Aug. 12, 1969 D. R. JACOBS 3,461,254

LIMIT SWITCH CONTROL HAVING SWITCH MOUNTING MEANS

Filed Feb. 27, 1967 2 Sheets-Sheet 1

Fig. 1.

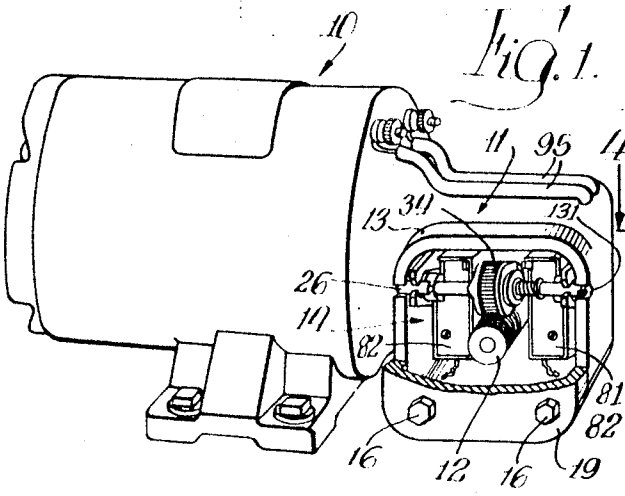


Fig. 2.

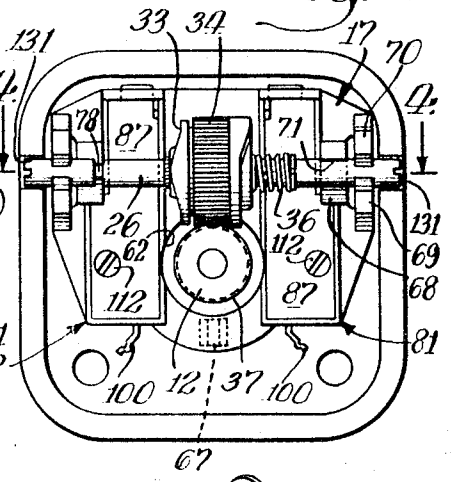


Fig. 3.

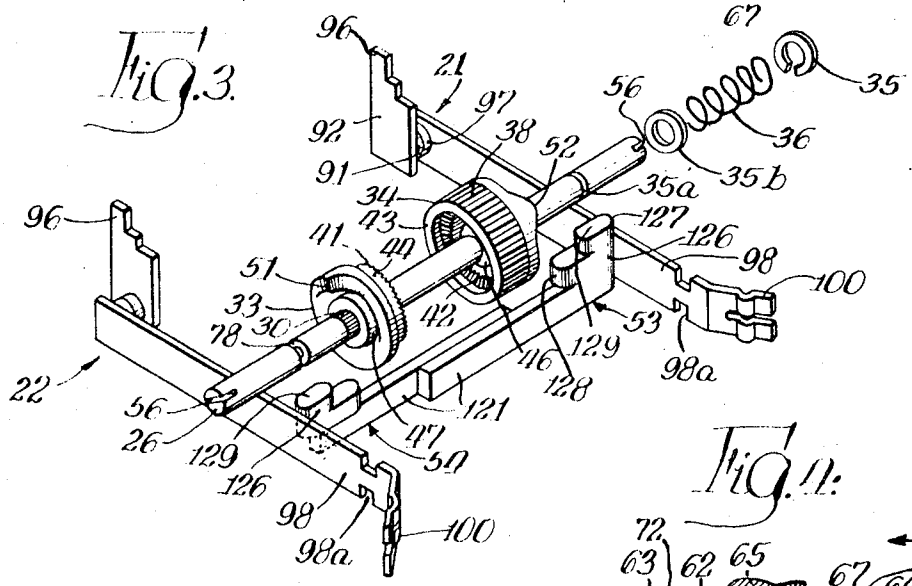


Fig. 4.

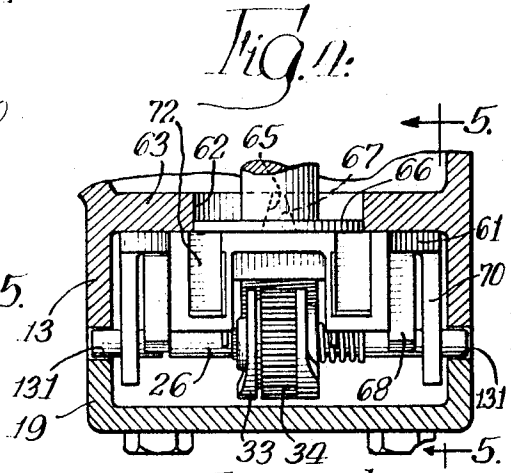
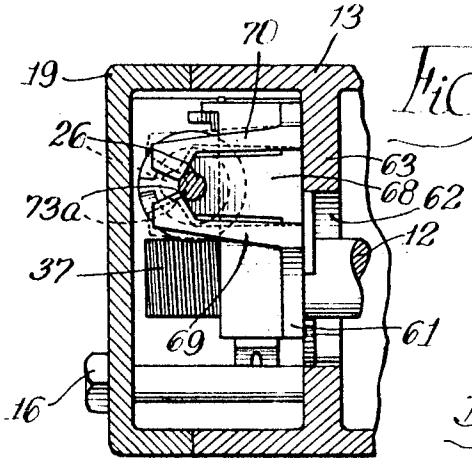


Fig. 5.



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LIMIT SWITCH CONTROL HAVING SWITCH MOUNTING MEANS

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Fig. 6.

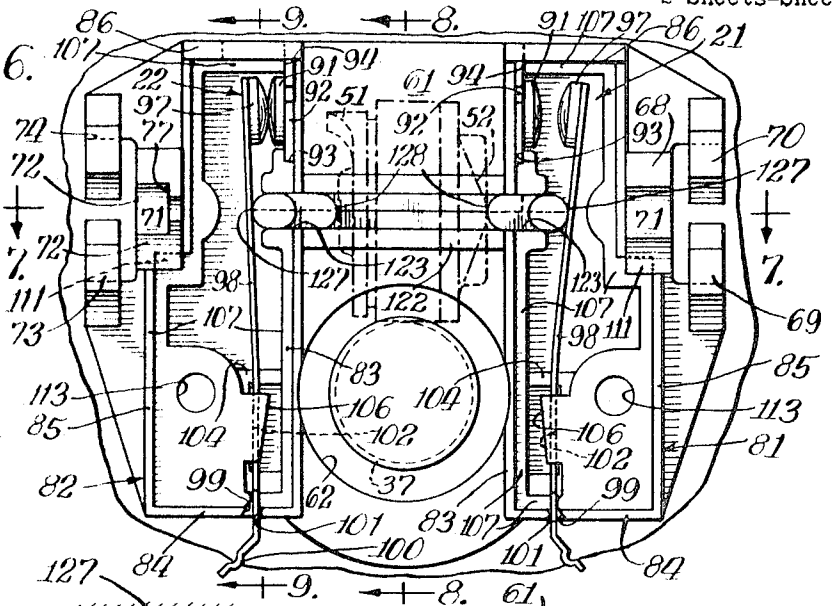


Fig. 7.

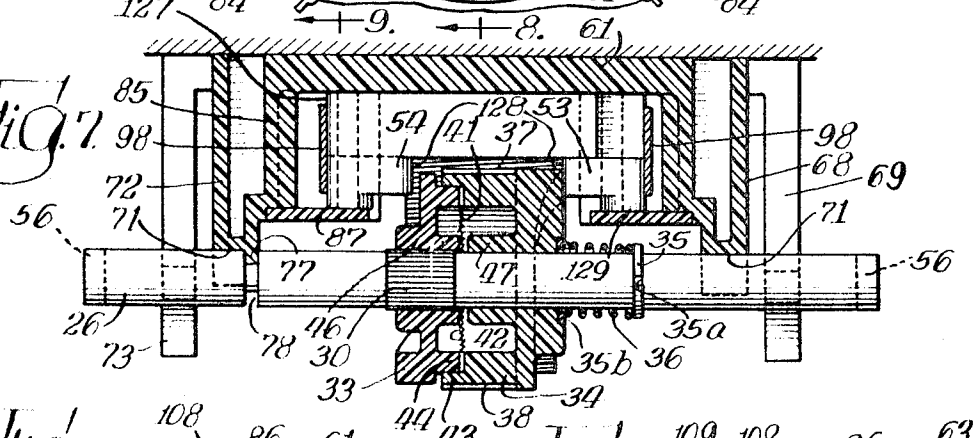


Fig. 8.

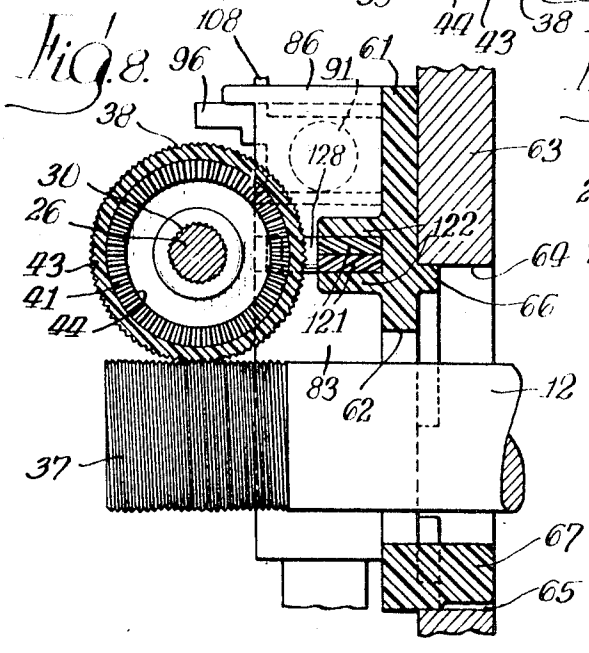
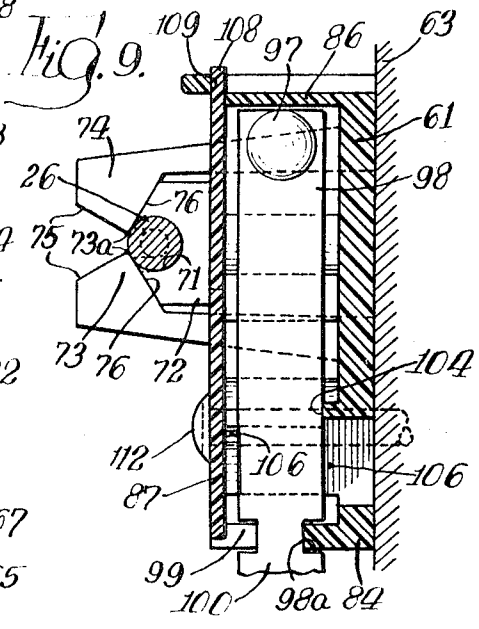


Fig. 9.



United States Patent Office 3,461,254 Patented Aug. 12, 1969

3,461,254

LIMIT SWITCH CONTROL HAVING SWITCH MOUNTING MEANS

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Int. Cl. H01h 3/16, 9/02
U.S. Cl. 200—47 7 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure deals with a limit switch control for a drive unit which includes a power output shaft. The control includes two cams which are connected by a worm-gear arrangement to be rotated by the power output shaft. Two plungers are located to be moved by the two cams, and each plunger actuates a limit switch upon movement thereof. The control further includes a molded case which houses and supports the cams, plungers and switch parts of the drive unit.

Applicant's copending patent application Ser. No. 453,587, filed May 6, 1965 and entitled Limit Switch Control For A Motor Drive, now Patent No. 3,306,997, describes a limit switch control including a pair of relatively adjustable cam members connected through a worm-gear to be driven by the motor. The cam members are rotatably mounted in a housing for the control and are adapted to actuate a pair of microswitches of conventional form upon rotation.

While the foregoing mechanism operates very well, it is relatively expensive since a machined metal housing is employed and a relatively expensive type of switch structure is required.

Accordingly it is an object of this invention to provide a limit switch control of the general character described in the above application, but including a pair of cam members connected to be rotated by the motor drive, a pair of inexpensive simply constructed switches, plungers movable by the cam members for actuating the switches, and a plastic case for the foregoing parts. In addition to housing the foregoing parts, the case also serves to rotatably support the cam members, properly locate the parts relative to the motor drive, support the parts of the switches, and support the plungers for sliding movement into and out of engagement with the switches. The case and the parts mounted thereon form a complete assembly which may be used with different types of motor drives.

Objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying figures of the drawings, in which:

FIG. 1 is a perspective view of a motor drive unit including a limit switch control constructed in accordance with the invention;

FIG. 2 is an enlarged view showing a portion of the motor drive unit with the limit switch control therein;

FIG. 3 is an enlarged exploded perspective view of a portion of the limit switch control;

FIG. 4 is a sectional view taken on the line 2—2 of FIG. 2;

FIG. 5 is a fragmentary sectional view taken on the line 5—5 of FIG. 4;

FIG. 6 is an enlarged view of the limit switch control with some of the parts removed, and mounted in the motor drive unit;

FIG. 7 is a sectional view taken on the line 7—7 of FIG. 6;

FIG. 8 is a fragmentary sectional view taken on the line 8—8 of FIG. 6; and

FIG. 9 is a fragmentary sectional view taken on the line 9—9 of FIG. 6.

In greater detail, in FIG. 1 there is shown a motor, indicated by the numeral 10, having a rotor shaft (not shown). The rotor shaft is connected through a gear box 11 to a cam drive shaft 12, which may be either an extension of the power output shaft of the motor-gear box unit or a shaft connected to be rotated by the power output shaft. Formed on the side of the gear box 11 is a control housing portion 13 which contains a limit switch control 14. A cover 19 cooperates with the portion 13 to enclose the control 14, and is fastened to the portion 13 by a plurality of bolts 16.

The limit switch control 14 includes a limit shaft 26 which is journaled at its ends in a case 17. Mounted on the limit shaft 26 are an adjustable face cam member 33 (FIGS. 3 and 7) and a fixed face cam member 34, the former cam member 33 being secured to the limit shaft 26, as by knurling a portion 30 of the surface of the shaft 26 and pressing the member 33 on the knurled portion, and the latter cam member 34 being loosely mounted on the limit shaft 26. A compression spring 36 is positioned around the limit shaft 26 between the cam member 34 and a snap ring 35, and urges the fixed cam member 34 toward the adjustable cam member 33. The snap ring 35 is positioned around the shaft 26 in a groove 35*a* formed in the shaft 26, and a washer 35*b* is positioned between the other end of the spring 36 and the cam member 34. When the terms "fixed" and "adjustable" are used herein with regard to the two cam members 34 and 33, it is meant that the cam member 33 is adjustable in the rotary direction with the shaft 26 but is substantially stationary in the axial direction, while the cam member 34 is fixed against rotation by the worm on the shaft 12 but is axially movable relative to the shaft 26 as the latter is rotated for adjustment.

One end of the cam drive shaft 12 extends into the limit switch control case 17 adjacent the cam member 34 (FIGS. 2 and 5) and this end of the shaft 12 has a worm 37 formed on it. The cam member 34 is cylindrical and its outer surface has axially extending gear teeth 38 formed on it, which mesh with the worm 37 of the shaft 12. Therefore, rotation of the cam drive shaft 12 also causes rotary movement of the cam member 34.

The two cam members 33 and 34 are adjustably connected together by a clutch arrangement including similar sets of V-shaped radially extending clutch teeth 41 and 42 formed on the cam members 33 and 34, respectively. The members 33 and 34 may, for example, be molded plastic members. The cam member 34 is shown as having an annular flange 43 (FIG. 7) at its outer periphery, the flange 43 extending around an annular axially extending flange 44 formed on the cam member 33. The adjacent surfaces of the flanges 43 and 44 act as a guide during movement of the cam member 34 relative to the cam member 33. The clutch teeth 41 and 42 are formed on the outer radially extending surface of the flange 44 and on an adjacent radially extending surface of the cam member 34. The members 33 and 34 are also provided with hubs 46 and 47, respectively, which engage the shaft 26, and the interior of the members 33 and 34 may be recessed between the surfaces having the teeth 41 and 42, and the hubs 46 and 47.

The spring 36 urges the cam members together and tends to hold the teeth 41 and 42 in engagement. When the teeth 41 and 42 are engaged as shown in FIGS. 2, 4 and 7, rotation of the cam drive shaft 12 causes rotation of the cam member 34 due to the connection between the worm gear 37 and gear teeth 38, and the clutch con-

nection, including the sets of teeth **41** and **42**, imparts motion from the cam member **34** to the cam members **33** and the limit shaft **26**.

The two cam members **33** and **34** are respectively provided with raised cam surfaces **51** and **52** on their radial faces which are away from the teeth **41** and **42**. Two switches **21** and **22** are provided along with movable actuating plungers **53** and **54**, respectively, and the cam surfaces **52** and **51** are engageable with the two plungers **53** and **54** which in turn are engageable with the switches **21** and **22**. Upon rotation of the limit shaft **26** and the two cam members **33** and **34** in one direction, the cam surface **52** engages the plunger **53** and actuates the switch **21**, and upon rotation of the limit shaft **26** in the opposite direction, the cam surface **51** engages the plunger **54** and actuates the other switch **22**. The drive motor **10** is connected in a conventional manner to be energized through the switches **21** and **22**, and engagement by the plungers **53** and **54** opens the switches **21** and **22**. Therefore, if the drive motor **10** is energized for rotation in one direction, energization will continue until the cam member **52** engages the plungers **53** and actuates the limit switch **21** to turn off the motor. Energization of the motor **10** in the opposite direction rotates the limit shaft **26** and the two cam members in the opposite direction until the raised cam surface **51** engages the other plunger **54** and actuates the switch **22** and again deenergizes the motor **10**.

It will be apparent that the number of revolutions of the motor **10** required to go from one limit to the other, depends upon the gear ratio between the worm **37** and the gear teeth and the angular separation between the two cams **51** and **52**.

The construction of the teeth **41** and **42** of the clutch and the construction of the worm **37** and gear **38** teeth are preferably such that the angular separation between adjacent teeth of each set of teeth **41** and **42**, is equal to the angular displacement of the two cam members **33** and **34** due to one complete revolution drive shaft **12**. Therefore, when adjusting the position of the cam member **33** relative to the cam member **34**, the number of revolutions of the drive shaft **12** to be increased or decreased is first determined and the two cam members **33** and **34** are then angularly displaced a corresponding number of clutch teeth **41** and **42**. To aid in case of adjustment of one of the cam members relative to the other of the cam members, at least one end of the limit shaft **26** is provided with a screwdriver receiving slot **56**. As will be explained hereinafter, the slotted ends of the shaft **26** are located in holes formed through the housing portion **13**, so that the limit switch control **14** may be adjusted without removing the cover **19**.

The case **17** of the control **14** comprises a substantially flat base **61** (FIGS. 4 to 9) having a hole **62** formed therein through which the saft **12** extends. With reference to FIG. 8, an interior wall **63** is formed within the gear box **11** adjacent the portion **13**, and a hole **64** for the shaft **12** is also formed in the wall **63**. The control **14** is located with the hole **62** overlying the hole **64** which is the larger of the two. A circular locating rabbet or flange **66** is formed on the back side of the base **61**, and the flange **66** extends into the hole **64** in order to properly align the limit switch control relative to the shaft **12**. A rearwardly extending tapered projection **67** (FIGS. 4 and 8) may also be formed on the back side of the base **61**, the projection **67** preferably extending into a mating cavity **65** in the wall **63** in order to angularly align the limit switch control with the shaft **12**.

To rotatably support the shaft **26** and the cam members **33** and **34** on the case **17**, a bearing post **68** and two clip posts **69** and **70** (FIGS. 5 and 6) are formed on the front side and adjacent the right hand edge of the base **61** as seen in FIG. 6, and a bearing post **72** and two clip posts **73** and **74** are formed on the front side and adajacent the left hand edge of the base **61**. The posts extends forwardly from the base **61** and rotatably support the shaft **26** in spaced relation therefrom. The outer or forward ends of the bearing posts **68** and **72** have semi-circular recesses **71** formed therein, the recesses having substantially the same curvature as the shaft **26** and receiving this shaft. As shown in FIGS. 5 and 9, the forward ends of the clip posts extend beyond the ends of the bearing posts, and the sides of the clip posts, which are adjacent the bearing posts, include projections or clips **73** which project partially over the bearing posts. The forwardmost edges **74** of the clips **73** slant rearwardly and toward the associated bearing post which the rearwardmost edges **76** of the clips **73** slant forwardly and toward the associated bearing posts, the edges **74** and **76** meeting at peaks **73***a* (FIG. 9). The minimum distance between the peaks **73***a* of each pair of clip posts when in their normal or unflexed condition is less than the thickness of the shaft **26**. Further, in the absence of the shaft **26**, the edges **76** are spaced from the recesses **71** a distance which is slightly less than the thickness of the shaft **26**. The clip posts are relatively flexible, and the shaft **26** may be located in the recess **71** of each bearing post by positioning the shaft **26** against the edges **74** of the clip posts and applying enough rearward pressure on the shaft **26** to flex or cam the clip posts apart. Once the shaft **26** is moved rearwardly past the peaks **73***a* and is seated in the recesses **71**, the clip posts flex toward each other and the shaft by the edges **76**. Sufficient forward pressure may be applied to the shaft to cam the clip posts apart in order to release the shaft **26**. To prevent axial movement of the shaft **26** and the cam members relative to the case **17**, a circular groove **78** (FIGS. 3 and 7) is formed in the shaft **26** adjacent the bearing post **72**, and a ridge **77** is formed in the recess **71** of the post **72**, the groove **78** receiving the ridge **77** and thereby preventing axial movement of the shaft **26**. With the exception of the ridge **77**, the case **17** is symmetrical about a vertical center line as seen in FIGS. 2 and 6.

With reference to FIGS. 2, 6, 7 and 9, the switches **21** and **22** are respectively located in enclosures **81** and **82**. The enclosure **82**, which is identical with the enclosure **81**, comprises four forwardly extending walls **83**, **84**, **85** and **86** and a cover **87** (FIGS. 2 and 9), the walls **83** to **86** being formed integrally with each other and with the base **61**, and the cover **87** being secured within the walls.

The switch **22**, which is similar to the switch **21**, includes a stationary contact **91** which is secured as by welding to a stationary contact arm **92**. To fasten the arm **92** to the base **61**, forwardly extending grooves **93** and **94** are formed in the walls **83** and **86**, having a width which is substantially equal to the thickness of the arm **92**. The arm **92** may thus be fastened to the case by positioning the forwardly extending edges of the arm **92** in the grooves with the contact **91** facing away from the walls **83**, and pushing the arm rearwardly in the grooves until the rearward edge of the arm **92** meets the base **61**. One corner portion **96** of the arm **92** (FIGS. 3 and 8) extends forwardly out of the enclosure through a recess in the cover and is adapted to be secured to an external lead such as one of the two leads **95** (FIG. 1).

The switch **22** also includes a movable contact **97** secured as by welding to one end of a movable contact arm **98** which extends out of the enclosure through a slot **99** formed in the wall **84**. The outer end **100** of the arm **98** is also adapted to be secured to the other of the two leads **95**. The two contacts **91** and **97** are located at the end of the enclosure which is adjacent the wall **86**, and face each other, and the arm **98** is supported such that the switch contacts **91** and **97** are normally closed. The support for the arm **98** comprises one edge **101** of the slot **99**, and an abutment **102** formed in the corner between the walls **84** and **85**. The abutment **102** engages the side of the arm **98**, which is away from the contact **97** and bows the center portion of the arm **98** in the direction of the edge **101** and the stationary contact **91**, thus normally holding the contacts **91** and **97** closed. How-

ever, the arm is flexible and may be bowed to move the contact **97** out of engagement with the contact **91** as will be explained. Forward and rearward movement of the portion of the contact arm **98** adjacent the abutment **102** is normally prevented by a ridge **104** and the bottom of the slot **99**, and by a ledge **106** which extends from the abutment **102** and overhangs the arm **98**. Movement of the arm **98** in the direction of its length is prevented by making the depth of the slot **99** in the wall **84** such that the wall will fit into a notch **98***a* formed in the arm **98** as shown in FIG. 9.

The cover **87** for the enclosure **82** has substantially **86**. Narrow ledges **107** are formed on the inner sides of the walls **83**, **85** and **86**, and the cover **87** is seated on the ledges **107** and on the forward surface of the abutment **102**, with the forward surface of the cover being substantially flush with the forward edges of the walls **83** to **86**. The corner of the cover **87** which is adjacent the stationary contact arm **92** is notched to provide clearance for the portion **66** of the arm **92** as previously explained. To fasten the cover **87** to the case **17**, a tab **108** (FIGS. 8 and 9) is formed on the end of the cover **87**, which is adjacent the wall **86**, and a slot **109** is formed in the wall **86** to receive the tab **108**. The post **72**, which is formed integrally with the wall **85**, is undercut as at **111** and the cover extends into the undercut **111** and is releasably held thereby. Further, the cover is releasably fastened to the case and the case is fastened to the wall **63** by a screw **112** (FIGS. 2 and 9) which extends through a hole formed in the cover, through a hole **113** (FIG. 6) formed in the case **17**, and into the wall **63**.

The construction of the enclosure **81** and the cover for the other switch is the mirror image of the foregoing construction, and the same reference numerals are used for those parts.

As previously stated, the plungers **53** and **54** respectively actuate the two switches **21** and **22** in response to turning movement of the cam members **33** and **34**. With reference to FIGS. 3 and 8, the two plungers extend parallel to the shaft **26** and are located between the shaft **26** and the base **61**. Each plunger includes an elongated generally rectangular guide portion **121**, and the two portions **121** are positioned in side-by-side relation within a slide channel formed by two forwardly extending walls **122** formed on the base **61**. The walls **122** are substantially the same height as the portions **121** and guide the movement of the plungers **53** and **54**. As shown in FIG. 6, openings **123** are formed in the walls **83** of the two switch enclosures, and the plungers **53** and **54** respectively extend through the openings **123** into the enclosures **81** and **82**.

While the switches **21** and **22** could be either of the normally closed type or the normally open type in the present instance they are normally closed, and to actuate the switches **21** and **22** from the closed to the open position, the plungers **53** and **54** include cam follower portions **126** which extend forwardly from the outer ends of the guide portions **121** respectively into the space between the cam member **33** and the switch **22** and the space between the cam member **34** and the switch **21**. As shown in FIG. 3 the forwardly extending outer edge **127** of each portion **126** engages the associated movable contact arm **98** while the inner edges **128** are engageable by the cams of the cam members. The outer edge **127** is slightly longer than the inner edge **128**, thereby producing a stepped appearance as shown in FIG. 3. The forwardmost surface **129** of each enlarged portion is located within the associated switch enclosure and slidingly engages the inner or rearward surface of the associated cover **87**. Such engagement holding the cam follower portions of the plungers in place in the slide channel. To hold the other end of each plunger in place, each guide portion **121** is made sufficiently long that it extend adjacent the cam follower portion of the other plunger, and each cam follower portion extends laterally over the forward edge of the guide portion **121** of the other plunger, thus preventing the two guide portions from moving forwardly. Rotative movement of the cam members **33** and **34** moves the cam surfaces **51** and **52** into engagement with the plungers **54** and **53**, thus pushing the plungers and the movable contact arms **98** outwardly against the force of the spring action of the arms **98**. When the cams are subsequently turned to move the cam surfaces **51** and **52** out of engagement with the plungers, the spring force of the arms **98** causes the switches to close again and the plungers to slide in the slide channel inwardly.

To install a limit switch control in a drive unit, the switch contact arms **92** and **98** are fastened in their enclosures, the covers **87** are placed over the enclosures, the plungers **53** and **54** are positioned in the slide channel, and the shaft **26** with the cam members attached thereto are mounted on the bearing posts. The screws **112** are then inserted through the holes in the covers **87** and the case **17** to secure the case to the housing **13** of the drive unit with the worm **37** in mesh with the teeth **34**. As shown in FIGS. 1, 2 and 4, openings **131** are formed in the housing **13** and in the cover **19**, in axial alignment with the shaft **26**, and the length of the shaft is preferably such that the ends of the shaft are recessed slightly from the outer surfaces of the housing **13** but nevertheless are accessible by a screwdriver inserted into the openings **131**. The cover **19** is then fastened to the housing over the limit switch control, by the bolts **16**.

The limit switch control may be used with a drive unit which has its power output shaft **12** connected to raise or lower a garage door, for example. The power output shaft **12** may be connected to the door such that the switch **22** is actuated by the cam **51** when the garage door reaches the upper position. To adjust the lower position of the garage door at which the motor **10** will be denergized, the first step may be to determine the distance of travel of the garage door caused by one revolution of the drive shaft **12**. Then, the total number of revolutions of the shaft **12** to provide the desired adjustment may be determined. If it is decided, for example, that an adjustment equalling three revolutions of the shaft **12** is required, a screw driver is inserted into one of the slots **56** and rotary force is applied to turn the shaft **26** in one direction or the other, depending upon whether it is desired to increase or decrease the height of the garage door at which the motor **10** is to be turned off. Since the shaft **26** and the cam member **33** are axially stationary, except for slight movement due to play between the ridge **77** and the groove **78**, and the cam member **34** is held against substantial rotation due to the engagement of the gear teeth **38** with the worm **37**, the rotary force applied to the shaft **26** causes the cam member **34** to move axially away from the other cam member **33** as the teeth **41** and **42** pass each other. The fact that the gear teeth **38** extend axially and that the outer surface of the member **34**, having the teeth **38** formed thereon is flat, enables the member **34** to move axially without interference due to the engagement of the teeth **38** with the worm **37**. The ridges formed by the teeth **41** and **42** urge the two cam members **33** and **34** apart against the action of the spring **36**, and a "click" will usually be heard as the teeth pass each other and reengage. Furthermore, since the angular distance between the teeth **41** and **42** is related in a one-to-one ratio with the gear ratio between the worm **37** and the gear teeth **38**, rotation of the shaft **26** sufficient to cause 3 clicks will result in an adjustment equivalent to three complete revolutions of the shaft **12**. Even if a click cannot be heard, the action of the teeth passing each other may be felt through the screw driver. As soon as the rotative force applied to the limit shaft **26** is removed, the teeth **41** and **42** will be held in mutual engagement by the force of the spring **36**.

The limit switch control described has numerous ad-

vantages. For example, the relative positions of the two cam members **33** and **34** may be easily adjusted from outside the housing **13** making it unnecessary to remove the cover **19** in order to make an adjustment. Furthermore, an adjustment may be made either with or without power applied to the motor **10**. Still further, an accurate adjustment may be made because of the relationship between the teeth **41** and **42**, and the gear ratio between the worm **37** and the gear teeth **38**, which produces one "click" for each revolution of the cam drive shift **12**. Still another advantage of the construction is that a setting of the limit switch control is positive and relatively permanent. In other words, it is not easily changed by accident. Also, the limit switch setting will not be changed by vibration of the unit, by manual turning of the power output shaft of the motor unit, or through a careless adjustment of the unit.

The provision of a molded case on which the switches and the shaft **26** are mounted permits the limit switch control to be completely assembled before installation in a motor drive unit. Thus, a limit switch control in accordance with the present invention may be provided, which may be used with different types of drive units. Another principle advantage of the present limit switch control is that it permits the use of relatively in expensive easily manufactured switches.

I claim:

1. A limit switch control for a drive unit, comprising a one-piece molded case, a limit shaft connectable with said drive unit and rotatably mounted on said shaft for rotation therewith, at least one switch mounted on said case, said switch comprising a stationary contact member and a movable contact member which is movable into and out of electrical contact with said stationary member, and movable plunger means extending between and engageable with said cam means and said movable contact member of said switch, said case including a portion for supporting and guiding the movement of said plunger means and a portion for supporting said members of said switch, whereby rotative movement of said cam means said plunger means to move, and such movement of said plunger means causes said movable contact member of said switch to move into and out of contact with said stationary contact member.

2. Apparatus as in claim **1**, wherein two switches and two plunger means are provided in said case, said two plunger means including interlocking portions which prevent them from accidentally falling out of said case.

3. Apparatus as in claim **1**, wherein said movable contact member of said switch has an inherent spring force tending to hold said members in electrical contact, said cam means being adapted upon turning movement to move said plunger means and said movable contact member in one direction against said spring force, and continued turning movement of said cam means permitting said spring force to move said plunger means and said movable contact member in the opposite direction.

4. Apparatus as in claim **1**, wherein said second mentioned portion of said case releasably holds said members of said switch.

5. A limit switch control for a drive unit, comprising a one-piece molded case, at least one switch fastened to said case, a limit shaft, said case including means formed integrally therewith for rotatably supporting said shaft, and cam means on said shaft for actuating said switch upon rotative movement of said limit shaft and said cam means, said rotatable mounting means comprising a bearing post adjacent each end of said limit shaft, a rounded depression formed in the outer end of each bearing post and said shaft being seated in said depressions, and a pair of clip posts adjacent each of said bearing posts and engaging said shaft, the clip posts of each pair being on opposite sides of said shaft and overlying said shaft, whereby said clip posts hold said shaft seated on said bearing posts.

6. Apparatus as in claim **5**, wherein said clip posts are relatively flexible, whereby the clip posts of each pair may be flexed away from each other to permit said limit shaft to be mounted on said bearing posts and removed therefrom.

7. Apparatus as in claim **5**, wherein said limit shaft has a circular groove formed in its outer periphery and a ridge is in said depression of one of said bearing posts, said ridge extending into said groove and preventing relative axial movement of said limit shaft.

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ROBERT K. SCHAEFER, Primary Examiner

D. SMITH, JR., Assistant Examiner

U.S. Cl. X.R.

200—168; 308—37