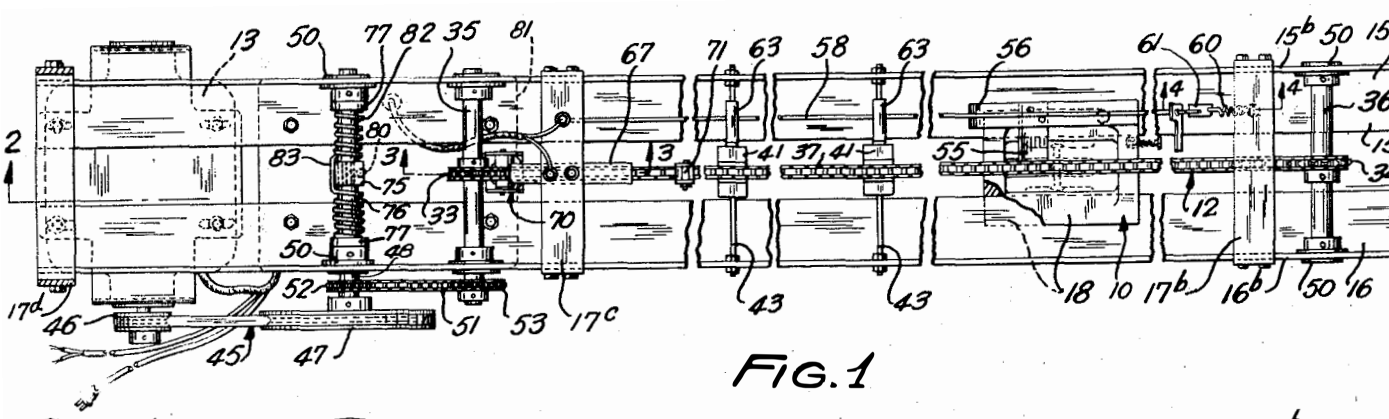

FIG. 1

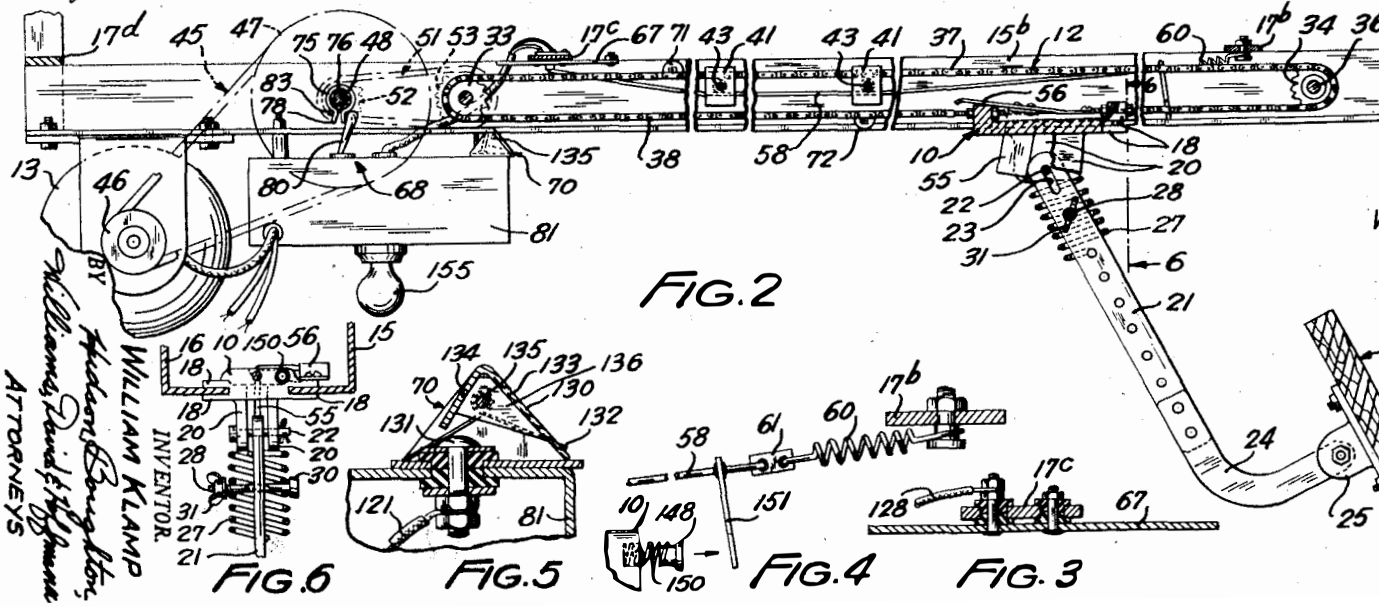

FIG. 2

FIG. 6

FIG. 5

FIG. 4

FIG. 3

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May 19, 1959 W. KLAMP 2,887,311

DOOR OPERATOR AND CONTROL THEREFOR

Filed April 4, 1957 2 Sheets-Sheet 2

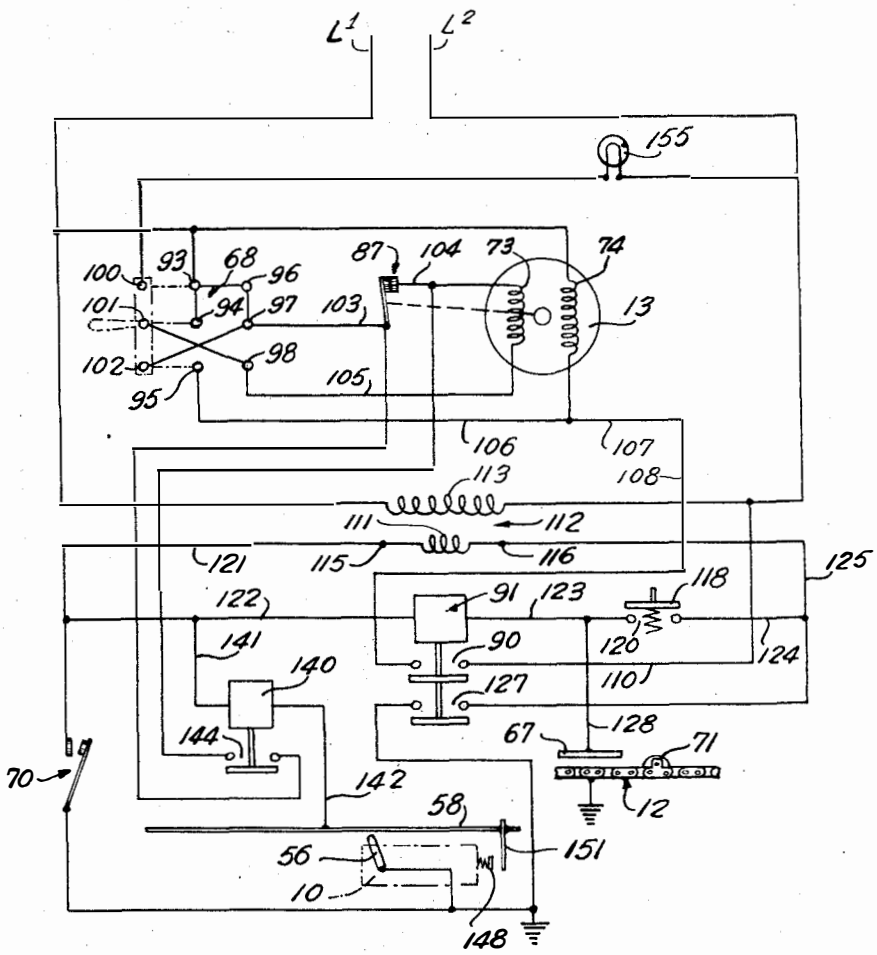

FIG. 7

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2,887,311
Patented May 19, 1959

2,887,311

DOOR OPERATOR AND CONTROL THEREFOR

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Application April 4, 1957, Serial No. 650,663

29 Claims. (Cl. 268—59)

The present invention relates to door operators and particularly to the controls therefor.

Door operators generally comprise a motor which is connected to reciprocate a carriage to effect the opening and closing of a door connected to the carriage and are commonly constructed so that if a fault occurs in the control circuit which maintains a control relay for the motor continuously energized, the motor will be continuously energized and in many types of operators the motor will operate to repeatedly open and close the door operated thereby. When such a fault occurs, the usual limit and other control means are rendered ineffective to stop the motor.

Furthermore, the door operators of the prior art have not been constructed to operate satisfactorily when the door meets an obstruction during its closing movement. In the majority of operators the obstruction must exert sufficient force to effectively stall the motor before the motor will reverse or the construction is such that the motor merely stops rather than reverses. In still other operators the safety controls in the event of the door meeting an obstruction are not entirely satisfactory for various reasons, such as requiring the use of flexible electrical cable to the door, or failing to operate for all types of obstructions.

An important object of the present invention is to provide a new and improved door operating mechanism of the type referred to but in which the motor is not subject to continuous energization due to faults which would normally maintain the motor control relay in a condition whereby the motor is energized.

Another object of the present invention is to provide a new and improved door operating mechanism of the type referred to but which will not operate continuously or be continuously energized even though the relay coil of the motor control relay is maintained in an energized condition upon the actuation thereof to start the motor, by a fault which renders the door limit means ineffective to de-energize or actuate the relay to its motor "stop" position.

Yet another object is to provide a door operating mechanism of the type referred to in which a switch is actuated in relationship to the movement of the door operating carriage through its door operating cycle, the switch being effective to stop the motor in the presence of a fault that maintains the motor control relay in a condition where the motor is continuously energized.

Another object of the present invention is to provide a door operating mechanism of the type referred to in which the motor control circuit is conditioned immediately after the motor is started to effect operation in the reverse direction when the starting winding of the motor is next energized and in which means is provided for effecting energization of the starting winding to reverse the motor in response to the door striking an object in its closing movement, which means preferably comprises a switch being grounded by a part moved in response to the door meeting an obstruction.

A further object of the present invention is the provision of a new and improved door operating mechanism in which a relay is alternately actuated to first and second positions to respectively start and stop the motor by successive momentary energizations thereof and in which a switch is actuated by the operating mechanism, preferably once during each cycle of door operation, to actuate the motor control relay from its immediate position to its other position if the relay is energized when the switch is operated.

A still further object of the present invention is to provide a door operating mechanism of the character set out above in which the motor is controlled by a relatively low voltage control circuit including a two-position ratchet type relay having motor-stop and motor-run positions and contacts which ground one side of the low voltage power supply when the relay is in its motor-run position and in which means is provided for momentarily connecting the relay coil across the power supply to actuate the relay and in which the motor is stopped at the limits of movement of the door by connecting one side of the relay to ground and continuous operation prevented in the event of a short circuit which maintains the relay energized on starting by momentarily short circuiting the relay, preferably once during each cycle of door operation, at a time the relay should, under normal operation, be de-energized.

The present invention also contemplates the provision of a new and improved simplified door operating mechanism in which the motor for driving the operator is reversed in response to the actuation of contacts which operate independently of motor speed when the door meets an obstruction, the mechanism being so constructed and arranged that it will have a long life and does not require a flexible electrical connection to the door in order that the mechanism will reverse in response to all types of small forces which oppose the closing of the door.

The present invention further contemplates a door operating mechanism as set out in the preceding paragraph in which the parts of the mechanism are not called upon to stall the motor when the door meets an obstruction, even though certain of the limit means and control elements are rendered ineffective.

Furthermore, it is an object of the present invention to provide a new and improved door operating mechanism in which the control circuit therefor is so constructed and arranged that the inertia of the door does not present a control problem and does not limit the maximum size of motor which can be used to drive the operator, the control circuit being such that it is not conditioned to reverse the motor on the next start until the inertia of the door has been overcome.

The invention resides in certain constructions and combinations and arrangements of parts and further objects and advantages thereof will be apparent from the following detailed description of the preferred embodiment made with reference to the accompanying drawings forming a part of this specification for all matter shown therein, whether or not expressly described, and in which:

Fig. 1 is a plan view of a door operating mechanism embodying the present invention;

Fig. 2 is a vertical sectional view taken approximately along line **2—2** of Fig. 1;

Fig. 3 is a fragmentary sectional view taken approximately along line **3—3** of Fig. 1;

Fig. 4 is a fragmentary detailed view showing the support for the safety cable used with the preferred and

Fig. 5 is a sectional view through a safety switch embodied in the mechanism shown in Fig. 1;

Fig. 6 is a fragmentary sectional view taken approximately along line 6—6 of Fig. 2; and

Fig. 7 is a simplified control circuit for the motor or the door operating mechanism.

The preferred embodiment of the present invention contemplates the provision of a door operating mechanism including switch means actuatable to operate the motor control relay to a stop condition if the relay is in an energized condition at the time the switch means is actuated, the switch means preferably being actuated once during each complete cycle of door operation and the motor control relay preferably being a ratchet relay which is momentarily short circuited by the actuation of the switch means to cause a pulsing of the relay and the actuation of the same to a stop position in the event that the relay is energized at the time of short circuiting. The broader aspects of the present invention contemplate the provision of safety means which is actuated in relationship to the door opening and closing cycle to stop the operation of the door in the event the control circuit, due to a fault therein, is in such a condition that the motor for driving the operator will remain continuously energized.

Furthermore, the present invention contemplates the provision of circuit means for reversing the door in response to an obstruction in its path during its closing movement, which circuit means is actuated independently of motor speed. It is also contemplated to provide a door operating mechanism where the control circuit for the motor is arranged in such a manner that the inertia of the door does not present a problem. In the preferred embodiment, the reversing circuit for the motor is not conditioned to operate the motor in the reverse direction on the next start until the motor has operated a sufficient time to overcome the effects of door inertia.

Referring to the drawings, the door operating mechanism shown therein comprises a carriage 10 connected to an overhead door or similar closure member 11 for closing an opening in a wall W and reciprocated to open and close the door by an endless flexible member or chain 12 driven by a motor 13, a reversible motor in the illustrated embodiment.

The carriage 10 is slidably supported for reciprocation between limits which correspond to fully open and fully closed positions of the door 11 by a pair of spaced angle members 15, 16 having horizontal flanges 15*a*, 16*a* and vertical flanges 15*b*, 16*b*. The angle members 15, 16 are disposed side by side with the carriage 10 therebetween and with the vertical flanges 15*b*, 16*b* extending upwardly from the remote side edges of the horizontal flanges 15*a*, 16*a*. The vertical flanges 15*b*, 16*b* are connected by straps 17*a*, 17*b*, 17*c* and 17*d*, which secure the angle members 15, 16 in spaced relationship. The straps 17*a* and 17*d* are also utilized to connect the operating mechanism to the wall W and to other supporting structure for the operating mechanism.

The carriage 10 is, in the illustrated embodiment, a cast body having a pair of spaced horizontal flanges 18 extending from each side thereof and forming a slidway which receives the horizontal flanges 15*a*, 16*a* to slidably support the carriage on the angle members 15, 16. The carriage 10 also has spaced depending vertical flanges 20 which are utilized to connect the carriage to the door 11. The carriage 10 is connected to the door 11 by a link 21 which has its upper end disposed between the flanges 20 and which is connected to the flanges 20 by a pin 22 supported by flanges and received in an elongated slot 23 in the upper end of the link 21. The elongated slot 23 permits relative movement of the link 21 with respect to the carriage 10. The lower end of the link 21, as the latter is viewed in Fig. 2, is connected to an arm 24 having its other end pivotally connected bent, in the illustrated embodiment, to define a right angle as is shown in Fig. 2. The door 11 is a conventional overhead door which is comprised of horizontal sections hinged together and which is guided for movement by guide channels disposed along the opposite side edges of the door and extending along the path of movement of the door. The door 11 and the guide channels therefor are not shown or described in detail since they do not, per se, form a part of this invention and since the details of their construction are well known to those skilled in the art.

The weight of the door 11 normally causes the link 21 to move to a position where the pin 22 engages the upper end of the elongated slot 23 as the latter is viewed in Fig. 2. In addition to the weight of the door 11 the link 21 is urged so that the pin 22 engages the upper end of the slot 23 therein by a spring 27 which encircles the link 21 adjacent the slot 23 and the one end of which abuts the lower ends of the flanges 20. The spring 27 is held compressed against the lower ends of the flanges 20 by a bolt 28 supported in an opening in the link 21 and extending through the coiled spring 27 between adjacent convolutions thereof and having a head 30 at one end which engages the outer sides of the convolutions and a wing nut 31 threaded onto the other end to engage the outer side of the convolutions at a point diametrically opposed to the point of engagement of the head 30. The loading due to the spring 27 may be adjusted by rotating the coil spring which will cause the helical convolutions of the spring to ride on the bolt 28 in the manner of a screw to increase or decrease the spring load depending upon the direction of rotation and the direction of lead of the helical convolutions. The slot 23 and the spring 27 cooperate to permit a relative movement to occur between the link 21 and the carriage 10 when the door meets an obstruction during its closing movement. This relative movement between the carriage 10 and the link 21 is used, as will be explained in detail hereinafter, to stop the movement of the carriage in a door closing direction.

The chain 12 for reciprocating the carriage 10 between its limits corresponding to the open and closed positions of the door 11 passes around spaced sprockets 33, 34 mounted on shafts 35, 36, respectively, journally supported by the vertical flanges 15*b*, 16*b* of the angle members 15, 16. The sprockets 33, 34 and the chain 12 are located in a vertical plane with the sprocket 34 being at the end of the channels 15, 16 adjacent the wall W.

The chain 12 has an upper run 37 and a lower run 38 to which the carriage 10 is connected. The upper run 37 of the carriage is additionally supported by cradles 41 carried by rods 43 extending between the vertical flanges 15*b*, 16*b*. The cradles 41 prevent sag of the upper run 37 of the chain 12. The chain 12 is driven to move the carriage 10 through its door opening and door closing movements by the motor 13 which is supported from the angle members 15, 16 at the end thereof remote from the wall W. The motor 13 is connected to drive the shaft 35 which mounts the sprocket 33 through a belt drive 45 having a driven pulley 46 mounted on the armature shaft of motor 13 and a driving pulley 47 fixed to an end of a shaft 48 extending between the vertical flanges 15*b*, 16*b* and extending outwardly of the latter and journally supported for rotation by bearing members 50 respectively mounted in the flanges 15*b*, 16*b*. The driving pulley of the belt drive 45 is fixed to the end portion of the shaft 48 that extends outwardly of the vertical flange 16*b*. The shaft 48 is, in turn, connected to drive the shaft 35 by a chain drive 51 including a sprocket 52 fixed to the shaft 48 and a sprocket 53 fixed to the end portion of shaft 35 which extends outwardly of the flange 16*b*. If the motor 13 is rotated in one direction the chain 12 is moved in one direction through its path to open or close the door and if th

is moved in the other direction through its path to actuate the door in its other direction.

As pointed out above, if the door during its closing movement meets an obstruction, the link **21** will move relative to the carriage **10** to effect the stopping of the door closing movement. In the illustrated embodiment, the upper end of the link **21** is in engagement with a lever **55** which is supported in a depending manner by a leaf spring **56** having one end thereof fixed to the upper side of the body of the carriage **10**. The lever **55** extends downwardly from the leaf spring **56** through an opening in the body of the carriage to engage the link **21**. Upon relative movement between the link **21** and the carriage **10** against the action of spring **27**, the lever **55** will be moved upwardly to cause the free end of the leaf spring **56** to move upwardly into engagement with a conductive member or cable **58** extending along the path of movement of the carriage **10** adjacent the upper side of the carriage. The cable **58** is supported at its opposite ends by the straps **17***b*, **17***c* connecting the angle members **15**, **16**. The end of the cable **58** adjacent the wall W is connected to the strap **17***b* by a connection which comprises a spring **60** having one end connected to the strap **17***b* and its other end received in an opening in an insulator **61** which has another opening for receiving the right-hand end of cable **58**. The insulator **61** insulates the cable from the strap **17***b* of the framework of the operating mechanism. The other, or left-hand end, of the cable **58**, as the latter is viewed in the drawing, is connected to the strap **17***c* and is insulated therefrom. The spring **60** urges the cable against the underside of rods **43**. The cable, however, is insulated from the rods by insulating sleeves **63**, coaxially supported on the rods. In the preferred and illustrated embodiment the control circuit for the motor **13** is arranged so that when the leaf spring **56** is moved into engagement with the cable **58** the motor **13** will reverse its direction of operation to cause the door **11** to move in the opposite direction.

The control circuit for the motor **13** is shown schematically in Fig. 7 and includes, in addition to the safety cable **58**, a limit bar **67**, a reversing switch **68** and a safety switch **70**. The limit bar **67** is supported from the strap **17***c* and is insulated therefrom.

When the carriage **10** is in its position corresponding to the fully closed position of the door **11** the limit bar **67** is engaged by a lug **71** on the upper run **37** of the chain **12** and when the carriage **10** is in its position corresponding to the fully open position of the door **11** the limit bar **67** is engaged by a lug **72**. The lug **72** is normally on the lower run of the chain **12** but just prior to its engagement with the limit bar **67** moves around the sprocket **33** to engage the rearward, or left-hand end of the limit bar, as the latter is viewed in the drawings. Engagement of the limit bar **67** by either the lug **71** or the lug **72** grounds the bar and causes the motor **13** to stop.

The motor **13** is of the type in which the direction of motor rotation depends upon the phase relationship of the current in a start winding **73** of the motor with respect to the current in a main motor winding **74** and in the illustrated embodiment is a split phase motor. The start winding is cut out immediately after the motor reaches a predetermined speed. The reversing switch **68** of the control circuit controls the sense of the current in the start winding and is operated each time the motor is started to condition the motor energizing circuit so that upon the next energization of the start winding the motor will effect operation of the motor in the opposite direction. The throwing of the switch **68** each time the motor starts is accomplished by a switch actuating band **75** which encompasses a sleeve **76** of fibrous material on the shaft **48**. The sleeve **76** has collars **77** at its opposite ends which respectively abut collars fixed to the shaft **48**. The sleeve tional engagement therewith, but if held will permit the shaft **48** to rotate relative thereto.

The switch actuating band **75** loosely encircles the sleeve **76** and has its opposite ends bent outwardly to form a radially extending tab **78** for engaging and actuating a switch operating member **80** for the reversing switch **68**, the reversing switch **68** being disposed immediately below the shaft **48** in a control box **81** supported from the underside of the angle members **15**, **16** and having housed therein the controls for the motor **13** and additionally mounting the safety switch **70**. The switch actuating band **75** is caused to move with the sleeve **76** to actuate the reversing switch **68** by a spring **82** coiled on the sleeve **76** and having a straight portion **83** intermediate its ends which passes over the switch actuating band **75** and joins the portions of the spring disposed on the opposite sides of the band. The ends of the spring **82** abut the collars **77** and the frictional engagement of the spring with the sleeve **76** is such that the sleeve and spring will move as a unit. The straight portion **83** of the spring **82** is such that it can move relative to the arcuate portion of the band between the opposite sides of the tab **78**. Assuming that the switch **68** is in the position shown in Fig. 2 with the switch operating member **80** being thrown to the right as viewed therein and with the tab **78** engaging the left-hand side of the member **80** and the straight portion **83** being in engagement with the left-hand side of tab **78** of the band, and if the motor is operating with the switch at the described position, the shaft **48** is rotating in a counterclockwise direction as viewed in Fig. 2, which tends to move the sleeve **76** and the spring thereon in a counterclockwise direction. Movement of the sleeve **76** and the spring **82** in a counterclockwise direction is prevented, however, by engagement of the straight portion **83** of the spring with the tab **78** which is, in turn, held against movement by the switch operating member **80** of the reversing switch **68**. With the switch in the position referred to, the motor **13** will operate, the next time the start winding is energized, in a direction to move the shaft clockwise to drive the carriage **10** in the opposite direction. When the motor is next started it will be seen that clockwise movement of the shaft **48** will cause the sleeve **76** and the spring **82** to move clockwise with the shaft since the straight portion **83** of the spring is free to move in a clockwise direction away from the tab **78**. After the shaft **48** has moved one revolution in the clockwise direction the straight portion **83** of the spring will engage the right-hand side of the tab **78** as the latter is viewed in Fig. 2 to cause the tab to move with the spring and sleeve **76**. The tab **78** and the band **75** will move clockwise with the sleeve **76** away from engagement with the switch operating member **80** of the switch **68** until the tab **78** has completed approximately a full revolution and engages the other side of the switch actuating member **80**. Continued clockwise rotation of the shaft **48** after reengagement of the tab **78** and the member **80** will cause the tab **78** to throw the switch to its other or left-hand position as viewed in Fig. 2 to condition the motor energizing circuit to start the motor in the opposite direction the next time the start winding **73** is energized. It can now be seen that the sleeve **76**, the switch actuating band **75**, and the spring **82** function to throw the reversing switch **68** approximately two revolutions after the start of the motor **13**. As is apparent from the following description, the throwing of reversing switch **68** conditions the motor **13** to start in the opposite direction the next time the start winding of the motor is energized.

Referring to the control circuit shown schematically in Fig. 7, the motor **13** includes a centrifugal switch **87**, which is operated to an open position to de-energize the start winding **73** after the motor has come up to a predetermined speed. The motor **13** is designed to operate at the voltage of the available power supply which is

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