ELECTRO-MECHANICAL DOOR OPENING AND CLOSING MECHANISM

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Our invention relates to electro-mechanical door opening and closing mechanism.

An object of our invention is to provide reliable and efficient mechanical devices which are electrically driven and electronically controlled and which will produce reciprocating motion well adapted for opening and closing garage doors and other doors and for performing similar operations.

Another object is to provide highly efficient cable operated devices for imparting reciprocating movement to a door operating carriage which runs in or on a track, said devices including a rotatably mounted reversibly driven drum having an external thread type spiral groove and having a cable operating in said groove with two ends of the cable attached to the drum and with an intermediate portion of the cable extending in a loop away from the drum and around one or more sheaves so that rotation of the drum will move the cable lengthwise while simultaneously winding one lap of the cable onto the drum and unwinding the other lap of the cable from the drum, the cable always being taut, the direction of movement of the cable being reversible by reversing the direction of rotation of the drum, and the carriage being attached to one lap of the cable between the drum and the sheave or sheaves around which said cable passes.

Another object is to provide door opening and closing mechanism which embodies efficient limit means for stopping movement of the door moving devices and door without substantial shock or jar in both the closed door and the open door position and which further embodies efficient means for stopping the movement of said door moving devices and the door in the event of an emergency which overloads the motor by which said devices are being moved.

Another object is to provide door opening and closing means having therein clutch mechanism of novel construction which is quickly releasable manually to permit manual opening and closing of the door.

Another object is to provide improved electrical operating means and electrical control means for door opening and closing mechanism, said means including an automatically reversible electric motor which will always run successive cycles of operation in opposite directions, together with novel and efficient start, stop, and control means for said motor.

Other objects of our invention will be apparent from the following description taken in connection with the accompanying drawings.

In said drawings:

FIGURE 1 is a top plan view, with parts broken away and parts in section, showing a door opening and closing device constructed in accordance with our invention.

FIG. 2 is a side elevation of the same, showing parts broken away and parts in section and showing a fragment of a door with which the device is connected.

FIG. 3 is a sectional view, with parts in elevation, taken substantially on broken line 3-3 of FIG. 1 and on a larger scale than FIG. 1.

FIG. 4 is a view in cross section, with parts in plan, taken substantially on broken line 4-4 of FIG. 3.

FIG. 5 is a detached edge elevational view of a clutch plate used in this device.

FIG. 6 is a detached plan view of another clutch plate which is suitably recessed in interlock with the clutch plate shown in FIG. 5.

FIG. 7 is a detached view in elevation of a yoke used in connection with a worm in providing motor overload control means.

FIG. 8 is a detached isometric view, on a smaller scale than FIGS. 3 to 7 and, showing a cable drum housing.

FIG. 9 is a detached elevational view of a cable drum.

FIG. 10 is a somewhat diagrammatic view in elevation, looking in the direction of broken line 10-10 of FIG. 4, showing overload and limit switch means and operating devices for the same.

FIG. 11 is a wiring diagram showing electrical control means for this door opening and closing mechanism, said means being shown in its relation to a control box, which is indicated by dot and dash lines.

FIG. 12 is another wiring diagram showing the electrical control devices and their connection with an automatically reversible electric motor.

Like reference numerals refer to like parts throughout the several views.

This door operating mechanism comprises a housing formed preferably of three main parts 15, 16 and 17 secured together by bolts or cap screws 18. A control box 14, shown fragmentarily in FIGS. 1, 2, 4 and 10 and shown by dot and dash lines in FIG. 11 is secured to the housing part 15. The part 15 is a gearbox which houses driving and clutch means. The part 16 is a partition plate and bearing support, and the part 17 is a cable drum housing. The housing formed by members 15, 16 and 17 is supported from track members 41 by bracket plates 28 which are rigidly attached to the housing part 47 by cap screws 47 and to the track members 41 by other cap screws or bolts 47'. Two of the track members 41 are provided in spaced apart parallel relation and the ends of these track members 41 remote from housing 15, 16, 17 are rigid with an end bracket 29. Said end bracket 29 is fixedly attached to a permanent support, such as an upright wall 29' of a building.

The partition plate 16 has spaced apart marginal flanges 19 and 20 forming therebetween a groove which fits over and receives the open end portion of a gear housing 15 which has an oil seal gasket 22 in the bottom thereof. A bearing hub 23 is provided on the end of the housing member 15 shown lowermost in FIGS. 2 and 3. A shaft 24 is disposed within the housing formed by parts 15, 16 and 17. Said shaft 24 is journaled in a bushing 25 in the hub 23 and in bearings 26 and 27 in the respective housing parts 17 and 16. The housing part 15 is adapted to contain lubricant and the operating part therein run in this lubricant. Suitable oil seal packing 21 is provided in a hub 16' of the partition plate 16.

A cable drum 30, FIG. 3, is disposed within the drum housing 17 and secured to the shaft 24 by a cross pin 31. The pin 31 extends through the shaft 24 and has outwardly protruding ends which extend through the housing 32 in the end of the hub 30' of said cable drum. The periphery of the cable drum 30 has a spiral groove 33 which is like a thread except that it is of arcuate cross section to better adapt it to receive and form a trackway for the reception of convolutions of flexible cable. Two runs or laps 34 and 34' of cable extend in floor or loop support of anchoring these cable ends to the drum 30 is to insert and fasten them within perforations 35 which are provided near the respective ends of the drum 30. Preferably...
the convolutions of cable occupy substantially the full length of the spiral groove 33 on drum 30 but obviously this can be varied. The two laps or runs 34 and 34' of cable are made from two diametrically opposite locations on the drum 30 and extend outwardly from said drum in the same direction along track members 41. Each run of cable between drum 30 and sheave 60 is herein regarded as a lap. One lap, for instance the lap 34 of said cable is attached to a carriage 37 which is to be reciprocally moved along the track 41. The cable may be cut at the location where it fastens to the carriage 37 if desired but it is obvious that the two laps 34 and 34' of cable and the carriage 37 form a closed loop having its two end portions wound on and attached to the drum 30. Rotation of drum 30 will unwind and pay out one lap and simultaneously wind in the other lap of cable and in so doing will longitudinally move the carriage 37 without changing the over all length of the loop formed by the two cable laps 34 and 34' and the carriage 37. Obviously more than one sheave can be used to perform the function of sheave 36 and the carriage can operate in either track member 41.

The groove 33 guides the cable and causes the convolutions thereof to lie close together on the drum 30 and at the same time prevents these convolutions from overlapping or piling up and from rubbing against each other. Since there is only one layer of cable convolutions on the drum 30 the cable loop formed by the laps 34 and 34' and the carriage 37 is always fairly taut and does not change length. Spring means can be provided in the cable preferably at the location where connection with the carriage is made. Also the sheave 36 can be adjustably supported.

The carriage 37 can be of conventional construction and it is shown in the drawings as comprising a frame 38 having four wheels 39 mounted thereon by bearing studs 40. The wheels 39 of said carriage run in one of the track members 41. The carriage frame 38 has a rigid arm 42 which extends downwardly through a slot 43 in the track 41 in which the carriage operates and has a bar 44 connected therewith by a pivot member 45. The bar 44 is pivotally connected with a door 46 or any similar member to which back and forth movement is to be applied in operating the same. Preferably the bar 44 is formed of two parts adjustable secured together by bolts 47 and the over all length of this bar can be varied. Hanger brackets 48 of any desired shape and length are used to support the end portions of tracks 41 to which the housing parts 15, 16, 17 are attached from a ceiling, wall or any other suitable support.

The housing member 17, FIGS. 1 and 8, is provided with two upright slots 49 and 50 through which the cables 34 and 34' operate. It will be understood that the door 46 is conventionally mounted in such a manner that movement of the carriage 37 to the left, from the closed door position in which it is shown in FIG. 2, will tend to open the door 46 and movement of the carriage in the opposite direction after the door has been opened will tend to close said door.

The clutch and gear mechanism disposed within the gear housing 15 comprises a clutch plate 51, FIGS. 3 and 5, having a hub 52 which fits snugly on the shaft 24. A cross pin 53 extends through the shaft 24 and has its end portions seated in notches 54 in the hub 52 to secure the clutch plate 51 non-rotatively on the shaft 24. A worm wheel 55 has its hub portion 56 rotatively mounted on the hub 52 of the clutch plate 51. The worm wheel 55 has peripheral teeth 57. The hub 52 of the clutch plate 51 extends entirely through the hub 56 of the worm wheel 55 and the ends portion of the hub 52 is shaped like a jaw clutch by providing the same with alternate jaw clutch segments or teeth 58 and notches 59. Another clutch plate 60 is disposed on the opposite side of the worm gear 55 from the plate 51 and is provided with a hub part 61 having a central opening 62 fitting over the shaft 24 and having alternate segments or teeth 63 and notches 64 which interfit with the notches 59 and segments 58 of the hub 52. The two clutch plates 51 and 60 are internally intermeshed so that they will rotate synchronously with each other and with the shaft 24 and will have a limited amount of movement toward and away from each other.

One or more friction plates 65, preferably of metal, are disposed between each clutch plate 51 and 60 and the adjacent face of the worm wheel 55. The face of the clutch plate 60 remote from the worm wheel 55 is provided near its periphery with a plurality of spaced apart bearing or thrust lugs 70. The lugs 70 are engaged by a bearing plate or pressure plate 71. The plate 71 is reinforced by a second plate 71'. Both plates 71 and 71' are disc shaped and the plate 71' is of smaller diameter than the plate 70. Both plates 71 and 71' are at least slightly resilient and both are sidable on the shaft 24 and the disc 71' rests against a cross key 72. The cross key 72 is movable in a longitudinal slot 73 in the shaft 24. The slot 73 is intersected by an axial bore 74 in the shaft 24. The bore 74 extends to the lower end of shaft 24 and is internally threaded. A clutch applicator screw 75 is threaded into the bore 74 and the inner end of said screw 75 engages the cross key 72. The outer end of the screw 75 is provided with a turn knob 76 whereby said screw 75 may be turned to selectively clamp the friction discs 65 between the worm wheel 55 and the respective clutch plate 51 and 60 or to release said friction discs relative to these parts. If the friction discs 65 are clamped against the worm wheel 55 and said worm wheel is driven the clutch plates 51 and 60 will be driven by the worm wheel and the shaft 24 will be driven by the cross pin 53 which connects it with the hub of clutch plate 51. This will drive the drum 30. The screw 75 is readily operable to engage or disengage the clutch. When said clutch is disengaged the door with which the door operating device is connected may be readily opened and closed manually.

The worm wheel 55 meshes with a worm 77, FIG. 4, on the shaft 78 of an automatic reversing motor 79. The motor 79 is secured to a motor end-bell 69, FIGS. 1, 2 and 3, which is attached to the housing part 15. The worm 77 is disposed within a yoke 80 and preferably two ball bearings 81 and 82 are provided between the respective end portions of the worm 77 and the yoke 80. The yoke 80 is mounted on a spline 83 on the motor shaft 78 so that it is non-rotatable but is longitudinally movable on said shaft 78. The end 84 of the yoke 80, shown at the left in FIG. 4, is rotatively supported on the motor shaft 78. The other end of the yoke 80 is secured by a set screw 85 to a rod 86. The rod 86 extends outwardly through the wall of the housing part 15 and is secured by a cross pin 87 to a lever 88 which operates a motor overload switch 84. A relatively small amount of clearance, shown at 86c in FIG. 4, is provided between each end of the yoke 80 and the adjacent wall of the housing part 15. This provides for limited endwise movement of the yoke 80 and rod 86 for the purpose of operating the motor overload switch 84. The use of the spline 83 in mounting the worm 77 on the shaft 78 allows for some longitudinal movement of worm 77 relative to shaft 78 in the event no longitudinal movement of the shaft 78 in the motor 79 is provided. However, the shaft of an electric motor usually has some endwise play and in such instances we find it practical to mount the worm 77 rigidly and non-movably on the motor shaft and take advantage of the longitudinal movement or play of said motor shaft for the purpose of operating said overload switch 84.

The switch operating lever 88 can be oscillated a limited amount on the pin 87. The outer end of said lever 88 is positioned to engage the switch 84. The inner end of said lever fits over a bolt 89 which is threaded.
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Into the housing part 15 and extends outwardly therefrom. A compression spring 90 on the bolt 89 is adjust-ably supported by a nut 91 and yielding holds the inner end of the lever 88 against the housing 15.

A fulcrum member 93 rigid with a flange 93*, FIG. 10, of the housing part 15 is provided between the rod 86 and the switch 84. The lever 88 rests against and is fulcrummed on this member 93. A bolt 94 extends through a perforation 92 in the fulcrum member 93 and is thread-ed into the lever 88. A compression spring 95 is pro-vided on the bolt 94 between the fulcrum member 93 and a nut 96 on said bolt. This spring 95 yieldingly urges the lever 88 against the fulcrum member 93 and the pressure exerted by said spring is can be adjusted by adjusting the nut 96 on the bolt 94.

If the rod 86 is moved outwardly the spring 90 will be compressed, the lever 88 will be caused to fulcrum on the member 93 and the outer end of said lever 88 will be moved toward the switch 84 to operate the same. If the rod 86 is moved inwardly, the spring 95 will be com-pressed and the outer end of said lever 88 will be similarly moved toward said switch 84 to operate the same. When the device is not in operation, or when during operation the worm 77 is only being subjected to a nor-mal strain, the springs 90 and 95 will hold said worm in a predetermined position with both ends of the yoke 80 clear of the housing 15. However, if the worm 77 is subjected to an excess strain or load in either direction it will move the yoke 80 and rod 86 to operate the switch 84 and this will change the condition of the circuit controlled by said switch 84 and stop the motor 79. The springs 90 and 95 can be adjusted so that the switch 84 will be operated by a relatively light overload if such a condition is desired.

The limit of travel mechanism for stopping the motor 79 at the end of a predetermined distance of travel of the carriage 37 in either direction is shown in FIGS. 1, 3, 4, and 10. This mechanism comprises a control shaft 100 journaled in bearings 101 in the gear housing 15 and extending transversely of the main shaft 24. A worm wheel 102 is rigid with the control shaft 100 and meshes with a thread like worm 103 on the main shaft 24. This provides slow speed rotation of the control shaft 100 when the main shaft 24 is being driven. The control shaft 100 extends to the exterior of the housing 15 and the outwardly protruding end portion thereof has a disc 104 rigidly secured thereon. The disc 104 has two switch operating cams 106 and 107 adjustable elastically thereon. Preferably each cam 106 and 107 is of two piece construction, FIG. 4, and the two pieces thereof are releasably and adjustably clamped to the disc 104 by a screw 105. The cams 106 and 107 protrude radially from the disc 104 and are positioned so that rotation of the shaft 100 will cause these cams to engage with and lift a switch operating arm 109. The lifting of the arm 109 will bring about the opening of a normally closed limit switch 113 and stop the operation of the motor 97, as hereinafter explained. Preferably the limit switch 110, cams 106 and 107 and disc 104 are all disposed within the control box 14.

The electrical control and operating means includes the automatic reversing motor 79, which is constructed so that each time it is stopped it will run the next cycle in the opposite direction. The control box 14, indicated by dot and dash lines in FIG. 11, contains a twenty-four volt transformer 112, an electric lamp 112, which is connected from such control box, and three relays 1, R2, and TD. The relay R2 is a single pole double throw relay having 110 volt contacts and a twenty-four volt coil. The relay R1 is a double pole single throw relay having a 110 volt coil. The relay TD is a time delay relay having a 110 volt coil and contacts that are normal-ly closed. In the control box 14 there are also two switches, one the limit switch 113 operated by the cam 106 and 107 and the other the overload switch 84 op-

erated by the arm 88. Both of these switches 84 and 113 are normally closed switches. The cam 106 opens the normally closed limit switch 113 when the door 46 reaches a fully closed position and the carriage 37 is at the end of the track 41 remote from the motor 79. The other cam 107 opens said normally closed limit switch 113 when the door 46 reaches a desired open position. When the door 46 is fully open or fully closed one of the cams 106 or 107 will be in engagement with the arm 109 and will be holding the limit switch 113 in an open position. The motor 79 can be started with the limit switch 113 thus held open and, if it is so started, the cam 106 or 107 move away from and release the arm 109 in about one second after the starting of the motor and the switch 113 will close.

In the wiring diagrams, FIGS. 11 and 12, a one hun-dred ten volt neutral wire 116 is connected with the lamp 115, the transformer 111, the double pole single throw relay R1, and the time delay relay TD. A one hundred ten volt positive wire 117 goes through the motor over-load switch 84 to both sides of the double pole single throw relay R1, the common pole of the single pole double throw relay R2, the transformer 111, and the lamp 112. A twenty-four volt energizing current for the single pole double throw relay R2 comes from the trans-former 111, one side being hooked directly to the trans-former and the other side being energized when the cir-cuit is closed, either by a switch 118 in said circuit or by the closing of contacts 119, resulting in the energizing of a radio receiver 120.

An example of what happens if the garage door 46 is closed and the carriage 37 in the forward position shown in FIG. 2 is: The cam 106 will be in engagement with the switch arm 109 and the switch 113 will be open. If the circuit to the twenty-four volt coil of the transformer 111 is closed through either the manually operated switch 118 or the receiver operated switch 119 the normally open one hundred ten volt contacts of relay R2 will be closed. This allows one hundred ten volt current to flow from the hot side of the double pole single throw relay R1, through the single pole relay R2, through the normally closed contacts of the time delay relay TD to the coil of the double pole single throw relay R1 closing the contacts of said relay. One circuit from relay R1 goes to the motor 79 and starts the same and the other circuit ener-gizes the coil of said relay and holds it closed from two to three seconds. This time delay hold-in allows the cam 106 to release the arm 109 and bring about the closing of the switch 113 as the motor 79 starts to rotate the shaft 100 and cam carrying disc 104. Thus a one hundred ten volt circuit is completed through the contacts of the normally closed twenty four volt relay R2 and through the two then closed switches 84 and 113 and the coil of R3 is kept energized until one of three things happens, namely, one of the switches 118 or 119 is opened; an emergency, such as some object obstructing movement of the door, brings about the opening of the overload switch 84, or the door reaches the end of its travel and opens switch 113.

If one of the switches 118 or 119 is closed by a person who desires to stop the door while it is in motion and has been operating for more than two or three seconds the closing of the circuit to the relay R2 will stop the motor 79. This occurs because the coil of the time delay relay TD will have been energized more than two or three seconds and its contacts will be open thus breaking the circuit through relay R1 and switches 84 and 113 to the one hundred ten volt coil of the relay R2. But the circuit of the coil of relay R1 is thus broken no elec-tricity is carried to any of the coils of any of the relays and they are all in de-energized condition and again the contacts of the time delay relay TD move to their nor-mally closed position and are ready for the next operation.

Should some object block the opening or closing move-
ment of the door 46 the overload on the motor 79 will result in a slight endwise movement of the shaft 78 and rod 86 and this will move the control switch 84 and stop the motor 79, providing the time delay relay TD has been energized more than two or three seconds in the cycle and its normally closed circuit is open.

If the door is being opened or closed and one of the cams 106 or 107 opens the limit switch 101 at the end of the door travel the relay R1 will be de-energized, the circuit controlled thereby opened and the motor 79 stopped, providing the time delay relay TD has been energized more than two or three seconds in the cycle and has opened its circuit.

The motor 79 is a conventional automatic reversing motor which runs successive cycles in opposite directions. In FIG. 12 RS indicates a reversing switch in this motor, TS indicates a throw-out switch, RW indicates a running winding, and SW indicates a starting winding.

The energy for the motor 79 is carried through one set of contacts of the one hundred ten volt relay R1 and any one of these, a preferred method being energized the circuit is opened and the motor 79 stops. The other set of contacts of the relay R1 control the circuit to the coil of said relay R1. Thus the coil of relay R1 can, in starting the motor 79, be energized by a circuit including one side or set of contacts of said relay R1, the normally closed contacts of the relay R2, the normally closed contacts of the time delay relay TD, and the coil of said relay R1.

Once the coil of relay R1 is energized and its contacts closed current is carried through one set of its own contacts to its coil and it remains closed for from two or three seconds, during which time the other or second circuit to the motor 79 will be completed by the closing of the limit switch 84. One hundred ten volt current will then flow through one set of contacts of relay R1, through the normally closed contacts of relay R2, through the two normally closed switches 84 and 113 to the coil of relay R2. Thus the coil of relay R2 will remain energized and its contacts closed until the circuit is broken, either by the opening of one of switches 118 or 119, or by the opening of either of the switches 84 or 113.

If one of the control switches 118 or 119 is closed while the motor 79 is operating said motor 79 will be stopped and the next closing of a control switch 118 or 119 will start the motor in a reverse direction. If none of the control switches 118 or 119 is being held closed at the time the limit switch 113 or the overload switch 84 is opened the motor 79 will be stopped by the opening of the normally closed contacts of time delay relay TD.

The lamp 112 is connected in the circuit so that it will be energized at all times except when the door 46 is stopped while traveling in a down ward direction and the motor is stopped.

The limit switch 113 is positioned and adjusted so that it will stop the motor 79 without shock or jar when the door reaches the limit of its movement in either direction.

The foregoing description and accompanying drawings clearly disclose the principle of our invention but it will be understood that this disclosure is merely illustrative and that changes may be made within the scope of the following claims.

We claim:

1. In devices of the class described, a housing; a drum rotatorably mounted in said housing, said drum having a continuous external spiral groove; a cable wound in a single layer on said drum and lying in said spiral groove, spaced apart end portions of said cable being attached to said drum near the respective ends of the drum, one turn of said cable between said attached end portions forming a loop extending away from the drum and carrying said loop, the cable parts forming the two laps of said loop, a sheave rotatorably mounted remote from said drum, the loop of said cable passing around said sheave; a carriage secured to one lap of the loop of said cable between said sheave and said drum; and reversible driving means connected with the carriage and cable to reciprocally move the carriage by reverse rotation of the drum.

2. In door opening and closing mechanism, a housing; a drum rotatorily mounted in said housing, said drum having a continuous external spiral groove; a cable wound in a single layer on said drum and lying in said spiral groove, spaced apart end portions of said cable being attached to said drum, one part of said cable between said attached end portions extending away from said drum and back to said drum forming a loop the two laps of which engage the drum on opposite sides; a track secured to said housing and extending outwardly therefrom; a sheave rotatorily mounted by said track remote from said drum, one turn of said cable between said attached end portions extending away from said drum and back to said drum forming a loop the two laps of which engage with opposite sides of the drum; a track secured to the housing and extending outwardly therefrom; a sheave rotatorily mounted by said track remote from said drum; the loop of said cable passing around said sheave; a carriage secured to one lap of the loop of said cable between said sheave and said drum; reversible driving means connected with said drum providing reciprocating movement of the carriage along the track by rotation in reverse directions of said drum; and a readily releasable clutch embodied in said reversible drum driving means.

3. In door opening and closing mechanism, a housing; a drum rotatorily mounted in said housing, said drum having a continuous external spiral groove; a cable wound in a single layer on said drum and lying in said spiral groove, spaced apart end portions of said cable being secured to said drum, one turn of said cable between said attached end portions extending away from said drum and back to said drum forming a loop the two laps of which engage with opposite sides of the drum; a track secured to the housing and extending outwardly therefrom; a sheave rotatorily mounted by said track remote from said drum; the loop of said cable passing around said sheave; a carriage secured to one lap of the loop of said cable between the sheave and the drum; reversible driving means connected with said drum operable in reciprocatingly moving said carriage; and driving means reversing devices operated by said reversible driving means.

4. In door opening and closing mechanism, a housing; a drum carrying shaft rotatorily mounted in said housing; a drum carried by said shaft, said drum having a continuous external spiral groove; a track rigid with and extending away from said housing; a sheave rotatorily supported by said track in spaced relation from said housing; a cable having a bight portion extending around said sheave and having two relatively taut laps extending from the sheave to approximately diametrically opposite sides of said drum and wound on a single layer on said drum with the convolutions of cable lying in and positioned and guided by said spiral groove, the extremities of the two laps of cable being secured to the respective end portions of the drum; a carriage movably supported by said track and secured to one lap of said cable between the sheave and the drum; reversible shaft driving means having a driving connection with said drum carrying shaft; and manually releasable clutch means interposed in said shaft driving means.

5. In door opening and closing mechanism, a housing; a drum carrying shaft rotatorily mounted in said housing; a drum carried by said shaft, said drum having a continuous external spiral groove; a track rigid with and extending away from said housing; a sheave rotatorily supported by said track in spaced relation from said housing; a cable having a bight portion extending around said sheave and having two relatively taut laps extending from the sheave to said drum and wound in a single layer on said drum with the convolutions of cable lying in said spiral groove, the extremities of cable being secured to the respective end portions of the drum; a carriage movably supported by said track and secured to one lap of said cable between the sheave and the drum; a worm wheel rotatorily mounted on said drum carrying shaft; reversible driving means connected
with said worm wheel; manually releasable clutch means provided between said worm wheel and said drum carrying shaft; and driving means stopping and reversing devices connected with said drum carrying shaft limiting the rotation of said shaft in two directions, whereby longitudinal movement of said carriage in two directions along said track is limited.

6. In door opening and closing mechanism, a housing; a drum carrying shaft rotatively mounted in said housing; a drum carried by said shaft said drum having a continuous external spiral groove; a track rigid with and extending away from said housing; a sheave rotatively supported by said track in spaced relation from said housing; a cable drawn through said sheave and extending between said sheave and said drum and wound within the spiral groove on said drum and having two end portions attached to the respective end portions of said drum; a carriage movably supported by said track and secured to said cable; a worm wheel rotatively mounted on said drum carrying shaft; manually releasable clutch means provided between said worm wheel and said shaft; reversible driving means connected with said worm wheel; a control shaft journaled in said housing and extending to the exterior of said housing; speed reduction worm drive means connecting said control shaft with said drum carrying shaft; and means connecting said control shaft externally of said housing limiting rotary movement in two directions of said reversible worm wheel driving means.

7. In door opening and closing mechanism, a housing; a drum carrying shaft rotatively mounted in said housing; a drum on said shaft said drum having a continuous external spiral groove; a track rigid with and extending away from said housing; a sheave rotatively supported by said track in spaced relation from said housing; a cable secured to said drum and lying in said groove and having a loop portion extending to and around said sheave; a carriage movably supported by said track and secured to one lap of said cable between the sheave and the drum; a worm wheel having a driving connection with said drum carrying shaft; a worm meshing with said worm wheel; a worm driving shaft having a driving connection with said worm driving shaft; and driving means operable by longitudinal overload displacement of said worm on said shaft.

8. In door opening and closing mechanism, reciprocable means capable of opening and closing a door; operating devices connected with said reciprocable means; an electric motor having a shaft capable of endwise play relative to said motor; means including a worm on said shaft connecting said shaft with said operating devices; an overload switch controlling a supply of energy to said motor; a switch operating arm supported for pivotal movement and positioned to operate said switch; means connecting said switch operating arm with said motor shaft capable of swingly moving said arm in response to endwise movement in either direction of said shaft; and springs engaging said arm yieldingly holding said arm inoperative relative to said switch and yieldingly longitudinally positioning said motor shaft; said springs being yieldable to endwise overload in either direction on said shaft, whereby an overload in either direction on said shaft will move said shaft and said arm and operate said overload switch.

9. In door opening and closing mechanism, reciprocable means capable of opening and closing a door; operating devices connected with said reciprocable means; and an automatically reversible electric motor having a driving connection with said operating devices.
movement of the rod; and an overload control switch controlling the supply of current to said motor and positioned in the path of movement of said lever for operation thereby.

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