Nov. 19, 1968 A. J. CARLI 3,412,350

RATCHET RELAY WITH DUAL ACTION PAWLS

Filed April 11, 1966 3 Sheets-Sheet 1

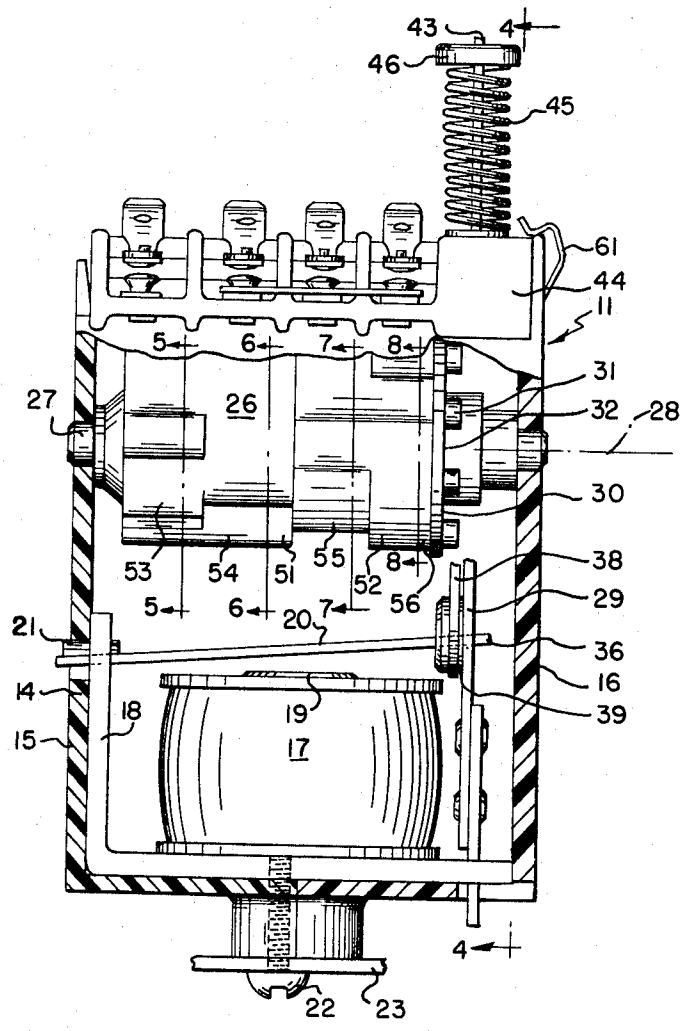


FIG.1

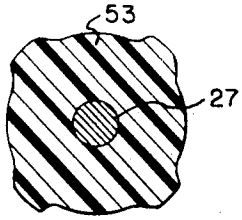


FIG.5

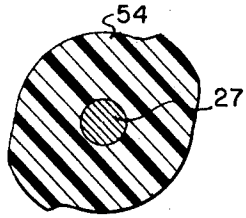


FIG.6

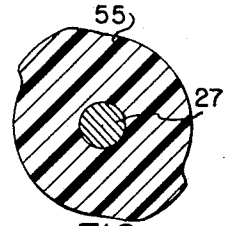


FIG.7

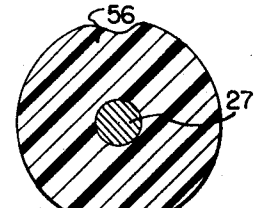


FIG.8

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RATCHET RELAY WITH DUAL ACTION PAWLS

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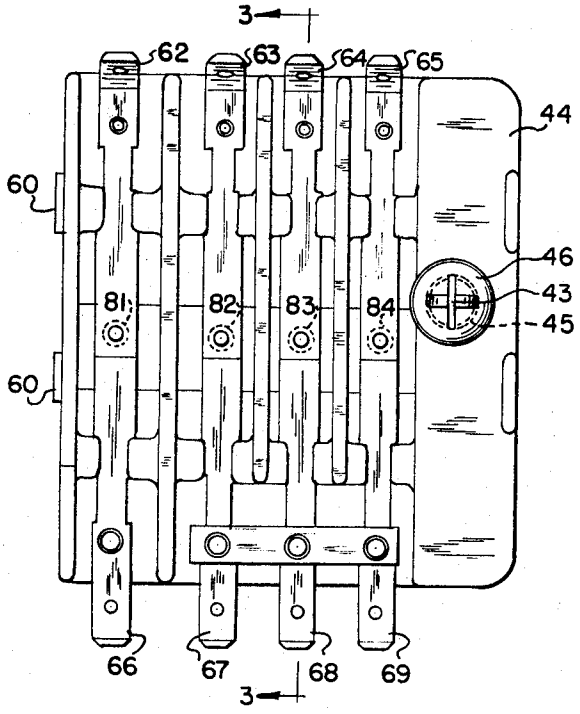


FIG. 2

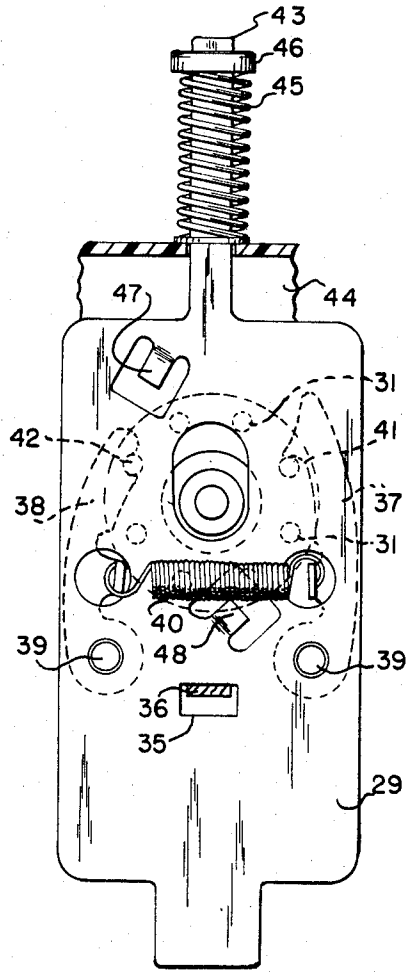


FIG. 4

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RATCHET RELAY WITH DUAL ACTION PAWLS

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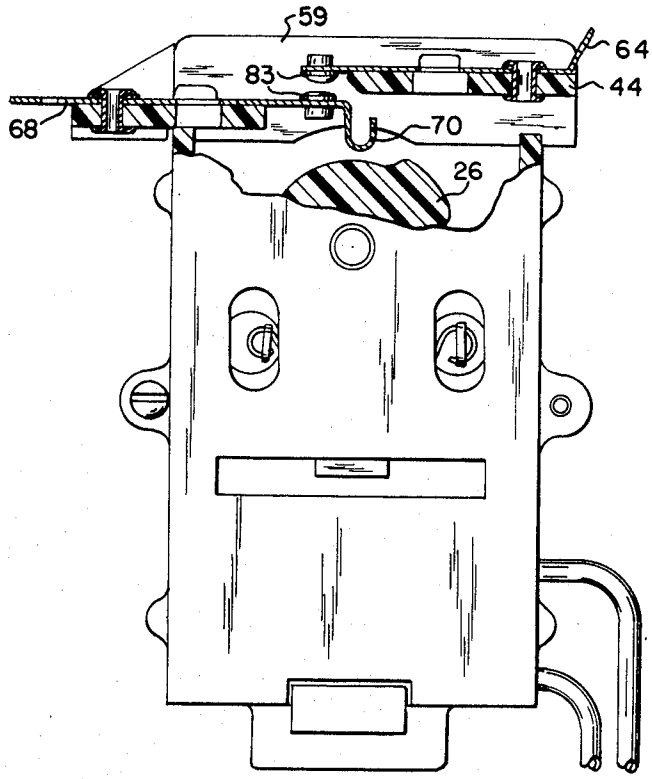


FIG. 3

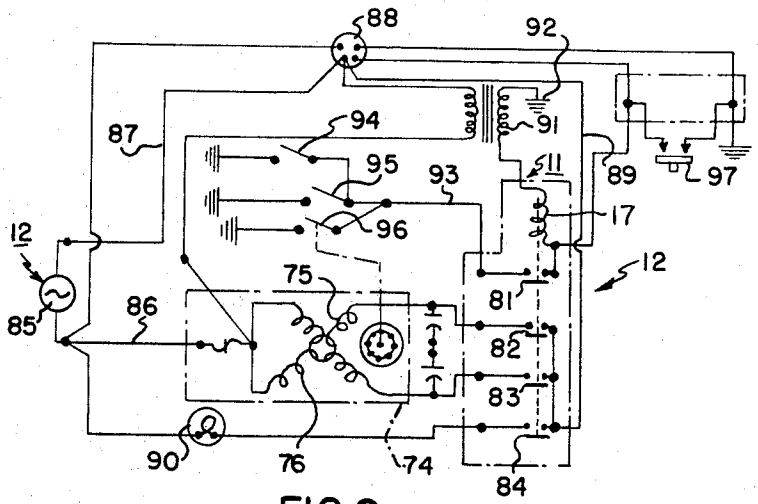


FIG. 9

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RATCHET RELAY WITH DUAL ACTION PAWLS

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18 Claims. (Cl. 335—123)

ABSTRACT OF THE DISCLOSURE

The disclosure shows a multiple contact electromagnetic relay wherein the armature moves an actuator plate in a rectilinear path. First and second pawls are pivoted on the actuator plate to cooperate alternatively with cylindrical pins on a ratchet wheel. During the attraction stroke of the armature the first pawl rotates the ratchet wheel through a first arc and during the retraction stroke of the armature the second pawl rotates the ratchet wheel through a second arc. A plurality of cams are rotated with the ratchet wheel and some contacts are actuated on the attraction stroke of the armature and others are actuated on the retraction storke of the armature.

The invention relates in general to a ratchet relay and more particularly to a multi-position relay actuated switch capable of having a variety of circuit conditions.

A four-position ratchet relay has been described in Patent 3,178,627 entitled, "Electrical Control System for Motor Operated Doors," issued Apr. 13, 1965. The relay of the present invention may be used in a door operator control circuit, as one example of use.

In ratcheting relays involving a plurality of contacts and a plurality of circuit conditions it has been found that for reliable operation a fairly complex and expensive structure has been required. However, the complexity has detracted from the reliability simply because of the large number of parts and also the complexity has increased the labor and hence cost of assembly of the complete relay.

Accordingly an object of the invention is to provide an inexpensive, simple, rugged and reliable ratcheting relay.

Another object of the invention is to provide a relay with multiple conditions of plural contacts yet one which is extremely reliable in operation.

Another object of the invention is to provide a relay with a contact assembly which may be removed and replaced independently of the relay actuating coil and without requiring calibration of the contact positions.

Another object of the invention is to provide a relay with dual stroke capabilities to actuate a ratchet wheel on both the up and down strokes of the relay armature.

Another object of the invention is to provide a ratcheting relay with a simplified cam assembly which may be readily manufactured and assembled without error in assembly and without need to manually calibrate the position of the contact blades actuated by the cam assembly.

Another object of the invention is to provide a ratcheting relay having a given number of active positions of the contacts and moved into those positions by the combined advance and retract movements of the relay armature.

Another object of the invention is to provide a ratcheting relay with rounded ratchet teeth to provide a large bearing surface under all conditions of actuation of the ratchet wheel by a pawl.

Another object of the invention is to provide a ratcheting relay with an actuator plate carrying first and second pawls, both pawls being movable in the same direction for advancing movement of the armature and operative to partially rotate the ratchet wheel, and both pawls being movable in the opposite direction during retract of the armature to again advance the ratchet wheel in the same direction.

The invention may be incorporated in a ratcheting relay, comprising, in combination, a relay coil, an armature movable upon energization of said coil, a rotatable cam assembly, rotatable ratchet wheel means having teeth and connected to rotate said rotatable cam assembly, pawl means cooperable with said teeth of said ratchet wheel means, means connecting said armature to relatively move said ratchet wheel means and said pawl means upon movement of said armature, energization of said relay coil moving said armature in a first direction and causing said pawl means to rotate said ratchet wheel means and said cam assembly through a first given arc, deenergization of said relay coil moving said armature in a second direction to rotate said ratchet wheel means and said cam assembly through a second given arc, a contact assembly, first and second pairs of contacts in said contact assembly, rotation of said cam assembly through said first given arc positioning said cam assembly for actuation of said first pair of contacts and rotation of said cam assembly through said second given arc positioning said cam assembly for actuation of said second pair of contacts.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a elevational view, partly in section of a relay incorporating the invention;

FIGURE 2 is a top view of the relay;

FIGURE 3 is a sectional view on line 3—3 of FIGURE 2;

FIGURE 4 is a sectional view on line 4—4 of FIGURE 1;

FIGURES 5, 6, 7, and 8 are sectional views on the similarly numbered lines on FIGURE 1; and,

FIGURE 9 is a schematic diagram of a motor control circuit with which the relay may be used.

The figures of the drawings show a ratcheting relay **11** which is the preferred embodiment of the invention. This relay may be used in many different circuit arrangements and FIGURE 9 shows one possible use in a door operator control circuit **12**. This is almost the same control circuit as shown in Patent 3,178,627 wherein a four-position relay was used to control a motor to open and close a garage door. The relay **11** includes a housing **14** made of identical halves **15** and **16**. A relay coil **17** is mounted in the lower end of the housing **14** and includes a permeable frame **18** and a pole piece **19**. A movable armature **20** is pivoted to the frame **18** and a leaf spring **21** urges the armature **20** away from pole piece **19**. A mounting screw **22** may extend into a threaded aperture in the frame **18** to fasten the entire relay **11** to a support **23**.

A rotatable cam assembly **26** is fixed on an axle **27** journalled in the two halves of the housing **14**. This cam assembly has an axis **28**. An actuator plate or support **29** forms a link between the armature **20** and the cam assembly **26** for rotation thereof. This actuator plate **29** moves in a path perpendicular to the axis **28**. The cam assembly **26** includes a ratchet wheel **30** having a plurality of teeth **31**. These teeth are in the form of cylindrical pins extending on axes parallel to the axis **28** from a planar face **32** of the ratchet wheel **30**.

The actuator plate **29** has an aperture **35** receiving a tongue **36** on the end of the armature **20**. This links the armature to the actuator plate **29** to move this plate. First and second pawl arms **37** and **38** are pivoted on the actuator plate **29** by pivot pins **39**. A coil tension spring **40**

urges the arms together and toward engagement with the ratchet wheel teeth or pins **31**. The first pawl **37** is provided with a pull notch **41** and the second pawl **38** is provided with a push notch **42**. These notches engage generally diametrically opposed portions of the ratchet wheel **30**. In this preferred embodiment there are eight of these pins **31** with eight positions on the cam assembly **26**. Four positions make up a complete cycle and hence one revolution of the cam assembly completes two complete cycles of the circuit **12**. The actuator plate **29** has a tongue **43** extending through a contact plate assembly **44** which closes the end of the housing **14** opposite the relay coil **17**. A coil compression spring **45** is held on the tongue **43** by a retainer **46** and urges the actuator plate **29** upwardly as viewed in FIGURE 1 and hence urges the armature **20** away from the pole piece **19**. A stop lug **47** on the actuator plate **29** engages one of the ratchet teeth **31** to limit the down stroke of the actuator plate **29** and a stop lug **48** engages another pin **31** to limit the up stroke of plate **29**.

The cam assembly **26** includes first and second cam parts **51** and **52**, respectively. The first cam part includes first and second rotary cams **53** and **54**, respectively. The second cam part **52** includes third and fourth rotary cams **55** and **56**, respectively, and the ratchet wheel **30**. The first and second cam parts **51** and **52** are fixed on the axle **27** for positive rotation of the entire cam assembly upon rotation of the ratchet wheel **30**. The first and second cam parts **51** and **52** are suitably made from some insulation material such as nylon or Delrin which are easily molded and having smooth, low-friction surfaces. The first cam part includes both the first and second rotary cams **53** and **54** as shown in FIGURES 1, 5, and 6. These two rotary cams **53** and **54** may be made in a simple two-part mold separable on the junction line between the rotary cams **53** and **54**. The second cam part **52** may also be made in a simple two-part mold separable on a parting line between the ratchet wheel **30** and the fourth rotary cam **56**. This is possible because the fourth rotary cam **56** has no undercuts relative to the third rotary cam **55** and hence the parting line may be at the face of the ratchet wheel **30** which is contiguous to the fourth rotary cam **56**. This permits the cam assembly **26** to be made from only two parts for quick and easy assembly and assurance of proper actuation of the contact plate assembly. The two cam parts **51** and **52** may be forced onto a splined portion of the axle **27** in order to assure positive rotation of the parts of this cam assembly **26**.

The contact plate assembly **44** includes an insulator plate **59** which closes the open end of housing **14**. This insulator plate **59** has tabs **60** extending through apertures in the side wall of housing half **15**. Spring clips **61** plus the tabs **60** retain this insulator plate **59** on the housing **14**. A plurality of pairs of contact strips may be mounted on the insulator plate **59**. FIGURE 2 best shows that in this preferred embodiment four fixed contact strips are provided, numbers **62** to **65** respectively, and four movable contact strips are provided, number **66** to **69** respectively. Cooperating contacts are provided on the outer ends of each respective pair of contact strips as illustrated in FIGURE 3. Each of the movable contact strips **66–69** includes a U-shaped cam follower **70** on the inner end for cooperation with the respective rotary cam of the cam assembly **26**.

With the eight ratchet teeth or pins **31** provided, eight positions of the relay switch **11** may be accommodated. In the preferred embodiment only four switch conditions are needed and accordingly two complete cycles of switch conditions are provided for each full revolution of the cam assembly **26**.

FIGURE 9 shows a door operator control circuit **12** with which this relay **11** may be used. The circuit **12** includes a motor **74** having a stator winding **75** energized directly for the upward movement of a garage door and having another stator winding **76** energized directly for the reverse rotation of the motor to cause downward movement of the garage door. The contact plate assembly **44** includes pairs of contacts **81**, **82**, **83** and **84** on the first through fourth contact strips respectively. These pairs of contacts are illustrated in the circuit diagram of FIGURE 9. The circuit is energized from a suitable voltage source **85** such as 115 volts A.C. 60 cycle with energization to the motor including a conductor **86** to one end of both stator windings **75** and **76**. A conductor **87** leads to a radio connector plug **88** for energization of a radio receiver which may also receive signals to control operation of the control circuit **12**. A conductor **89** connects to conductor **87** and supplies source voltage to the stator windings **75** and **76** through the relay contacts **82** and **83**, respectively. Relay contacts **84** control a lamp **90** for illumination of the garage. Relay contacts **81** control application of low voltage power such as 24 volts from a transformer secondary **91** to the relay coil **17**. One end of the secondary **91** may be grounded at **92** and relay contacts **81** are connected to ground through a conductor **93** and several switches in parallel. These switches include an up limit switch **94**, a down limit switch **95** and a torque switch **96**. A push button switch **97** is also connected to ground to energize the relay coil **17**.

Operation

When the relay coil **17** is energized, the armature **20** will be attracted toward the pole piece **19**. This moves the actuator plate **29** downwardly, as viewed in FIGURE 1. The first pawl **37** has the pull notch **41** in engagement with one of the pins **31**. The downward movement of actuator plate **29** thus pulls on the engaged pin **31** to rotate the cam assembly **26** about 22½ degrees in a clockwise direction as viewed in FIGURE 4. The stop lug **47** engaging one of the pins **31** limits this first arcuate motion of the cam assembly **26**. During this downward movement of actuator plate **29**, the second pawl **38** also moves downwardly because it is also pivoted on plate **29**. The push notch **42** has thus moved into engagement with the next adjacent pin **31**. Upon deenergization of the relay coil **17**, the springs **21** and **45** effect retractile movement of the armature **20** away from pole piece **19** and this moves the actuator plate **29** upwardly as viewed in FIGURE 1. During this upward movement, the pawl **38**, by means of the push notch **42**, rotates the ratchet wheel **30** approximately another 22½ degrees for a total of 45 degrees arcuate movement for one energization and deenergization of the relay coil **17**. A second arcuate motion of the cam assembly **27** is limited by the stop lug **48** engaging one of the lower ratchet teeth or ratchet pins **31**. The push button switch **97** is connected from one end of relay coil **17** to ground **92**. When this push button switch **97** is actuated, the relay coil **17** will be energized. This moves the cam assembly **26** about 22½ degrees, as described above. This closes contacts **83** and **84** to turn on the lamp **90** and also to start the motor **74** running to open the door. When the push button **97** is released the relay coil **17** will be deenergized. This moves actuator plate **29** downwardly rotating cam assembly **26** about another 22½ degrees clockwise. This closes contacts **81** and maintains contacts **83** and **84** closed. Closing of contacts **81** does not change the circuit condition, it merely places into the circuit the switches **94**, **95**, and **96** to control energization to relay coil **17**. The torque switch **96** may be like a centrifugal switch driven from the output of the motor **74** to be closed when the motor is at rest and to be opened when the motor is up to speed. The limit switches **94** and **95** may be actuated at the ends of travel of the door moved by the motor **74**.

When the door has reached the end of its upward travel to an open position, the up limit switch **94** will be actuated. This energizes relay coil **17** moving actuator plate **29** downwardly to rotate the cam assembly **26** approxi-

mately another 22½ degrees. The open contacts **81** and **83** and contacts **84** are maintained closed to maintain the lamp **90** illuminated. With contacts **83** open, the motor **74** is deenergized. The opening of contacts **81** relieves the grounding condition on the relay coil **17** and thus it is deenergized permitting actuator plate **29** to move upwardly rotating cam assembly **26** another approximately 22½ degrees. This does not change the condition of the contacts **81–84**.

Upon the push switch **97** again being actuated the relay coil **17** is energized to move the armature **20** and actuator plate **29** downwardly. This again rotates the cam assembly **26** approximately 22½ degrees clockwise. This closes contacts **82** and maintains contacts **84** closed. This conditions the motor **74** for a reverse direction of movement to close the door, and the motor starts to run. When the push button switch **97** is released, the relay coil **17** is deenergized and the actuator plate **29** moves upwardly to move the cam assembly **26** another approximately 22½ degrees clockwise. Such movement closes contacts **81** and maintains contacts **82** and **84** closed. Thus the motor continues to run in reverse and the lamp **90** is energized and also the closing of contacts **81** means that switches **94**, **95** and **96** are now available to control energization or relay coil **17**. When the motor reaches its down limit, either the down limit switch **95** is actuated or the torque switch **96** is closed by stalling of the motor **74** and this energizes the relay coil **17**. This pulls actuator plate **29** down to open the contacts **81** and **82**, yet contacts **84** remain closed. Opening of contacts **82** deenergizes the motor **74** and opening of the contacts **81** removes the energization for relay coil **17**, hence it is deenergized. Upon deenergization of this relay coil **17**, the actuator plate **29** moves upwardly to rotate cam assembly **26** another approximately 22½ degrees, and this opens contacts **84**. Thus the complete cycle of operation of the door operator control circuit **12** has been achieved by one-half revolution of the cam assembly **26**.

It will be noted at the beginning of the cycle contacts **83** and **84** are closed upon the advance movement of the armature **20** whereas contacts **81** do not close until the retractile movement of this armature **20** and contacts **83** and **84** remain closed. This has a very definite advantage in the relay **11**. In the prior Patent 3,178,627 it was necessary to have separate switch **60** actuated by the condition of the relay armature in order to control the circuit effectiveness of the up and down limit switches and the torque switch. In the present relay construction the necessity for this series switch **60** is eliminated. In many garage door operators such as on commercial garages and other such establishments, it is necessary to hold the push-button switch depressed in order to make the door move in an up or down direction. Accordingly some people, not familiar with the proper operation of a household garage door operator, may hold the push button switch **97** depressed during the entire door movement in an up or down moving direction. This was the reason for providing the switch controlled by the armature position in the Patent 3,178,627, because it prevented the control system from getting out of synchronization with the door operator. If the contacts **81** in the present invention were to close immediately upon armature advance movement, along with closure of contacts **83** and **84**, then the motor **74** would start to run to move the door. However if the push button switch **97** were held depressed for the entire door opening movement, then this would keep the relay coil **17** energized and when the limit switch **94** was actuated it would not be able to again energize the relay **17** to again ratchet the cam assembly **26** to the next position whereat the motor would be deenergized. The person would observe that the door had completely closed or completely opened and then would release the push button switch **97**, however the relay coil **17** would remain energized, because of the now closed limit switch **94**, **95** or torque switch **96**. If this were a door closed condition, and the person left the garage, then the relay coil **17** could be retained energized and burn out this relay, especially after several hours of energization.

In the present invention this lack of synchronization of the relay position and the door operator condition is eliminated. When the person observes that the door has opened or closed and has removed his finger from the push button **97**, this will deenergize the relay coil **17** and close relay contacts **81**. With a closed door condition and either the limit switches **94** or **95** closed and also the torque switch **96** closed, this will again energize the relay coil **17** to ratchet the cam assembly **26** to the next condition whereat the motor **74** will be deenergized and also the relay coil **17** will be deenergized. Thus by having the relay contacts **81** not closed until after the armature retractile movement has completed, the present invention of a relay eliminates the need for the series switch **60** of Patent 3,178,627 and also prevents the door operator from getting out of synchronization with the relay **11**.

The contact plate assembly **44** may easily be removed by removing the spring clips **61**, the retainer **46** and spring **45** and then the contact plate assembly **44** may easily be slipped from the end of the housing **14**. Because the housing **14** may be made from two molded halves of insulating material, the dimension between the end of the housing upon which the contact assembly **44** seats and the journals for the axle **27** may be precisely controlled. Also the insulator plate **59** may be made from insulation material in a simple two-part mold and the dimensions thereof may be controlled quite accurately. Accordingly it is possible to assemble all the contact strips on the insulator plate **59** and then to mount this contact plate assembly **44** on the end of the housing **14** for actuation by the rotatable cam assembly **26** without any calibration or adjustment of the contact strips **62–69**. In the usual relay construction it is necessary, after assembly of the complete relay, to bend the contact strips to adjust the position thereof to be properly actuated upon movement of the armature of the relay. In this relay **11** the position of these contact strips and hence the contacts is carefully controlled during manufacture so that any one contact plate assembly **44** will fit on the housing **14** without the necessity of adjusting the positions of the contacts. This saves considerably in assembly time and thus lowers the cost of the relay.

It will be noted that both pawls **37** and **38** move in the same direction upon advance movement of the armature **20** and both pawls **37** and **38** again move in the same opposing direction upon retractile movement of the armature **20**. First the pawl **37** pulls the cam assembly through a first given arc and second the pawl **38** pushes the cam assembly **26** through a second given arc. In this preferred embodiment each of the two arcs are preferably the same and about 22½ degrees for a total 45 degree rotation for advance and retract of the armature **20**. Because the pawls **37** and **38** act on generally diametrically opposed portions of the ratchet wheel **30** and because they act alternatively, no locking pawl is necessary as is usually found in ratchet wheel mechanisms. Such normal locking pawl is one which prevents reverse rotation of the ratchet wheel during the retract stroke of the pawl normally causing arcuate movement. This is another simplification in the relay **11** by elimination of such locking pawl.

The ratchet teeth **31** being cylindrical pins provides a large cylindrical bearing surface between the notches **41** and **42** and the teeth or pins **31**. In the normal ratchet wheel mechanism there is only a line contact between the pawl and the tooth of the ratchet wheel and thus this can cause rapid wear on the pawl and on the ratchet teeth. With this large cylindrical bearing surface of the present invention, such rapid wearing is eliminated and also the cylindrical bearing surface is maintained even during rotation of the cam assembly **26**, which changes

the attitude of the cam assembly **26** relative to the pawls **37** and **38**.

The present disclosure includes that contained in the appended claims, as well as that of the foregoing description.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A ratcheting relay, comprising, in combination, a relay coil, an armature movable upon energizing of said coil, a rotatable cam assembly means,

rotatable ratchet wheel means having teeth and connected to rotate said rotatable cam assembly,

pawl means cooperable with said teeth of said ratchet wheel means, means connecting said armature to relatively move said ratchet wheel means and said pawl means upon movement of said armature,

energization of said relay coil moving said armature in a first direction and causing said pawl means to rotate said ratchet wheel means and said cam assembly through a first given arc,

deenergization of said relay coil moving said armature in a second direction causing said pawl means to rotate said ratchet wheel means and said cam assembly through a second given arc,

a contact assembly,

first and second pairs of contacts in said contact assembly,

means establishing actuation of said first pair of contacts upon rotation of said cam assembly means through said first given arc,

and means establishing actuation of said second pair of contacts upon rotation of said cam assembly means through said second given arc.

2. A ratcheting relay as defined in claim **1** wherein said pawl means includes first and second pawls, said first pawl positively rotating said cam assembly in a given rotational direction for the first direction of movement of said armature and said second pawl positively rotating said cam assembly in said given rotational direction for the second direction of movement of said armature to have said rotatable cam assembly always under positive rotation and to thereby preclude reverse rotational direction of said rotary cam assembly without need for any locking pawl.

3. A relay as defined in claim **1** wherein said pawl means includes two pawls mounted on a common actuator to move both pawls in one direction upon said armature moving in said first direction and to move both pawls in the opposite direction upon said armature moving in said second direction.

4. A relay as defined in claim **1** wherein said pawl means includes two pawls which cooperate with generally diametrically opposed portions of said ratchet wheel means.

5. A relay as defined in claim **1** including a planar surface on said rachet wheel means perpendicular to the axis of rotation thereof,

a plurality of cylindrical pins extending from said planar surface parallel to said axis,

and arcuate engagement surfaces on said pawl means to engage the cylindrical surfaces of said pins as the teeth of said ratchet wheel for an arcuate bearing surface between said pins and pawl means despite changing attitudes therebetween throughout said first given arc.

6. A relay as defined in claim **1** including a frame,

means to journal said cam assembly on said frame,

means to fix said ratchet wheel means to said cam assembly for mutual rotation,

and means to move said pawl means upon movement of said armature to rotate said ratchet wheel means.

7. A relay as defined in claim **1** wherein said first and second given arcs are approximately equal,

rotation of said cam assembly through said first given arc actuating said first pair of contacts and rotation of said cam assembly through said second given arc actuating said second pair of contacts.

8. A relay as defined in claim **1** wherein said rotatable ratchet wheel means is a single ratchet wheel,

means causing said pawl means to act on one side of said ratchet wheel during movement of said armatrue and in said first direction,

and means causing said pawl means to act on the generally opposite side of said ratchet wheel during movement of said armature in said second direction for unidirectional movement of said ratchet wheel and cam assembly without need for a locking pawl.

9. A relay as defined in claim **1** including said first pair of contacts being actuated closed upon movement of said armature in said first direction and wherein said second pair of contacts are actuated closed and said first pair of contacts are maintained closed upon movement of said armature in said second direction.

10. A relay as defined in claim **1** including first and second rotary cams on said cam assembly,

said first and second rotary cams being formed from insulation material and being moldable in a two-part mold separable on a parting line at the junction of said first and second rotary cams.

11. A relay as defined in claim **1** including first and second rotary cams on said assembly,

said first rotary cam being adjacent said ratchet wheel means,

said first and second rotary cams and said ratchet wheel means being of insulation material with said first rotary cam contiguous to said ratchet wheel means and having no undercuts relative to said second rotary cam in order to permit manufacture in a two-part mold separable on a parting line between said ratchet wheel means and said first rotary cam.

12. A ratcheting or stepping relay, comprising, in combination, a relay coil.

an armature movable in an advancing stroke upon energization of said coil,

said armature being movable in a retracting stroke upon deenergization of said coil,

rotatable ratchet wheel means, pawl means cooperable with said ratchet wheel means,

contact means,

means acting through said ratchet wheel and pawl means effective upon completion of said advancing stroke of said armature to establish said contact means in a first condition,

and means acting through said ratchet wheel and pawl means effective upon completion of said reaction stroke of said armature to establish said contact means in a second condition.

13. A relay as defined in claim **12**, including cam means actuated by said ratchet wheel means and pawl means,

said cam means establishing said first and second conditions of said contact means upon said advancing and retracting strokes of said armature.

14. A ratcheting relay, comprising, in combination, a frame,

a relay coil mounted on said frame,

a movable armature cooperating with said coil,

a rotatable cam assembly journalled on an axis on said frame,

a rotatable ratchet wheel having teeth and connected to rotate said rotatable cam assembly,

first and second pawls each moved by said armature and cooperable with said wheel,

energization of said relay coil moving said armature toward said pole piece of said relay coil and causing said first pawl to move in a first direction to rotate said ratchet wheel and said cam a first given arc,

said second pawl also moving in said first direction to engage the next adjacent tooth to that formerly engaged,

deenergization of said relay coil effecting retractile movement of said armature away from said pole piece to move said pawls in a second opposing direction and causing said second pawl to rotate said ratchet wheel a second given arc,

a contact plate assembly having an insulator plate mounted on said frame,

a first pair of contacts on said insulator plate being actuated upon movement of said first pawl in said first direction and a second pair of contacts on said insulator plate being actuated upon movement of said second pawl in said second direction.

15. A relay as defined in claim **14** including an actuator plate slidable on a path in said frame,

means pivoting said first and second pawls on said actuator plate to cooperate with said ratchet wheel,

said actuator plate slidable in a rectilinear path generally perpendicular to the axis of said cam assembly.

16. A relay as defined in claim **14** including an actuator plate moveable by said armature,

means movably mounting each of said first and second pawls on said actuator plate,

said first and second pawls extending in the same general direction and cooperating with generally diametrically opposed portions of said ratchet wheel,

and a pull notch on said first pawl and a push notch on said second pawl for cooperation with said ratchet teeth on opposite strokes of said actuator plate.

17. A ratcheting relay, comprising, in combination, an enclosing housing,

a relay coil and a pole piece mounted in one end of said housing,

a pivoted armature cooperating with said pole piece,

an actuator plate slidable on a path in said housing and connected to said armature to be slidably moved thereby,

first and second pawl arms pivotedly carried on said actuator plate,

a spring urging said arms toward each other,

a rotatable cam assembly journalled on an axis in said housing perpendicular to said path,

a rotatable ratchet wheel fixed to said cam assembly,

eight pins symmetrically disposed on a circle on said ratchet wheel having the center thereof on said axis,

a pull notch and a push notch on said first and second arms, respectively,

said spring causing said notches to engage pins generally diametrically opposed on said ratchet wheel,

energization of said relay coil moving said armature into close engagement with said pole piece of said relay coil and sliding said actuator plate in a first direction on said path to have said pull notch on said first arm rotate said ratchet wheel and said cam approximately 22½ degrees,

said second arm also sliding in said first direction to

have said push notch engage the next adjacent pin to that formerly engaged,

deenergization of said relay coil effecting retractile movement of said armature away from said pole piece to slide said actuator plate in a second opposing direction on said path to cause said push notch on said second arm to rotate said ratchet wheel approximately another 22½ degrees,

said cam assembly including first and second parts of insulation material,

first and second rotary cams on said first cam part,

third and fourth rotary cams and said ratchet wheel on said second cam part,

said first cam part and said second cam part being assemb'ed on a shaft together to form said cam assembly,

said first cam part being molded in a two-part mold separable on a parting line at the junction between said first and second rotary cams,

said fourth rotary cam on said second cam part being contiguous to said rotary ratchet wheel and having no undercuts relative to said third rotary came in order to permit manufacture in a two-part mold separable on a parting line between said rotatable ratchet wheel and said fourth cam,

a contact plate assembly having an insulator plate mounted on and closing the end of said housing opposite the end containing said relay coil,

said contact plate assembly including four movable contact strips on said insulator plate and each having cam followers for cooperation with a different one of said rotary cams,

four fixed contact strips on said insulator plate and each carrying a fixed contact for cooperation with a movable contact on a respective one of said movable contact strips,

and one of said pairs of contacts being actuated upon movement of said actuator plate in said first direction and another of said pairs of contacts being actuated upon movement of said actuator plate in said second direction.

18. A relay as defined in claim **12**, including a support,

said pawl means including first and second pawls carried on said support,

and means guiding said support for rectilinear movement so that each of said first and second pawls cooperates substantially equally with said ratchet wheel means.

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