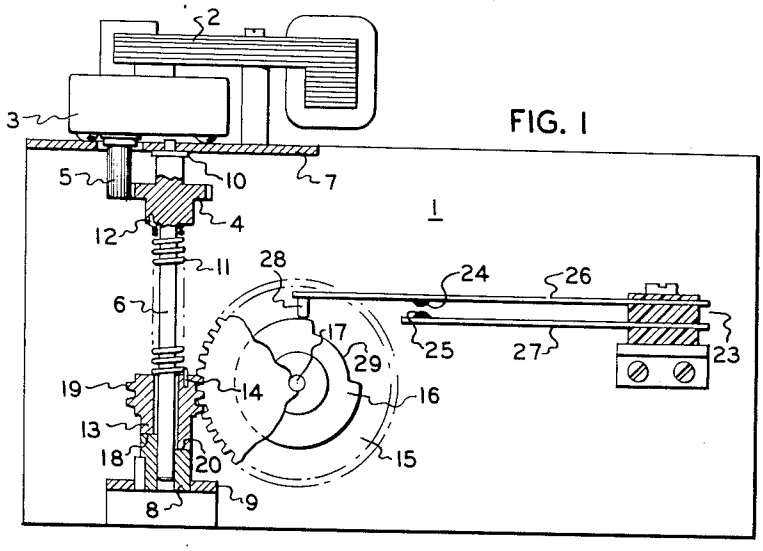


FIG. 2

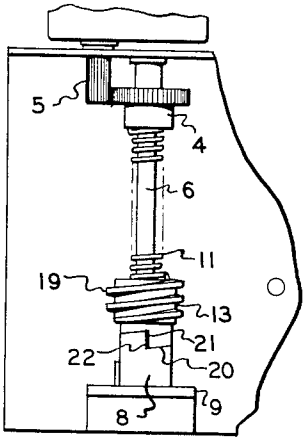


FIG. 3

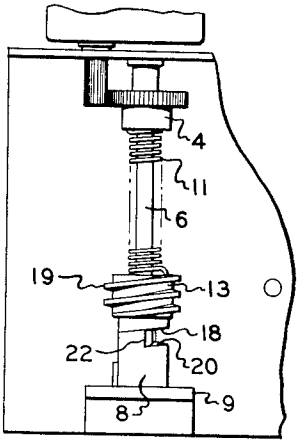


FIG. 4

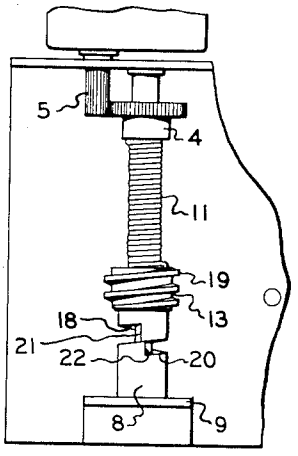
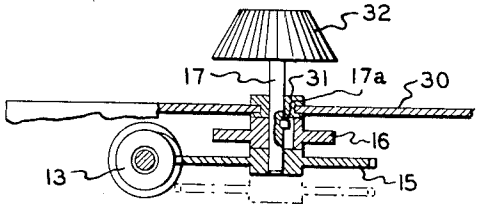


FIG. 5



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ELECTRIC SWITCH MECHANISM

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4 Claims. (Cl. 200—38)

My invention relates to electric switch mechanisms and more particularly to electrical timing devices including rotary motion translating means.

Electrical timing devices are provided in various automatic machines, as for example automatic washing machines, in order to control the sequence of operations performed therein. Specifically in washing machines the timing device actuates various contacts to regulate the different operations occuring during the operating cycle of the machine. Ordinarily these contacts are opened and closed by means of a cam which is rotated at a constant rate by a direct geared synchronous motor. But such an arrangement although providing generally satisfactory results does present several undesirable aspects. Firstly, in order for the slowly moving cam to provide a quick make and break action of the contacts, rather expensive switches, as for example switches of the column spring type, are required. Secondly, such an arrangement results in the load on the cam and therefore on the control motor consisting of intermittent peak points occuring at the switch operation points with relatively small friction loads in between.

These problems could however be obviated if a satisfactory impulse type mechanism were provided within the timing device. Such an impulse mechanism could store energy from the control motor at a comparatively constant rate over a period of time, and then deliver this energy to the contact actuating cam in a pulse of very short duration. Since the energy is stored over a period of time, a relatively constant load would be presented to the motor. Moreover since the energy from the motor is delivered to the cam in a pulse of short duration, less expensive switches could be used. The resulting rapid displacement of the cam wheel would itself provide the quick make and break action of the switch contacts necessary to minimize arcing without there being any need for snap action devices being incorporated in the switches.

Therefore it is a primary object of my invention to provide a new and improved electrical switch mechanism.

It is another object of my invention to provide an improved timing device including a rotary motion translating mechanism of the impulse type.

Another object of my invention is to provide an improved impulse type rotary motion translating mechanism.

A further object is to provide a novel device capable of delivering intermittent forward motion from a source of constant rotary motion.

Still a further object of my invention is to provide an improved switch mechanism in which a novel helical gear arrangement is utilized to drive a control cam intermittently from a source of constant rotary motion.

Another object of my invention is to provide an improved electrical timing device in which a constant rotary input is translated to intermittent forward movement of a control cam by means of an impulse mechanism including a worm and worm wheel.

My invention also has as its object the provision of an improved electric timing device including an impulse

mechanism in which the output member may be adjusted relative to the input member to vary the operation of the timing device.

In carrying my invention into effect I provide an electrical time switch which includes a rotary motion translating device operable to convert a constant rotary input motion into an intermittent output motion. The translating device includes a helical gear movable both axially and rotatably and a second gear mated therewith. The helical gear is rotated at a constant rate and means are provided for moving the helical gear axially in one direction during the rotation thereof. This means so correlates the axial movement of the helical gear with its pitch that the second gear is caused to remain stationary during the combined axial and rotary movement of the helical gear. Further included in the device are means for storing energy during the combined movement of the helical gear, and means actuated by the stored energy for moving the helical gear rapidly in the reverse axial direction after it has moved a predetermined distance in the first direction. When the helical gear moves in the reverse direction a sudden impulse is imparted to the second gear causing a displacement thereof, and since the reverse movement of the helical gear occurs periodically intermittent movement of the second gear is the result. This intermittent movement of the second gear is then used to control the one or more pairs of contacts of the switch. A movable actuating member is provided for controlling each pair of contacts and a cam for positioning this movable member is driven by the second gear. The cam moving intermittently with the second gear causes a sudden displacement of the contact actuating member or members at predetermined positions thereof, and thereby effects quick make and break actions of the contacts without any additional snap-acting devices being required.

The novel features which I belive to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation may best be understood by reference to the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a view partially in section of a preferred embodiment of my new and improved electrical time switch;

Fig. 2 is a fragmentary view showing the continuously rotating portion of my switch in one position thereof;

Fig. 3 is a fragmentary view similar to Fig. 2 showing the continuously rotating portion in a second position thereof;

Fig. 4 is still another view similar to Fig. 2 showing the continuously rotating portion in a still different position thereof; and

Fig. 5 is a fragmentary plan view showing the means for adjusting the operation of my switch.

Referring now to Fig. 1 I have shown therein an electric time switch mechanism **1** driven by means of an electric motor **2**. The continuous rotary output of the motor is taken off through a set of reduction gears **3** and fed to a spur gear **4** by means of a pinion **5**. The spur gear **4** is itself mounted on a shaft **6** and in my preferred embodiment is affixed thereto by any suitable means, although it should be understood that the illustrated device will operate satisfactorily with the gear being freely rotatable with respect to the shaft. The mounting shaft **6** is journaled at its one end in a flange of the switch frame and at its other end in a bearing **8** which is keyed to a shoulder **9** of the frame. The shaft is held in position by a thrust collar **10** which contacts the lower surface of flange **7** and a spring **11** surrounding the shaft which biases the gear and shaft upwardly. The spring **11** surrounding the center portion of shaft **6** is firmly affixed at its one end to the gear **4** by an end portion **12** which extends into a recess in the gear and at its other end is affixed to a gear **13** by

means of an end portion 14 extending into a similar recess in that gear.

In accordance with my invention and as will be more fully explained hereinafter, the gear 13 together with its cooperating gear 15 comprise the means whereby the continuous rotary input to gear 4 is changed into an intermittent output motion. In a time switch this intermittent output motion may then be transferred to contact actuators by any suitable means, as for example the cam 16 driven from gear 15. Specifically driven gear 15 and the output cam 16 are here shown as both mounted on the same shaft 17. The gear 15 is rigidly attached to shaft 17 but the cam 16 is joined thereto for rotary motion only. As shown in Fig. 5, a sliding key 17*a* or other suitable means while locking the cam and shaft for rotary motion allows some axial displacement of the shaft relative to the cam. This axial displacement feature is desirable for adjustment purposes, as will be more fully explained hereinafter.

In order that they may convert continuous rotary motion into an intermittent output movement, I have so arranged the gears 13 and 15 that they form a novel impulse mechanism. By my invention the driving gear 13 of the mechanism is of the helical type and is so mounted on the shaft 6 that it may move axially with respect to the shaft. Specifically in my preferred embodiment illustrated, the helical gear 13 is of the worm gear type. The second gear of the impulse combination is, of course, adapted to mesh with the helical gear 13 and thus in my preferred embodiment is shown as a worm wheel or spur gear.

If the movement of gear 15 is to be intermittent, it is of course necessary that it remain stationary during the greater portion of the rotation of gear 13. To accomplish that result means are provided which move the helical gear axially in one direction during its rotation, and the axial movement of the gear 13 and the pitch thereof are so correlated that the second gear 15 is caused to remain stationary during the combined axial and rotary movement of the helical gear. Thus in my preferred embodiment the gear 13 is provided with a spiral base surface 18, i. e. a base surface in form of a helical track. This spiral base surface 18 is of the same pitch as the thread 19 of the worm 13 and cooperates with a spiral or helical track 20 formed on the upper edge of the journal bearing 8. The spiral track 20 of bearing 8 is also of the same pitch as the worm thread 19 and thus through its engagement with the base surface 18 causes the worm to move axially in one direction at the same rate as its thread traverses in the reverse direction. As will be later explained, this results in there being no turning force applied to the gear 15 during the combined axial and rotary movement of gear 13.

The gear 13 can be driven from the gear 4 by any suitable means but is here shown as being resiliently connected thereto by means of the spring 11. It should be understood though that the gear 13 could be keyed to the shaft 6 and driven therefrom just so long as it is free to move axially along the shaft. However, no matter what the connection between the gear 4 and the worm 13, the worm will be driven continuously while the drive motor 2 is rotating. Due to the aforesaid engagement of the spiral base 18 of the worm with the spiral track 20 of bearing 8, the worm will be moved upwardly along the shaft as a result of its rotation. This axial movement of the worm continues as shown in Figs. 2, 3, and 4 until cooperating transverse or return portions 21 and 22 of the surfaces 18 and 20 are brought into alignment. At that point the tracks are instantaneously disengaged so that the worm gear is free to move in the reverse axial direction to its base position shown in Fig. 2. In other words during each revolution of the worm it is moved a predetermined axial distance along shaft 6 due to the cooperation between its base surface 18 and track 20 of bearing 8 and at the end of that revolution is permitted to return to its base axial position at the start of the revolution. It should be understood, however, that other means, as for example a one tooth rack, could be used to provide this same movement of the worm gear.

In order to positively return the worm to its base position after its axial movement along the shaft means are provided which store energy during the axial movement. In my preferred embodiment this energy storing means comprises the spring 11 which is biased as a result of the axial movement of the worm. Thus as illustrated in Figs. 2, 3, and 4 the spring is gradually biased or, more specifically, compressed as the worm moves upwardly along shaft 6. Then when the transverse track portions 21 and 22 come into alignment, the spring 11 expands rapidly snapping the worm back to its original position. In other words the energy stored in the spring during the greater portion of the worm actuates or pushes the worm to return it to its base position.

As mentioned above, the pitch of the base surface 18 of the worm and the pitch of the track 20 of bearing 8 are the same as that of the thread 19 of the worm. This causes the entire worm 13 to move axially forward during its rotation at the same rate as its threads traverse backwards, or more accurately at the same rate as a gear member in engagement with its thread would tend to rotate backward. In other words in my illustrated embodiment the effect of the axial movement of the worm 13 on the worm wheel 15 exactly counterbalances the effect transmitted thereto by the rotation of the thread 19 so that the worm wheel 15 remains stationary during the combined axial and rotatable movement of the worm 13. Since the combined axial and rotary movement of the worm 13 continues through practically all of each revolution thereof, the worm wheel 15 thus remains stationary most of the time. However, when the ends or transverse portions of the spiral tracks 18 and 20 come into alignment, the energy stored in the spring snaps the worm 13 back to its base position and this reverse axial movement of the worm transmits a sudden impulse to the worm wheel. This sudden impulse in turn causes the worm wheel 15 to move quickly through a small angle. Specifically during the sudden return of the worm 13 to its base position, the worm wheel is moved through an angle equal to that subtended by its circular pitch. The time required to move the worm wheel through this angle, i. e., discharge the energy stored in the spring, is of course very small when compared to the time required to store the energy, and since this effect occurs once per revolution of the worm gear, the result is that an intermittent motion of the worm wheel is accomplished. In other words the cooperating gears 13 and 15 thus operate as an impulse mechanism in which the ouput gear is moved briefly and quickly once per revolution of the input gear.

The intermittent movement of gear 15 is of course transferred through the shaft 17 to the cam 16 keyed thereto. The resulting intermittent movement of the cam may then be used to control various switches, which switches themselves can be used to regulate the sequence of operations in automatic machines or the like. Since the cam itself in effect snaps from one position to another during its intermittent movement, inexpensive switches can be used in conjunction with it. Or more exactly the snap action of the cam obviates the need for a snap device being incorporated in the cooperating switches.

Thus is my preferred embodiment I have shown by way of example a switch 23 whose contacts 24 and 25 are mounted respectively on simple spring arms 26 and 27. The spring arm 26 has mounted at its outer end a cam follower 28 which engages the surface of the cam wheel 16. Normally the raised surface of the cam 16 holds cam follower 28 upwardly to keep the contacts 24 and 25 separated. However, when the cam follower is in

the recessed portion **29** of the cam surface, the contacts **24** and **25** will be closed.

As a result of my invention the make and break of the contacts in this simple switch is accomplished with a snap action effective to break the circuit connected to the contacts without any appreciable arcing occuring. Specifically at one point of the movement of the cam wheel one pulse or incremental movement thereof carries the cam follower into the recessed portion **29** of the cam surface to close the contacts; and at a somewhat later position of the cam wheel another pulse thereof carries the cam follower out of the recess to open the contacts. Since the closing and the opening of the contacts each result from a single pulse or movement of the cam, which pulse or movement occurs very rapidly due to the aforesaid escapement mechanism, the result is that the contacts themselves are engaged or separated very quickly. In this manner arcing at the contacts is substantially avoided.

In my preferred embodiment I have shown only one pair of contacts controlled by the cam **16**. It should however be understood that I contemplate switches in which a number of pairs of contacts are controlled by the cam, and in fact still other switches in which a plurality of cams are driven from the output gear of my impulse mechanism. Moreover, I realize that in these time switches it is usually desirable that means be provided whereby the output cam or cams may be adjusted relative to the controlled contacts. Such an adjustment feature is desirable in a timer since it is often wished to omit or vary certain portions of the cycle controlled thereby.

Thus in Fig. 5 I have shown a preferred means for manually adjusting the position of the output cam **16** relative to the cam follower **28**. In that structure the shaft **17** mounting the cam and the worm wheel is extended outwardly through a wall **30** of the switch **1** by means of a bearing **31**, the bearing **31** mounting the shaft and being firmly affixed to the wall **30**. The relationship between bearing **31** and shaft **17** is however such that the shaft may be moved axially with respect to the bearing. Since as mentioned above the gear **15** is firmly affixed to the shaft, axial movement of the shaft also causes movement of the gear. The cam **16** however does not move axially due to the axial play provided between it and the shaft by sliding key **17***a*. Therefore, when the shaft **17** is pushed inwardly by means of a dial **32** affixed on the end thereof, the gear **15** will also be moved inwardly as shown by the dotted lines, but the cam **16** will remain in engagement with cam follower **28**. This inward movement of the gear **15** clears or removes it from engagement with the worm **13**, and once it has been removed from engagement with the worm, the gear **15** and its driven cam **16** may then be turned freely. By so rotating the gear and cam once the gear has been freed from the worm, the position of the cam relative to the cam follower **28** is of course adjusted. When the cam has been set in the proper position, the dial is then pulled outwardly and the gear **15** again placed in engagement with worm **13**. The dial **32** may be calibrated or otherwise marked to show to what position the dial is adjusted.

Summing up, it may be seen that through my invention I have provided a new and improved electrical timing device in which the intermittent movement of the control cam permits the use of inexpensive switches but yet provides satisfactory operation substantially free from contact arcing or the like. The novel impulse mechanism which provides this intermittent movement of the output cam is itself simple and inexpensive to manufacture and assemble. The impulse mechanism not only has very few moving parts but may also be adapted readily to rugged construction to provide a long operating life. Further, this impulse mechanism provides positive

alignment between the input and the cam wheel without the use of auxiliary indexing mechanisms with their resultant power losses and chance of failure in operation. Moreover, since the output gear may be manually freed from and rotated with respect to the input gear, this mechanism allows variation of the operating effects of the switch or other device in which it is incorporated.

In accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my invention. However, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. An electrical timing device comprising a worm gear movable axially and rotatably, a worm wheel mating with said worm gear, electrical means for rotating said worm gear, means for moving said worm gear axially in one direction during the rotation thereof with the axial movement of said worm gear and the pitch thereof being correlated to cause said worm wheel to remain stationary during the combined axial and rotary movement of said worm gear, means for storing energy during said combined movement, means actuated by said stored energy for moving said worm gear rapidly in the reverse axial direction after a predetermined displacement thereof in said one direction thereby to cause intermittent movement of said worm wheel, a pair of contacts, a movable member for controlling said contacts, a cam driven by said worm wheel for positioning said member, and manually actuated means for removing said worm wheel from engagement with said worm gear and for rotating said worm wheel independently of said worm gear, whereby said cam may be set to actuate said member to operate said contacts after different periods of rotation of said worm gear.

2. An electrical time switch comprising a worm gear movable axially and rotatably, a worm wheel mating with said worm gear, means including an electric motor for rotating said worm gear, a stationary member engaging said worm gear and adapted to cause said worm gear to move axially in one direction during the rotation thereof whereby no turning effect is applied to said worm wheel during the combined axial and rotary movement of said worm gear, a spring engaging said worm gear and biased by the axial movement of said gear in said one direction, means included in said stationary member and said worm gear permitting reverse axial movement of said worm gear after a predetermined displacement thereof in said one direction, with said spring forcing said worm gear in the reverse direction and causing said reverse axial movement to occur rapidly thereby to effect intermittent movement of said worm wheel, a pair of contacts, a movable member for controlling said contacts, a cam driven by said worm wheel for positioning said member, and manually actuated means for removing said worm wheel from engagement with said worm gear and for rotating said worm wheel independently of said worm gear, whereby said cam may be set to actuate said member to operate said contacts after different periods of rotation of said worm gear.

3. An electrical timing device comprising a worm gear movable axially and rotatably and having a spiral base surface, a worm wheel engaging said worm gear, means including an electrical motor and reduction gears for rotating said worm gear, a stationary member having a spiral track engaging said base surface and adapted to cause said worm gear to move axially in one direction during the rotation thereof whereby no turning effect is applied to said worm wheel during the combined axial and rotary movement of said worm gear, said spiral track and

said base surface including cooperating transverse portions permitting said worm gear to move in the reverse axial direction to a base position after moving a predetermined distance in said one direction, a spring engaging said worm gear and adapted to be compressed during the movement of said worm gear in said one direction, said spring biasing said worm gear toward said stationary member and causing said worm gear to move rapidly in said reverse direction to said base position upon said worm gear having moved said predetermined distance in said one direction thereby to effect intermittent movement of said worm wheel, a pair of contacts, a movable member for controlling said contacts, a cam driven by said worm wheel for positioning said member, and manually actuated means for removing said worm wheel from engagement with said worm gear and for rotating said worm wheel independently of said worm gear, whereby said cam may be set to actuate said movable member to operate said contacts after different periods of rotation of said worm gear.

4. An electrical timing device comprising a rotatable shaft, a spur gear mounted on said shaft for turning said shaft, a worm gear mounted on said shaft and having a spiral base surface, said worm gear being movable axially and rotatably on said shaft, a spring mounted between said spur gear and said worm gear for driving said worm gear at the same rotational speed as said shaft, a worm wheel engaging said worm gear, an axially movable output shaft mounting said worm wheel, a stationary member having a spiral track engaging said base surface of said worm gear and adapted to cause said worm gear to move axially in one direction during the rotation thereof whereby no turning effect is applied to said worm wheel during the combined axial and rotary movement of said worm gear, said spiral track and said base surface including cooperating transverse portions permitting said worm gear to move in the reverse axial direction to a base position after moving a predetermined distance in said one direction, said spring being compressed during the movement of said worm gear in said one direction and biasing said worm gear toward said stationary member, whereby said spring causes said worm gear to move rapidly in said reverse direction to said base position upon said worm gear having moved said predetermined distance in said one direction thereby to effect intermittent movement of said worm wheel, a pair of contacts, a cam follower for controlling said contacts, a cam mounted on said output shaft and driven by said worm wheel for actuating said cam follower, and a dial fixedly mounted on the end of said output shaft for moving said output shaft axially to remove said worm wheel from engagement with said worm gear and for rotating said output shaft, said cam, and said worm wheel independently of said worm gear, whereby said cam may be set to actuate said cam follower to operate said contacts after different periods of rotation of said worm gear, said dial being calibrated to indicate the angular position of said output shaft and said cam.

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