Feb. 13, 1962 W. C. BORNEMANN 3,021,131

DOOR OPENER

Filed June 20, 1957 2 Sheets-Sheet 1

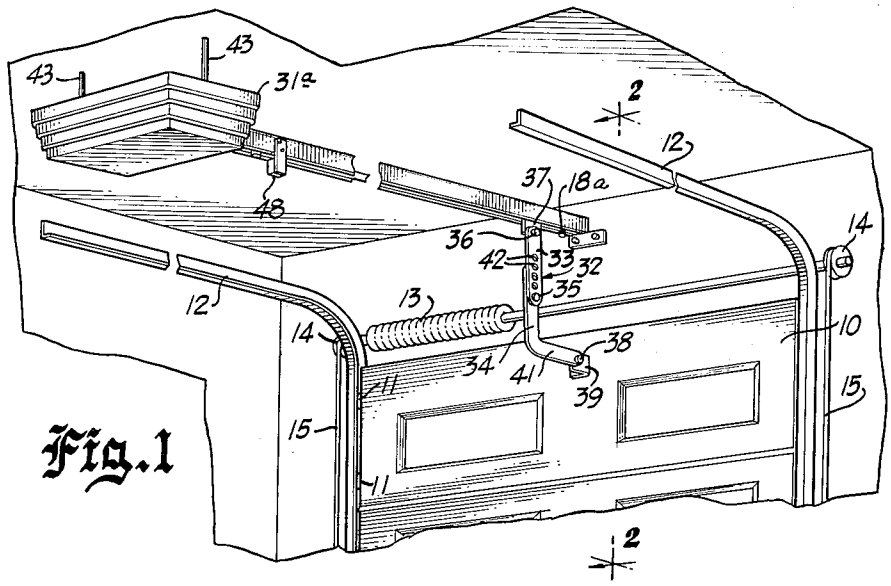

Fig. 1

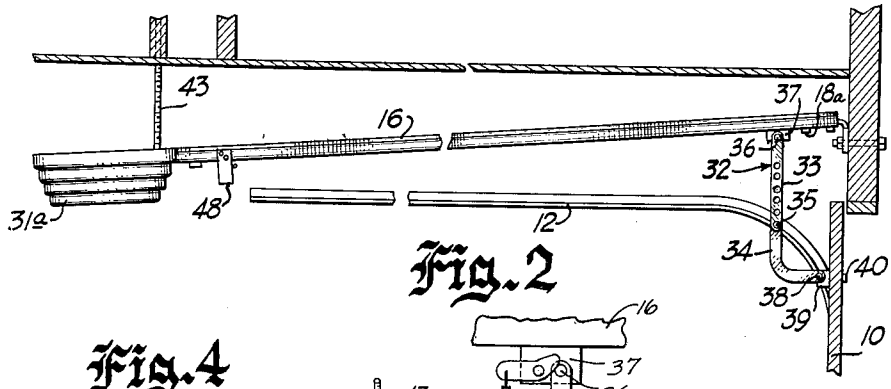

Fig. 2

Fig. 4

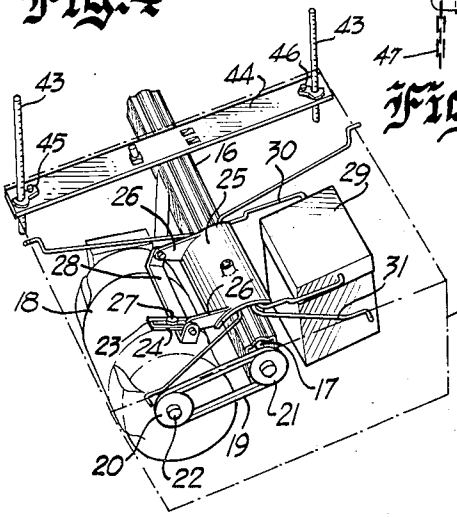

Fig. 5

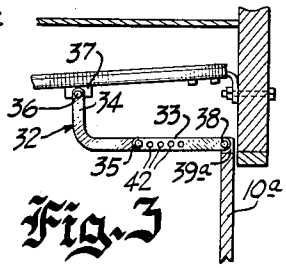

Fig. 3

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Feb. 13, 1962 W. C. BORNEMANN 3,021,131

DOOR OPENER

Filed June 20, 1957 2 Sheets-Sheet 2

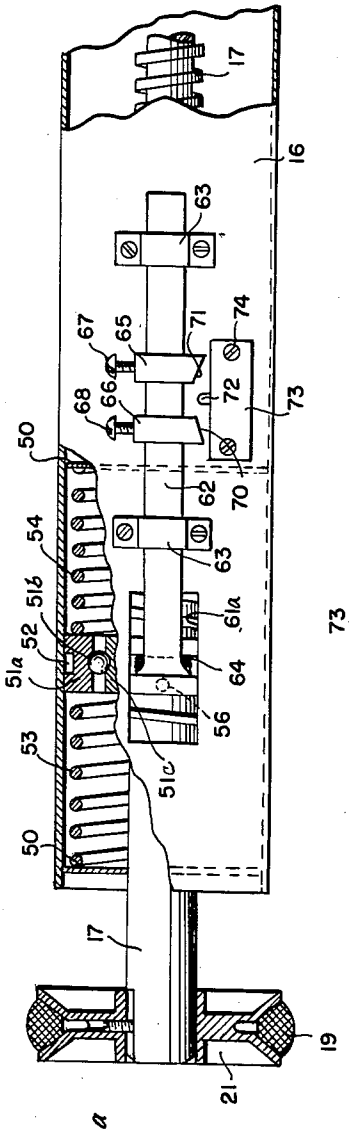

FIG. 1a

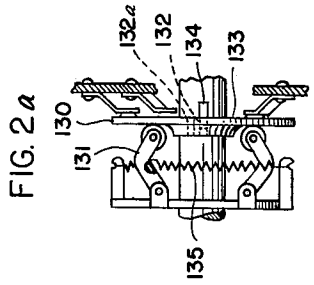

FIG. 2a

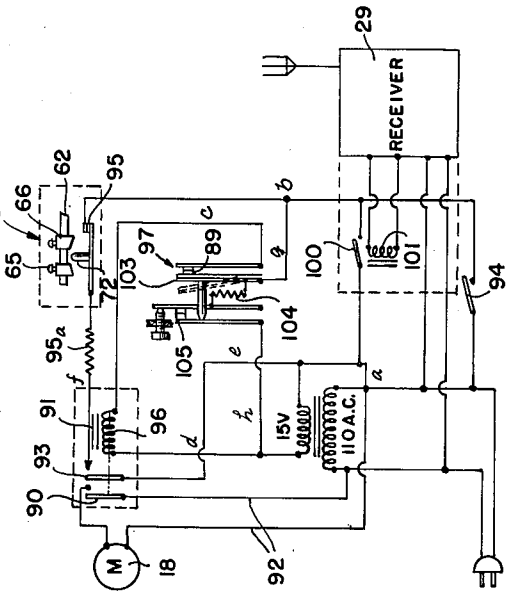

FIG. 1b

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DOOR OPENER

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5 Claims. (Cl. 268—59)

This invention relates to door-opening devices, and particularly to manually and electronically-controlled operators for heavy doors or gates such as those for use in garages, shipping docks and fireproof barriers, either hinged or single panel, together with novel lift means for carrying the door into or out of stored position.

Heretofore, various garage door operators have been available, but these devices have suffered from the mechanical problem of moving the door, whether sectional or single-piece, along tracks which make it difficult or impossible to provide a suitable connection between the drive shaft gear carrier and the door.

Accordingly, it is an object of the present invention to provide a door operator as described, wherein a "hockey stick" connecting arm is provided for connecting the upper end of either a sectional or single-piece door to the bracket driven by the operator, this connecting arm providing a pivotal relationship between the door and the moving bracket so that a constantly calibrated adjustment therebetween is provided without any binding resulting from variation in distance and angle such as has occurred with connecting arms of the type used heretofore.

Another object of the invention is to provide a "hockey stick" connecting arm as described, in which two parts are pivotally secured in either of two end-to-end relationships, to provide the aforementioned calibrated adjustment for a single-piece door or a sectional door selectively.

Other objects and advantages of the invention will become apparent as the description proceeds in accordance with the drawings in which:

FIGURE 1 is a perspective view showing the preferred embodiment of the invention installed and ready for operation in opening and closing a sectional garage door that travels upon tracks;

FIGURE 1*a* is a side elevational view partially in section showing the load switch control for stopping the motor;

FIGURE 1*b* is a schematic line diagram of the circuit controlling the operation of the embodiment shown in FIG. 1;

FIGURE 2 is a vertical sectional view taken along the lines 2—2 of FIGURE 1;

FIGURE 3 is a view corresponding to the view of FIGURE 2, and showing a second embodiment of the invention adapted for use with doors having a single-piece construction;

FIGURE 2*a* is a diagrammatic view of the self-reversing motor switch forming a part of the motor construction;

FIGURE 4 is a perspective view of the actuating means and disclosing a compact nested arrangement of these parts within a plastic container as hereinafter set forth; and

FIGURE 5 is a side elevation of the arrangement by which disengagement between the opener and the door may be accomplished easily.

Referring now to FIGURE 1 and FIGURE 4, the invention contemplates a rotatable worm shaft with a segmented gear disposed in mesh therewith to apply an opening and closing force upon a slidably mounted garage door. The shaft rotates at motor speed for fast operation of the door and is supported against whipping in an extruded housing. Reversing the direction of the rotation of the worm provides for the opening and closing movements of the door. The worm shaft is also mounted for actuation by a self-reversing motor employed to drive the shaft in a predetermined direction of angular rotation until a load on the worm shaft acts to open a switch in the field circuit of a self-energizing relay as hereinafter set forth.

A sectional garage door 10 is shown as mounted by rollers 11 to roll upwardly and horizontally on tracks 12. A torsion spring 13 balances the weight of the door as applied through reels 14 having lift lines 15 connected to the bottom of the door by a suitable bracket (not shown). A handle upon the door (not shown) provides for raising and lowering the door manually if desired. Just above the uppermost level of the door in its opening movement is mounted a substantially horizontally disposed extrusion 16, whose construction is best shown in FIGURE 4 and which retains in journalled relationship therein the worm shaft 17 which is driven by a motor 18 supported upon main channel assembly 16 as hereinafter set forth.

The motor 18 drives the worm shaft 17 by means of a pulley belt 19 received in pulley wheels 20 and 21 attached to the motor drive shaft 22 and the worm shaft 17 respectively. The tension of this motor drive belt 19 is adjustable by means of a guide slot 23 defined in a bracket 24 secured to a sleeve 25 and one of its arms 26, and receiving a pin 27 which is secured to a crossplate 28 fastened to the motor 18 and the arms 26. Within the extrusion 16 is a cylindrical portion at the end thereof near the motor 18 in which are received fixed stop washers 48 and 50 and the outer race 51*a* of a ball bearing 51 having an external groove 52 therewith. The ball bearing 51 including the bearing balls 51*b* and the inner race 51*c* supported thereby is held equidistant from the stops 50 by compression springs 53 and 54.

The inner race 51*c* of the ball bearing receives and is fastened to the worm shaft 17 by the cross-pin 56. Thus, the inner race and the worm shaft turn together as a unit.

With the construction described thus far, it will be seen how the worm shaft is supported for rotary movement in the extrusion 16 without danger of its whipping when rotating at high speed. Yet it can move when forced to do so in either axial direction against the springs 53 or 54 through the ball bearing 51. When the screw member moves in either axial direction, the outer race 51*a* moves with it.

An aperture 61*a* in the wall of the extrusion 16 on the side opposite the motor 18 exposes the groove 52 of the bearing 51 so that a switch rod 62 slidably mounted upon the extrusion by elements 63 will follow the movement of the bearing through a finger 64 engaging in the groove 52.

As shown in FIG. 1*a*, adjustable cam members 65 and 66 are secured to the switch rod 62 by set screws 67 and 68 respectively with the cam surfaces 70 and 71 movable with the switch rod along paths interfering with the button 72 of a conventional normally closed microswitch 73 mounted upon the bracket by screws 14. This arrangement operates to open the microswitch 73 whenever the switch rod 62 is moved far enough in either direction that either one of the cams 70 and 71 depress the button 72.

Referring to FIG. 2*a*, the motor 18 is identified as a self-reversing motor because its alternate starting windings are under the control of a two position switch 130 rotatable about said motor axis between fixed points, and which opens in an axial direction as the motor reaches full speed as the centrifugal elements 131 move outwardly. A keyway arrangement 132 holds the switch in either one

of its two positions until the body 133 clears the key 134 as the elements 131 centrifugate. Then, once cleared, the body 130 is rotated by its inertia to its other position and the second keyway 132*a* is ready to engage the key and close in the new position when the motor slows up and stops and the centrifugal elements 131 yield to springs 135 for that purpose. As the armature makes its last two or three revolutions the starting switch is then closed in its alternate position by axial movement of the body 130 in which it places the starting windings of the motor for rotation in the opposite direction in contact with each other preliminary to the next time that the motor is again energized.

In order to provide for operation of the door by remote control, as when the operator is sitting in a car approaching the door, a radio receiver assembly 29 is also mounted upon the channel assembly 16 as held by extensions 30 and 31 engaging within the sleeve 25.

It will be understood that a suitable radio transmitter and mounting assembly (not shown) is provided within the vehicle from which the door is to be operated; and the circuits for controlling the operation of the radio transmitter and door switches may be understood by reference to FIGS. 1*a* and 1*b* in which the schematic circuit controlling energization of the motor is illustrated wherein the motor 18 is under the control of the normally open switch 90 of a relay 91 as powered with 110 A.C. electrical current through leads 92. The other switch 93 of the relay is a self-energizing switch for the relay 91 and is connected in series with a normally open manual switch 94 and the microswitch 95. A 40 ohm resistor 95*a* is included to control the safety cut-out switch or circuit breaker. In parallel with the switches 93 and 95 is a circuit which includes the coil 96 of the relay and a 15 volt source of transformer power which is so indicated.

This last circuit also includes a safety circuit breaker of novel design 97 which will be described shortly.

When the manual switch 94 is closed, the field coil 96 of the solenoid 91 is energized through the last-mentioned circuit "*a*" to "*d*" inclusive. Energization of the coil 96 closes the switch 93 and the switch 90. The switch 90 starts the motor whereas the switch 93 sustains energization of the coil 96 through the microswitch 95 and the safety breaker 97. This circuit is identified by the letters "*e*", "*f*", "*g*", "*h*". Thus when either the microswitch 95 or the overload switch 97 is opened, the coil 96 is de-energized and the motor switch 90 drops out to stop the motor.

Connected in parallel with the manual switch 94 and supplementing its operation is a switch 100 of a relay 101 powered from a radio receiver 103. The radio receiver is pretuned to receive a signal sent momentarily from a transmitter carried by the automobile or any other device such as fire alarm broadcast whose operation is intended to ultimately culminate in a closure or opening of the door.

Referring now to the overload safety device same includes a bimetal 183 subjected to the heat of a heater 104 when energized quickly by the closure of a circuit which includes a manual switch 94 and a switch 105 controlled by the bimetal 103 or very slowly while the motor is running. The first circuit includes the leads *a*, *b*, *g*, *h*, while second circuit *e*, *f*, *b*, *g*, *h* includes the coil 96 and switch 93, which if "on" too long will be shut off as a safety precaution.

When the motor has been energized to open the door and the door reaches its raised limit as determined by the stops 17*a* the strain upon the worm shaft 17 now opposed by the follower or nut carrier 37 being held stationary, will cause the spring 54 to be collapsed and the continued rotation of the worm shaft causes the worm shaft to be moved in that direction. The ball bearing 51 will carry the switch rod 62 forwardly to bring the cam 70 in contact and depress the switch button 72 to break the supply of current to the motor relay. Thereupon the motor will stop and the starting windings for starting the motor in reverse direction will be closed. The strain upon the worm shaft being relieved by the stopping of the motor, the ball bearing 51 will recover itself enough for the engagement between the cam 70 and the switch button 72 will be terminated.

Thereafter when the motor is again energized, it will rotate the armature in the opposite direction and correspondingly the worm shaft 17 to move the carrier 37 in the opposite direction driving the link 32 in a direction forcing the door to close. When the door is fully closed, a strain is developed upon the worm shaft in the opposite direction under continued rotation of the motor, the spring 53 will be compressed, the switch bar 62 moved in the direction opposite to its previous movement and the cam 71 will engage the switch button 72 to open the circuit controlling the motor. The starting switch of the motor is again reversed.

All of the parts described and referred to by numbers 22 through 34 are contained preferably in a plastic bag 31*a* which may desirably be given a stepped configuration and which is useful to maintain these parts in concealed relationship at the top of the garage as supported by lag screws, as hereinafter set forth.

In order that the door 10 may be raised and lowered along the tracks 12 without variable relationship between the top of the door and the channel 16 thereby causing strain and interfering with the effective movement of the door, a door connecting arm 32 is provided which in the embodiment of FIGURE 1 comprises a relatively long upper arm section 3 which is preferably straight in configuration, and a preferably right-angled section 34 pivotally secured to the lower end of the element 32 by a pivot pin 35 or the like. The upper end of the straight element 33 is pivotally connected by a pin 36 to a "nut carrier" 37 which is engaged in meshing relationship with the drive shaft 17 by means of suitable sectional gear structure (not shown) so as to be actuated along the channel 16 by the rotation of the shaft 17 substantially as described in connection with the aforementioned Patent No. 2,883,182. The outer and lower end of the right-angularly curved section 34 is connected by a pin 38 to a bracket 39 secured to the upper section of the door 10 by suitable bolt means 40. The lower end 34 of the hockey stick element 32 has a transverse leg 41 such that the door 10 is spaced from the nut carrier 37 by a distance which will cause the door 10 at its upper end to define an arc whose apex is in predetermined spaced relation to the main channel assembly 16 and is smoothly continuous so as to eliminate all catching and binding during raising and lowering of the door.

In order that the movement of the door 10 may be precisely calibrated with respect to the tracks 12, in achieving the aforementioned arcuate movement, it is desired to form a plurality of apertures 42 in the upper bracket member 33 thereby affording adjustment and variation of pull upon the door 10 when the pin 35 is secured in one or the other of the apertures 42, as may be desired.

Referring now to FIGURE 3, a second embodiment of the invention is shown for use with a door of single-piece construction, as opposed to the sectional construction of the door 10. The straight arm 33 is, in this form of the invention, secured directly to the door 10*a* by means of a bracket 39*a*, and the hockey stick element 34 is connected to the nut carrier 37. Because the upper edge of the door 10*a* will define a path differing substantially from the path defined by the sectionally formed door 10, this reversed relationship of the elements 33 and 34 in the solid construction door 10*a* provides precisely the travel for the door 10*a* which assures greatest efficiency, ease of operation and freedom from binding and jamming.

It will be noted that the moment of force provided by

the increased distance from the bracket 37 to the door 10*a* assures that the horizontal component of force exceeds the vertical component, so that the initial impetus is sufficient to carry the single-piece door along the tracks 12 without difficulty, from the closed position. In the door 10, this relatively great horizontal component was not required because the upper section of the door is adapted to yield readily toward the horizontal without requiring a movement of the entire door in that direction.

In preparing the door of the invention for operation, the door itself and the roller members 11 thereof are first mounted in accordance with the aforementioned Patent No. 2,883,182, so that the door when installed and balanced will not require a force of more than thirty pounds to operate and will not rise or fall when opened in the interval from one to three feet from the floor.

Thereupon, a point as close as possible to the center of the door is selected to provide a guide line for the installation to follow, and this point is marked on the top and inside frame of the top door section. A plumb line is utilized to project this guide line vertically on the front wall and it will be noted that if only limited clearance exists between the door and ceiling, special care must be taken in that the guide line location will allow the channel 16 to clear any external handles or other hardware.

Next, the high point of the door travel is located, this being measured from the upper top edge of the door to the ceiling. For example, a minimum clearance of 1⅞ inches was required in practice with a standard-size door between the high point of the door and the ceiling. Thereupon, the mounting point of the front channel bracket 39 is marked on the previously established guide line, a minimum of ⅜ of an inch above the high point of door travel having been found necessary. This point is preferably about 2½ inches above the high point of door travel so that the channel 16 will clear the high point by 1½ inches.

Thereupon, the most convenient ceiling joist, between eight and eleven feet from the front of the garage, is chosen using marks on the door as a guide, and the special wrought iron lag screw 43 is mounted on this beam with another screw corresponding thereto seven to twelve inches equidistant therefrom on each side of the guide line.

The pulley and rear mounting bracket 44 is secured to the lag screws 43 and supports the channel 16 while the open garage door is utilized as a rest for the main channel 16 at its front portion, it being preferred to attach the rear mounting bracket 44 to the screws 43 by means of locking hooks 45 and 46.

With the rear of the main channel 16 mounted, the garage door is partially closed until the top edge thereof is at the highest point of travel and is supporting the front end of the channel. The door is then secured in this position by nailing it or wedging it to prevent it from closing, and the alignment of the main channel 16 between the previously located point and the rear mounting is checked so that the main channel 16 is horizontally parallel to the direction of the door tracks 12. The point selected for the bracket 39 as previously described, may be moved horizontally to either side of the guide line to correct the alignment if necessary. The bracket is then secured to the point selected by any suitable means such as the screw 40.

The motor 18 and drive belt are installed by placing the motor drive belt 19 on the pulley 20, whereupon the belt is slipped on the main drive pulley 21. With the belt 19 in place, the motor mounting yoke or sleeve 25 is attached to the channel 16 with the member 28 secured to the arms 26 by suitable cotter pins or the like. The tension of the belt may then be adjusted by means of the pin 27 which permits the motor to drop for decreased tension or be raised for increased tension.

The door arm bracket 39 is mounted on the door at

a point as close as possible to the junction of the center line of the operator and the axis of the first roller on a sectional door, such as the door 10. On a one-piece door, such as the door 10*a*, the door arm bracket 39*a* is mounted on the top edge of the door at the guide line. Then the element 32, including the pieces of the door arm hockey stick 33 and 34, is assembled with the multiple holes 42 on element 33 permitting assembly to the correct length for any given installation. As noted, on a sectional door, the curved element 34 attaches to the door bracket 39, whereas on a one-piece door the curved piece attaches to the nut carrier 37 of the operator.

A quick release pull chain 47 is provided which in attaching the door arm to the nut carrier is pulled downwardly to expose the nut carrier pin 36, and the door arm is slipped over the pin of the nut carrier 37 and the pull chain 47 released to allow the safety lock to return to place. Suitable adjustment screws are provided (not shown) to permit adjustment of the power applied by the operator, and with the door full open the rear stop 18 is reset so that the rubber bumper just touches the nut carrier 37. An opening limit switch 48 is secured substantially three inches in front of the rear stop 18. The door is started downwardly and when a few inches from closing, the operator or carrier 37 is stopped by a suitable push button circuit means provided therewith and, as previously stated, corresponding to the structure of the Patent No. 2,883,182, so that the door will coast to its closed position. Thereupon, the front stop 18*a* is reset so that the rubber bumper thereof is firmly against the nut carrier 37 in a position such that the operator is stopped by the said stop and not by the door striking the floor.

Although I have herein described and set forth my invention with respect to certain specific principles and details thereof, it will be understood by those skilled in the art that these may be varied without departing from the concept of the invention as set forth in the hereunto appended claims.

I claim:

1. In combination with a vertical closed door movable upwardly and inwardly to a substantially horizontal open position for garages and the like having a door frame, a door operating mechanism including a worm shaft, a member connected to drive said worm shaft, a straight support member journalling said shaft to carry a load in an axial direction, a self-reversing electric motor supported on one end of said support member, means for supporting said support member at opposite ends including a vertically adjustable member at the end adjacent said motor disposing the support member in an angular orientation defining a line of convergence toward the innermost end of said door when the door is in the open position thereof, a follower engaging in mesh with said shaft and traveling on said support member to transmit axial loads to said worm shaft, a bi-partite arm connecting said follower with said door comprising a relatively straight section having one end adapted to be pivotally secured to said follower, and a substantially right-angled section adjustably secured to said straight section at the other end thereof, said right-angled section having the other end thereof pivotally secured to said door, the distance between said pivots being only slightly greater than the closest distance from the support member to the pivotal connection to the door when said door is in a vertical closed position, said pivotal connection to said follower being carried by said follower for movement through and beyond a position at which said support member is closest to the pivotal connection to the door as the door is closed and back through said position as the door is opened, and switch means located for actuation by said follower for stopping said motor when said pivotal connection to the follower passes beyond said position.

2. In combination with garage door tracks having vertical and substantially horizontally disposed components, a door supported on the tracks and whose upper edge moves upwardly and inwardly as directed by the tracks when opening, an operator for said door including a straight support, a follower carried on said support, and rotary means carried by said support including a resilient load carrying means for reciprocating said follower longitudinally along said support for movement along a straight line converging toward the innermost end of said horizontal components of said tracks and said door when the door is in the open position thereof, switch means for stopping said rotary means controlled by said resilient load carrying means, a connecting arm comprising a straight section and a substantially right-angled section having one end thereof secured to an end of the straight section, the other ends of said sections being pivotally secured respectively to said follower and said door, the distance between said pivots being only slightly greater than the closest distance from the support member to the pivotal connection to the door when said door is in its vertical closed position, said straight section being carried by said follower in door closing movement to pass through and beyond a vertical position above said door when closed to carry the pivotal connection to said follower to a point on said support member at which said support member is closest to said pivotal connection to the door when in its said closed position, and follower stop means located beyond said follower when said straight section has passed through said vertical position.

3. In combination with a track means and a garage door supported thereby and having a single-piece construction whose upper end moves upwardly and inwardly when moving from a vertically closed position to a substantially horizontal open position, an operator for said door having a follower, means for actuating said follower including a straight support inclined to the horizontal upwardly at the outermost end thereof for slidably supporting said follower and a rotary worm shaft drive journalled in said support for driving said follower, an adjustable hanger for the innermost end of said support, said actuating means carrying said follower for movement on the support along a line of convergence toward the innermost end of said track means and garage door during opening movement of the garage door, a connecting arm comprising a straight section pivotally secured to said follower at one end thereof and a curved section to the door at the other end, the distance between said pivots being only slightly greater than the closest distance from the support member to the pivotal connection to the door when said door is in its vertical closed position, said straight section passing through and outwardly beyond a vertical position when the door is moved to its said closed position to carry the pivotal connection to said follower to a point on said support member at which said support member is closest to said pivotal connection to the door when in its said closed position, switch means carried by said actuating means for stopping said worm shaft as the follower passes beyond its position in which said straight section is vertical during closing movement of the door.

4. In combination a track having a vertical lower section, an upwardly and rearwardly curved section and a horizontal upper section, a garage door having a horizontally sectional construction supported for movement on said track with the upper edge portion movable upwardly and rearwardly on said curved section when opening, an operator for said door comprising a straight support and a follower slidable thereon, means for actuating said follower including a rotatable worm journalled on said support for sliding said follower along said support, said follower being supported thereby for movement along an axis converging toward said horizontal section of the track toward the innermost end of said door when the door is in the open position thereof, a connecting arm comprising a substantially right-angled section pivotally secured at one end thereof to the upper edge portion of the door and a straight section having its free end pivotally secured to the follower at a point well within a vertical projection of said curved section of said track at approximately the place where the support is closest to the pivotal connection to the door when the door is closed, the distance between said pivots being only slightly greater than the closest distance from the support member to the pivotal connection to the door when said door is in its vertical closed position, and switch means controlled by said worm and follower for stopping said actuating means at said point.

5. In combination with a door frame, door track and a door mounted therein for opening movement of the top of the door upwardly and inwardly on a horizontal portion of the track, an operator for the door comprising an elongated straight support member, means for mounting one end of the support member above the door, means adjustable as to height for supporting the other end of the support member at a point remote from the door frame to dispose the support member above the path of travel of the top of the door in its opening movement on said horizontal track and at an incline converging with said path of travel in the direction of said adjustable means, a worm shaft journalled in said support member, a follower slidably mounted on the support member engaging in mesh with the worm shaft, a self-reversing electric motor mounted on said other end of the support member and connected to drive said worm shaft, switch means responsive to the work load upon the worm shaft for stopping the motor, releasable means interconnecting said follower and the top of the door on the inside thereof below its upper edge including a connecting arm adjustable as to length and having a straight section at one end pivotally secured to the follower and an angled portion at the other end pivotally secured to the door, the distance between said pivots being only slightly greater than the closest distance from the support member to the pivotal connection to the door when said door is in its vertical closed position, the length of said connecting arm and the incline of the supporting member being such that said follower is bodily movable within the vertical projection of the length of the arm of said angled portion secured to said door when the door is in closed position to carry the pivotal connection to said follower to a point on said support member at which said support member is closest to said pivotal connection to the door when in its said closed position, and stop means carried by said support member for engagement by said follower when said straight section is within said vertical projection.

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