Sept. 24, 1968 J. N. PEARSE ET AL 3,403,363

OPERATING MEANS FOR PUSHBUTTON SWITCHES AND THE LIKE HAVING MAGNETICALLY OPERABLE CONTACTS

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Fig. 1

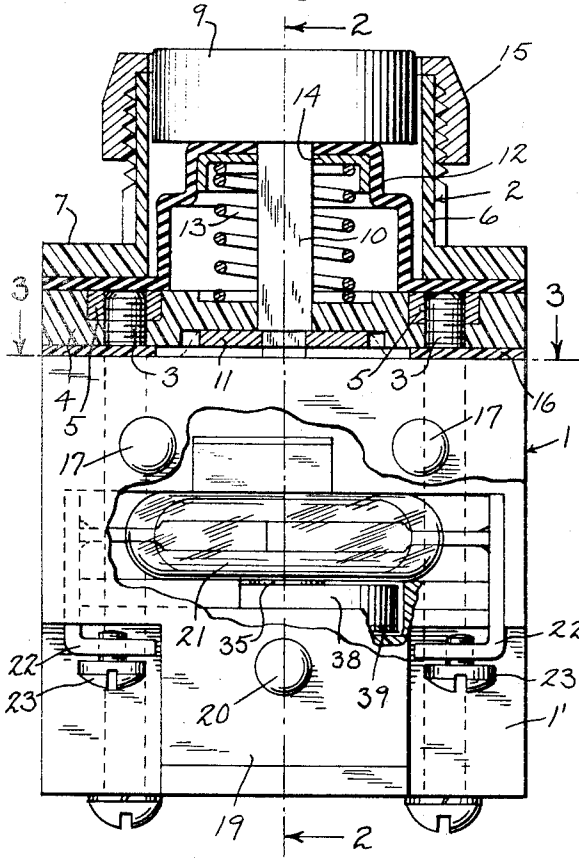


Fig. 2

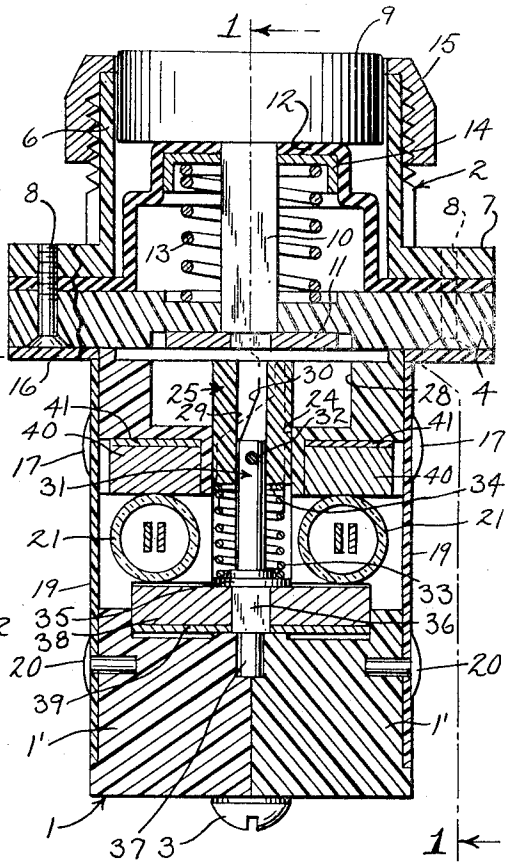
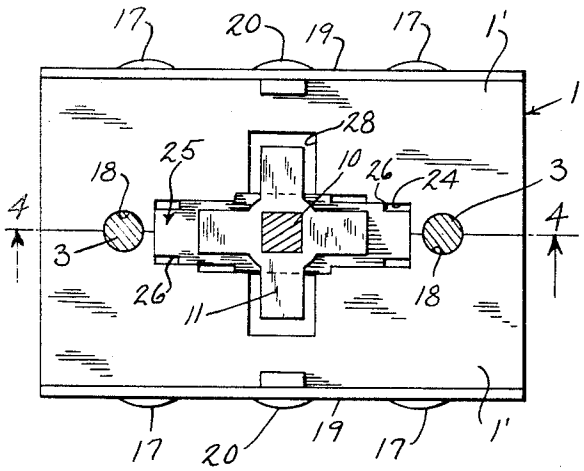


Fig. 3



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Fig. 4

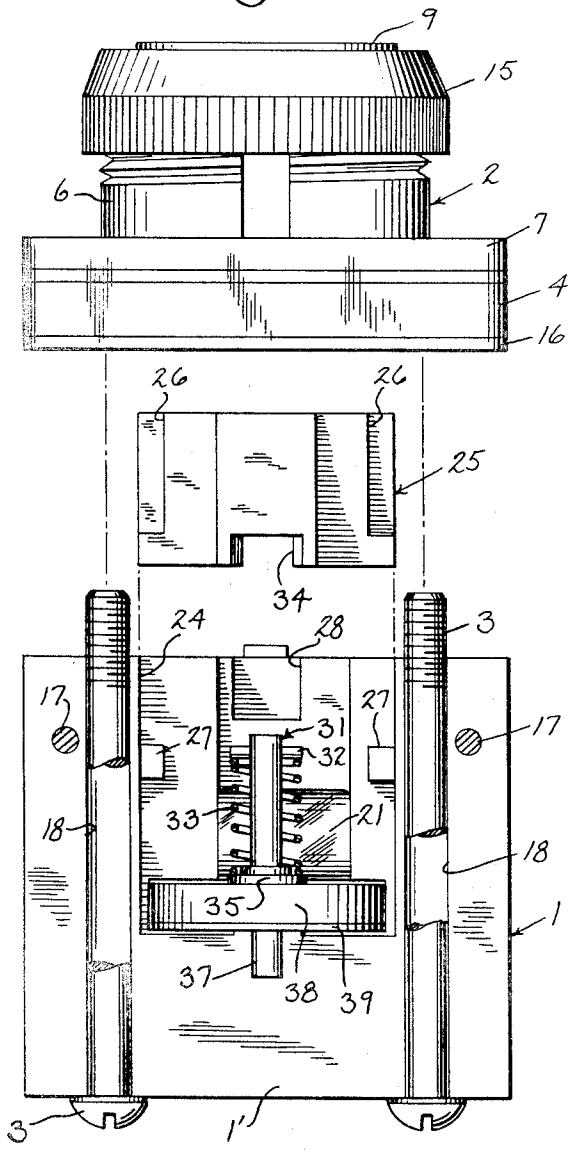


Fig. 5

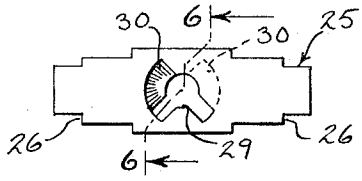


Fig. 6

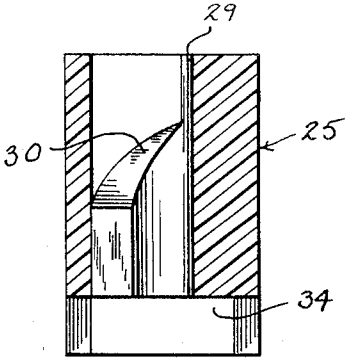
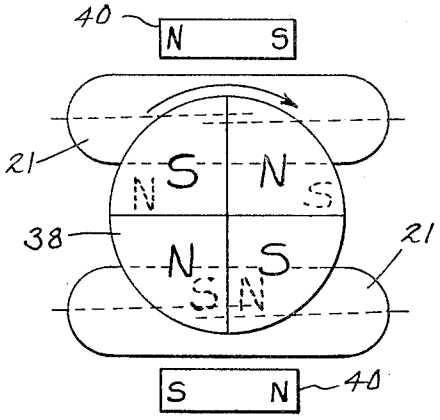


Fig. 7



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OPERATING MEANS FOR PUSHBUTTON SWITCHES AND THE LIKE HAVING MAGNETICALLY OPERABLE CONTACTS

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4 Claims. (Cl. 335—205)

ABSTRACT OF THE DISCLOSURE

A pushbutton switch includes a linear actuator, a pair of magnetically operable reed switches, each with a bias magnet across its contacts, a rotatable operating magnet facing the switch contacts, and an operating mechanism to rotate the operating magnet in response to linear movement of the actuator. The operating magnet is quadrantially magnetized and aligned with the switches to present a pair of opposite poles across the contacts of each switch, a quarter turn rotational movement of the magnet serving to reverse the polarity, thus—depending on the polarity of the bias magnets—opening or closing the switches. The operating mechanism includes a cam movable between normal and operated positions and engageable by the actuator to be moved to operated position. A cam bore leads through the cam and presents opposite inclined cam surfaces, and a cam follower connected to the operating magnet has pins engageable with the surfaces to cause the magnet to be moved rotationally in response to movement of the cam in either direction. Bias means urges the cam toward normal position.

This invention relates to operating means for pushbutton switches and the like having magnetically operable contacts; and resides more particularly in means including, in combination with a set of magnetically operable contacts and a linear actuator, an operating magnet that is rotatable between selected positions with respect to the contacts and an operating mechanism interposed between the actuator and magnet to effect rotational movement of the magnet in response to linear movement of the actuator.

Although it has many other possible applications, the invention is especially adapted for use in pushbutton or limit switches or other devices incorporating buttons, plungers or other actuators that have linear movement and in which it is desired to use magnetically operable contacts, particularly sealed reed switches. Reed switches are particularly suited for such devices because of their reliability and long life, and because they can be easily actuated by moving a permanent magnet between selected positions with respect to the contacts. Limit and pushbutton switches are necessarily quite small, however, and space requirements have heretofore made it difficult to utilize reed switches therein, primarily because of the travel required for the permanent operating magnet to insure effective operation of the switches. It is conventional, for example, to actuate reed switches by placing a bar magnet alongside and parallel to the reeds and using the pushbutton or other actuator at one end of the magnet and a bias means at the other end of the magnet to slide it between a position where it is across the contacts and a position where it is removed from the contacts. For reliable operation in this manner, however, substantial

magnet travel is necessary and in many cases the required space is simply not available.

Further, in many cases, especially in limit switches, the pushbutton or other actuator must have a short, fixed length of travel. If it acts directly on a magnet to slide it along a reed switch, the magnet can have no greater travel than the actuator and this may be insufficient for effective, reliable operation.

Space and travel requirements become especially critical when it is desired to incorporate reed switches in standard pushbutton or limit switch designs which have a fixed size and actuator travel.

It is the general object of this invention to overcome these difficulties by providing an operating actuating means for such devices which incorporates a rotatable operating magnet and an operating mechanism between the magnet and actuator to effect rotational movement of the magnet in response to linear movement of the actuator, and to amplify such movement if desired. It is among the specific objects to provide an operating means that is highly effective and versatile while being relatively simple and inexpensive and which allows the provision of a pushbutton switch or other device that is reliable and efficient while being of minimum size with minimum actuator travel. Another specific object is the provision of a particularly effective operating arrangement for a device with two sets of contacts.

The aplications and advantages of the invention will be obvious from the description to follow. In the description reference is made to the accompanying drawings, which form a part hereof and in which, by way of illustration and not limitation, a preferred embodiment of the invention is shown.

In the drawings:

FIG. 1 is a front view in elevation, with parts shown broken away and in cross section, of a pushbutton switch formed according to the invention,

FIG. 2 is a view in cross section through the plane 2—2 shown in FIG. 1,

FIG. 3 is a view in cross section through the plane 3—3 shown in FIG. 1,

FIG. 4 is an exploded view further illustrating certain elements of the switch of FIG. 1,

FIG. 5 is a top plan view of a cam member forming a part of the operating mechanism of the switch of FIGS. 1–4,

FIG. 6 is a view in cross section through the plane 6—6 shown in FIG. 5, and

FIG. 7 is a schematic view illustrating the operation of the switch of FIGS. 1–6.

The pushbutton switch shown in the drawings includes an insulating case designated generally by the reference numeral 1 and an actuating head designated generally by the reference numeral 2 which is attached to the case 1 by bolts 3.

The actuating head 2 is of generally conventional construction and includes a generally square base 4 of insulating material in the upper surface of which are set nuts 5 for the bolts 3. Atop the base 4 is a tubular housing 6 which has a square base flange 7 which is substantially coextensive and in alignment with the base 4. Screws 8 are threadedly received in the flange 7 and connect the base 4 to the housing 6.

A pushbutton 9 is vertically reciprocally slidably received in the housing 6 and has an integral or connected plunger 10 which extends downwardly through an opening in the base 4 to terminate therebelow in a cross-

shaped member **11**, the underside of the base **4** being recessed to receive the member **11** so that it is normally flush therewith. The plunger **10** and the opening therefor in the base **4** are preferably square to prevent rotation of the button **9**, plunger **10** and member **11**. To guard against the entry of moisture or dust, there is also provided an internal natural or synthetic rubber cover **12** which has a peripheral portion disposed and clamped between the base **4** and flange **7** and a dished central portion immediately under the button **9** through which the plunger **10** is received with a tight fit. A compression spring **13** operates between the base **4** and an inverted cup **14** within the cover **12** and under the button **9** to urge the button **9**, plunger **10** and member **11** upwardly to the position shown in the drawings, which is termed a retracted position. The button **9**, plunger **10** and member **11** can of course be moved downward manually to a depressed or actuated position. A retaining ring **15** is externally threaded on the housing **6** to allow the entire switch to be mounted through a control panel or the like.

Although the actuating head **2** has been shown and described in detail for the sake of completeness, it forms no part of the invention except insofar as it constitutes an actuator that is reciprocally movable in linear fashion. Other types of pushbutton heads could be substituted as could other forms of linear actuators such as a mechanically engageable limit switch plunger, various constructions being well known to those skilled in the art. It is necessary to the invention only that there be some type of actuator with linear movement.

As previously indicated, the head **2** is secured to the case **1** by the bolts **3**, a gasket **15** being interposed and clamped therebetween. The case **1** is preferably formed as two identical facing halves **1'** which are secured together by rivets **17**, the inner face of one half **1'** being shown clearly in FIG. 4. Various openings in the case **1** will be referred to hereinafter, and it will be appreciated that some of these will be formed by providing facing half openings in the portions **1'**. Bores **18** for the bolts **3** are, for example, formed in this manner. The front and rear surfaces of the case **1** are closed off by covers **19** secured thereto by rivets **20**.

Disposed within the case **1** at the front and rear thereof are two parallel, horizontally disposed, spaced apart sealed reed switches **21**. The switches **21** are connected to terminals **22** which extend downwardly and out of the case **1** and are provided with terminal screws **23** for required line connections. The switches **21** are of conventional design and each presents a set of resilient, normally open, magnetically operable contacts. It is of course not necessary that this particular type of switch be used, and other types of magnetically operable contacts may be used.

The case **1** is provided with a central upwardly opening operating bore **24** of generally rectangular cross section. Vertically reciprocally slidably disposed in the bore **24** is a cam member **25**, seen most clearly in FIGS. 4 and 5, which is also of generally rectangular cross section. The vertical edges of the cam **25** are cut away to define guide tracks **26** which terminate short of its lower end. Projections **27** formed on the facing surfaces of the case halves **1'** are received in the tracks **26** to guide the cam **25** in its vertical movement, the projections **27** being engageable with the ends of the tracks **26** to limit upward movement of the cam **25**. When the cam **25** is in the uppermost position allowed by the projections **27**, which is termed a normal position herein and is seen for example in FIG. 2, its upper surface is substantially flush with the upper surface of the case **1**.

As can be seen most clearly in FIG. 3, the upper surface of the cam **25** is engageable by one cross leg of the member **11** so that depression of the button **9** will cause the cam **25** to be moved downwardly in the bore **24**. The case **1** is provided with opposite recesses **28** in its upper surface to receive the other leg of the member **11**, the floors of the recesses **28** serving, in effect, to limit downward movement of the button **9**.

The cam **25** is provided with a vertical cam bore **29** therethrough which is seen most clearly in FIGS. 5 and 6. The bore **29** has what is essentially a keyhole cross section with straight upper and lower portions and facing intermediate circumferential cam surfaces **30** which extend for one quarter of a turn. The appearance of the bore **29** from the top of the cam **25** is shown in FIG. 5, and its appearance from below is the same but reversed. One of the cam surfaces **30** is shown clearly in FIG. 6 and faces upwardly. The other surface **30**, outlined in broken lines in FIG. 5, is opposite and faces downwardly.

Below the cam **25** and between the switches **21** is a cam follower **31**, seen in FIGS. 2 and 4, which is essentially a vertical shaft provided near its upper end with opposite radially extending cylindrical cam pins **32**. The upper end of the follower **31** is received in the bore **29**, the keyhole configuration serving to admit the follower **31** and pins **32**, and the pins **32** are cammingly engageable therein with the cam surfaces **30**. The cam **25** is vertically reciprocally movable with respect to the follower **31**, and a compression spring **33** is interposed between the floor of a recess **34** in the lower surface of the cam **25** around the bore **29** and a radial flange **35** on the follower **31** to urge the cam **25** upwardly.

Below the flange **35**, the follower **31** is provided with a squared shaft portion **36**, and at its bottom end is a bearing portion **37** which is rotatably received in the case **1**. Mounted on the follower **31** at the portion **36** is a permanent operating magnet **38** in the shape of a circular disc, which is preferably provided at its lower surface with a keeper **39**. The magnet **38** should be a ferrite magnet to allow for the establishment of a number of poles as will be described below. The magnet **38** has a central squared opening which receives the shaft portion **36** whereby it is rotatable with the follower **31**. As can be seen in FIGS. 1 and 2, the magnet **38** extends under and lies close to the central portions of the switches **21** at the contacts thereof, the center of the operating magnet **38** preferably being directly in line with the contacts of the switches **21**.

In FIGS. 1 and 2 the actuator, comprising the button **9** and its associated elements, is in a retracted position in which the button **9** is at the top of the housing **6**. The cam **25** is at its normal position at the top of the bore **24**. The follower **31** and magnet **38** are in normal positions of rotation, and the spring **33** is in a normal position in which it is extended. If the actuator is now moved to actuated position by depressing the button **9**, the member **11** will cause the cam **25** to be moved downwardly against the spring **33** to what can be termed an operated position near the bottom of the bore **24**, the spring **33** then also being in an operated position where it is compressed. During this movement, one cam pin **32** will engage and ride along the downwardly facing surface **30** and cause the follower **31**, and the magnet **38**, to rotate through one quarter turn to what are also termed operated positions. Upon release of the button **9** the actuator will return to its retracted position under the influence of the spring **13**. The spring **33** will simultaneously cause the cam **25** to move upwardly to normal position, and during this movement the other cam pin **32** will engage and move along the upwardly facing cam surface **30** to cause the follower **31** and magnet **38** to be rotated back one quarter turn to their normal positions.

A pair of permanent magnets **40**, preferably ferrite bar magnets, are mounted, as by gluing, in the case **1** above and close to the contacts of respective switches **21**. The magnets **40** act as biasing magnets as will be described, and are preferably provided at their upper surfaces with keepers **41**.

The particular embodiment shown provides two normally open switches, and its magnetic operation is illustrated in FIG. 7. As can be seen therein, the bias magnets

40 are placed with their poles across the contacts of the switches 21, the poles of the two magnets 40 being disposed oppositely from one another. The operating magnet 38 is magnetized in what can be termed a quadrantial manner, there being four poles, one in each quadrant, with like poles at diametrically opposite quadrants. When the magnet 38 is in normal position, the poles are located as shown in full lines in FIG. 7. In this position, there are in effect two facing magnets acting on the contacts of each switch 21, the bias magnet 40 that is above it (the magnets 40 being shown to the side in FIG. 7 only for purposes of clarity) and the half of the operating magnet 38 that is under it, the other half of the magnet 38 being too remote to substantially affect operation. For each set of contacts, the facing poles of these two magnets are opposed, there being a south pole of the magnet 38 facing the north pole of the associated magnet 40, and a north pole facing the south pole of the associated magnet 40. The contacts of the switches 21 are of course normally open as is conventional in such switches, and with the magnets 38, 40 in the normal full line position shown the magnetic forces developed tend to force or hold the contacts open.

When the magnet 38 rotates a quarter turn, in either direction, to its operated position, the polarity of the magnet 38 will be as shown in dotted lines in FIG. 7. Like poles of the magnet 38 will then face the poles of the magnets 40 and the resulting magnetic forces will cause both sets of contacts to close. Rotation of the magnet 38 back to normal position will reestablish the full line polarity of FIG. 7, which not only releases the contacts to open of their own resiliency but develops magnetic forces forcing them toward open position to insure a reliable and quick break.

Either or both switches 21 may easily be converted from normally open to normally closed operation simply by reversing the polarity of the associated magnet 40, so that it is possible with the construction shown to provide two normally open switches, two normally closed switches, or one normally open switch and one normally closed switch.

The rotational movement of the operating magnet 38 between normal and operated positions is effected in response to linear movement of the actuator by means of the operating mechanism interposed therebetween which comprises the cam 25, follower 31 and the spring 33, the cam 25 and follower 31 being active in the movement from normal to operated position, and all three elements being active in a return to normal position. This mechanism is both highly effective and relatively simple. It should also be noted that the required quarter turn of the magnet 38 can be effected even where the allowed path of travel of the actuator is quite short by establishing an appropriate slope for the cam surfaces 30, so that the motion of the actuator can in effect be amplified. Although the mechanism shown is highly satisfactory, however, it will be apparent that modifications might be made without departure from the scope of the invention. Other cam connections between the cam 25 and follower 31 are, for example, possible. If desired, the member 11 could be directly connected to the cam 25 whereupon the spring 33 might be eliminated with the spring 13 in effect serving to provide a bias force urging the cam 25 upwardly. The operating mechanism might even be combined more closely by increasing the vertical depth of the button 9 and providing a cam bore therein for the follower 31, whereupon the button would serve as a cam as well as an element of the actuator.

Similarly, and although the version shown is particularly useful, variations in use are possible within the scope of the invention. As previously indicated, the invention is applicable to devices other than the pushbutton switch shown. If desired, the same arrangement could of course be used with only one set of contacts. For operation with either one or two sets of contacts it would be possible to omit the magnets 40 and provided a bar or circular magnet like the magnet 38 but with only two poles which would be lined up transverse to the contacts in normal position and across the contacts in operated position, or vice versa.

In view of the possible modifications, it is not intended that the invention be limited by the specific showing herein, or in any other way, except insofar as limitations appear specifically in the following claims.

We claim:

1. In a device having (a) an actuator movable in linear fashion between retracted and actuated positions, (b) a set of magnetically operated contacts, (c) an operating magnet that is rotatable between normal and operated positions with respect to the contacts, and (d) an operating mechanism interposed between the actuator and the magnet to effect rotational movement of the magnet in response to linear movement of the actuator, said operating mechanism including (i) a cam that is movable in linear fashion between normal and operated positions and that is engageable by the actuator to be moved to operated position as the actuator moves to actuated position, (ii) a follower which mounts the operating magnet for movement therewith and has a cam connection with the cam to be moved rotationally to bring the operating magnet to operated position in response to linear movement of the cam to operated position, and (iii) bias means to move the cam to normal position when the actuator moves to retracted position, the improvement wherein: there is a case provided with an operating bore; and the cam is reciprocally slidably disposed in the operating bore and is provided with a cam bore therethrough presenting a cam surface; and the follower comprises a shaft rotatably mounted in the case that includes a portion received in the cam bore and presents a cam pin engageable with the cam surface to effect rotation of the follower in response to sliding movement of the cam in the operating bore.

2. The combination of claim 1 wherein the cam bore presents opposite upwardly and downwardly facing inclined cam surfaces, and the follower is provided with two opposite cam pins, one cam pin being engageable with one cam surface to effect rotation of the follower in one direction as the cam moves in one direction, the other cam pin being engageable with the other cam surface to effect rotation of the follower in the other direction as the cam moves in the other direction.

3. In a device having an actuator movable in linear fashion, a set of magnetically operable contacts, an operating magnet that is rotatable between normal and operated positions with respect to the contacts, and an operating mechanism interposed between the actuator and the magnet to effect rotational movement of the magnet in response to linear movement of the actuator, the improvement wherein: there is a bias magnet with its poles across the contacts; and the operating magnet is polarized to have poles across the contacts that face the poles of the bias magnet, the facing poles of the two magnets being the same when the operating magnet is in one of its positions and opposite when the operating magnet is in its other positon.

4. In a device having an actuator movable in linear fashion, a set of magnetically operable contacts, an operating magnet that is rotatable between normal and operated positions with respect to the contacts, and an operating mechanism interposed between the actuator and the magnet to effect rotational movement of the magnet in response to linear movement of the actuator, the improvement wherein: there are two sets of contacts; and there is a pair of bias magnets, one bias magnet being associated with each set of contacts with its poles across the contacts; and the operating magnet has its center in alignment with and between the sets of contacts and is quadrantially magnetized to present two opposite poles across each set of contacts; and the operating magnet makes a

quarter turn in its movement between normal and operated positions, such quarter turn movement serving to reverse its poles across each set of contacts.

References Cited

UNITED STATES PATENTS

2,195,237	3/1940	Bryant et al.	200—156
2,548,581	4/1951	Bigelow	200— 67 X
3,170,052	2/1965	Hajos	335—207
3,328,732	6/1967	Palmer	335—205

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