June 2, 1964 T. O. LILLQUIST 3,135,847

TIME DELAY RELAY

Filed Sept. 22, 1961

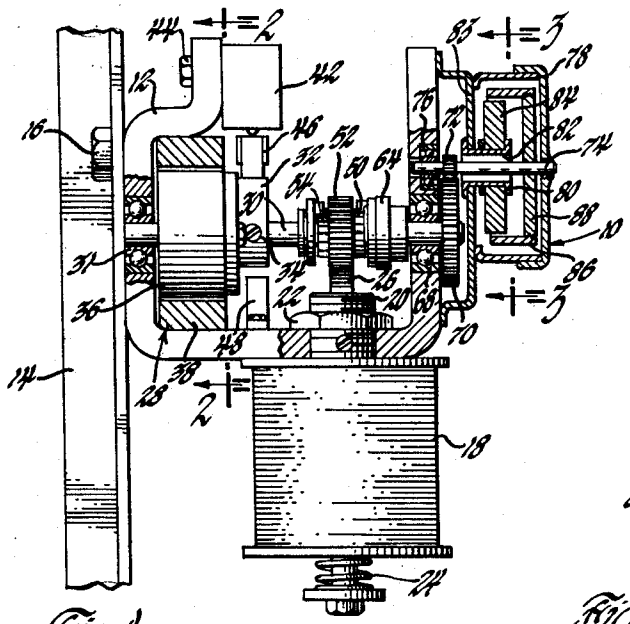

Fig. 2

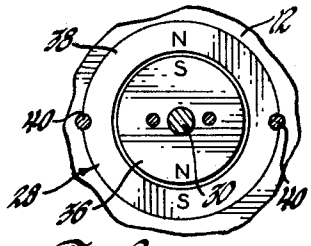

Fig. 2

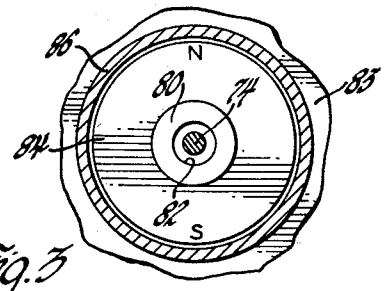

Fig. 3

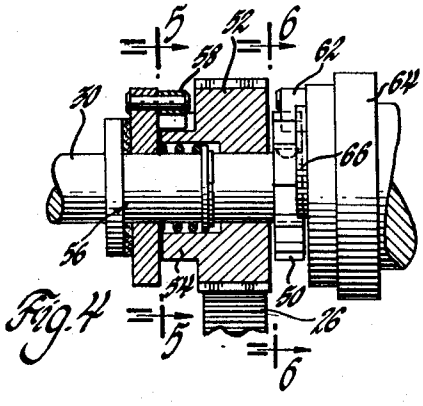

Fig. 4

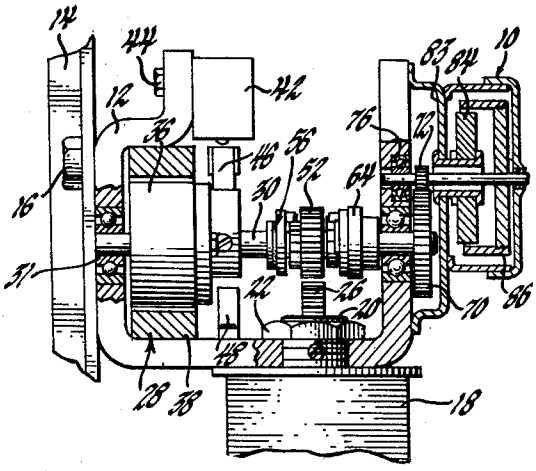

Fig. 7

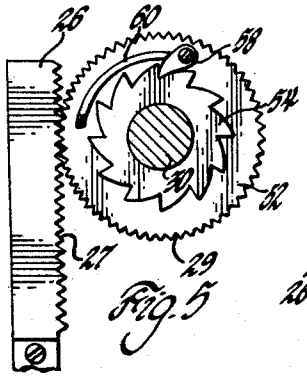

Fig. 5

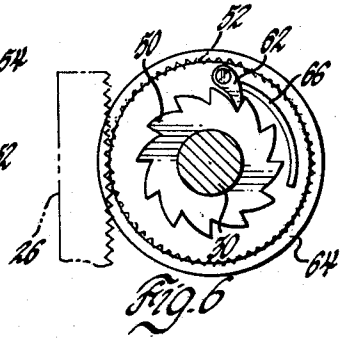

Fig. 6

INVENTOR.
Torsten O. Lillquist
BY
Paul J. Reising
ATTORNEY

United States Patent Office 3,135,847 Patented June 2, 1964

3,135,847
TIME DELAY RELAY

Torsten O. Lillquist, La Grange, Ill., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Filed Sept. 22, 1961, Ser. No. 139,938
6 Claims. (Cl. 200—97)

This invention relates to a time delay relay of the type that provides a predetermined time interval or delay between the energization of the relay and the closing or opening of an associated switch.

In the past, various forms of devices such as spring or counterweight levers have been utilized in time delay relays for the storage of energy for subsequent utilization in actuating a retarding mechanism that serves to control the time delay period. When utilizing a spring type device, an uncontrollable variable period occurs before the energy being stored in the spring can commence to operate, resulting in variation of a timed interval between the opening or closing of the switch contacts. Likewise, problems have occurred with a counterweight lever device in that the latter usually is composed of a weight threaded on a shaft. This arrangement can cause a variance in the time delay period in that the weight may reposition itself along the lever, and thereby fail to maintain a constant source of energy. Similarly, various devices have been provided for delaying or retarding the time involved for dissipating the stored energy. The dash pot is the most common device utilized and, for the most part, these devices are found to be mechanically defective when utilized for a sustained period.

The purpose of this invention is to alleviate the defects of the previous devices by providing a time delay relay having a magnetic arrangement for storing energy and for controlling the dissipation of this energy during a predetermined time interval. Briefly, the invention comprehends a time delay relay wherein a switch is actuated by a rotatable cam that is associated with a torque motor for receiving and storing energy during the rotation of the cam, and with a magnetic brake for controlling the return movement of the torque motor and the cam; suitable clutch means being provided for engaging and disengaging the magnetic brake with the cam and torque motor.

The above and other features of the invention will be readily ascertainable from the following description of a preferred embodiment made with reference to the accompanying drawings in which:

FIGURE 1 is an elevation view with parts broken away and in section of a time delay relay incorporating the present invention;

FIGURE 2 is a sectional view taken on lines 2—2 of FIGURE 1;

FIGURE 3 is a sectional view in an enlarged form taken on lines 3—3 of FIGURE 1;

FIGURE 4 is an enlarged view with parts broken away of a one-way clutch arrangement employed by the time delay relay of FIGURE 1;

FIGURE 5 is a sectional view taken on lines 5—5 of FIGURE 4;

FIGURE 6 is a sectional view taken on lines 6—6 of FIGURE 4; and

FIGURE 7 is another view of the device shown in FIGURE 1 with some parts thereof repositioned.

Referring now to the drawings, FIGURE 1 illustrates a time delay device or relay including a U-shaped support bracket 12 that is fastened to a vertically extending beam 14 by a bolt 16. An electromagnetic device or solenoid 18 is screwed into the lower portion of the bracket 12 by a threaded portion 20 with a hexagonal nut 22 securely mounting the solenoid 18 to the bracket 12. For purposes which will hereinafter be explained, the hexagonal

nut 22 may adjustably position the solenoid so that the latter is movable in a vertical direction with respect to the bracket. The solenoid 18 includes an armature normally biased into a downward position by a spring 24. The upper end of the armature is formed as a rack 26, and as best seen in FIGURE 5, consists of an elongated bar having a plurality of teeth 27 formed on one side thereof with a tooth free portion disposed below the teeth. The rack teeth 27 mate with teeth 29 of a pinion gear 52 that is rotated by the rack upon energization of the solenoid.

A torque motor, generally indicated by the numeral 28, is mounted on a rotatable shaft 30 that has an adjustable cam 32 fixed thereby by a screw 34. One end of the shaft 30 is journaled in a ball bearing 31 while the other end is associated with a dual one-way clutch arrangement that will hereinafter be described. As best viewed in FIGURE 2, the torque motor 28 includes a cylindrical rotor 36 that is magnetized with North and South polarities at points diametrically opposite to each other, and is concentrically located in a ring-type stator 38 that is rigidly connected to the support 12 by a pair of pins 40. As in the case of the rotor, the stator 38 is magnetized with North and South polarity at points diametrically opposed to each other resulting in an arrangement wherein the unlike poles of the stator and rotor attract each other and maintain the rotor in the position shown in FIGURE 2.

Immediately above the cam 32, a switch 42 is fixed to the bracket 12 by a screw 44. An intermediate member 46 is interposed between the cam and the switch 42 and serves to maintain the latter in an open or closed position depending upon the position of the cam 32. A stop member 48 in the form of an upstanding bar is located immediately below the cam 32 for limiting the rotary movement of the cam.

As best seen in FIGURES 4 through 6, the shaft 30 has a star wheel or ratchet 50 rigidly mounted thereon that forms one part of a one-way clutch arrangement for permitting drive to be directed from the shaft 30 to a retarding mechanism that will hereinafter be described. The pinion gear 52 is rotatably positioned on the shaft adjacent the ratchet 50 and is integral with a second star wheel or ratchet 54. The ratchet 54 is a portion of a second clutching mechanism that permits the pinion 52 to direct drive through the shaft 30 to a torque motor 28, and also provide slippage of the pinion 52 through a slip-disc clutch arrangement 56 whenever the cam 32 has engaged the stop 48 prior to the full upward travel of the rack 26. The slip-disc clutch arrangement includes a pivotally mounted pawl 58 with a spring 60 engaging the outer surface of the pawl and maintaining the latter in engagement with the teeth of the ratchet 54. At this point it can be seen that the ratchet 54, and pawl 58 constitute a portion of a clutching arrangement that directs drive from the pinion 52 to the shaft 30 upon an upward movement of the rack. As seen in FIGURE 6 a spring 66 biases a pawl 62 into engagement with the teeth of the ratchet 50 and, as in the aforementioned arrangement, a one-way clutching mechanism is formed by these parts. In this instance, however, clockwise rotation of the shaft 30 as viewed in FIGURE 6, causes the pawl 62 to ride over the ratchet teeth, and drive can only be transmitted through this clutch to a shaft 64 when the shaft 30 rotates in a counterclockwise direction.

The shaft 64 is rotatably mounted in the support bracket 12 by a ball bearing 68 with a gear 70 fixedly mounted on the end of the shaft. The gear 70 is engageable with a gear 72 that is fixed to a shaft 74 which is spaced above the shaft 64 and has one end journaled in a ball bearing 76 and the other end rotatably mounted in an enclosure 78. The enclosure 78 houses the retarding or brake

mechanism that includes a cylindrical support member 80 having an opening 82 that is large enough to permit the shaft 74 to extend therethrough without any interference. The support 80 is fastened to a wall 83 and rigidly carries a disc-shaped magnet 84 that is disposed concentrically within a ring member 86 made of a soft iron and rigidly mounted to a plate 88. The plate 88, in turn, is mounted in the shaft 74 by a frictional connection that permits the plate 88 and associated ring member 86 to be driven by the shaft, and, in addition, be movable axially along the shaft so as to vary the magnitude of the magnetic field existing between the ring member and the magnetized disc 84. As best viewed in FIGURE 3, the ring member 86 circumferentially surrounds the disc magnet 84 that is similar to the rotor 36 in that it is magnetized with North and South polarities at points diametrically opposite to each other.

Referring now to FIGURE 7, the time delay device of FIGURE 1 is shown, however, in this instance the solenoid 18 is adjusted so that the rack 26 is situated in a new lower position with respect to the pinion 52. This adjustment is accomplished by the hexagonal nut 22 and threaded portion 20 of the solenoid 18. This new arrangement of the solenoid and associated rack 26 brings about a new result in the operation of the time device which is explained below.

The operation of the present invention is as follows:

Upon energization of the solenoid 18, the armature and the attached rack 26 are raised vertically upwardly against the bias of the spring 24. Because of the tooth engagement between the rack 26 and the pinion 52, this movement causes a clockwise rotation of the pinion as viewed in FIGURE 5. At the same time the ratchet 54 which is rigid with the pinion engages the pawl 58 to transmit rotational drive to the shaft 30 through the disc member 56. Inasmuch as the ratchet wheel 50 is rigid with the shaft 30, a clockwise rotation of this wheel also occurs. However, in this instance the pawl 62 rides over the ratchet teeth without transmitting any drive to the shaft 64. The rotation of the shaft 30 results in a corresponding angular displacement of the attached rotor 36 and cam 32 causing the raised position of the cam to release the intermediate member 46 from engagement with switch 42 thereby opening the switch contacts. Assuming the rack 26 moves in an upward direction so as to cause a 170° rotation of the pinion 52, a similar angular displacement of the rotor with respect to the stationary stator 38 results. Due to the rotation of the rotor 36, the North and South poles of the rotor are rotated so as to be disposed closer to the respective poles of the stator 38. In other words, the North poles and South poles of both the rotor and stator are then located proximate to each other. As is well known from the principles of magnetism, like poles tend to repel each other while unlike poles attract each other. In accordance with this principle the magnetic forces acting between the displaced rotor and the stator exert a returning force on the rotor urging it to return to the original position shown in FIGURE 2. It should be noted that upon energization, the solenoid 18 extends the rack in an upward direction beyond the end of the teeth so as to present the tooth free area adjacent the pinion. Therefore, the rotor and the shaft 30 are free to rotate in a counterclockwise direction under the influence of the magnetic forces.

During the counterclockwise return movement of the rotor, the rigidly connected ratchet wheel 50 engages the pawl 62 mounted on the shaft 64 and transmits counterclockwise rotation to the shaft 64. The shaft 64, in turn, rotates the gear 70 and, due to the engagement with the gear 72, drives the shaft 74 in a clockwise direction. As aforementioned, the frictional connection between the shaft 74 and the plate 88 serves to rotate the ring 86 about the periphery of the magnetized disc 84. The magnetic forces acting between the disc 84 and the ring 86 act as a retarding force or brake for controlling the rotation of the gears 70 and 72 and thereby govern the return movement of the torque motor or rotor 36. In this manner, a predetermined time interval elapses before the rotor 36 returns from its normal position as shown in FIGURE 2. When the rotor 36 returns to its initial position, the raised portion of cam 32 once again engages the intermediate member 46 and closes the contacts of switch 42. This completes the cycle.

The time delay device shown in FIGURE 7 is identical to that shown in FIGURE 1, however, here the solenoid is lowered so that the teeth of rack 26 do not disengage the pinion 52 when the solenoid 18 is energized. This is accomplished by loosening the hexagonal nut 22 on the threaded portion 20 followed by rotating the solenoid about its axis to move the entire unit to the new position shown in FIGURE 7. Now, energization of the solenoid raises the rack 26, however, due to the engagement of the rack teeth with the pinion, the rack prevents the pinion from moving in a counterclockwise direction. Inasmuch as the pinion is connected to the shaft 30 through the pawl 58, the shaft 30 is held from counterclockwise rotation until the solenoid 18 is deenergized. Upon deenergization of the solenoid 18, the rack 26 returns to its original position, moving in a downward direction and causing a counterclockwise rotation of the pinion 52 and the ratchet wheel 54. This latter movement of the pinion has no effect on the associated parts of the device because as the pinion moves in a counterclockwise direction, the pawl 58 simply rides over the teeth of the ratchet 54. Thereupon, the rotor 36 is free to return to its original position under the control of the magnetic brake as described above.

It should be noted that the slip-disc clutch arrangement 56 permits the rack 26 to travel the full extent of the toothed portion thereof in the event that the solenoid 18 is energized, momentarily de-energized, and immediately re-energized. This can be understood best by noting that upon initial energization of the embodiment shown in FIGURE 1, the rack moves upwardly to a point where the rack teeth 27 clear the pinion teeth and the tooth-free portion is adjacent the pinion, as aforementioned. Immediately, the torque motor 28 begins to return to its original position under the control of the magnetic brake mechanism. During the return movement of the torque motor, a de-energization of the solenoid 18 causes a downward movement of the rack without effecting the operation of the time delay device. However, if the solenoid is immediately re-energized prior to the full return movement of the rotor 36, the slip-disc clutch arrangement 56 permits the rack 26 to re-wind the torque motor to the point of cam contact with the stop 48 and thereupon continue its upward movement until all of the teeth 27 are clear of the pinion so that a new full cycle is reinitiated.

It is to be understood that the device as described and shown herein is for the purpose of illustration and that various changes and modifications may be made without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim:

1. A time delay device comprising a support, a switch mounted on said support, a shaft having a magnetic torque motor mounted thereon and rotatably carried by said support, said magnetic torque motor comprising a rotor and a ring stator having opposite polarity at diametrically opposed points, a switch actuator fixed to said shaft and having a first position for closing the switch and a second position for maintaining the switch open, means for moving the actuator from the first to the second position, whereby said rotor is angularly displaced with respect to the stator so as to cause a magnetic attracting force urging said rotor to its normal position, clutch means, and delay means including a magnetic brake connected with said clutch means for controlling the move-

ment of the actuator from the second to the first position during a predetermined time interval.

2. The device of claim 1 wherein said means comprises an electromagnetic device having a rack, a pinion mounted on the shaft and engageable by said rack for rotating the shaft a predetermined angular distance.

3. The device of claim 2 wherein a one-way clutch is associated with said pinion for rendering said electromagnetic device effective in one direction only.

4. The device of claim 3 having means including said electromagnetic device for adjustably positioning the latter whereby upon energization of the electromagnet the rack maintains tooth engagement with the pinion and thereby precludes movement of the actuator until deenergized.

5. A time delay relay comprising a support having a switch mounted therein, a first shaft rotatably mounted in said support and having a switch actuator for opening and closing said switch, a magnetic torque motor associated with said shaft and comprising a rotor fixed to one end of said shaft, a stator circumferentially enclosing said rotor and fixed to said support, said rotor and stator being magnetized with North and South polarity, a second shaft in axial alignment with said first shaft, a third shaft disposed adjacent said second shaft and in parallel relationship therewith, gear means connecting said second shaft to said third shaft, a stationary magnetized disc, a cylindrical member adjustably connected to one end of the third shaft and disposed so as to circumferentially enclose said magnetized disc and rotate thereabout, said disc and said cylindrical member constituting a magnetic brake for controlling the speed of

rotation of said second shaft, first and second clutch means interposed between said first and second shafts, electromagnet means for rotating said first shaft in one direction whereby said actuator opens said switch and said rotor is angularly displaced with respect to said stator so as to cause a magnetic force to act on said rotor urging it to return to its original position, and said second clutch means adapted to receive the return drive from said rotor through said first shaft and transmit said drive to said second shaft under the control of the magnetic brake during a predetermined time interval.

6. The device of claim 5 wherein said switch actuator includes a cam, a stop incorporated with said device to limit the angular movement of said cam, said electromagnet means having a rack, a pinion mounted on said first shaft and engageable by the rack, a slip-disc clutch arrangement associated with the pinion and adapted to provide slippage between said pinion and said shaft whenever said electromagnet is energized and the cam engages said stop prior to the full travel of the rack.

References Cited in the file of this patent

UNITED STATES PATENTS

1,027,440	Schley	May 28, 1912
1,499,178	McLain	June 24, 1924
2,319,279	Watkins	May 18, 1943
2,598,748	Alles	June 3, 1952
2,636,095	Schulte	Apr. 21, 1953
2,945,932	Nemeth	July 19, 1960
2,976,379	Rhodes	Mar. 21, 1961