Sept. 27, 1960 H. E. ANDERSON ET AL 2,953,928

RECIPROCAL MOVEMENT CONTROL MECHANISM

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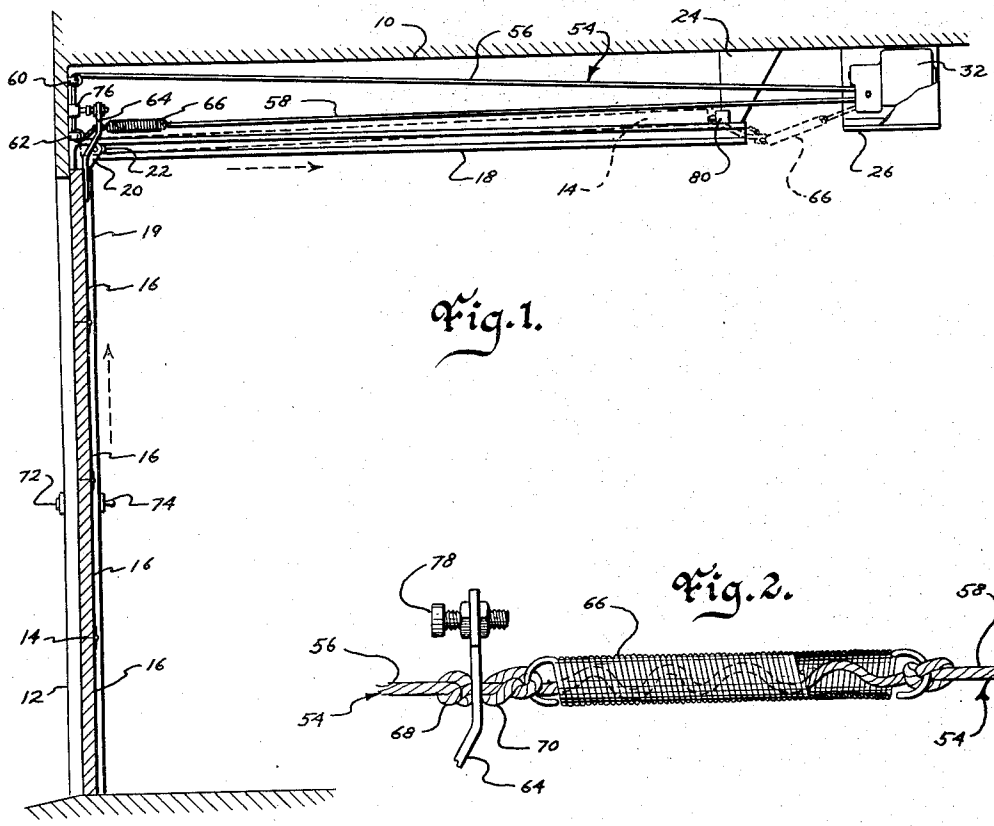

Fig. 1.

Fig. 2.

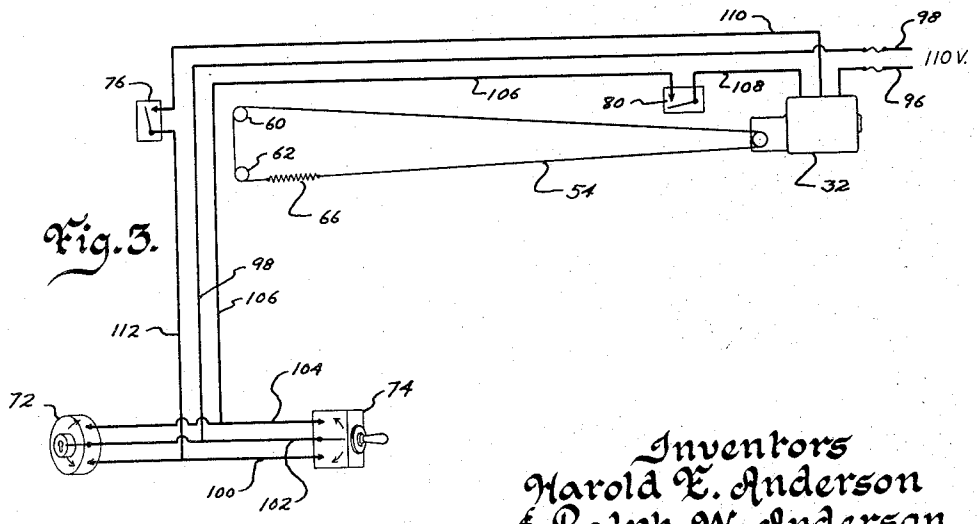

Fig. 3.

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Fig.4.

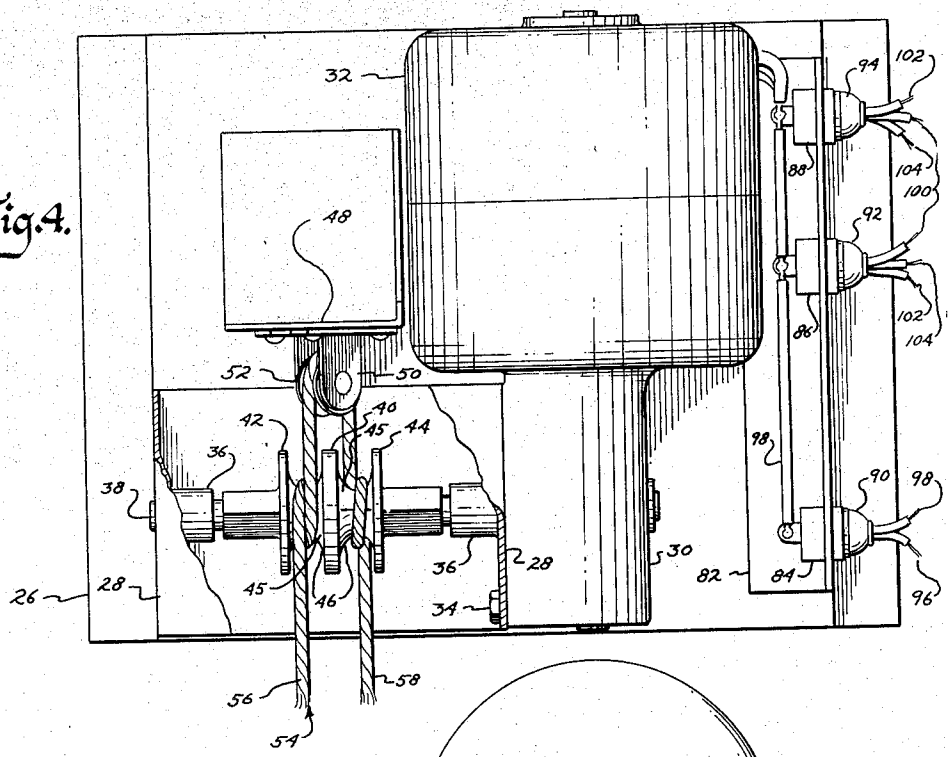


Fig.5.

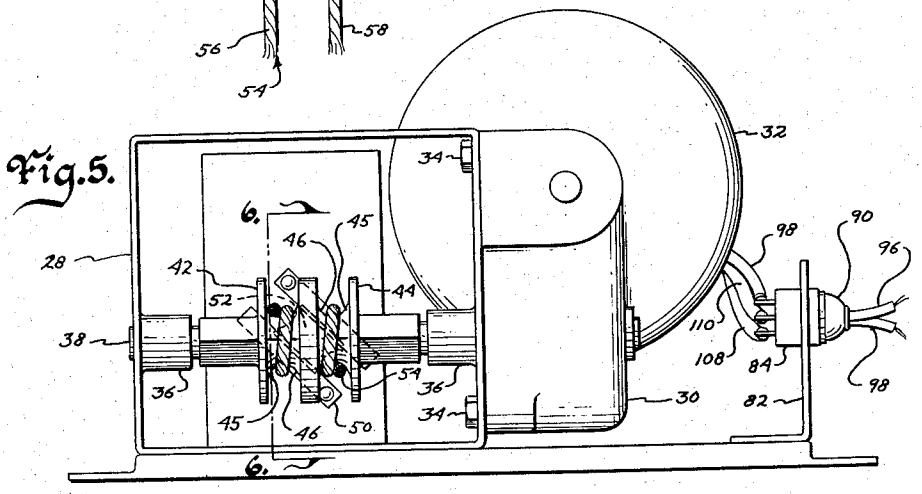
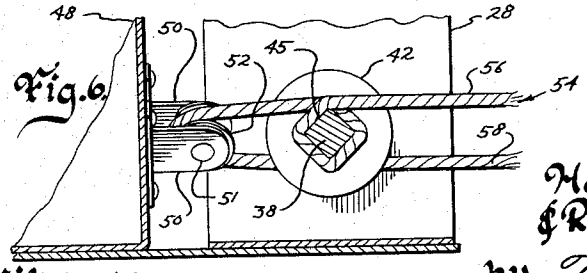


Fig.6.



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RECIPROCAL MOVEMENT CONTROL MECHANISM

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1 Claim. (Cl. 74—95)

Our invention relates to control mechanisms and more particularly to a mechanism which can electrically control the reciprocal movement of a member through the use of a single cable element.

Many devices in common use are adapted to reciprocal movement. Examples of such devices are doors, windows, valves, belts, and the like. In many cases, some measure of control must be exercised over the reciprocating member, and other cases make this element of control mandatory. Various chains, linkage elements and springs are often employed, jointly or severally, to accomplish this control phase.

An overhead garage door is one example of a reciprocating member where at least some degree of control over the movement thereof is desirable. Usually, a spring element assists in the manual lifting of the door and the same spring helps to slow down the gravitational acceleration of the door while being lowered. Some devices known to us have attempted to move such a door in one direction by the direct pull of a cable which simultaneously displaces the door and expands a spring secured to the door. The eventual release of the pulling energy on the cable permits the spring to reverse the movement of the door. Obviously, the spring-like action movement of the door is a relatively uncontrolled action. The control devices known to us have not been able to utilize a single cable to control reciprocal movement of an element with a single power source and some have therefore resorted to the use of link chains and arm link mechanisms. Obviously, such devices are expensive to manufacture and require much space in which to operate. Furthermore, such devices generally must be located within a close proximity of the reciprocating element itself. These devices known to us are also quite cumbersome to install because of their complex structure.

Therefore, the principal object of our invention is to provide a control mechanism for reciprocating elements that can utilize a single cable element with a single power unit.

A further object of our invention is to provide a control mechanism for reciprocating elements whose proximity to the reciprocating element is not critical.

A still further object of our invention is to provide a control mechanism for reciprocating elements that can maintain positive control over the elements through all phases of the reciprocating cycle.

A still further object of our invention is to provide a control mechanism for reciprocating elements that can be easily installed and adapted for use with the reciprocating elements.

A still further object of our invention is to provide a control mechanism for reciprocating elements that requires very little operating space.

A still further object of our invention is to provide a control mechanism for reciprocating elements which is refined in appearance and durable in use.

These and other objects will be apparent to those skilled in the art.

Our invention consists in the construction, arrangements, and combination, of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in our claim, and illustrated in the accompanying drawings, in which:

Fig. 1 is a sectional view taken through a garage door opening showing how our device can be used to operate a conventional overhead garage door structure;

Fig. 2 is a detailed elevational view of a spring element that is placed in series with the continuous cable used on our device. This figure also shows one means of securing the cable to a door member for movement thereof in two directions;

Fig. 3 is a wiring diagram which is typical of the wiring involved in the installation of our device, as seen in Fig. 1;

Fig. 4 is a plan view of the control and power units of our device;

Fig. 5 is a front elevational view of the structure shown in Fig. 4, and views our device from the point where the cable element enters and departs from the structure shown in Fig. 4; and

Fig. 6 is a sectional view of our device taken on line 6—6 of Fig. 5.

We have used the numeral **10** to generally designate the ceiling of a garage unit which has a garage door frame **12**. A garage door **14** comprised of foldable sections **16** is rotatably and movably mounted by its top in overhead track **18**. A vertical portion **19** of track **18** is secured to door frame **12** to support the sides of door **14** when the door is closed. The connection between track and door is effected by a bracket **20** which is secured to the top of the door **14** in any convenient manner and which has wheel **22** which rides within track **18**. A bracket **24** can connect the inner end of track **18** to ceiling **10**. Other brackets similar to bracket **20** can be used on door **14** to maintain the door's path of movement within the track portions **18** and **19**. The structure thus far described constitutes only a garage unit and a conventional door thereon and does not comprise the critical elements of our invention.

We have used the numeral **26** to designate a platform upon which vertical rectangular frame **28** can be secured in any convenient manner. The gear head **30** of conventional reversible motor **32** can be secured to one side of frame **28** by bolts **34**. Inwardly extending bearing members **36** can be rigidly secured on opposite sides of frame **28** in the same horizontal plane. A shaft **38** is rotatably mounted within bearing members **36** and has one of its ends operatively connected to motor **32** through gear head **30**.

The center portion of shaft **38** is square in cross section and a dual pulley **40** having pulley elements **42** and **44** is rigidly secured in any convenient manner to the center of the shaft. As shown in Fig. 6, the throats **45** of pulley elements **42** and **44** are also substantially square in cross section, but we have used beads **46** on at least the quarter points of the pulleys to give the throats a rounded shape, as seen in Figs. 4 and 5. The diameter of throats **45** of pulley elements **42** and **44** is very critical and will be discussed further hereafter.

A vertical L-shaped bracket **48** is rigidly secured in any convenient manner to platform **26** at a point directly behind pulley elements **42** and **44**. Ears **50** are riveted to the forward face of bracket **48** and are inclined at an angle of 45° with the horizontal platform **26**. A pulley element **52** is rotatably mounted between ears **50** on pin **51**. Pulley element **52** is of such size and is so located

between ears 50 that horizontal tangent lines extending rearwardly from the top of pulley element 42 and the bottom of pulley element 44 also serve as tangent lines extending forwardly from the upper and lower extremities of pulley element 52. The importance of this arrangement will be discussed hereafter.

A continuous flexible cable 54 is threaded over the top and thence down and around pulley element 42 and thence rearwardly towards the upper extremity of pulley element 52. Cable 54 which is preferably composed of nylon, is threaded halfway around pulley 52 and then extends forwardly over the bottom of pulley element 44. The cable then extends upwardly around pulley element 44 and then forwardly away from the bottom of the pulley element. The numeral 56 designates the portion of cable 54 leading into pulley element 42 and the numeral 58 designates the portion of cable 54 leading away from pulley element 44. The position of the cable 54 with respect to the pulley elements 42, 52 and 44 can be reversed without effect if the angle of inclination of pulley 52 is also reversed. A very important aspect of pulleys 42 and 44 is that the diameter of their respective throats 45 should be approximately one and one-half times that of the cable 54, and in no case should the diameters of throats 45 equal or be greater than twice the diameter of the cable.

As seen in Fig. 1, platform 26 can be mounted on garage ceiling 10 in any convenient manner, and pulley elements 60 and 62 can be conventionally mounted on the portion of the garage just above door 14. A bracket 64 is secured to the top of door 14, as also shown in Fig. 1. The portion 56 of cable 54 can be threaded through pulley element 60, thence around pulley element 62, and can then be secured to the bracket 64 on door 14, as shown in Fig. 2. Portion 58 of cable 54 can extend towards door 14 and be tied to one end of spring 66. Cable 54 then extends through the spring 66 and is tied onto the other end of the spring. The length of cable inside spring 66 should always be greater than the compressed length of the spring. The length of cable between the ends of the spring could just as well be outside the spring. Fig. 2 clearly illustrates the relation of cable 54 to spring 66. If cable 54 is a continuous cable, it can extend through a hole in bracket 64 and have knots 68 and 70 on either side of the bracket to effect the tying of the cable to the bracket. Knot 70 can also be utilized to tie cable 54 to one end of spring 66, as seen in Fig. 2.

A three-way electrical, key-operated switch 72 is located on the outside of garage door frame 12 and a three-way electrical bat-type switch 74 is located on the inside of door frame 12. The exact location of these switches 72 and 74 is not critical as long as they are outside and inside, respectively, of the garage door 14. As shown in Fig. 3, switches 72 and 74 are electrically connected together in parallel circuits. Switches 72 and 74 are normally in an open position and can close their respective circuits only when manually held in one of two alternate positions.

An electrical limit switch 76 is secured to the garage at a point just above garage door 14 and is adapted to be opened by contact element 78 on bracket 64 when door 14 is in a closed position. A similar electrical limit switch 80 is mounted on the rearward end of track 18, as shown in Fig. 1, and is adapted to be opened by the garage door 14 when the garage door is in the opened position shown by the dotted lines in Fig. 1.

A control panel 82 is secured in any convenient manner to platform 26 and at least three electrical female plugs 84, 86 and 88 are secured thereto. Female plug 84 is adapted to receive a two wire lead male plug 90, and female plugs 86 and 88 are adapted to receive three wire lead male plugs 92 and 84 respectively. The numerals 96 and 98 designate two wires on male plug 90 which are connected to a source of electrical energy.

By referring to Fig. 3, it can be seen that threeway switches 72 and 74 are electrically connected by wires 100, 102 and 104. Wire 98, which leads from a source of electrical energy, is connected directly to wire 102 between switches 72 and 74. A wire 106 connects wire 104 with one terminal of limit switch 80 and wire 108 connects the other terminal of limit switch 80 with the field windings of motor 32. A wire 110 connects an intermediate terminal or motor 32 with one terminal of limit switch 76 and wire 112 connects the other terminal of limit switch 76 to wire 100 between three-way switches 72 and 74. Wire 96, which is connected to a source of electrical energy, is directly connected to the field windings of motor 32.

The normal operation of our device is as follows: To move the door 14, the motor 32 must be electrically energized to induce motion to cable 54. Obviously, motor 32 is capable of rotating shaft 38 in one of two directions, and the motor 32 is capable of inducing motion to cable 54 through the specific structure of pulley elements 42 and 44 along with the assistance of pulley element 52. Since the throats 45 of pulley elements 42 and 44 are one and one-half times that of cable 54, it is necessary for cable 54 to partially overlap itself upon one complete turn about the pulley element. The overlapping of the cable 54 upon itself as it embraces a pulley element causes the tension on the cable alone to force the cable into frictional engagement with the pulley element when the pulley element is rotated in a single given direction. By observing Figs. 4, 5 and 6, it can be seen that the portion 56 of cable 54 will bind itself upon the pulley element 42 whenever the pulley element is rotated in a clockwise direction, as viewed in Fig. 6. To provide for a frictional binding action between pulley element and cable when a reverse in the direction of rotation of shaft 38 was encountered, pulley element 44 was also mounted on the shaft so that a reverse winding of cable 54 with respect to pulley element 42 could be made on pulley element 44. Thus, cable 54 "grips" pulley element 42 when shaft 38 is rotated in one direction, and the cable "grips" pulley element 44 when the direction of rotation of the shaft is reversed. The size and position of pulley element 52 permits the cable 54 to be placed on and removed from pulley elements 42 and 44 on a "straight line feed." This arrangement of structure enhances the above described frictional binding action between the cable and pulley elements. The overlapping binding action of the cable 54 on the respective pulley elements prevents any "backlash" action of the cable during the operative phase.

With the door 14 in the position of the solid lines in Fig. 1, three-way switches 72 and 74 are in a normal open position. The closed door 14 has forced the contact member 78 on bracket 64 into engagement with limit switch 76 to open this switch. Limit switch 80 is in its normal closed position. The door 14 can be opened by manually closing either of the three-way switches 72 or 74 to electrically connect wires 102 and 104. The electrical circuit thus established to energize motor 32 can be traced from the source of electrical energy, thence through wire 98, thence to wire 102, thence through whichever switch 72 or 74 is being held closed, thence through wire 104; thence through wire 106, closed limit switch 80 and wire 108; thence through motor 32 and wire 96 back to the source of electrical energy. The energization of motor 32 can be assumed to then result in a counterclockwise rotation of cable 54, as viewed in Figs. 1 and 3. The rotation of the cable in this direction will cause the bracket 64 to move rearwardly on track 18 to effect the opening of door 14 to which the bracket is attached. Since a length of cable 54 is slack between the ends of spring 66, the motor 32 will have an opportunity to gain acceleration easily by having its motion resisted only by the expansion of spring 66. As soon as the spring 66 is expanded enough to take the slack out of cable 54, the cable then begins to move the door 14 upwardly and rearwardly. The movement of the door can

be stopped at any stage of operation by merely releasing the switch **72** or **74** which will permit the switch to revert to its open position to break the electrical circuit. As the door **14** begins to open and contact **78** on bracket **74** moves away from limit switch **76**, limit switch **76** will revert to its normal closed position. When the door **14** is fully opened, as shown by the dotted lines in Fig. 1, the top of the door will engage and open limit switch **80** which will break the "opening circuit." Thus, the operator does not need to remember to release the switch **72** or **74** at the instant the door **14** reaches its maximum open position.

To close the opened door **14**, the operator needs only to move switch **72** or **74** to the position where wires **100** and **102** are electrically connected. The field of motor **32** is then reversed from the above described circuit and cable **54** is then rotated in the opposite direction to effect the closing of the door. The circuit defined by this action is traced from the source of electrical energy to wire **98**, thence to wire **102**, thence through whichever switch **72** or **74** is being manually held in a closed position, thence through wire **100**; thence through wire **112**, closed limit switch **76**, and wire **110** to motor **32**; and thence to the source of electrical energy through motor **32** and wire **96**. Limit switch **80** automatically closes as the door **14** starts to close and the "closing" circuit is automatically broken when the closed door opens limit switch **76** by means of bracket **64** and contact element **78**. As in the opening operation, the opening of whichever switch **72** or **74** is being held closed will stop the closing of the door at any point.

Although we have shown platform **26** to be mounted on the garage ceiling **10**, it will be appreciated that cable **54** could be mounted on innumerable pulleys which would permit the location of platform **26** to be at any convenient point. Thus, the operating space required for our device is negligible.

Since the cross sectional areas of throats **45** on pulley elements **42** and **44** are of such small "diameter," it is virtually impossible to turn shaft **38** by exerting tension on cable **54**. Thus, when the various electrical circuits are broken, it is not possible to manually operate the door **14**. An effort to do so makes the binding action between the pulley elements and cable react as if the cable were "tied" to the pulley elements. Thus, our control mechanism is substantially self-locking.

From the foregoing, it can be seen that our invention accomplishes at least all of its stated objectives.

Some changes may be made in the construction and arrangement of our reciprocal movement control mechanism without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claim, any modified forms of structure or use of mechanical equivalents which may be reasonably included within its scope.

We claim:

In combination, a supporting unit, a member adapted for reciprocal movement on said supporting unit and a control means, comprising, a base platform, a reversible motion power unit mounted on said platform, a shaft operatively connected to said power unit and adapted to be rotated in alternate directions thereby, first and second pulley members of the same diameter rigidly secured to said shaft, a third pulley member operatively mounted on said platform; a continuous cable threaded around at least half the periphery of said first pulley, thence to and about said third pulley, thence back to and at least half way around the periphery of said second pulley; a fourth pulley on said supporting unit, said cable thence extending directly away from said first and second pulleys to extend around said fourth pulley, and means connecting said member to said cable.

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