March 15, 1966 W. KLAMP 3,240,484

DOOR OPERATOR

Filed Oct. 18, 1961 3 Sheets-Sheet 1

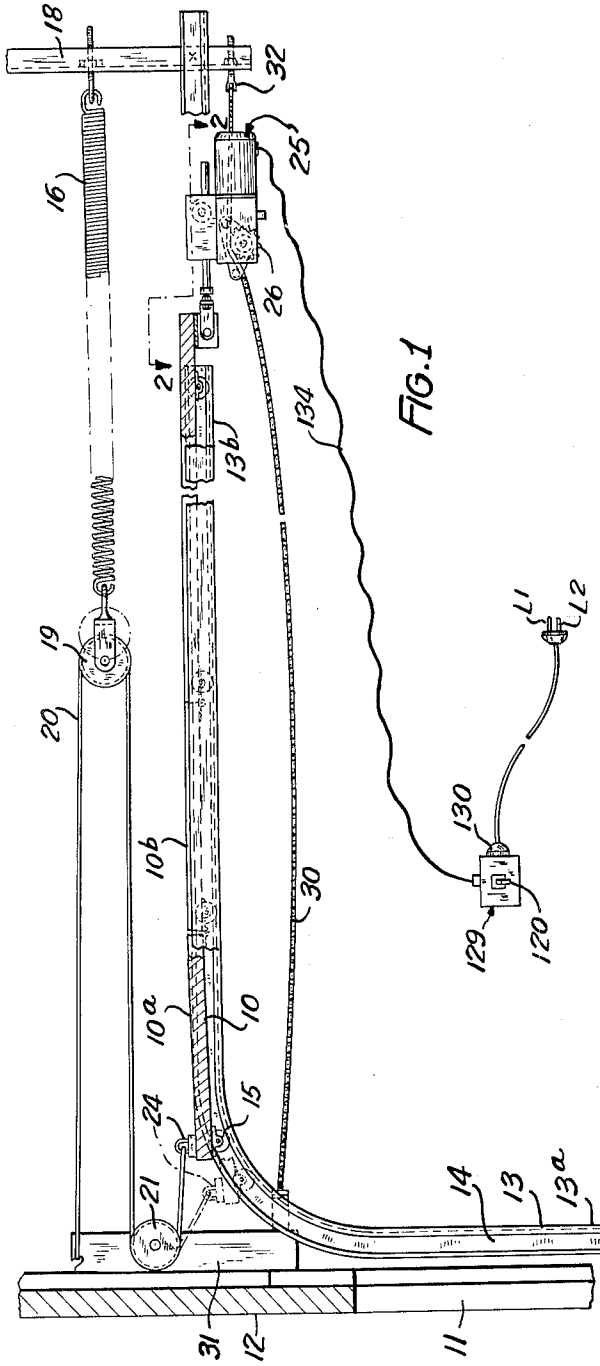


FIG. 1

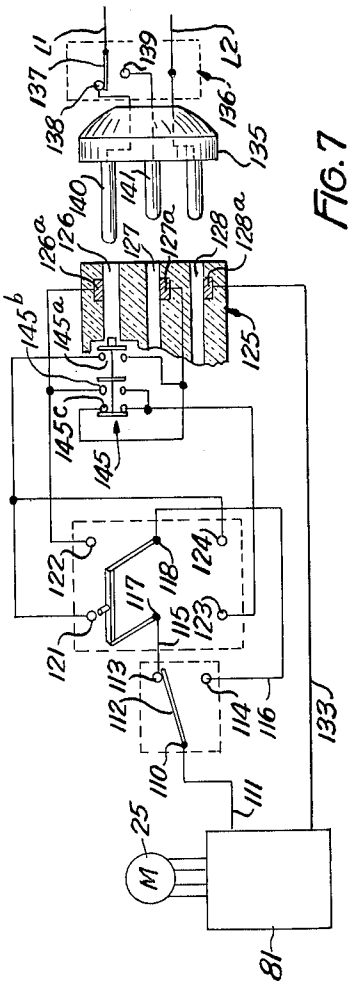


FIG. 7

INVENTOR.
WILLIAM KLAMP

BY

Williams, David, Hoffmann & Yount
ATTORNEYS

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DOOR OPERATOR

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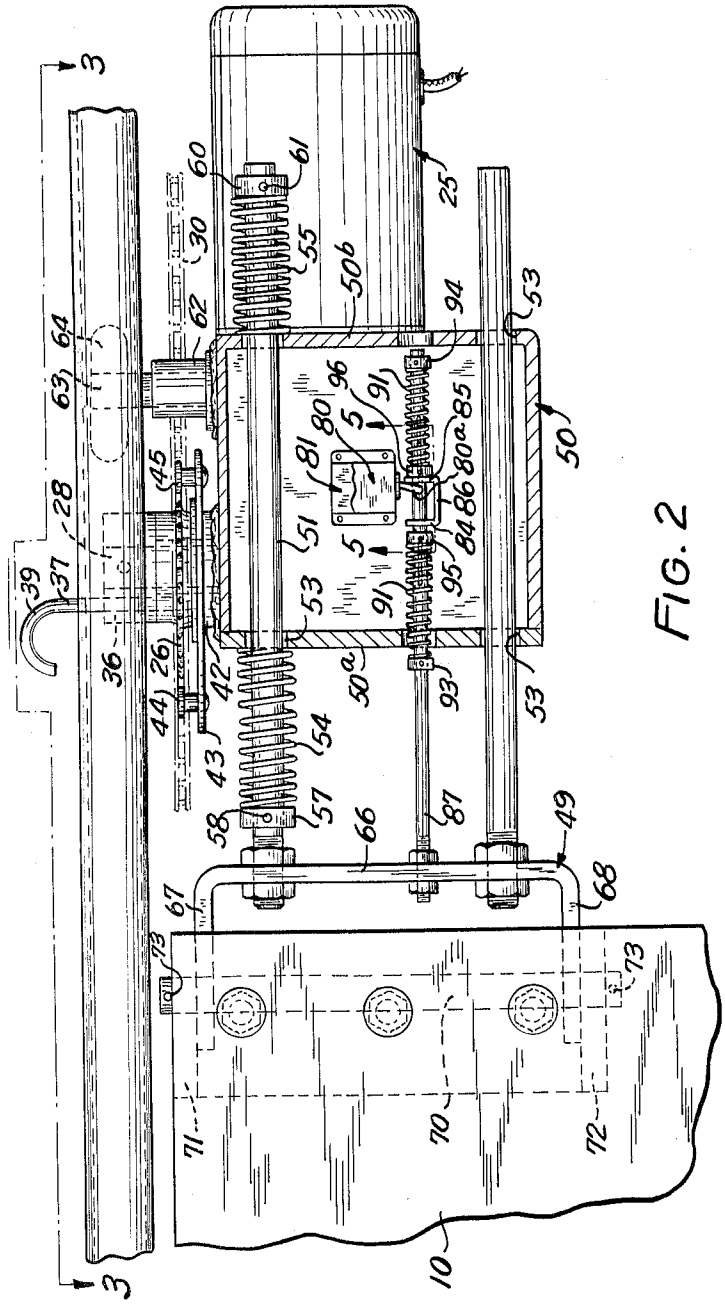


FIG. 2

INVENTOR.
WILLIAM KLAMP

BY
Williams, David, Hoffmann & Pond
ATTORNEYS

March 15, 1966 W. KLAMP 3,240,484

DOOR OPERATOR

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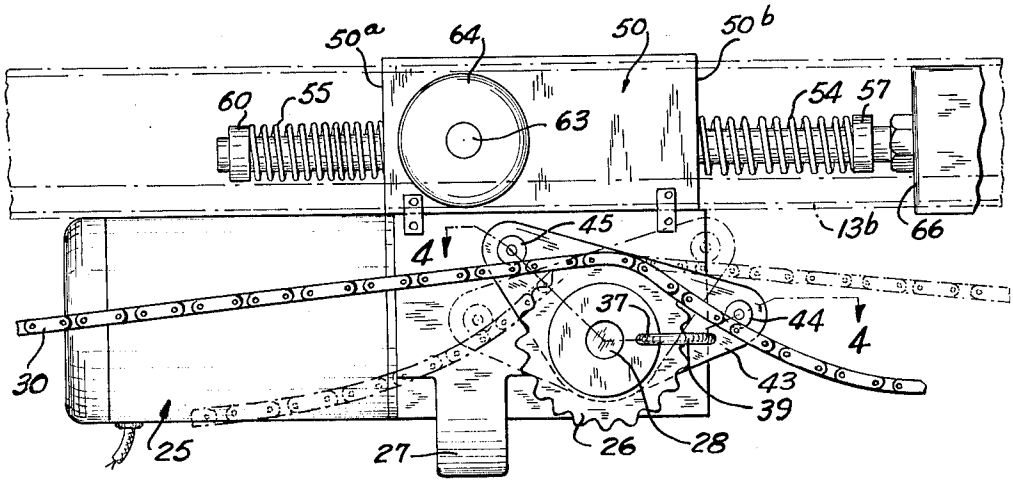


FIG. 3

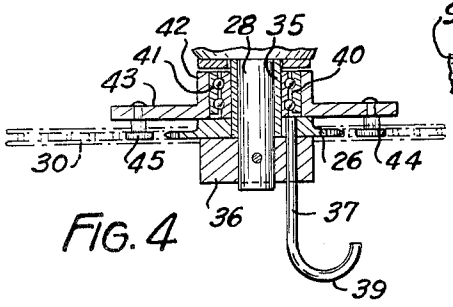


FIG. 4

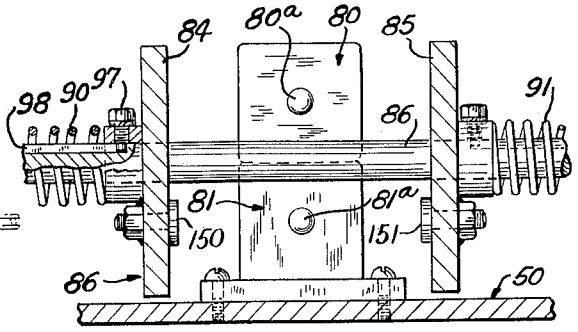


FIG. 5

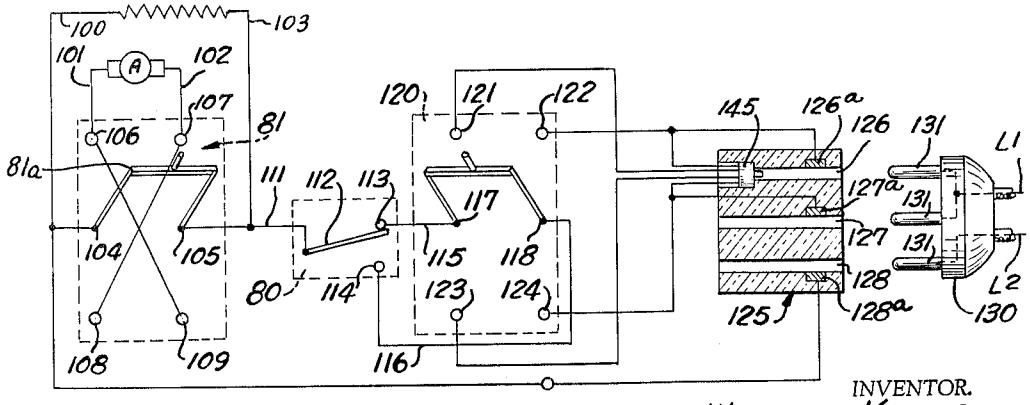


FIG. 6

INVENTOR.
WILLIAM KLAMP

BY
Williams, David, Hoffmann & Faunt
ATTORNEYS

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3,240,484

DOOR OPERATOR

William Klamp, Rocky River, Ohio, assignor to Cleveland-Detroit Corporation, Cleveland, Ohio, a corporation of Delaware

Filed Oct. 18, 1961, Ser. No. 145,824
10 Claims. (Cl. 268—59)

The present application relates to an operating mechanism for reciprocating a member between limit positions and, more particularly, to such an operating mechanism for reciprocating an overhead garage door between open and closed positions.

Problems have been encountered in providing an operating mechanism for opening and closing a garage door which is of such a character that it is low in cost and can easily be applied by a home owner. The installation of garage door operators can be very critical due to problems of alignment. While some operators have been proposed which will minimize this problem of alignment, these operators have often been high cost operators or have been subject to malfunctioning or a short life.

An important object of the present invention is to provide a new and improved door-operating mechanism for operating overhead garage doors between limit positions, which mechanism can be sold as a package and readily applied to the garage door and which does not normally require the adjustment of switches or switch actuators, etc., by the installer.

Another object of the present invention is to provide a new improved door operator having a motor mounted on the door and adapted to move itself and the door along a stationary chain and in which a conventional chain of the bicycle type can be used and will have a long life.

It is also an object of the present invention to provide a new and improved door-operating mechanism wherein the motor moves with the door by rotating a sprocket wheel in mesh with a chain and wherein the wheel is maintained in mesh with the chain by self-adjusting idler means which change their position when the direction of operation is reversed.

Yet another object of the present invention is to provide a new and improved door operator for an overhead door counterbalanced by a spring, the operator being of the type wherein the drive motor moves with the door and in which operator the assembly that is mounted on the door includes the switches and switch-actuating means for stopping the movement of the door in both the door-opening and door-closing directions.

Another object is to provide a new and improved door operator as in the next preceding object wherein the door is stopped in response to a force of certain magnitude opposing the movement of the door and wherein the forces necessary to stop the door can be different for the opening and closing directions.

Still another object of the present invention is to provide an overhead door and operator therefor wherein the door in moving to its open position moves through a dead center position for biasing means for counterbalancing the closing movement of the door and completes its opening movement against the action of the biasing means, with the stopping of the drive motor for the door in both directions being done in response to a predetermined force opposing the movement of the door and the counterbalancing springs being adapted to provide the force when the door is moving upwardly to stop the door at its open position.

A further object of the present invention is to provide a new and improved operator in which the electric power circuit for the operator includes limit switch means and

reversing switch means supported for movement with the door, and a three-wire combined power and control circuit for controlling the starting and stopping of the operator connects the reversing and limit switches with stationary switch drives.

A still further object is to provide a new and improved operator as in the preceding object wherein the operator comprises a single package which only requires a motor support to be pivoted to the door, the supporting of a traction member at its two ends, the hanging of a switch box in a wall and the plugging in of a cord to install the operator and set it for operation.

A further object of the present invention is to provide a new and improved operator mechanism for a garage wherein a three-wire circuit is used to control the motor and wherein the operator can be changed from control by a single, manually operable switch to control by either the manually operable switch or a radio-controlled switch device.

In the preferred form of the present invention, the above objects and others are accomplished by providing a door-operating mechanism including a drive motor mounted for movement with the door and adapted to rotate a sprocket wheel which meshes with a chain extending along the path of movement of the door as it moves between open and closed positions to move the motor, and in turn the door, along the chain as the motor is operated. According to one aspect of the present invention, the chain has slack therein and the drive sprocket preferably has associated therewith idlers which are spaced angularly about the sprocket and are adapted to maintain a wrap of chain in mesh with the sprocket, the idlers in accordance with another aspect of the invention being supported for orbital movement about the axis of the sprocket so that the idler rollers are self-adjusting. The motor of the operating mechanism is supported on a motor mount which is slidable toward and away from the door on a support pivotally connected to the door. The motor mount is biased to a predetermined position on the support and is yieldable to accomodate movement of the mount either toward or away from the door. The biasing means for the motor mount will yield when a predetermined force opposes movement of the door by the motor and the mount will move relative to the support and this movement relative to the support is used to actuate control switches which are movable with the door-mounted mechanism. Preferably, the door is counterbalanced by springs when it is moved to its closed position and when the door is moved to its open position, the door moves through a dead center position for the spring counterbalance so that movement of the door to its fully open position is completed against the action of the counterbalancing springs. The springs, then, operate to apply a force to the door as it moves to its open position to effect a shifting of the motor mount and this movement is used to operate switch means on the door-mounted mechanism to stop the door in its raised position. The drive between the motor and the sprocket is preferably a self-locking or no-back drive, such as a worm and worm wheel, which will hold the door in its open position against the bias of the springs. Because of the self-locking drive, lost motion movement will occur when the direction of operation of the motor is reversed and this motion can be used to operate door latches, etc. In the preferred embodiment, the door-mounted mechanism includes a bracket which may be readily connected to the door and a wheel adapted to ride in an adjacent guide channel for guiding the door between its open and closed positions and all that needs to be done by an installer is to connect the bracket to the door, insert the wheel into the guide channel, fasten the chain at its ends

to any suitable adjacent stationary members, hang a switch on the wall for operating the mechanism and to plug the power supply into an adjacent outlet. The control which is used for controlling the motor is essentially a three-wire control and limit switch means and reversing switch means are on the door-mounted mechanism when the door is stalled in its opening or closing movement to stop the operation of the motor and to set the motor to operate in the next direction on the next energization thereof. The three-wire control system includes a switch box adapted to hang on a stationary member and which includes a switch that can be operated as a three-way switch or in conjunction with a ratchet radio-controlled relay to effect either control of the door operator by means of the manual switch or by radio control and all that is necessary to effect radio control is to plug a matching plug from the radio control into a plug on the manually controlled switch box.

Further objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof made with reference to the accompanying drawings forming a part of the present specification and in which:

FIG. 1 is a vertical sectional view of a garage embodying an overhead door having a door-operating mechanism associated therewith;

FIG. 2 is a sectional view, taken approximately along line 2—2 of FIG. 1;

FIG. 3 is a view looking approximately from along line 3—3 of FIG. 2;

FIG. 4 is a sectional view taken approximately along line 4—4 of FIG. 3;

FIG. 5 is a sectional view, taken approximately along line 5—5 of FIG. 2 with parts thereof in a shifted position;

FIG. 6 is a circuit diagram of the circuit used with the preferred embodiment of the present invention; and

FIG. 7 is a circuit diagram showing the use of a radio-controlled switch device with the circuit of FIG. 6.

While the present invention is susceptible of various uses, constructions, and modifications, it is particularly designed for and suitable for use as a door-operating mechanism for reciprocating an overhead door between its open and closed positions, but it will be understood that the mechanism could be used to operate other members which are to be reciprocated between two positions.

Referring to the drawings, an overhead door is shown in FIG. 1 and the door is guided and supported for movement from an overhead, fully open position, shown in FIG. 1, to a vertical position closing an opening 11 in the wall 12 of a garage or other structure by a guide member supported adjacent each of the side edges of the door. Only one of the guide members is shown in the illustrated embodiment, and this guide member has been designated by the reference numeral 13 and, as is conventional, has a guide channel 14 therein adapted to receive rollers 15 supported on studs extending outwardly from the side edge of the door to guide the door between its open and closed positions and to support the door in its open position. As is conventional, the guide member 13 includes a generally vertical section 13*a* immediately adjacent the opening 11 and a generally horizontal section 13*b* extending inwardly of the garage away from the wall 12 and the door 10 is sectionalized to provide sections 10*a*, 10*b*, etc., to accomodate movement of the door between its horizontal overhead position shown in the drawings and its vertical position closing the opening 11. Also as is conventional, a counterbalancing spring 16 of the tension type is provided on each side of the door to counterbalance the weight of the door as it is moved to its closed position and to provide a spring force acting in a door-opening direction to aid the opening of the door from a closed position. The spring 16 is disposed above and preferably slightly outwardly of the section

13*b* of the guide member 13 and has one end tied to a hangar 18 for the free end of the section 13*b* and the other end connected to a pulley 19. A cable 20 passes around the pulley 19 and has one end connected to the wall 12 and extends from the wall 12 around the pulley 19 and then around a pulley 21 supported adjacent the wall 12 and then to the bottom of the door 10 to which the other end of the cable is connected by means of an eye 24. As the door is lowered from the overhead position shown in FIG. 1, the spring 16 is stretched in a conventional manner to counterbalance the weight of the door and to provide a spring bias for aiding the opening of the door. It will be noted that the shortest distance between the pulley 21 and the door 10, or the eye 24, occurs when the door is short of its open position and the cable 20 positioned as is shown in dot-dash lines in the drawing. When the door moves to its open position from the dot-dash position, the spring 16 will be tensioned to apply a spring force to the door for purposes which will be explained hereinafter.

The door is moved between open and closed positions by the operation of a motor 25 forming a part of the door-mounted mechanism supported to move with the door 10. The motor 25 drives a sprocket 26 through a gear reducer 27 fixed to the forward end of the motor housing and the output shaft of the gear reducer, designated by the reference numeral 28, is adapted to be connected to drive the sprocket 26. The sprocket 26 is supported for rotation about the output shaft 28 in a manner to be explained in more detail hereinafter. The sprocket 26 meshes with a chain 30, of the bicycle type, that extends from a bracket 31 fixed to the front wall 12 rearwardly and in the illustrated embodiment, extends to the hanger 18 to which the chain is connected. The chain 30 is disposed below the channel portion 13*b* and, as is shown in the drawing, is connected to the hanger 18 by an eye bolt 32 which may be adjusted to adjust the tautness of the chain 30. As is shown in FIG. 1, the length of chain between its points of connection to the eye bolt 32 and the bracket 31 for mounting it to the front wall 12 is greater than the straight-line distance between these points so that there is slack in the chain. In other words, the chain 30 is a non-taughtened chain. The chain 30 wraps around the sprocket 26 for a portion of the periphery of the sprocket and when the sprocket 26 is rotated, the sprocket will pull iteself, the motor 25, and in turn the door 10, along the chain 30. When the door is open, the motor 25 is operated to rotate the sprocket in a clockwise direction, as viewed in FIG. 1, a counterclockwise direction, as viewed in FIG. 2, to move the motor 25 along the chain 30 toward the wall 12 to move the door between its open and closed positions.

In view of the fact that the chain 30 is slack and is free to move, no alignment problem is involved in maintaining a mesh between the chain 30 and the sprocket 26, as the door and motor, moves through the nonlinear path in which it is guided by the channels 14. Idler rollers, as will be described hereinafter, are provided for maintaining the sprocket and chain in mesh.

The sprocket 26 is supported on the output shaft 28 for rotation relative thereto by a sleeve bearing 35, as is best shown in FIG. 4. The sprocket is disposed immediately inwardly of a coliar 36 pinned, keyed, or otherwise fixed to the outer end of the shaft 28 for rotation therewith. The sprocket 26 and the collar 36 are connectable for rotation as a unit by a pin 37 received in aligned bores in the sprocket 26 and the collar 36, respectively. The pin 37 extends outwardly from the collar 36 and has a bent outer end to provide a hook portion 39. The pin 37 is a removable pin and, when it is desired to disconnect the sprocket 26 from the shaft 28, the pin 37 can be pulled from the sprocket 26 and the sprocket 26 is then free to rotate on the shaft 28.

A roller bearing 40 is disposed about the sleeve bearing

35 intermediate the sprocket 26 and the housing of the gear reducer 27. The outer race of the ball bearing 40 is pressed into an opening 41 in the hub 42 of an idler support plate 43. The idler support plate 43 has spaced rotatable idler rollers 44, 45 thereon which are adapted to maintain a portion or wrap of the chain 30 in mesh with the sprocket 26. The idlers 44, 45 are circular washer-like elements which are adapted to roll on the cross-pieces of the chain intermediate the chain side links.

The idler plate 43 is rotatable about the axis of the shaft 28 to move the idler rollers 45 in an orbit about the circumference of the sprocket 26 and the idler plate will adjust itself in accordance with the tension on the chain to a position which produces a minimum of wear between the idler rollers and the chain and between the sprocket and the chain. When the sprocket 26 is rotating clockwise, as viewed in FIG. 3, the idler rollers 44, 45 are as shown in full lines, while if the sprocket 26 is rotating in a counterclockise direction and pulling the motor and door to the right, as viewed in FIG. 3, along the chain 30, the chain will shift to the position shown in dot-dash lines with the slack in the chain to the left of the sprocket 26 and the idler rollers 44, 45 shifted angularly about the axis of the shaft 28, as is shown in the drawing. It has been found with idler rollers of a type which are free to adjust thermselves relative to the circumference of the sprocket 26 as the direction of drive is reversed, the life of the chain 30 is substantially prolonged. This, coupled with the slack in the chain which allows the paths of approach and recession of the chain to the sprocket to vary depending on the direction of drive, as well as eliminating the problem of maintaining alignment, provides a drive of the chain type which has a long life. The chains which have heretofore been used have been taut chains or tensioned chains and a short life results.

The motor 25 and gear reducer 27 are fixed to the underside of a motor mount 50 slidably supported on a pair of rods 51, 52 extending outwardly away from a bracket 49 to be pivotally connected to the door 10 adjacent the top and one side thereof, the side adjacent the guide member 13. The rods 50, 51 extend through vertical side walls 50*a*, 50*b* of the motor mount 50 and the latter has openings 53 in the side walls 50*a*, 50*b* thereof receiving the rods 51, 52 and the motor mount is biased to a predetermined position on the rods 51, 52 by springs 54, 55 disposed about the rod 51 adjacent the opposite sides 50*a*, 50*b*, respectively, of the motor mount 50. The opposite ends of the spring 54 abut the side 50*a* of the motor mount 50 and a collar 57 which is adjustable on the rod 51 and is lockable by a setscrew 58 so that the tension of the spring 54 can be adjusted by adjusting the position of the collar 57. Similarly, one end of the spring 55 abuts the side 50*b* of the motor mount 50 and the other end of the spring 55 abuts a collar 60 adjustably positioned on the rod 51 and adapted to be set in a predetermined position by a setscrew 61.

The side of the motor mount 50 adjacent the channel 13 has a boss 62 thereon which supports a shaft 63 for a wheel 64. The wheel 64 is rotatable on the shaft 63 and is adapted to be received in the channel 14 of the guide member 13.

The bracket 49 has a generally straight portion 66 which extends parallel to the upper edge of the door and from which the rods 51, 52 extend. In addition to the straight portion 66, the bracket 49 comprises spaced arms 67, 68 extending perpendicularly to the straight portion 66 at opposite end thereof and the arms have aligned pin-receiving openings for pivotally receiving a pin 70 supported by spaced lugs 71, 72 on the door 10. The arms 67, 68 are disposed immediately adjacent the sides of the lugs 71, 72 which face each other and the pin 70 is a removable pin and may be held in position by cotter keys 73 at each end of the pin.

The foregoing described construction provides a door-operating mechanism wherein the motor 25 is mounted on a motor unit movable with the door 10 to move the door between open and closed positions, and the motor mount is biased to a predetermined position with respect to a support provided by the rods 51, 52 and the bracket 49 for connecting the motor mount and the motor to the door. It will be appreciated that, if the motor is operating in a door-closing direction and the door meets an obstruction, the motor will continue to pull itself along the chain to compress the spring 54 as long as the motor continues to rotate after the door is stalled. Similarly, if the motor is operating in a direction to open the door, the stalling of the door will cause the motor mount 50 to move against the bias of the spring 55, as long as the rotation of the motor continues after the stalling of the door. This movement of the motor mount 50 on the support provided by the rods 51, 52 is utilized to control the motor 25, and in the preferred embodiment, the movement of the motor mount 50 against the bias of the spring 54 is used to stop the door when it reaches a fully closed position or stalls for any other reason during the door-closing movement and to set a reversing switch for operating the door in the opposite direction. Similarly, movement against the spring 55 is used to stop the operation of the motor in a door-opening direction and to set the reversing switch to effect operation of the door in a door-closing direction upon the next energization of the motor.

The limit switch which is actuated to stop the movement of the door is the same switch regardless of whether the door is moving in a door-closing direction or door-opening direction and in the illustrated embodiment, this switch is designated by the reference numeral 80. When the switch 80 is actuated, a reversing switch is also actuated so that the motor will operate in the opposite direction the next time it is energized. This reversing switch is designated by the reference numeral 81.

As is best shown in FIGS. 2 and 5, the switches 80, 81 are supported on the inside bottom of the motor mount 50, and are disposed in vertical relation with respect to each other. The switches have actuators 80*a*, 81*a* which are disposed between abutments 84, 85 of an actuator member 86 slidably carried by a rod 87 which is fixed to the straight portion 66 of the bracket 49 and extends from the straight portion 66 parallel to, and in-between, the rods 51, 52 and is receivable in openings in the side walls 50*a*, 50*b* of the motor mount. The actuator 86 is biased to a predetermined position on the rod 87 by springs 90, 91 disposed about the rod 87 on opposite sides of the switch actuator 86. The springs 90, 91 are disposed between the switch actuator member 86 and respective collars 93, 94 and the collars 93, 94 are adjustable along the rod 87 to adjust the force of the springs 90, 91. The ends of the springs 90, 91 adjacent the switches 80, 81 abut respective collars 95, 96 which are disposed immediately adjacent the abutments 84, 85. The collars each have a threaded pin 97 therein which is received in a corresponding groove 98 in the rod 87. When the switch operator 86 is in a centered position with respect to the switches 80, 81, the pins engage the ends of the groove 98 so that the collars 95, 96 take the force of the springs. If the actuator is moved in either direction from its centered position, one of the collars 95, 96 will be moved to compress the corresponding spring, while the other collar will remain in its position where the pin 97 therein engages the end wall of the corresponding groove 98. Thus it can be seen that by adjusting the collars 93, 94 to adjust the compression in springs 90, 91, the force necessary to move the switch operator 86 from its centered position can be varied. Moreover, the springs can be adjusted so that the force to move the switch operator in one direction can be different from the force necessary to move it in the other direction.

During operation, when the door 10 stalls by reason

of meeting an obstruction or reaching a limit position, the motor mount will continue movement along the chain 30, as hereinbefore described, to compress either the spring 54 or the spring 55 depending upon the direction of movement. Assuming that the spring 55 is compressed as is shown in FIG. 2, the movement of the motor mount 50 will carry the switches 80, 81 into engagement with the abutment 85 and continued movement after engagement with the abutment will cause the switches 80, 81 to be actuated. The switches 80, 81 may be conventional toggle switches and will require a certain force to throw the actuators from one position to their other position. The settings of the springs 90, 91 will determine the amount of movement of the motor mount 50 after the switch actuators 80*a*, 81*a* engage the abutment 85 to effect a throwing of the switch. If the springs 90, 91 are light, the initial force applied by the springs to the actuators 85 will not be sufficient to throw the actuators and the springs will compress until the springs exert sufficient force against the actuator to effect a throwing of the actuator. It will be appreciated that by reason of the spring arrangement 90, 91, the door can be set to be responsive to one force in a downwardly direction and to a different force when moving in an up direction. Similarly, when the spring 54 is compressed, the actuators 80*a*, 81*a* will engage and be thrown by abutment 84 after a movement determined by the setting of spring 90.

The control system for the motor 25 is essentially a three-wire control system and when the motor is operating in one direction, operation of the switch 80 will break the circuit for operating the motor in that direction and the operation of the switch 81 will set the circuit to be operated in the opposite direction upon the next completion of a circuit to the motor.

The motor circuit is shown in FIG. 6 and as shown therein, the motor is a motor having armature connections 101 and 102 and field connections 100, 103. The direction of operation of the motor 25 depends upon the sense of the current applied to the armature connection 101 with respect to the sense of the current flowing in the field winding. The motor 25 is an A.C. motor and the field winding is always connected in the same manner to the power supply and the phase of the current in the armature relative to the field winding is dependent upon the setting of the switch 81 which is a double-pole, double-throw switch having center contacts 104, 105 which may be respectively connected to contacts 106, 107 or contacts 108, 109 by throwing the switch actuator 81*a* between its two positions to reverse the connections of the armature to the power supply. In the illustrated circuit, the L1 side of the power supply is connected by a connection 111 to the contact 105 through switching to be described hereinafter, and the contact 104 is directly connected to the L2 side of the power supply. The field winding is connected between the contacts 104, 105, and the connections 101, 102 for the armature winding of the motor 25 are connected respectively to the contacts 106, 107. The contacts 106, 107 are respectively tied to the contacts 109, 108. It will be apparent that, when the toggle switch is in its position where the actuator 81*a* connects the contacts 104, 106 and the contacts 105, 107, L1 is applied to the armature connection 102 and L2 is applied to the armature connection 101; and when the actuator 81*a* is in engagement with the contacts 108, 109, L2 is applied to the armature connection 102 and L1 is connected to the armature connection 101. This will cause operation of the motor 25 in a direction dependent upon the position of the switch 81. The contact 105 of the switch 81 is connected by a connection 111 to a switch arm 112 of the single-pole, double-throw switch 80 which can be moved to engage either a contact 113 or a contact 114. The contacts 113, 114 are connected by connections 115, 116, respectively, to respective center contacts 117, 118 of a double-pole, double-throw switch 120. The double-pole, double-throw switch 120 has two positions wherein the contacts 117, 118 are respectively connected to contacts 121, 122 or a second position wherein the contacts 117, 118 are respectively connected to contacts 123, 124.

The double-pole, double-throw switch 120 is mounted in a switch box 129 adapted to be hung on a wall or similar stationary support in a readily accessible position. The box 129 also includes a female receptacle 125 having three openings therein for receiving the prongs of a cooperating plug 130. Two of the openings designated by the reference numerals 126, 127 have contacts 126*a*, 127*a* which are connected to the contacts 122, 123, respectively, of the switch 120. The connection between the plug contact 127 and the switch contact 123 is through normally closed contacts 145*c* of a switch 145 (see FIG. 7). The third receptacle opening designated by the reference numeral 128 includes a contact 128*a* connected to the contact 104 of switch 81 by a connection 133. When the switch 120 is to be used as the sole control for the operator, the plug 130 which is inserted into the receptacle 125 has prongs 131 which are connected to the power supply and the prongs which are received in the openings 126, 127 are respectively connected to L1 and the prong which is received in opening 128 is connected to L2. This means that L1 is applied to the contacts 122, 124 and L2 is connected directly to the contact 104. The opening 126 has the switch 145 disposed therein and the switch 145 is not actuated by the prong of plug 130 received in the opening 126. This switch, when actuated, cross-ties contacts 122, 123, for purposes to be explained hereinafter, and breaks the connection between plug contact 127 and switch contact 123 and connects the former to switch contacts 121, 124. The contacts 121, 124 are normally tied together but in the absence of the actuation of switch 145, the contacts 121, 124 are dead contacts and the switch 120 functions as a single-pole double-throw switch.

By reference to FIG. 6, it can now be seen that with the switches 80, 120 set as shown in FIG. 6, no current flows to the motor, since the switch 120 connects contacts 118, 122 to apply L1 to the line 116 and the switch 80 is set to connect the conductor 115, rather than the conductor 116 to the motor through the reversing switch 81; consequently, no current flows. If the switch 120 is now operated to connect the contact 117 with the contact 121, L1 is applied to conductor 115 and the switch 80 is set to apply this potential to the conductor 111 to the switch 120 to cause operation of the motor. The motor will operate in the direction dictated by the reversing switch 81. Assuming that the door had been in its closed position and the reversing switch 81 is set to open the door, the motor will operate in a door-opening direction until it moves to its fully open position and the movement of the door is stalled by the counterbalancing springs 16, at which time the motor mount 50 will shift to operate the switch 80 to move it from its position shown in FIG. 6 to its position where the switch arm thereof is in engagement with the contact 114. This breaks the circuit for energizing the motor. Since the reversing switch 81 is operated with the switch 80, the next time that L1 is applied to the contact 105, the motor will operate in a door-closing direction. The door can be operated in the door-closing direction by now switching the double-pole, double-throw switch 120 to its position shown in FIG. 6 to connect the contacts 118, 122 and apply L1 to the conductor 116 connected to the contact 114. This will cause the door operator motor to operate in its direction to close the door and when the door is closed, or if the door meets an obstruction during its closing movement which causes it to stall, the motor mount 50 will shift to throw the switch 80 and stop the motor. The reversing switch 81 will also be thrown so that the motor will operate in a door-opening direction the next time that L1 is applied to the connection 111.

Thus it can now be seen that the three-wire circuit stops the motor each time the switches **80**, **81** are actuated and sets the motor circuit to operate the motor in the opposite direction the next time the motor is energized.

In the preferred embodiment, the switch box **129** has a three-wire flexible conductor **134** extending from the switch box to the motor mount **50** and the conductor is of the expansible and contractable type. The switch box **129** is preferably located about midway of the length of the horizontal section **13***b* of the guide member **15** to minimize the length of the conductor **80**. It will be noted that it is only necessary to carry three wires, the connections **115**, **116** and **133**, from the switch box **129** to the motor mount **50**.

When the door operator is also to be radio controlled, a plug **135** from the radio-controlled unit **136** is plugged into the receptacle **125** in place of the previously described plug. The circuit which is set up when this plug **135** is inserted is shown in FIG. 7 and, as shown therein, the radio-controlled unit **136** includes a single-pole, double-throw switch arm **137** which is adapted to be moved between contacts **138**, **139** on successive energizations of the device in response to successive radio signals. The switch arm **137** is connected to **L1** so that **L1** is alternately applied to the contacts **138**, **139**. The switch arm **137** and contacts **138**, **139** may be part of a ratchet relay and, of course, separate switches which are alternately made and broken may be used in the place of a double-pole, single-throw switch device including switch arm **137**.

The contacts **138**, **139** are respectively connected to prongs **140**, **141** of the plug **135** and these prongs are respectively received in the openings **126**, **127** of the receptacle **125**. The prong **140** of the plug **135** is longer than the other prongs of the plug and, when inserted, actuates the switch **145** which is adapted to tie the contact **122** of the switch **120** with the contact **123** and to connect the plug contact **127***a* to switch contacts **121**, **124** instead of contact **123**. This is done by the closing of contacts **145***a*, **145***b* of the switch and the opening of contacts **145***c*.

From FIG. 7, it can be seen that with the switch **120** and the switch arm **137** in the position shown in the figure, the circuit from the contact **138** with which the switch arm **137** is in engagement is made through the contact **126***a* of receptacle **125**, the contacts **122**, **118** of the switch **120** to the contact **114** of the switch **80**. The switch arm **112** is, however, in engagement with contact **113** and, consequently, **L1** is not applied to connection **111** and the motor is not energized; **L1** can, however, be applied to the connection **111** to the switch **81** by throwing either the switch **120** or the switch arm **137**. If the switch arm **137** is thrown, **L1** is applied to the prong **141** and, in turn, through the contacts **145***a* of switch **145**, contacts **121**, **117** of switch **120**, and contact **113** to the connection **111**. The motor will then operate until the switch **20** is operated, or the switch mechanism **136** is operated, or the switch **80** operated as hereinbefore described. If the switch **120**, rather than the switch arm **137**, is thrown, **L1** will be applied to the connection **115**, since contact **126***a* is connected through the contacts **145***b* to the contact **123** and this is now connected to terminal **117**. Since the switch arm **112** is in engagement with contact **113**, the motor will operate until any of the switches **80**, **120** or switch arm **137** is thrown. Assuming that the door either moves to a limit position or stalls to operate the switch **80**, it can be seen that the motor can again be started by applying an **L1** potential to the connection **111** by throwing either the double-pole, double-throw switch **120** or the single-pole, double-throw switch arm **137** of the radio-controlled unit **136**. It can now be seen that the described circuitry provides a simple control unit for a radio operator which can be quickly converted from purely manual operation at a single station to either manual operation at the station or radio-control operation. Furthermore, the arrangement of the operator is such that its flexibility of control is provided without requiring any internal wiring, changes, or any additonal wring on the part of the installer. Consequently, the present invention provides a door-mounted operator which need merely be hung on a door in the channel and the switch box mounted on the wall and plugged in. As a result, the operator is particularly designed for installation by amateurs and non-professionals.

In summary, it can be said that, when only the switch device **120** is used to control the door-operating mechanism, the switch is connected to function as a single-pole, double-throw device for connecting **L1** to either the connection **115** or the connection **116**, depending upon the position of the switch. When, however, the radio-controlled switch unit **136** which is a single-pole, double-throw device, is plugged in, the switch **120** is used as a double-pole, double-throw switch device to connect the contacts **138**, **139** to the connections **115**, **116**, respectively when switch **120** is in one position and to connections **116**, **115**, respectively, when in its other position.

As described hereinbefore, the setting of the switch **81** determines the direction of operation of the motor **25**. Preferably, the switch-actuating mechanism is such that the switch **81** can be reversed slightly before the throwing of the switch **80**. This will reverse the connection of **L1** and **L2** to the armature, helping to brake the motor and will bring it to a quick stop. This is particularly desirable when the door meets an obstruction.

Referring to FIG. 5, adjustable plates **150**, **151** are preferably mounted on the abutments **84**, **85**, respectively, and are movable toward and away from the switch actuator **81** so as to adjust the point in the travel of the abutments **84**, **85** at which the switch actuator **81** is thrown. The actuator **81** will be engaged slightly ahead of the engagement of the actuator for the switch **80**, depending upon the spacing of the plates from the abutments **84**, **85**.

From the foregoing, it can be seen that by using a chain and sprocket arrangement, alignment problems are rendered noncritical and by providing a slack chain, the problems of wear of the chain and of the sprocket are minimized, the wear of the chain also being minimized by the provision of the following idlers **45**, **46**. Moreover, the door-operating mechanism is such that it need merely be mounted on the door, the wheel **64** inserted in the guide channel, the switch box **129** hung on the wall, and the conductor thereto plugged into a convenient outlet. Since a chain is used, the chain can be supplied in one length and cut to the proper length or merely supported with the excess length dangling. Consequently, the present invention provides an operator which can be readily installed by the average home owner without running into problems of alignment, misoperation, malfunctioning, etc.

While the preferred form of the present invention has been described in considerable detail, it will be understood that it is hereby my intention to cover all modifications, constructions, and arrangements which fall within the scope and spirit of the present invention and the ability of those skilled in the art.

Having described my invention, what I claim is:

1. A garage door operator for reciprocating an overhead door along a path between open and closed positions, a chain extending along the path of travel of said door, a reversible motor, a sprocket wheel in mesh with said chain, drive means interconnecting said motor and sprocket wheel, means connecting said motor to said door whereby operation of said motor to rotate said sprocket wheel causes said motor and door to move along said chain, means supporting the ends of said chain at fixed points spaced a distance less than the length of the

chain between said points to provide a chain having untensioned slack therein, means separate from said chain supporting and guiding said motor and wheel for movement along said chain to maintain a slack portion in said chain as said motor moves therealong, and idler means maintaining said chain and wheel in mesh.

2. A garage door operator for reciprocating an overhead door along a path between open and closed positions comprising a chain adapted to be supported along the path of travel of said door, means supporting the ends of said chain at fixed points spaced a distance less than the length of the chain between said points to provide a chain having untensioned slack therein, a reversible motor, a sprocket wheel in mesh with said chain, drive means interconnecting said motor and sprocket wheel to rotate the latter upon operation of the motor to move the wheel and motor along said chain, means for connecting said motor to said door whereby operation of said motor to rotate said sprocket wheel is adapted to cause said door to move with said motor along said chain, means separate from said chain supporting and guiding said motor and wheel for movement along said chain to maintain a slack portion in said chain as said motor moves therealong, a pair of spaced idler rollers disposed adjacent the periphery of said sprocket wheel for engaging said chain to maintain a wrap thereof in engagement with said sprocket wheel, and means supporting said idler rollers for translatory movement with said wheel along said chain for orbital movement about the axis of said sprocket wheel in response to forces applied thereto by said chain.

3. A door operator as defined in claim 2 wherein said means supporting said idler elements comprises an idler plate and said drive means comprises a shaft on which said sprocket wheel is supported and means for driving said wheel from said shaft, said plate being supported on said shaft for rotation relative thereto.

4. A door operator for reciprocating an overhead door along a path between open and closed positions comprising a chain extending along the path of travel of said door, means supporting the ends of said chain at fixed points spaced a distance less than the length of the chain between said points to provide a chain having untensioned slack therein, a reversible motor, a sprocket wheel in mesh with said chain, drive means interconnecting said motor and sprocket wheel to rotate said wheel and move said motor and wheel along said chain upon rotation of said wheel, means connecting said motor to said door whereby operation of said motor to rotate said sprocket wheel causes said door to move along said chain with said motor, means separate from said chain supporting and guiding said motor and wheel for movement along said chain to maintain a slack portion in said chain as said motor moves therealong, spaced idler elements disposed adjacent the periphery of said sprocket wheel and adapted to maintain a wrap of said chain in engagement with said sprocket wheel, and means supporting said idler elements for orbital movement as a unit about the axis of rotation of said sprocket wheel in response to forces applied by said chain.

5. A door operator as defined in claim 4 wherein said means supporting said idler elements comprise an idler plate and said drive means comprises a shaft on which said sprocket wheel is supported and means for driving said wheel from said shaft, said plate being supported on said shaft for rotation relative thereto.

6. A door operator for reciprocating an overhead door between open and closed positions comprising a chain extending along the path of travel of said door, means supporting the ends of said chain at fixed points spaced a distance less than the length of the chain between said points to provide a chain having untensioned slack therein, a reversible motor, a sprocket wheel engaging said chain drive means interconnecting said motor and sprocket wheel to rotate said wheel and move said wheel along said chain, said motor being translated along said chain as a unit with said motor upon rotation of said wheel, a motor mount fixed to said motor, a support pivotally connected to said door and supporting said motor mount for limited movement on said support toward and away from said door, means separate from said chain supporting and guiding said motor, motor mount, and wheel for movement along said chain to maintain a slack portion in said chain as said motor moves therealong, a force transmitting connection between said motor mount and said support to cause said door to move with said motor and motor mount and yieldable in first and second directions respectively in response to a predetermined force opposing movement of said door by said motor in its door opening and door closing directions respectively, means responsive to a predetermined movement of said motor mount relative to said door in either of its said directions relative to aid door to stop the operation of sad motor, and idler means comprising spaced idler elements disposed about the periphery of said sprocket wheel and adapted to maintain a wrap chain in engagement with said sprocket wheel, and means supporting said idler elements for adjusting movement relative to said sprocket wheel in response to forces applied by said chain.

7. An operating mechanism as defined in claim 6 wherein said support comprises a bracket adapted to be pivotally connected to the door and rod means extending from said bracket and received by said motor mount to slidably support the mount thereon, and said force transmitting connection includes springs on said rod means on opposite sides of said mount for urging said mount to a predetermined position and to transmit the movement of said mount to said door.

8. In a door operating mechanism having a reversible motor for opening and closing a door reciprocable along a predetermined path in guide channels adjacent each side of the door between open and closed positions and switch means actuatable to stop the motor when the door is in its open and closed positions respectively and operable when the motor is operating in one direction to condition the motor to operate in the opposite direction on the next energization thereof, said mechanism including a support pivotally mounted on said door, a motor mount movably mounted on said support for movement in first and second directions toward and away from said door respectively, spring means on said support urging said mount to a predetermined position on said support and yieldable to accommodate movement in said first and second directions from said predetermined position, means mounting said switch means adjacent said mount to be operated by said mount in response to movement thereof relative to said support in said first and second directions respectively, means mounting said motor on said mount for movement therewith, a drive element movable with and driven by said motor, an elongated member engaged by said drive element and supported at its ends to extend along the path of movement of the door, and idler means rotatably supported adjacent said drive and maintaing said drive element and member engaged, the operation of said motor rotating said drive element to move said motor support and door along said path and said springs yielding at said limit positions and in response to an overload indicating a predetermined force opposing movement of said door to provide movement of said motor mount relative to said support to operate said switch means.

9. A operating mechanism as defined in claim 8 wherein said support comprises a bracket adapted to be pivotally connected to the door and rod means extending from said bracket and received by said motor mount to slidably support the mount thereon and said spring means includes springs on said rod means on opposite sides of said mount for urging said mount to a predetermined position and to transmit the movement of said mount to said door.

10. In a door operating mechanism having a reversible

motor for opening and closing a door limited by supporting means therefor to reciprocation along a predetermined path between open and closed positions and control means including switches actuatable to stop the motor when the door is in its open and closed limit positions respectively and operable when the motor is operating in one direction to condition the motor to operate in the opposite direction on the next energization thereof, said mechanism including a support pivotally mounted on said door, a motor mount movably mounted on said support for movement in first and second directions toward and away from said door respectively, spring means on said support urging said mount to a predetermined position on said support and yieldable to accommodate movement in said first and second directions from said pre-determined position, means mounting said switches adjacent said mount to be operated in response to movement of said mount relative to said support in either of said first and second directions, means mounting said motor on said mount for movement therewith, a sprocket driven by said motor, a chain with which said sprocket meshes and supported at its ends to extend along the path of movement of the door, and idler means rotatably supported adjacent said sprocket and maintaining said sprocket and chain in mesh, the operation of said motor rotating said sprocket to move said motor, support and door along said path, said springs yielding in response to an overload indicating a predetermined force opposing movement of said door to provide movement of said motor mount relative to said support.

References Cited by the Examiner

UNITED STATES PATENTS

1,817,909	8/1931	Blodgett	268—59
2,695,781	11/1954	Wark	268—59
2,703,236	3/1955	Verdier	268—59
2,747,863	5/1956	Huppert et al.	268—59
2,879,058	3/1959	Phillips	268—59
2,991,403	7/1961	Groft	318—266
3,012,520	12/1961	Curtis	104—235
3,045,164	7/1962	Russell	318—266

HARRISON R. MOSELEY, *Primary Examiner.*

JEROME SCHNALL, *Examiner.*