

[54] **TIME DELAY RELAY**

[72] Inventors: **Arthur W. Haydon**, Middlebury; **Harry E. Crossley**, Cheshire, both of Conn.

[73] Assignee: **Tri-Tech, Inc.**, Waterbury, Conn.

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[51] Int. Cl. **H01h 43/14**

[58] Field of Search 335/68, 71, 72, 73, 74, 75, 335/76, 63; 200/33, 38; 74/1.5, 25, 527, 568

[56] **References Cited**

UNITED STATES PATENTS

2,325,860	8/1943	Kizaur	335/72
2,506,784	5/1950	Haydon	74/25
2,826,650	3/1958	Coulombe et al.	200/38 A

2,932,980 4/1960 Nestlerode et al. 74/527

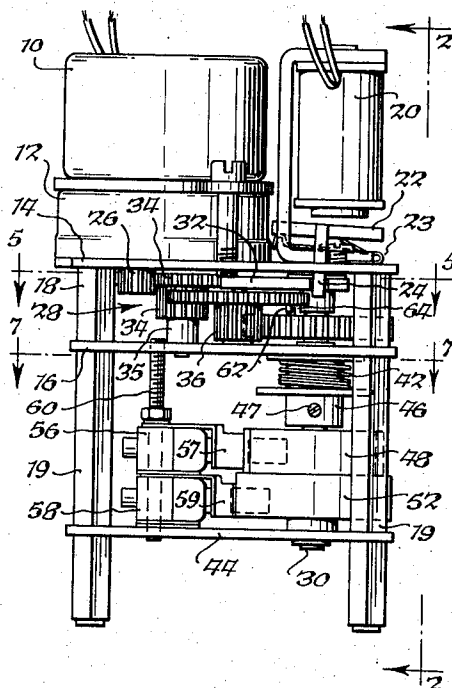
Primary Examiner—Harold Broome

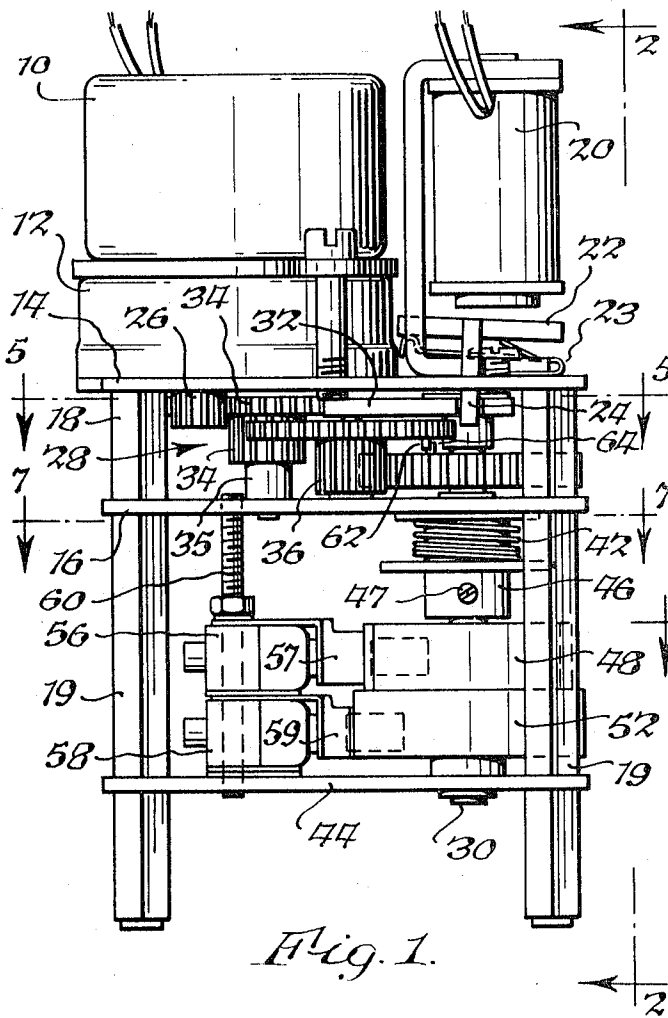
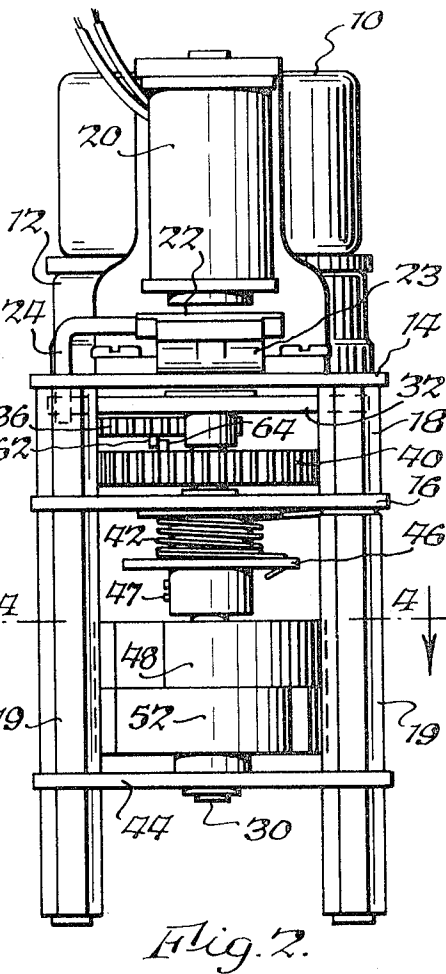
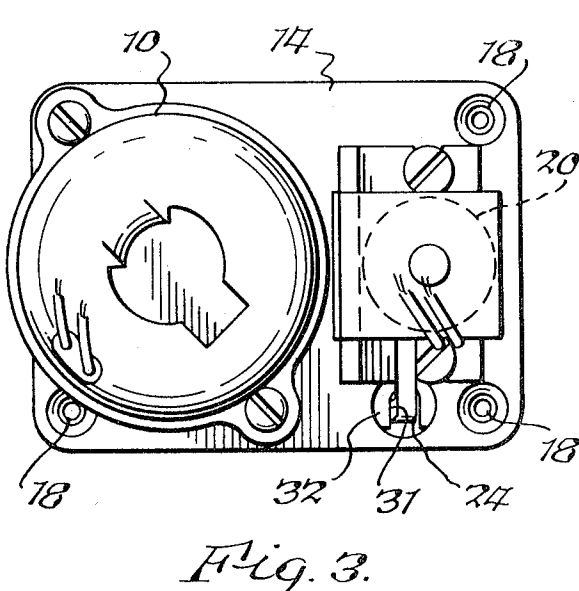
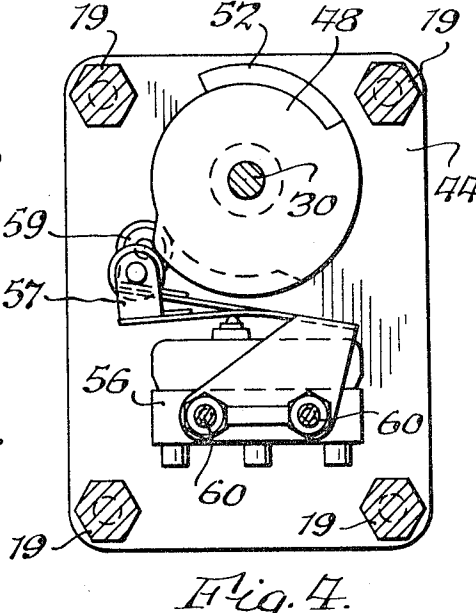
Attorney—Lee C. Robinson, Jr.

[57] **ABSTRACT**

One or more timing switches are operated by cams driven through a gear train by a constant speed motor. After turning through a predetermined cycle a portion of the gear train is disconnected from the motor by a solenoid actuated lever arm and the gear train and cams are reset by a coiled return spring. A pair of projecting lugs mounted on the faces of a pair of adjacent gears engage with each other to stop the reset operation and ensure that the gear teeth are in precise alignment when the driving motor is reengaged. In one embodiment, the motor is capable of being stopped substantially instantaneously, thereby allowing the gears to be remeshed after being reset with a minimum of gear slippage.

9 Claims, 12 Drawing Figures





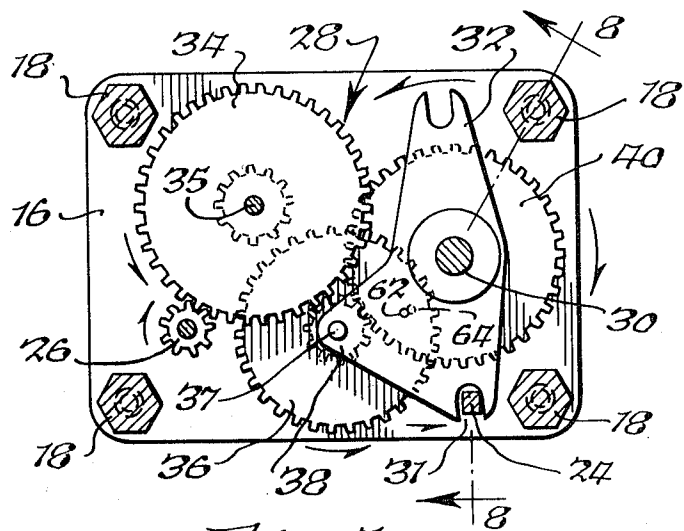


Fig. 5.

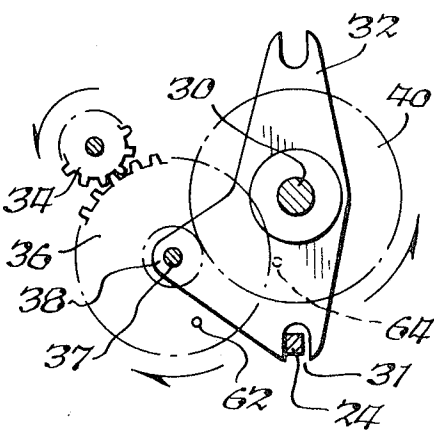


Fig. 6.

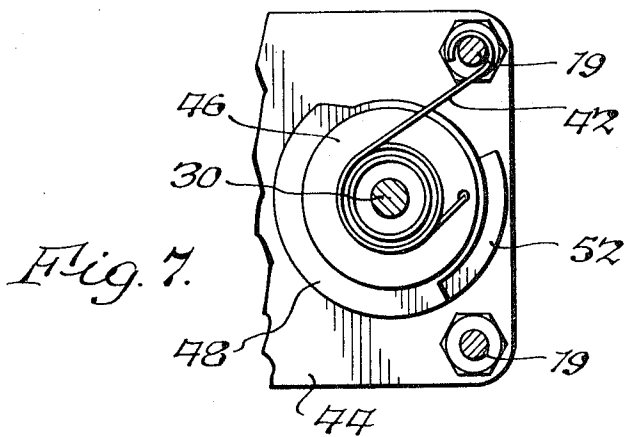


Fig. 7.

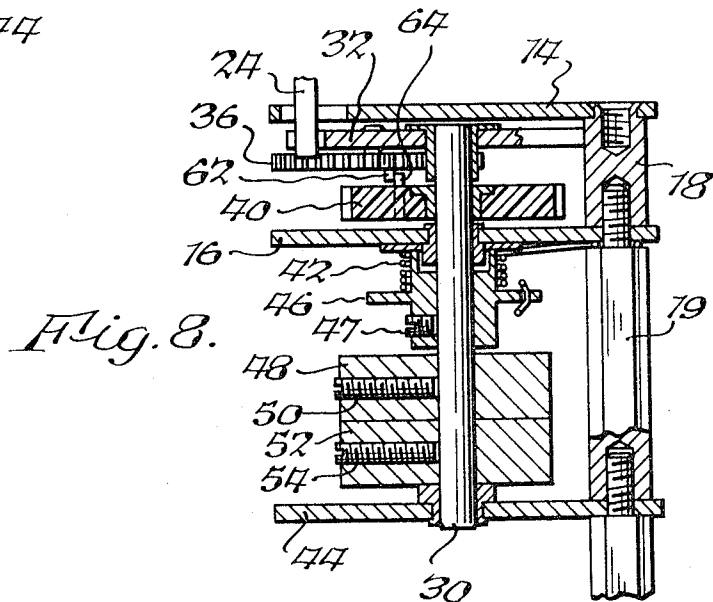


Fig. 8.

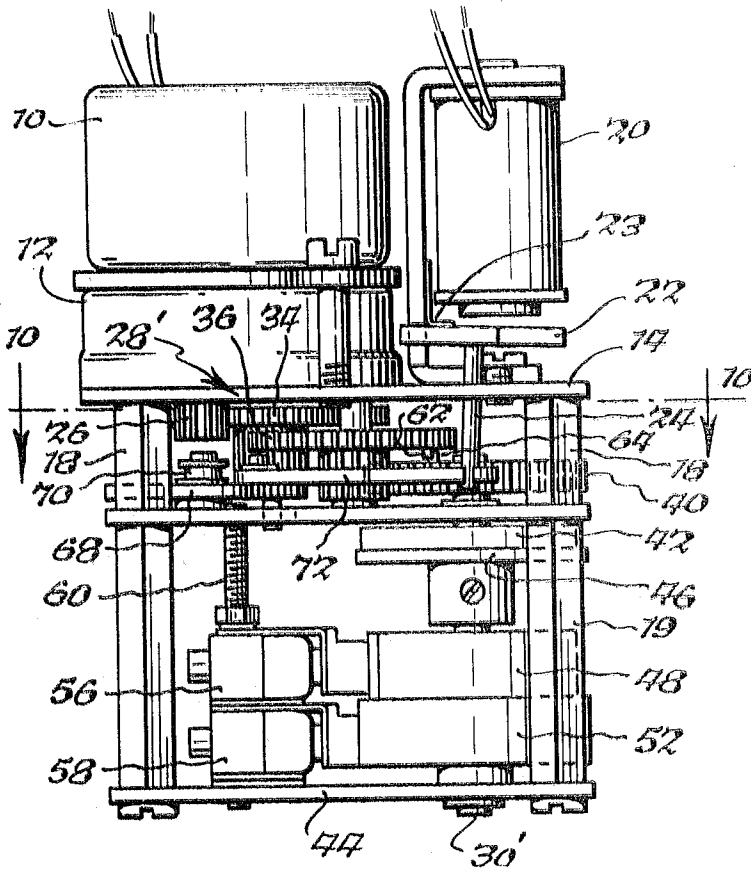


Fig. 9.

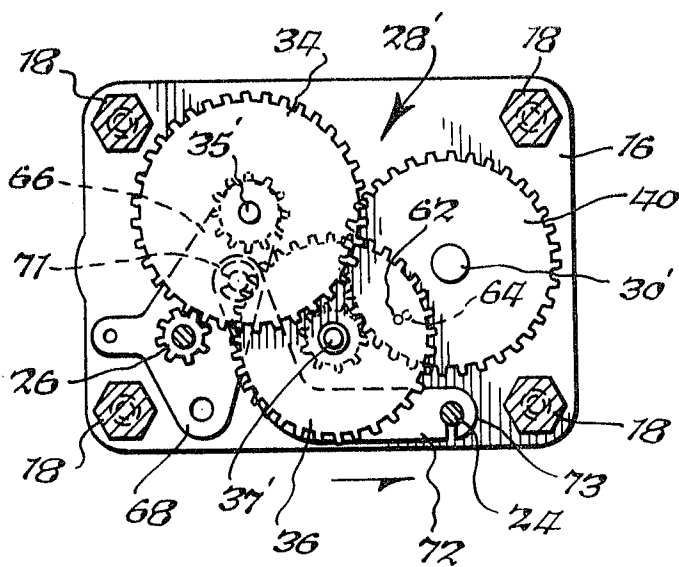


Fig. 10.

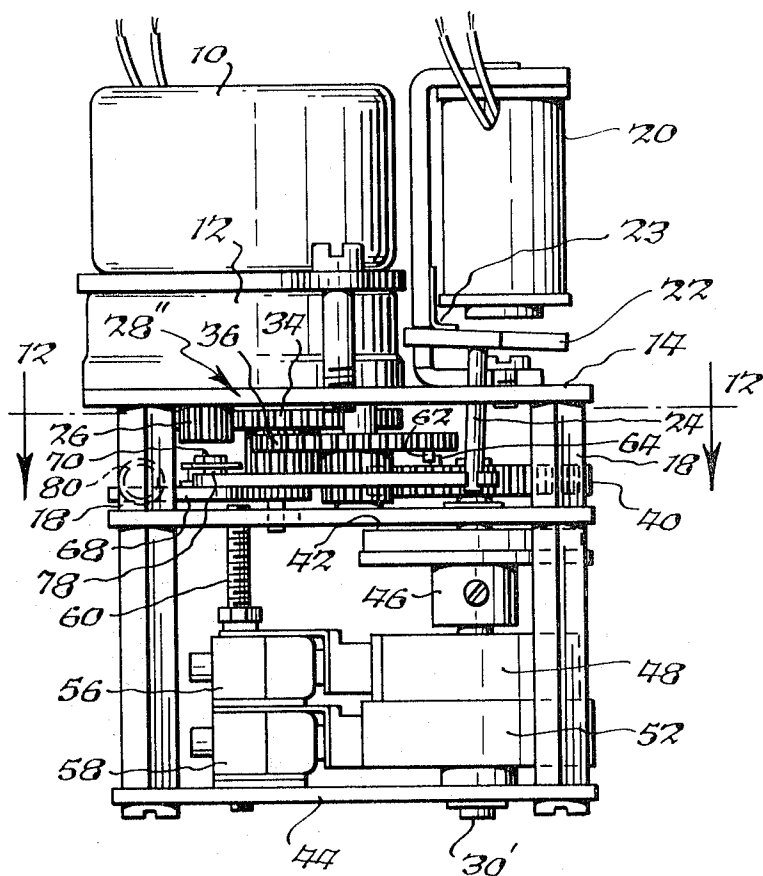


Fig. 11.

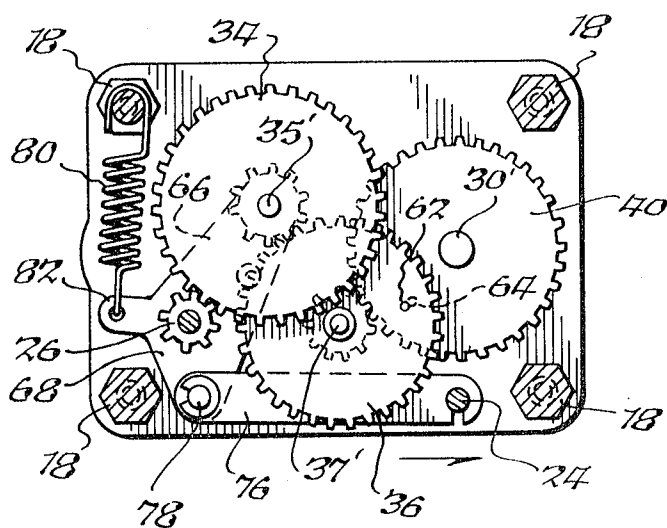


Fig. 12.

TIME DELAY RELAY

BACKGROUND OF THE INVENTION

The present invention relates to timing devices and more particularly to cam operated timing switches wherein the cams are turned through a gear train by a constant speed motor for a predetermined cycle. In certain applications such devices are called time delay relays. At the end of the cycle the motor is disconnected from the gear train and a spring rotates the gears in the opposite direction to reset them for another cycle.

One of the problems in timing switches of this type is to make sure that the gear teeth of the drive train mesh precisely when the device is reset.

SUMMARY OF THE INVENTION

The above and other disadvantages are overcome by the present invention comprising a substantially constant speed motor, a gear train driven by the motor, one or more timing cams rotatably mounted on a shaft and driven by the gear train, one or more timing switches which are operated by the cams, and electro-mechanical means for disconnecting the motor from a portion of the gear train and for resetting the gears to a predetermined position in precise alignment wherein a pair of projecting lugs mounted on the faces of a pair of adjacent gears are in contact with each other.

The electro-mechanical resetting means includes a reset coil spring and a solenoid. The coil spring has one end attached to a hub mounted on the cam shaft and the other end attached to a fixed frame. The spring is coiled in such a manner as to resist the cam shaft's direction of rotation when it is being driven by the motor. In one embodiment the solenoid, when energized by an electrical signal, moves a pivoted actuating arm to disengage one of the gears in the drive train. In other embodiments the solenoid, when energized, causes the actuating arm to move a select gear into engagement with the gear train.

In both embodiments when the select gear is disengaged from the gear train, the cams are returned to their initial condition by the reset spring. The pair of projecting lugs mounted on the faces of two adjacent gears in the gear train stop the rotation of the gears during the reset operation, leaving the gear teeth aligned so that they will mesh precisely when the device is reset. In some embodiments, a motor capable of being stopped substantially instantaneously is employed so that the motor pinion meshes with the gears aligned by the reset operation when the device is reactivated to time the next interval.

It is an object of the present invention to provide a time delay relay having a mechanism for precisely resetting the gears of the gear train.

It is another object of the invention to provide a mechanism for accurately timing a short interval upon activation by a control signal.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view in elevation of one embodiment of the invention;

FIG. 2 is a side view in elevation taken generally along the line 2—2 of FIG. 1;

FIG. 3 is a top plan view of the embodiment of FIG. 1;

FIG. 4 is a horizontal view in section taken generally along the line 4—4 of FIG. 2;

FIG. 5 is a horizontal view in section taken generally along the line 5—5 of FIG. 1, showing the drive gears disengaged;

FIG. 6 is a diagrammatic view representative of FIG. 5 showing the drive gears as they would appear when engaged and driving;

FIG. 7 is a fragmentary horizontal view in section taken generally along the line 7—7 of FIG. 1;

FIG. 8 is a vertical view in section taken generally along the line 8—8 of FIG. 5;

FIG. 9 is a side view in elevation of a second embodiment of the invention;

FIG. 10 is a horizontal view in section taken generally along the line 10—10 of FIG. 9;

FIG. 11 is a side view in elevation of a third embodiment of the invention;

FIG. 12 is a horizontal view in section taken generally along the line 12—12 of FIG. 11.

DESCRIPTION OF CERTAIN PREFERRED EMBODIMENTS

Referring now more particularly to FIG. 1, a substantially constant speed motor 10 driving an encased reduction gear assembly 12 is mounted on a flat deck 14. The motor 10 illustratively may be of the AC synchronous type, such as the motor disclosed in U.S. Pat. No. 3,495,113 issued on Feb. 10, 1970 to A. W. Haydon. The motor disclosed in that patent is capable of being stopped substantially instantaneously by interrupting its supply of electrical power. When stopped, the motor shaft, or pinion driven by the shaft, is oriented in a discrete position.

Another flat deck 16 is held in a parallel spaced-apart relationship with the deck 14 by four posts 18 at each corner of the decks 14 and 16. Also mounted on the deck 14 is a solenoid 20 having a "T" shaped armature or clapper 22 which is pivotally mounted on a leaf spring 23 on the deck 14. The clapper has a leg 24 which extends through an aperture in the deck 14.

A pinion gear 26 extends from the reduction gear housing 12 and passes through the deck 14 to project from the opposite side of the deck 14. A plurality of gears generally designated as 28 are mounted on separate shafts having their ends bearinged between the decks 14 and 16. The gears serially engage with each other and with the motor pinion 26 to drive a cam shaft 30. The shaft 30 has portions bearinged in the deck 16 and still another deck 44, held in a parallel, spaced-apart relationship with the deck 16 by four corner posts 19. Pivotally mounted on the shaft 30 is an actuating arm 32 whose purpose will become more apparent below.

With reference now more particularly to FIGS. 5 and 6 the motor pinion, as viewed in FIGS. 5 and 6 rotates in a clockwise direction to drive a primary gear 34 in a counter-clockwise direction. The gear 34 is rotatably mounted on a shaft 35 having its ends bearinged in the decks 14 and 16. The teeth of the reduced portion of the gear 34 as normally aligned engage the teeth of the enlarged portion of a gear 36 to turn it in a clockwise direction, as viewed in FIG. 6.

The gear 36 is rotatably mounted on a shaft 37 having one end bearinged in an elongated aperture in the deck 16 and the other end bearinged in an extension 38 of the actuating arm 32. The reduced portion of the gear 36 drives still another gear 40 mounted between the two decks 14 and 16 on the cam shaft 30. As the shaft 30 is rotated in a counter-clockwise direction by the gear 40 a resilient reset spring 42, mounted about the cam shaft 30 between the decks 16 and 44 is coiled to exert a counter-torque on the cam shaft 30. The purpose of this spring will become more apparent with the description of the reset operation below.

Referring now more particularly to FIG. 8, mounted on the cam shaft 30 between the deck 16 and the deck 44, is a drum 46 held in place by a set screw 47 on which the reset spring 42 is coiled. One end of the reset spring is fastened to the drum and the other end is fastened to a corner post 19. Also mounted on the cam shaft are a first cam 48, held in place on the shaft by a set screw 50, and a second cam 52, held in place by a set screw 54.

As shown more clearly in FIGS. 1 and 4, a pair of microswitches 56 and 58 are mounted on a pair of bolts 60 fitted between the decks 16 and 44. The switches 56 and 58 are held in a spaced-apart relationship with the cams 48 and 52 and have roller arms 57 and 59, respectively, which are operated by raised portions on the cams as the cams are rotated by the shaft 30.

When the motor has caused the cam shaft 30 to rotate the cams 48 and 52 through a predetermined cycle, an electrical pulse is applied either manually or automatically to the solenoid 20, energizing it, and causing the clapper 22 to pivot and move its projecting leg 24 in a direction away from the motor as indicated by the arrow adjacent the leg 24 in FIG. 5. The end of the leg 24 is fitted into a slot 31 in the actuating arm 32 so that the movement of the leg pivots the arm 32 in a counter-clockwise direction as indicated by the arrow adjacent the arm 32 in FIG. 5.

The rotation of the arm 32 disengages the teeth of the gear 36 from the gear 34, as illustrated in FIG. 5, thereby releasing the reset spring 42. The spring 42 thereafter uncoils, rotating the cam shaft 30 and the gear 40 in a clockwise direction and the gear 38 (through the gear 40) in a counter-clockwise direction as viewed in FIG. 5.

The gears 36 and 40 rotate backwards until such time as a projecting stop lug 62 on the under surface of the gear 36 engages with a projecting stop lug 64 mounted on the upper surface of the gear 40 as viewed in FIGS. 1, 2 and 5. When the two lugs contact each other, the reset rotation is stopped and the gears 36 and 40 are precisely aligned and set for reengagement with the gear 34.

Referring now more particularly to FIGS. 9 and 10 a second embodiment of the invention is shown comprising the basic structure of the embodiment of FIGS. 1-8 but with a modified means for disengaging a portion of the gear train from the motor in order to reset the device. Elements of the embodiment of FIGS. 9 and 10 which correspond to substantially the same elements of the embodiment of FIGS. 1-8 have been designated with the same reference numbers.

In this second embodiment a portion of a gear train 28' is brought into engagement with the motor pinion 26 when the solenoid 20 is energized by the application of an electrical control signal. The relay is reset by terminating the control signal to deenergize the solenoid and disengage the gear train 28'. The disengagement of the gear train allows the coil reset spring 42 to return the gears to their original positions. The gear 40 is mounted on the cam shaft 30' and is turned by a gear 36 mounted on a shaft 37'. In contrast to the embodiment of FIG. 1 the shaft 37', instead of having one end bearing in an actuating arm has its ends bearing in the decks 14 and 16.

The primary drive gear 34 is mounted on a shaft 35' bearing in an extension 66 of an actuating arm 68 which is pivotally mounted by a pin 70 to the deck 16. The ends of the shaft 35' are fitted in elongated recesses (not shown) in the decks 14 and 16 such that the shaft may be moved in an arc by the actuating arm 68 about the pin 70 without becoming disengaged from the pinion 26. A lever arm 72, generally "L" shaped, has one leg 71 pivotally mounted on the actuating arm 68 between the pin 70 and the shaft 35'. The other leg 73 is mounted with its end fitted about the leg 24 of the clapper. The bias spring 23 normally forces the leg 24 in a direction generally towards the pinion 26. This moves the actuating arm 68 to disengage the gear 34 from the gear 36.

When it is desired to time an interval, an electrical pulse is applied to the solenoid 20, energizing it, and thereby causing the clapper 22 to pivot and move the leg 24 in a direction away from the motor pinion 26 as illustrated by the arrow in FIG. 10. The motion of the clapper leg 24 moves the actuating arm 72 in the same direction and causes the actuating arm 68 to pivot the gear 34 clockwise, as viewed in FIG. 10, into engagement with the gear 36. Thereafter the timing mechanism operates in substantially the same manner as the timing mechanism of FIGS. 1-8. The gear 36 turns the gear 40 which rotates the shaft 30' and causes the cams 48 and 52 to operate the microswitches 56 and 58.

At the end of the timing interval, the electrical pulse is removed from the solenoid 20, deenergizing it, and causing the actuating arms 72 and 68 to disengage the gear 34 from the gear 36. The coil spring 42 thereafter resets the gears 36 and 40 in the same manner as was described for the embodi-

ment of FIG. 1. When the projecting stop lugs 62 and 64 contact each other to stop the reset operation, the gears are precisely aligned so that they mesh correctly when the gear train 28' is next engaged.

Referring now more particularly to FIGS. 11 and 12 still another embodiment of the invention is shown as a modified form of the embodiment of FIGS. 9 and 10. As in the first embodiment described in reference to FIGS. 1-8, a gear train 28' is normally engaged with the motor pinion 26. The mechanism is reset by energizing the solenoid 20. The modification of the embodiment of FIGS. 9 and 10 is basically in the replacement of the "L" shaped lever arm 72 with a straight lever arm 76. The lever arm 76 is pivotally mounted at one end to the clapper leg 24 and at the other end to a pin 78 protruding from the surface of the actuating arm 68. The pin 78 is located on the opposite side of the pin 70 from the shaft 35'.

The clapper biasing spring 23 forces the leg 24 in a direction generally toward the motor pinion 26. The force exerted by the leg 24 on the lever arm 76 is transferred to the actuating arm 68 through the pin 78, causing the actuating arm 68 to pivot in a clockwise direction as viewed in FIG. 12. The clockwise torque of the actuating arm 68 keeps the gear 34 engaged with the gear 36 and the device proceeds to time a specified interval when power is applied to the motor 10 in the same manner as described above in reference to the embodiment of FIGS. 9 and 10.

At the completion of the timing interval, the solenoid 20 is energized, causing the clapper 22 to pivot and move the leg 24 in a direction away from pinion 26 as indicated by the arrow in FIG. 12. The movement of the leg 24 draws the lever arm 76 in the same direction and thereby causes the actuating arm 68 to pivot in a counter-clockwise direction as viewed in FIG. 12. The pivoting of the actuating arm 68 disengages the gear 34 from the gear 36. With the remaining portion of the gear train thus disengaged from the motor pinion 26, the reset spring 42 returns the gears 36 and 40 to their original position with the stop pins 62 and 64 in contact with each other. The gears are thus left in alignment for precise meshing when the device is reactivated to time another interval.

In some variations of the embodiments of FIGS. 9 and 10 and 11 and 12 a bias spring 80 is attached between a protrusion 82 on the actuating arm 68 and one of the corner posts 18 to hold the actuating arm 68 in a desired position when the solenoid 20 is not energized, as illustrated in FIGS. 11 and 12.

In all of the above described embodiments the activation of the motor and the activation of the solenoid have been described as though done manually. It is also possible to operate the above embodiments in a semi-automatic mode by connecting the solenoid in series with one or more of the cam operated switches. Thus in modified forms of the embodiments of FIGS. 1-8 and 11-12 one of the switches is normally open, leaving the solenoid deenergized, while the motor turns the gears through a timing interval and coils the reset spring 42. At the end of the timing cycle a raised portion of the cam surface closes the switch, thereby energizing the solenoid, and also thereby resetting the mechanism in the manner described above. The mechanism continues to operate in such a semi-automatic manner as long as power is supplied to the motor.

Conversely, with respect to a modified embodiment of FIGS. 9 and 10 the control switch is normally closed, thereby supplying power to the solenoid and also thereby causing the motor pinion to engage with the gear train 28' throughout the timing of the interval. At the end of the timing cycle a raised portion of one of the cam surfaces opens the switch, deenergizes the solenoid, and thereby resets the device. Again the device continues on a semi-automatic basis as long as power is supplied to the motor and solenoid circuits.

While a particular type of motor has been suggested in the above description as being especially advantageous because of its substantially instant stopping capabilities in other embodiments other substantially constant speed motors or stepper motors, even types without the ability to stop substantially instantaneously, may be employed.

Also a stepper motor may be substituted for the synchronous motor, so that the switch will operate after a predetermined number of pulses have been received by the motor.

The terms and expressions which have been employed here are used as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described, or portions thereof, it being recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A switch operating device comprising a motor, a gear train driven in a predetermined direction by the motor, a shaft rotated by the gear train, means for rotatably mounting the shaft, at least one cam mounted on the shaft, the cam having at least one lobe, at least one switch, means for mounting the switch in a spaced-apart relationship with the cam such that the switch is operated by the lobe of the cam, means for disengaging a first portion of the gear train from the remainder of the gear train, the first portion including a first gear and a second gear driven by the first gear, resilient means for resetting the first portion of the gear train by rotating the first portion of the gear train in the reverse of the predetermined direction while it is disengaged, a first lug protruding from the first gear, a second lug protruding from the second gear, the first and second lugs being arranged to contact each other when the gear teeth of the first and the second gears are in a predetermined alignment with each other to stop the resetting of the first portion of the gears by the resilient means.

2. A switch operating device as recited in claim 1 wherein the means for disengaging the first portion of the gear train comprises a solenoid, a clapper, means for pivotally mounting the clapper adjacent the solenoid such that when the solenoid is energized by the application of an electrical signal the clapper will be caused to pivot, an actuating arm, means for pivotally mounting the actuating arm, the actuating arm having a first portion adapted for rotatably supporting a select one of the gears of the gear train such that when the actuating arm is pivoted in a predetermined direction the select gear is withdrawn from engagement with at least one other gear of the gear train, means for transferring the force exerted by the clapper when it pivots to the actuating arm to cause the actuating arm to pivot.

3. A switch operating device as recited in claim 1 wherein the resilient means comprises a coil spring, means for holding one end of the coil spring in a fixed position and means for holding the other end of the coil spring in a fixed relationship with the shaft such that when the motor rotates the shaft through the gear train the coil spring exerts a counter-torque upon the shaft.

4. A switch operating device as recited in claim 1 wherein the motor has a drive shaft and is capable of being stopped substantially instantaneously with the drive shaft in a predetermined rotational orientation.

5. A time delay relay comprising a substantially constant speed motor, a gear train driven by the motor including a first gear and a second gear driven by the first gear, a shaft rotated by the gear train, means for rotatably mounting the shaft, at least one cam mounted on the shaft, the cam having at least one lobe, at least one switch, means for mounting the switch in a spaced-apart relationship with the cam such that the switch is operated by the lobe of the cam as the cam is rotated by the shaft, an actuating arm, means for pivotally mounting the actuating arm, the actuating arm having a first portion, a second shaft for rotatably mounting the first gear, the second shaft being bearinged in the first portion of the actuating arm, electro-mechanical means for causing the actuating arm to pivot and disengage the first gear from that portion of the gear train

which is driven by the motor upon the application of an electrical signal to the electro-mechanical means, resilient means for resetting the first and second gears by rotating the first and second gears backwards while the first gear is disengaged from the gear train, a first lug protruding from the first gear, a second lug protruding from the second gear, the first and second lugs being arranged on the surfaces of the gears so as to contact each other when the gear teeth of the first and second gears are in a predetermined alignment with each other as the first and second gears are rotated backward by the resilient means.

6. A time delay relay as recited in claim 5 wherein the electro-mechanical means comprises a solenoid, an armature, means for movably mounting the armature adjacent the solenoid such that when the solenoid is energized by the application of an electrical signal the armature is caused to move, means for transferring a force exerted by the moving armature to the actuating arm to cause the actuating arm to pivot.

7. A time delay relay as recited in claim 6 wherein the electro-mechanical means comprises an armature in the form of a clapper, means for pivotally mounting the clapper, the clapper having a protruding leg which sweeps through an arc as the clapper is pivoted, and a lever arm, the lever arm having one end which is pivotally mounted to the actuating arm and another end which is fitted to the clapper leg such that when the solenoid is energized the clapper is pivoted and the lever arm is moved to exert a force on the actuating arm thereby causing it to pivot.

8. A switch operating timing device comprising a substantially constant speed motor, a gear train having a first and second portion, the first portion being driven in a predetermined direction by the motor, a cam shaft driven by the second portion of the gear train, means for rotatably mounting the cam shaft, at least one, lobed cam mounted on the cam shaft, a switch, means for mounting the switch in a spaced-apart relationship with the cam such that the switch is operated by the lobe of the cam as the cam is rotated by the cam shaft, electro-mechanical means for engaging and disengaging the first portion of the gear train with the second portion of the gear train upon the selective application of an electrical signal from an external source, resilient means for resetting the second portion of the gear train by rotating the gears within the second portion backwards while the first portion of the gear train is disengaged from the second portion of the gear train, the second portion of the gear train including a first gear and a second gear opposite the first gear and driven by it, the first and second gears each having opposing, substantially flat surfaces, a first lug protruding from the opposed flat surface of the first gear, a second lug protruding from the opposed flat surface of the second gear, the first and second lugs being arranged to contact each other when the gear teeth of the first and the second gears are in a predetermined alignment with each other to stop the resetting operation of the second portion of the gear train.

9. A switch operating timing device as recited in claim 8 wherein the electro-mechanical means comprises an actuating arm, means for pivotally mounting the actuating arm, the actuating arm having a first portion, a gear shaft for rotatably mounting a select gear of the first portion of the gear train, the gear shaft being bearinged in the first portion of the actuating arm, a solenoid, an armature, means for mounting the armature with respect to the solenoid such that when the solenoid is energized by the application of an electrical signal the armature is caused to move, means for transferring the force exerted by the armature when it moves to the actuating arm to cause the actuating arm to pivot and engage the select gear of the first portion of the gear train with the second portion of the gear train.

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