

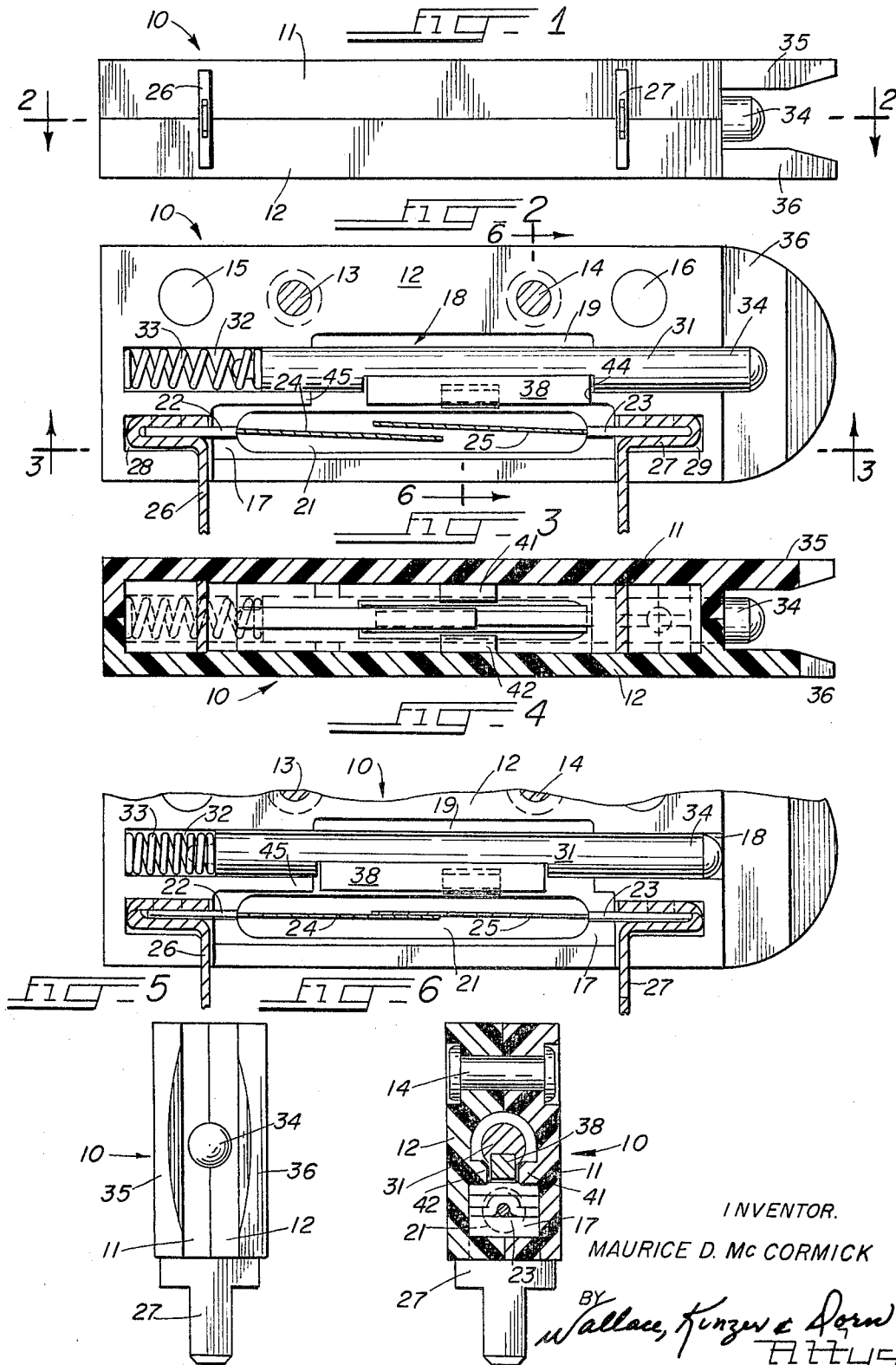
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PLUNGER OPERATED MAGNETIC REED SWITCH

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3,271,708 PLUNGER OPERATED MAGNETIC REED SWITCH

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This invention relates to a new and improved switching device and more particularly to a small, compact switching device capable of many thousands of operations without requiring replacement or maintenance.

There are numerous applications requiring small switching devices capable of repetitive operation over long periods of time without necessitating replacement or maintenance. For example, in many machines it is necessary to provide limit switches or similar sensing devices for detecting movements of elements of the machines. In many cases, the space available for the switches is limited and they must be restricted to maximum dimensions of the order of one inch or less. In other applications, such as automatic business machines and the like, sensing and actuating switches may be required which can be fitted in the spaces in compact and crowded keyboard mechanisms and the like.

In the past, a variety of different mechanical switch movements have been used for these applications. The best of these mechanical switches are capable of as many as one hundred thousand repetitive operations without failure. However, with the toggle mechanisms most prevalent in such switching devices, it is not reasonably possible to extend the switch life beyond this range without the danger of failure due to fatigue or to other manifestations of mechanical wear.

Another form of switching device that has seen some use in related applications is the magnetically actuated reed switch. A switch of this kind is generally constructed in the form of a pair of aligned contact reeds, of magnetic material, disposed within a sealed glass envelope or like container. The contact reeds are so aligned that they are normally not engaged with each other; closing of the switch is effected by developing a magnetic field that encompasses both reeds and causes them to be attracted to each other. Where switches of this kind are electrically controlled, they are of quite compact construction since the requisite magnetic field can be developed by an electrical coil wound in encompassing relation to the basic switch. These devices have been substantially less attractive for applications requiring magnetic actuation, however, because the actuating mechanisms, using permanent magnets, that have been previously available tend to be relatively bulky and expensive. Reed switches of this kind, in the switching mechanism itself, will last almost indefinitely and are good for literally millions of operations without failure.

It is a principal object of the present invention, therefore, to afford a new and improved switching device that is compact and inexpensive yet capable of operation through a million or more switching cycles without mechanical or electrical failure. Stated differently, it is an object of the invention to provide a new and improved switch construction that realizes the essential advantages of both the mechanical and magnetic switching devices previously available in the art without incurring the difficulties and disadvantages heretofore associated with such devices.

A particular object of the invention is to provide a new and improved magnetic reed switching device that consists primarily of a simple magnetic reed switch, a plunger, a permanent magnet, and an inexpensive housing.

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A further object of the invention is to afford a new and improved magnetic reed switching device that is readily adaptable for use as an actuating switch in business machines and like applications and is equally suitable for use as a limit switch or the like in other applications.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

In the drawings:

FIG. 1 is a bottom view of a switching device constructed in accordance with one embodiment of the present invention;

FIG. 2 is a sectional elevation view taken approximately along line 2-2 in FIG. 1;

FIG. 3 is a sectional view taken approximately along line 3-3 in FIG. 2;

FIG. 4 is a sectional elevation view similar to FIG. 2 but illustrating the switch mechanism in a different operating position;

FIG. 5 is an end elevation view of the plunger end of the switching device; and

FIG. 6 is a transverse sectional elevation taken approximately as indicated by line 6-6 in FIG. 2.

The switching device 10 shown in FIGS. 1 through 6, which comprises a preferred embodiment of the present invention, includes a molded plastic housing formed in two complementary half-sections 11 and 12. The two complementary halves of the housing are fitted together and are secured to each other by suitable means such as a pair of studs, bolts, or like fasteners 13 and 14, as best illustrated in FIGS. 2 and 6. Suitable apertures 15 and 16 may be provided in the housing members 11 and 12 to afford a means for mounting the switching device 10 in operative position as required.

The two complementary mating halves 11 and 12 of the switch housing are molded with internal cavities which, when the halves are mounted on each other, afford an elongated switch chamber 17 (FIGS. 2-4 and 6). The two halves of the switch housing are also provided with internal cavities which, when the housing is assembled, define an elongated plunger chamber 18. The plunger chamber 18 is axially aligned with the switch chamber 17 and is disposed in contiguous relation thereto. The plunger chamber 18 is provided with an enlarged central portion 19 that extends into and constitutes a continuation of the switch chamber 17.

A magnetically actuatable reed switch 21 is mounted within switch chamber 17 inside the housing of switch 10. Switch 21 is shown in solid lines in FIGS. 2 and 4 and the outline of the switch is shown in dash lines in FIGS. 3 and 6. Switch 21 is of conventional construction. It comprises an elongated envelope of glass or other insulator material having two conductive connectors 22 and 23 projecting from the ends of the envelope. Within the switch envelope, the conductors 22 and 23 are electrically connected to a pair of resilient magnetic contact reeds 24 and 25 that extend inwardly of the envelope into overlapping relation with each other. The construction of reeds 24 and 25 is such that, in the absence of an external magnetic field, the two reeds are spaced from each other, this condition being illustrated in FIG. 2. However, the switch 21 can be actuated from its open condition, as illustrated in FIG. 2, to a closed condition in which the reeds 24 and 25 contact each other in re-

sponse to the presence of a magnetic field in given alignment with the reeds, this condition being illustrated in FIG. 4.

A first terminal member 26 is mounted within a small cavity 28 at the left-hand end of the switch chamber 17, as viewed in FIG. 2, terminal member 26 projecting through a small aperture outwardly of the switch housing. A similar terminal member 27 is disposed within a small cavity 29 at the opposite end of the switch chamber, terminal 27 also extending outwardly of the switch housing. Terminal members 26 and 27 are employed to connect an external electrical circuit to switch 21. Thus, the conductive connector 23 that projects from the right of switch 21 extends into a slot or socket in terminal member 27 and is engaged therein in electrical contact as shown in FIGS. 2 and 6. Similarly, terminal member 26 is electrically connected to the conductive connector 22 at the left-hand end of switch 21.

A non-magnetic plunger 31 is mounted within plunger chamber 18. Plunger 31 is preferably constructed from non-magnetic stainless steel; however, other non-magnetic metals or non-metallic plunger structures may be used if desired. A compression spring 33 is disposed in the left-hand end 32 of plunger chamber 18, affording a biasing means biasing plunger 31 to the right as seen in FIG. 2. At the right-hand end of the plunger chamber, the tip portion 34 of the plunger projects outwardly of the switch housing. In the illustrated construction, the plunger tip 34 is located between a pair of protective projections 35 and 36. This construction may be utilized in actuating switches where it is desired to limit access to plunger tip 34 to a given external actuator. In other applications, as in limit switches or the like, the protective members 35 and 36 may be omitted.

The central portion of plunger 31 is provided with a longitudinally extending slot or aperture within which a permanent magnet 38 is mounted. As best shown in FIG. 6, the magnet 38 may be of rectangular cross-sectional configuration and projects downwardly from the plunger into close proximity to switch 21. Permanent magnet 38 is magnetized in a longitudinal direction but the polarization of the magnet is immaterial; that is, the right and left-hand ends of magnet 38 may be north and south poles respectively or the polarization may be reversed.

Switching device 10 further includes guide means for preventing rotation of plunger 31. In the illustrated embodiment, this guide means comprises a pair of projecting lugs 41 and 42 formed internally of housing members 11 and 12 respectively and projecting inwardly toward the side walls of permanent magnet 38 (see FIGS. 3 and 6). The guide lugs 41 and 42, by preventing rotational movement of the plunger assembly comprising plunger 31 and permanent magnet 38, maintain the magnet in alignment with and in close proximity to the switch 21.

The right-hand wall 44 of the enlarged central portion 19 of plunger chamber 18 constitutes a stop member positioned to engage the right-hand end surface of permanent magnet 38 when plunger 31 is urged outwardly of the plunger chamber by the action of biasing spring 33. Thus, the engagement of stop member 44 with the end wall of permanent magnet 38 effectively limits movement of the plunger assembly comprising plunger 31 and permanent magnet 38 and thereby defines a first operating position for the plunger. Similarly, the left-hand end 45 of the enlarged central portion of the plunger chamber affords a stop member positioned to engage the left-hand end surface of the permanent magnet to define a second operating position for the plunger when the plunger is forced inwardly of chamber 18 against the bias of spring 33. Stop member 45 may be positioned to leave a minimal space between the stop member and the end of permanent magnet 38 when plunger 33 is depressed just within the confines of chamber 18 as shown in FIG. 4.

With this construction, stop member 45 is not ordinarily used but is available to limit movement of the plunger assembly in the event that plunger 31 is pushed further into the plunger chamber.

In the illustrated embodiment, switch 21 is a normally open switch that can be actuated to closed condition in response to the magnetic field from permanent magnet 38. Permanent magnet 38 is always located adjacent switch 21. With plunger 31 at the right-hand limit of its movement, and with the tip 34 of the plunger projecting outwardly of the switch housing, however, the position of the permanent magnet is such that the overlapping portion of contact reeds 24 and 25 is at the edge of the magnetic field. Under these circumstances, the magnetic field is not strong enough to pull reeds 24 and 25 into contact with each other. Depending upon the strength of the magnetic field from permanent magnet 38, it may be necessary to locate the overlapping portions of the reeds 24 and 25 further to the left and thus further beyond the main portion of the permanent magnet field. In general, however, by proper selection of the permanent magnet it is possible to allow some overlap of the magnet with respect to the overlapping portions of the reed contacts.

To close the switch, plunger projection 34 is pushed inwardly of the switch housing to the position shown in FIG. 4. As shown therein, the overlapping portions of the two contact reeds 24 and 25 are now centrally aligned with respect to permanent magnet 38. Thus, the reeds are fully within the magnetic field of the magnet so that the magnetic field is able to pull the two contacts together and close the switch. The closing of the switch is a rapid, positive action; on the other hand, when plunger tip 34 is released and the plunger is returned to its original position in response to the biasing spring 33, opening of the switch is essentially equally instantaneous.

In its illustrated form, switch 10 is a normally open switch that is closed by movement of plunger 31 from its initial operating position (FIG. 2) to its second operating position, (FIG. 4). By utilizing a reed switch 21 having the overlapping portion of the reeds located near the right-hand end of the switch envelope, however, the device may be arranged to be normally closed, since the reeds would then be centrally positioned with respect to the magnetic field of permanent magnet 38. With this relatively minor modification of the switch structure, movement of the plunger 31 to its second operating position would be effective to shift the permanent magnet out of alignment with the contact reeds of the switch and thereby permit the switch to open.

The compression spring 33 affords a biasing arrangement that provides for momentary-contact operation of switching device 10. Thus, whenever tip 34 of plunger 31 is released, the switching device plunger immediately returns to its initial operating position and the switch is thus returned to its normal or initial operating condition, whether open or closed. A maintained-contact switch structure, however, can easily be constructed with the same basic mechanism. Thus, spring 33 may be replaced by a retained-position spring mechanism of the kind commonly employed in ballpoint pens or the like so that plunger 31, once depressed, remains in its second operating position within the switch housing until depressed a second time. Inasmuch as retained-position biasing mechanism of this kind are well known in the art, a mechanism of this type has not been illustrated in the drawings.

Switching device 10 may be made quite compact in size; for example, in one switch intended for use in business machines and specifically in an automated typewriter system, the overall length of the switch housing is less than one and a half inches and can be reduced further if required. The switching device is quite simple and inexpensive in construction and is inherently less expensive than either the toggle mechanisms frequently used

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for switches of comparable size in the art or the operating mechanisms for permanent magnet actuated reed switches as heretofore known. Moreover, the switching device 10 is capable of repetitive operation literally millions of times without requiring service or replacement. 5

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

I claim:

A switching device comprising:

a two-piece molded plastic housing having aligned, substantially totally enclosed, contiguous switch and plunger chambers formed between the two halves of the housing; 10

a magnetically actuatable switch mounted in said switch chamber and having at least two electrically conductive leads, said switch being actuatable between first and second operating conditions in response to the presence and absence of a magnetic field in given alignment therewith; 15 20

at least two spring clip electrical connectors, one for each switch lead mounted in said switch chamber and projecting outwardly thereof;

a plunger assembly comprising a non-magnetic plunger mounted in said plunger chamber for axial movement therein between first and second operating positions, said plunger projecting outwardly of one end of said chamber; 25

said plunger assembly further comprising a permanent magnet mounted on said plunger in position to actuate said switch, through the field of said magnet, between its first and second operating conditions in 30

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response to movement of the plunger between its first and second operating positions;

biasing means normally maintaining said plunger in its first operating position, said biasing means comprising a compression spring mounted in the end of said plunger chamber opposite said one end and biasing said plunger toward said one end;

and a pair of stop members in said housing adjacent opposite ends of said plunger assembly, positioned to engage complementary stop surfaces on said plunger assembly to limit axial movement of said plunger assembly, thereby defining the limits of said first and second operating positions for said plunger, said switch, said connectors and said plunger assembly all being mounted first in one half of the housing and being secured therein upon mounting of the second half of the housing on said one half.

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