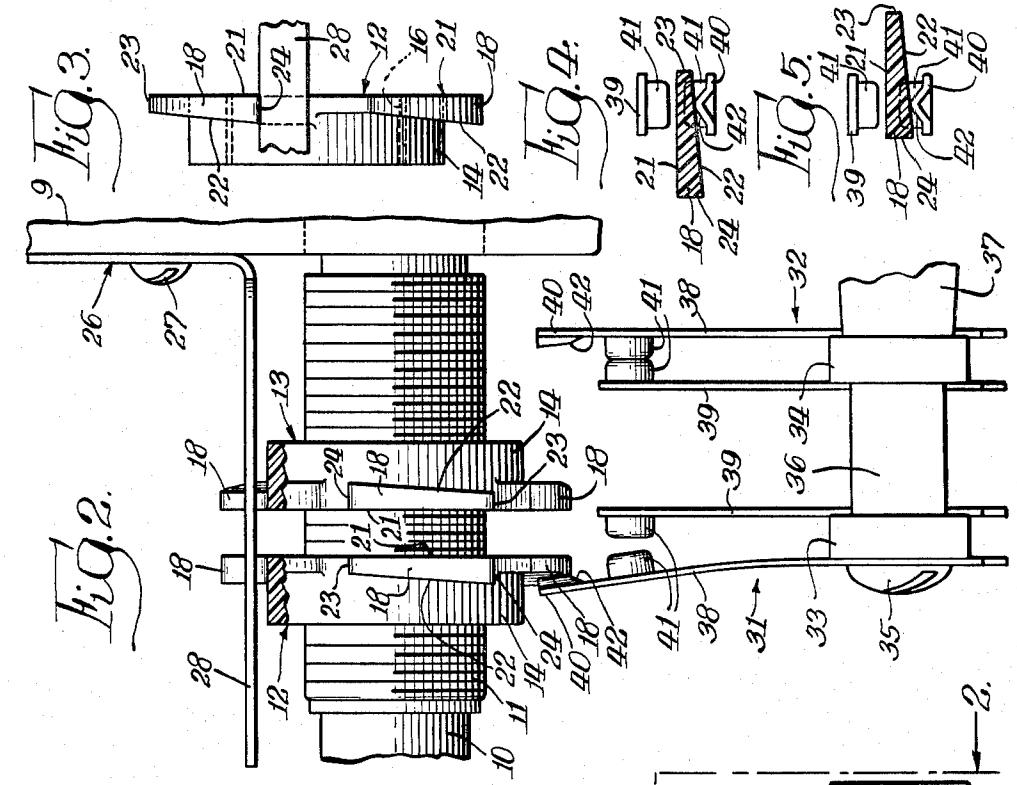
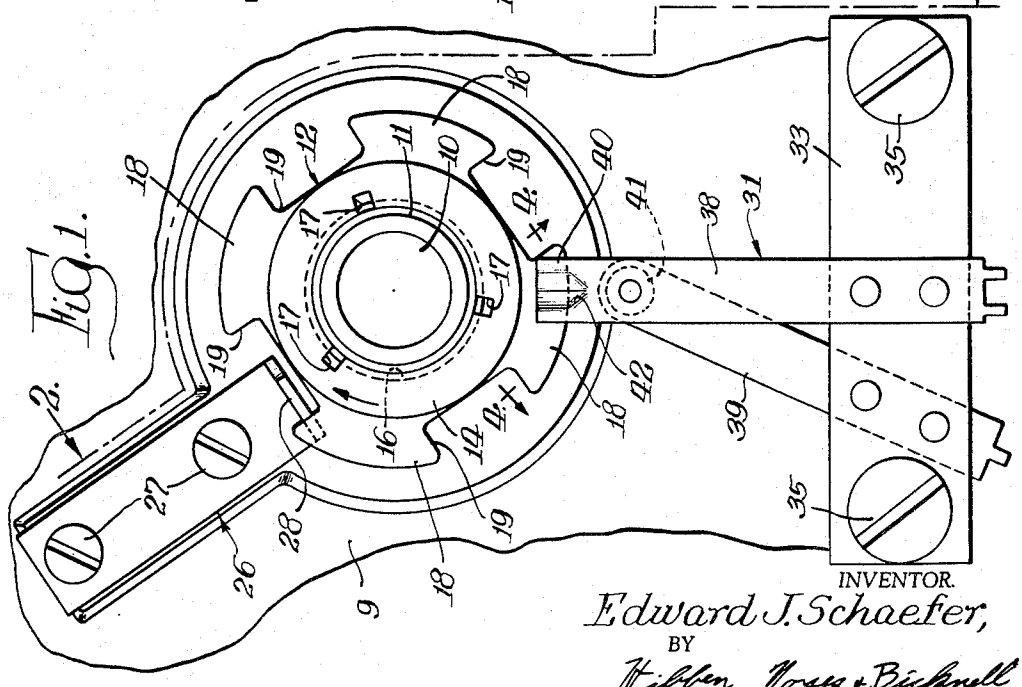
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SWITCH ACTUATING DEVICE

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SWITCH ACTUATING DEVICE

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This invention relates to a novel actuating device for a switch such as a limit switch.

Frequently a drive unit for a device is provided with a control to prevent the device from being driven beyond predetermined limits. One common type of control includes a switch positioned to be actuated by an actuating means when the device is driven in one direction to a limit, the switch being connected to prevent the device from being driven farther in that direction when the limit is reached. In some circumstances, it has been found that, after the limit switch has been actuated, the actuating means has a tendency to drift back a small amount in the reverse direction, and if this drift is sufficient the actuating means may permit the limit switch to deactuate. Deactuation of the limit switch is generally undesirable because it may cause power to again be connected to the device, which in some circumstances will lead to hunting or to some other undesired movement of the device. This problem is particularly acute when a switch having slow break contacts is used.

Accordingly, a primary object of this invention is to provide an actuating means for a limit switch, which will hold the limit switch open even though the actuating means drifts a small amount back from the limit.

Another object is to provide a switch actuating means which permits the use of a limit switch of a simple and inexpensive type having slow break contacts.

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

FIG. 1 is an end elevational view of apparatus including an actuating means embodying the invention;

FIG. 2 is a view taken along the line 2—2 of FIG. 1;

FIG. 3 is a side elevational view of part of the actuating device;

FIG. 4 is a view taken on the line 4—4 of FIG. 1; and

FIG. 5 is a view similar to FIG. 4 but showing a different position of the parts.

In general, a switch actuating means embodying the invention is adapted to be used in a system including a drive unit for a device and a limit switch. The actuating means includes a nut element adjacent an actuator element for the switch, and the system is designed such that, as the device is driven, the nut element and the switch actuator element are moved relative to each other along a path toward each other until the nut element engages and displaces the actuator element, and actuates the limit switch. After the nut and the actuator are brought into engagement, they may be moved a first predetermined distance along the path away from each other, due to drift. In that event, the nut element is rotatively moved laterally of said path a second predetermined distance. One of the nut and actuator elements includes means for increasing the displacement of said switch actuator element when said lateral movement occurs. In the present instance, this means is formed on the nut element, and comprises a cam surface which is the portion of the nut element engaging the actuator element. This cam surface slopes toward the switch actuator element from the point of initial engagement with said actuator element. The lateral movement of the cam surface and the switch actuator element relative to each other causes the switch actuator element to slide along the sloped cam surface said second predetermined distance. The slope of the cam surface is such that its rise during movement through the second predetermined distance increases the displacement of said actuator element. The increase in displacement is preferably substantially equal to said first predetermined distance, which is the distance the switch actuator element and the nut element drift away from each other. Accordingly, the switch is maintained actuated even though relative movement of the switch actuator element and the nut element is in a direction away from each other.

In greater detail, in FIGS. 1 and 2 there is shown a shaft 10 rotatably mounted on a frame 9, the shaft 10 being adapted to be connected in a system including a drive unit and a device driven by the drive unit (not shown in the drawings). Systems including drive units for the functions suitable for use with actuators embodying the invention are disclosed in my pending applications Serial No. 61,758, now Pat. No. 3,134,469, filed October 10, 1960, entitled "Drive Unit Control System," and Serial No. 40,959, now Pat. No. 3,129,607, filed July 5, 1960, entitled "Drive Unit and Control." It should be clearly understood, however, that a switch actuating device embodying the present invention is not limited to use in the systems described in these two pending applications.

The shaft 10 is connected to the driven device such that it rotates as the device is driven, the shaft rotating clockwise, in this instance, when the device is driven in one direction and the shaft rotating counterclockwise when the device is driven in the other direction. Secured to the outer surface of the shaft 10 is an externally threaded sleeve 11 which is coaxial with the shaft 10. In the event the use of the sleeve 11 is undesirable, it may be omitted and the exterior of the shaft 10 may be threaded.

Two internally threaded identical limit switch nuts 12 and 13 are threaded onto the sleeve 11. Each nut comprises a central hub or mounting portion 14 having a bore 16 formed therethrough. This bore is provided with threads of the same type and pitch as those of the sleeve 11. Three radially and axially extending grooves 17 (FIG. 1) may be formed in the bore 16, these grooves being provided to allow some self cleaning and to prevent the nut 12 from tightening on the threads of the sleeve 11.

The nut 12 also includes four equally spaced, radially extending flanges 18, which form four notches 19 (FIG. 1) therebetween. With specific reference to FIGS. 2 and 3, one surface 21 of each flange 18 is normal to the axis of the nut and the opposite surface 22 forms an angle with respect to a plane normal to the nut axis. The angled surface 22 is employed as a cam surface for engaging a switch actuator hereinafter described. Due to the angle of the surface 22 relative to the opposite surface 21, each flange has a thin edge 23 and a thick edge 24 (FIGS. 4 and 5).

With reference to FIG. 2, the two nuts 12 and 13 are threaded onto the sleeve 11 in axially spaced relation. A guide 26 is secured to the frame 9 as by screws 27, and includes an axially extending guide arm 28. This arm 28 is positioned within one of the four notches 19 of each nut 12 and 13 and the width of the arm 28 is less than the width of the notches 19, preferably approximately one-half of such width. It is apparent that, as the shaft 10 and the sleeve 11 rotate, for example in the clockwise direction, the friction between the sleeve 11 and the nuts 12 and 13 causes the nuts to be urged in the clockwise direction also. As soon as an edge of one of the flanges 18 contacts the guide arm 28, the nuts are prevented from further rotation, and the nuts then move axially of the shaft 10 in sliding engagement with the arm 28 as the shaft continues to rotate.

Two limit switches 31 and 32 are also provided, the two switches being mounted in axially spaced relation

on the frame 9. The switch mounting apparatus, in this instance, is shown as including two blocks 33 and 34, two bolts 35, and spacers 36 and 37 which maintain the blocks 33 and 34 away from each other and away from the frame 9. The blocks and the spacers are preferably made of insulating material. Each switch 31 and 32 includes a spring arm 38 and a fixed arm 39 fastened to the blocks 33 and 34, and each arm 38 and 39 includes a contact 41. The lower end of each switch arm may be provided with a tab for electrically connecting the switch arms into the control system. The outer end of each spring arm 38 extends beyond the fixed arm 39 and forms a switch actuator 40, and the two spring arms 38 are mounted on the outward sides of the fixed arms 39. The nuts 12 and 13 are positioned on the sleeve 11 between the switch actuator 40 and with the cam surfaces 22 of the flanges 18 facing outwardly.

When the shaft 10 rotates clockwise, the two nuts 12 and 13 move axially toward the left as shown in FIG. 2, and the limit switch 31 is positioned such that the cam surface 22 of one of the flanges 18 of the nut 12 engages the switch actuator 40 of the switch 31. When the shaft 10 rotates counterclockwise, the two nuts 12 and 13 move axially toward the right, and the limit switch 32 is positioned such that the cam surface 22 of one of the flanges 18 of the nut 13 engages the switch actuator 40 of the switch 32. When a flange 18 engages one of the actuators 40, the arm 38 is forced outwardly away from the fixed arm 39, thereby breaking connection between the contacts 41 of that switch. While the switches are shown and described as normally closed types, it is apparent that normally open switches could also be used, by mounting the switches with the spring arms on the inward sides of the fixed arms. As previously mentioned, the nuts 12 and 13 are mounted with the cam surfaces 22 of the flanges 17 facing outwardly, so that it is these surfaces which engage the switch actuators 40. Each switch actuator 40 is preferably formed with an inwardly facing tapered ridge 42 (FIGS. 2, 4 and 5) which engages the cam surface 22, and the guide arm 28 holds the nuts 12 and 13 such that the ridges 42 initially engage the cam surface 22 of a nut adjacent the thin edge 23 of a flange 18.

In operation, assume a system wherein the shaft 10 is coupled to a drive unit and to a device being driven, and the limit switches 31 and 32 are connected in a control circuit for the system. The switches 31 and 32 are preferably connected to either deenergize a drive motor or a clutch, or both, upon opening. When the shaft 10 is rotated in the clockwise direction, a side of one of the flanges 18 of each nut 12 and 13 engages the stationary guide arm 28 which prevents the nuts from rotating, and the nuts 12 and 13 move axially toward the left as seen in FIG. 2 until a flange 18 of the nut 12 engages the switch actuator 40 of the switch 31 and opens this switch. As shown in FIG. 4 and previously mentioned, the flange 18 initially engages the ridge 42 adjacent the thin edge 23 of the flange. The switch 31 is preferably connected in the control circuit such as to disconnect power from the device and cause the shaft 10 to stop rotating when it opens. If, for any reason, the shaft 10 subsequently drifts back in the counterclockwise direction after the switch 31 has been opened, the nuts 12 and 13 will also rotate in this direction with shaft 10 until the side of the flange adjacent the previously engaged flange in the clockwise direction engages the guide arm 28, which prevents counterclockwise rotation of the nuts 12 and 13 beyond an angle of approximately 25°. This movement back of the nut 12 causes the ridge 42 of the switch 31 to slide up the cam surface 22 to a position adjacent the thick edge 24 of the flange 18 as shown in FIG. 5. Due to slope of the cam surface 22, the contacts 41 of the switch arms 38 and 39 are moved farther apart than before. Therefore, even though the shaft 10 drifts in the counterclockwise direction and the nut 12 moves toward the right a small amount, the switch 31 will continue to be held open.

The amount of counterclockwise rotation of the shaft 10 permitted before the switch 31 closes is determined by the pitch of the threads of the sleeve 11, the slope of the cam surface 22 of the flanges 18, and the difference between the widths of the guide arm 28 and the notches 19 between the flanges 18.

In a specific embodiment of the invention, the pitch of the threads of the sleeve 11 and the nuts 12 and 13 is forty four threads to the inch. The width of the slots 19 is $\frac{7}{16}$ inch and the width of the guide arm 28 is $\frac{5}{16}$ inch, and the surface 22 makes an angle of $7° \pm 20'$ with a plane normal to the axis of the nut. This construction permits approximately one complete revolution back of the shaft 10 without closing of the switch 31. Of course, the width of the flanges 18 must be greater than the difference in width between the notches 19 and the guide arm 28 so that the ridge 42 will not slide off the flange 18 when the nut rotates back.

The rise of the cam surface 22 is preferably designed to be approximately equal to the expected amount of axial drift back of the nut. With reference to the construction described when the shaft 10 moves counterclockwise, the flange 18 moves laterally of the switch arm 38 a predetermined amount which is equal to the difference in width between the guide arm 28 and the slot 19. The rise of the slope 22 over this distance is equal to the amount by which the contacts 41 are initially moved farther apart. If the shaft 10 drifts back approximately one revolution, the nut 12 will move axially toward the right approximately the pitch of the threads of the sleeve 11 and the nut 12. It is apparent that, if the rise of the cam surface 22 over the above lateral distance is made approximately equal to the axial movement back of the nut 12, or the pitch of the threads, the switch contacts 41 will be in the same position as they were before the drift back of the shaft 10 occurred.

One type of system in which an actuating device embodying the present invention is useful is described in the previously mentioned application Serial No. 61,758. That application covers a control system for a drive unit of the type described in the other previously mentioned application Serial No. 40,959. The system of the former application comprises one reversible electric motor that is selectively connectible by a plurality of clutches to a plurality of shafts for driving different functions. For example, the shafts may be for driving different mechanisms of a hospital bed, such as one for raising and lowering the head, one for raising and lowering the foot, and one for raising and lowering the bed as a whole. Limit switch nuts embodying the invention may be used in place of the nuts 121 and 122 of application Serial No. 40,959.

A drift back of the shaft carrying the limit switch nuts, as described in the present application, may occur when the shaft is connected to drive the bed height function, and the control system shown in FIG. 1 of application Serial No. 61,758 is used to control the drive unit, the controller or handle 153 of FIG. 2 being used however instead of the handle 91. With reference to this last mentioned application, if toggle switch 149 is turned to the full line position shown in FIG. 1, relay coil 129 will be energized and relay contact 69 will close. Solenoid coil 18 is then energized which engages the clutch for this function, and power is also connected to the motor windings 22 and 23. The bed is then driven upwardly until the limit switch 87 opens and deenergizes the clutch coil 18 and the motor windings 22 and 23.

The type of clutch described in application Serial No. 40,959 is one which may engage or disengage only in increments of one revolution of the drive shaft. Unless a cam shown in that application is at a certain position, the clutch cannot disengage even though the solenoid coil (79 in Serial No. 40,959, 18 in Serial No. 61,758) is de-

energized by the opening of the limit switch (107 or 108 in Serial No. 40,959, 83 or 87 in Serial No. 61,758).

Assuming that the condition exists where the limit switch 87 (of Serial No. 61,758) is open but the bed height function clutch associated with coil 18 is still engaged, it may subsequently be desired to lower the foot of the bed. This is accomplishd by pressing switch 97*a* which closes circuits to energize the drive motor in the direction opposite its direction when the bed was raised. Since the clutch for the bed height function is still engaged, the drive shaft for this function will rotate a partial revolution back until the drive shaft is at the point where this clutch will disengage. As described in the present application, the partial revolution back of the shaft moves the limit switch nut away from the limit switch. If an ordinary type nut is used, the limit switch may close again. If it does close, as soon as the switch 97*a* is released power is applied to terminal 163, and the coils 129 and 18 are again energized, unintentionally, because the toggle switch 149 is still turned to the right. The bed will then be raised again until the limit switch 87 is opened. This difficulty is eliminated when using a limit switch nut embodying the present invention because the drive shaft for the bed height function may move a partial revolution back without the limit switch closing.

It should be understood that an actuating device embodying the invention is not limited to use with the foregoing systems. It may be used whenever a surface is used to engage and actuate a limit switch.

I claim:

1. Switch actuating means for use in a control system for a drive unit for a driven device, comprising an externally threaded member adapted to be connected to the drive unit and be rotated as the drive unit drives said device, a nut threaded on said member, means engaging said nut and permitting axial movement of said nut due to the rotation of said member, said means preventing rotation of said nut as said member is rotated in one direction but permitting rotation of said nut through a predetermined arc when said member is rotated in the other direction, and an actuator for a switch positioned to be engaged by said nut when said member is rotated in said one direction a predetermined amount, said rotation causing said nut to move axially toward and engage and displace said switch actuator, said nut having means for increasing the displacement of said switch actuator on rotation of said nut in said other direction through said predetermined arc.

2. Switch actuating means for use in a control system for a drive unit for a driven device, comprising an externally threaded member adapted to be connected to the drive unit and be rotated as the drive unit drives said device, a nut element threaded on said member, means engaging said nut element and permitting axial movement of said nut element due to rotation of said member, said means preventing rotation of said nut element as said member is rotated in one direction but permitting rotation of said nut element through a predetermined arc when said member is rotated in the other direction, a switch actuating element positioned to be engaged by said nut element when said member is rotated in said one direction a predetermined amount, said rotation causing said nut element to move axially toward and engage and displace said switch actuating element, one of said elements having means for increasing the displacement of said switch actuating element when said member and said nut element are rotated in said other direction through said predetermined arc.

3. Switch actuating means as in claim 2, wherein said means for increasing said displacement of said switch actuating element comprises a cam surface.

4. Switch actuating means for use in a control system for a drive unit, for a driven device comprising an externally threaded member adapted to be connected to the drive unit and be rotated as the drive unit drives said device, a nut threaded on said member, said nut including a cam surface on one side, means engaging said nut and permitting axial movement of said nut, due to rotation of said member, said means preventing rotation of said nut as said member is rotated in one direction but permitting rotation of said nut through a predetermined arc when said member is rotated in the other direction, and an actuator for a switch positioned to be engaged by said cam surface when said member is rotated in said one direction a predetermined amount, said rotation causing said nut to move axially toward and engage and displace said switch actuator, said cam surface sloping toward said switch actuator from its point of initial engagement with said switch actuator, whereby rotation of said member and said nut in said other direction through said predetermined arc causes said switch actuator to slide along said sloped cam surface and increase the displacement of said switch actuator.

5. A switch actuating device as in claim 4, wherein said nut further includes at least one radially outward extending flange, and said cam surface is formed on one side of said flange.

6. A switch actuating device as in claim 4, wherein said nut further includes at least one slot formed at its outer periphery, said means engaging said nut comprises a guide, and said guide includes an arm positioned in said slot.

7. A switch actuating device as in claim 4, wherein said nut further includes a plurality of radially and axially extending grooves formed in its inner periphery, said grooves rendering said nut self cleaning and preventing tightening of said nut on said threaded member.

8. A switch actuating device as in claim 4, wherein said nut moves axially away from said switch actuator a predetermined distance when said member is rotated in said other direction and said nut rotates through said predetermined arc, and the rise of said cam surface during movement through said predetermined arc is substantially equal to said predetermined distance.

9. A switch actuating device as in claim 4, wherein said nut further includes at least one slot formed in its outer periphery, and said guide includes an arm positioned in said slot, said predetermined arc being equal to the difference in width between said arm and said slot.

10. A switch actuating device as in claim 4 and further including a switch having a fixed arm and a spring arm, and said switch actuator comprises the outer end of said spring arm.

11. A switch actuating device as in claim 10, wherein said switch actuator includes a raised portion positioned to engage said cam surface of said nut.

12. A limit switch actuating means for use in a system including a drive unit, a device driven by the drive unit, and a limit switch, said actuating means comprising a mounting portion, and at least one flange portion attached to and extending outwardly from said mounting portion, said portions being adapted to be moved in a forward direction toward the limit switch as the device is driven until said flange portion engages and actuates the limit switch, and said portions being adapted to be subsequently moved in the rearward direction away from the limit switch a first predetermined distance and said flange portion being adapted to be moved laterally of the limit switch a second predetermined distance, said flange portion being formed such that it slopes in said forward direction from the point of initial engagement with the limit switch and the limit switch is adapted to slide on said slope as said flange portion is moved laterally said second predetermined distance, the rise of said slope through said second predetermined distance being substantially equal to said first predetermined distance, whereby said limit switch remains actuated even though said actuator moves in said rearward direction away from the limit switch substantially said first predetermined distance.

13. A nut for use in a system including a drive unit having a threaded drive shaft, a device driven by the drive unit, a guide for limiting the rotative movement of the nut but permitting axial movement of the nut, and a limit switch, said nut comprising an internally threaded hub adapted to be mounted on said shaft and having at least one radially extending flange, said nut being adapted to be moved in a forward direction toward the limit switch as the device is driven with said flange adapted to engage and displace the limit switch, and said nut being adapted to be subsequently moved in the rearward direction away from the limit switch a first predetermined distance and said flange being adapted to rotate with said shaft and thereby be moved laterally of the limit switch a second predetermined distance, said flange being formed such that it slopes in said forward direction from the point of initial engagement with the limit switch and the limit switch is adapted to slide on said slope as said flange is moved laterally said second predetermined distance, the rise of said slope through said second predetermined distance being at least substantially equal to said first predetermined distance, whereby said limit switch remains displaced even though said nut moves in said rearward direction away from the limit switch substantially said first predetermined distance, said nut having means adapted to be engaged by said guide.

14. A nut as in claim 13, wherein said hub includes a plurality of radially and axially extending internal grooves, said grooves rendering said nut self cleaning.

15. Switch actuating means for use in a control system for a drive unit for a driven device, comprising a member adapted to be connected to the drive unit and be moved as the drive unit drives said device, an actuator element connected to said member, a switch actuating element, said member being adapted to move said actuator element in a forward direction toward said switch actuating element as the drive unit drives said device until said actuator element engages and displaces said switch actuating element, said actuator element being adapted to be subsequently moved by said member laterally of said switch actuating element a first predetermined distance and to be moved in a rearward direction away from said switch actuating element a second predetermined distance, means engaging said actuator element and effective to cause said actuator element to move in said forward and rearward directions and to cause said lateral movement on changing its movement from said forward to said reverse directions, one of said elements having means for increasing the displacement of said switch actuating element when said actuator element is moved laterally through said first predetermined distance, said increase in displacement being at least substantially equal to said second predetermined distance, whereby said switch actuating element remains displaced even though said actuating element moves in said rearward direction said second predetermined distance.

References Cited by the Examiner

UNITED STATES PATENTS

1,601,346	9/26	Callahan	200—47
2,253,557	8/41	Collins	200—47
2,276,740	3/42	Saito	200—158
2,773,966	12/56	Mastropole	74—424.8 XR
2,951,920	9/60	Miller	200—47

FOREIGN PATENTS

6,425	1888	Great Britain.

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