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3,273,091

HERMETICALLY-SEALED MANUALLY-ACTUATED MAGNETIC SNAP SWITCH

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2 Sheets-Sheet 1

Fig. 1.

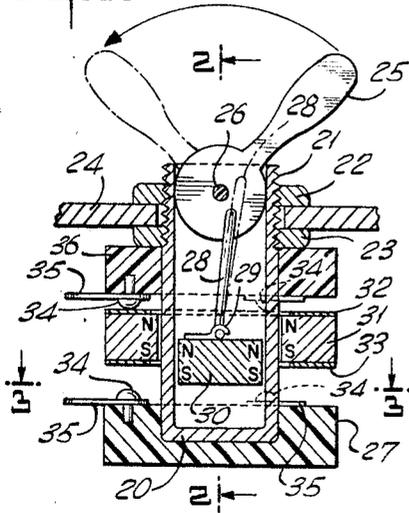


Fig. 2.

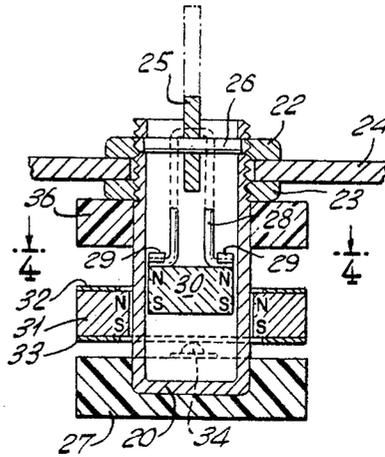


Fig. 3.

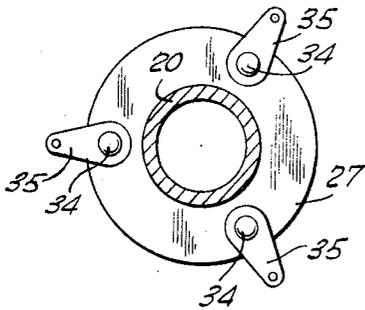


Fig. 4.

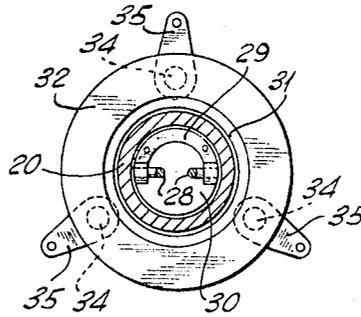
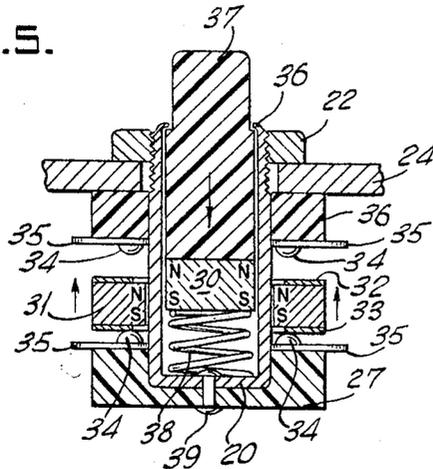


Fig. 5.



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2 Sheets-Sheet 2

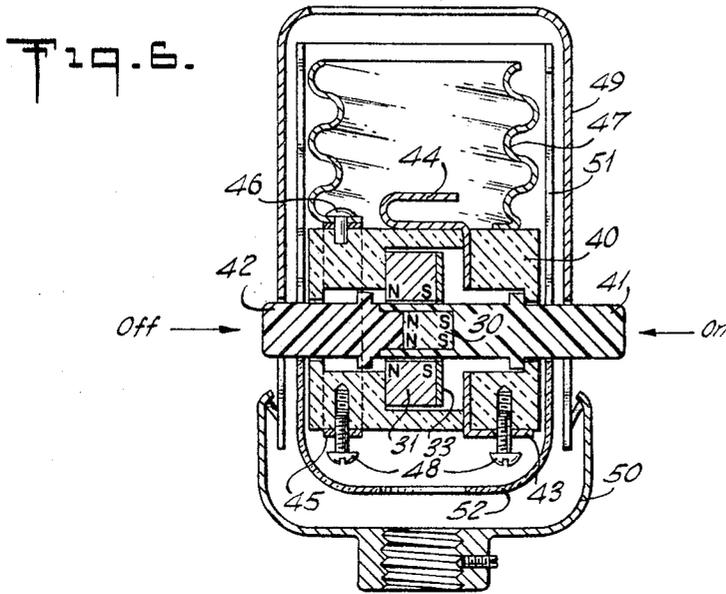


Fig. 7.

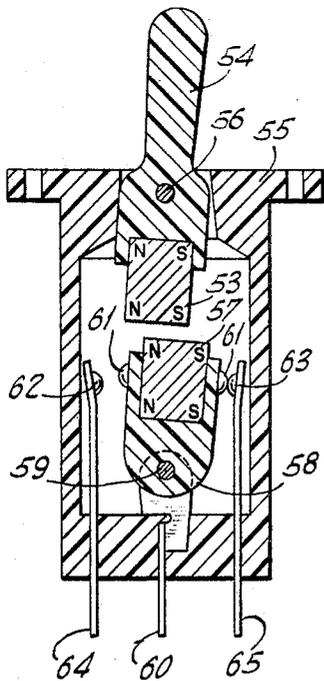
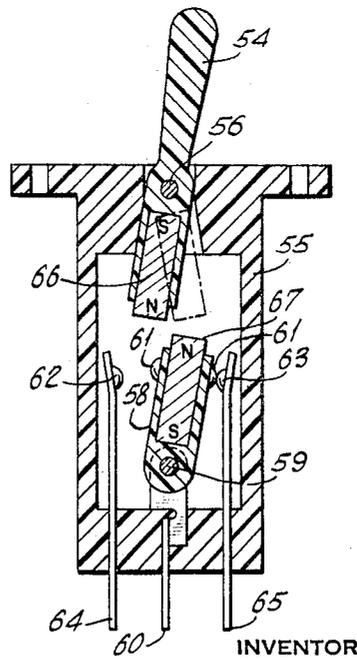


Fig. 8.



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HERMETICALLY-SEALED MANUALLY-ACTUATED MAGNETIC SNAP SWITCH

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2 Claims. (Cl. 335-207)

This invention relates to a snap action switch in which repulsive magnetic fields are made to provide a bistable positioning force for an electrical switching member.

The foregoing switching principle permits a switch design which is totally hermetically sealed because the use of magnetic repulsive forces to position the switch allows these forces to pass through an hermetically impervious barrier wall separating a manual control member from the switching contacts.

A feature of this invention is that the transition from one stable switching position to the other is extremely abrupt due to the absence of friction in the opposing magnetic force fields. Consequently it is not possible to "tease" or "hang up" such a snap switch in any intermediate position. This reduction in friction also greatly extends the expected life of such a switch.

In a preferred form of this switch the magnetic positioning forces are arranged to be divided so that a common electrical shorting member is pressed equally on to three insulated contact buttons. This versatile switching capability is especially useful where it is desired to isolate several electrical circuits until the switch shorts them together.

This invention teaches the application of this magnetic repulsion configuration to several types of snap switches including: toggle, push button, and reciprocating types of switches.

The principal object of this invention is to provide a simple, reliable, and durable design of electric switch which will permit hermetically sealed construction, together with ease and precision of operation.

Another object of the invention is to provide a switch design which avoids friction and wear by the use of mutually repulsive magnetic fields to position the switching member.

Still another object of the invention is to provide springless contacts for the switching art.

A further object of the invention is to provide a snap action switch in which bistable operation results from the interaction of the opposing magnetic leakage fields from two ceramic permanent magnets having high coercive forces.

A still further object of the invention is to provide a design of magnetically actuated switch which will not hesitate or hang up in an intermediate position.

For other objects, and a clearer understanding of the subject invention, reference is made to the following detailed specifications to be taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a transverse view of a first hermetically sealed toggle switch design, incorporating the magnetic repulsion principle of the invention;

FIGURE 2 is a view through the plane 2-2 of FIGURE 1 but taken with the toggle in the dotted line position of FIGURE 1;

FIGURE 3 is a view through the plane 3-3 of FIGURE 1;

FIGURE 4 is a view through the plane 4-4 of FIGURE 2;

FIGURE 5 is a transverse view through a push button form of the invention using a return spring;

FIGURE 6 is a transverse view through a light bulb socket switch form of the invention;

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FIGURE 7 is a transverse view through a second toggle switch form of the invention; and

FIGURE 8 is a transverse view through a third toggle switch form of the invention.

Referring to FIGURES 1 through 4, 20 is a non-magnetic thin walled tube closed at one end and provided with a thread 21 at the other end. Nuts 22 and 23 secure tube 20 to a panel 24 in a convenient one hole mount.

Two insulating disks 27 and 36 are rigidly secured to tube 20 in spaced relation, and each said disk is provided with three coplanar buttons 35 and corresponding connecting lugs 35 each secured to their disk at equally spaced positions on a circle concentric with tube 20.

In the annular space between disks 27 and 36, there is moveably located an annular permanent magnet 31, preferably made of a non-conductive ceramic material of great magnetic coercive force, such as "Indox."

Magnet 31 is magnetized parallel to its annular axis so that as seen in figure one the upper face is a north pole and the lower face is a south pole. There is enough clearance between ring magnet 31 and tube 20 so that the former can slide freely in axial translation.

Magnet 31 is provided with, two thin electrically conductive (i.e., silver plated brass) washers 32 and 33 secured to the opposite faces thereof such as by cementing.

Consequently, if enough downward force (FIGURE 2) is applied to magnet 31, it and contact ring 33 will move downward to rest on and electrically connect together the three contact buttons 34 on disk 27, whereas if enough upward force (FIGURE 1) is applied to magnet 31, it will carry contact ring 32 upward to the position shown in FIGURE 1 where it is shorting together the three contact buttons 34 carried by disk 36. Since three points geometrically define a plane, it is assured that each group of three buttons 34 will be positively inter-connected when the appropriate axial magnetic force is acting on magnet 31.

A second high coercive force permanent magnet 30 is slideably mounted inside tube 20, in the form of a cylinder having the same height as annular magnet 31, and having the same polarity of axial magnetization so that its upper face (FIGURE 1) is a north pole and its lower face is a south pole.

A hinge plate 29 is secured by cementing to magnet 30 so as to form a journal for the inverted U shaped link member 28, which is formed out of wire, and which by passing through an eccentric hole in a toggle handle member 25, links together magnet 30 with handle 25. Handle 25 is journaled with respect to tube 20 by the diametrically located pin 26, so that toggle handle 25 effectively forms a bell crank whose motion from the solid line position of FIGURE 1 to the dotted line position will correspondingly cause magnet 30 to move axially from its position in FIGURE 1 to its position in FIGURE 2.

In the position of concentric magnets 30 and 31 shown in FIGURE 1, the proximity of the like north and south poles through tube 20 causes them to mutually repel one another, so that there is a strong upward force on magnet 31 pushing ring 32 into positive contact with the contact buttons 34 of ring 36, while there is a strong downward force on magnet 30 tending to force bat handle 25 into its limiting clockwise position through link 28.

If the foregoing repulsive force is overcome by the manual forcing of handle 25 in the counter-clockwise direction from its position in FIGURE 1, the contact pressure will first increase until magnets 30 and 31 are coplanar, whereupon there will be an abrupt reversal in the axial direction of the forces of mutual repulsion between magnets 30 and 31, and annular switching member magnet 31 will rapidly snap into its lower position of FIG-

FIGURE 2. Concurrently, the force on magnet 30 will change to an upward force tending to bias handle 25 to the dotted counter-clockwise position of FIGURE 1.

In designing such a switch, the required open contact gap, and the required contact pressure will determine the proper choice of magnet thickness and diameter, respectively.

Since shell 20 is a closed tube, this switch may be made to be hermetically sealed with respect to panel 24, by properly sealing the joint between 24 and tube 20 with suitable flanges and gaskets well known to the art.

It is to be noted that in the foregoing construction the inside surface of tube 20 forms a constraint for magnet 30 which limits its movement to a specific linear trajectory, while the outside of tube 20 forms a constraint for magnet 31 which limits its movement to a different and shorter linear trajectory. These two limited trajectories over which the poles of the two magnets may move are so related that there can be a point of closest approach of the repelling poles of like polarity at each end of the trajectory of magnet 31. Further, due to the fact that the trajectory of magnet 30 is greater than that of magnet 31, the continued motion of magnet 30 past the region of closest approach will cause the abrupt reversal of force on magnet 31 which is responsible for the snap action of this device.

Also, in addition to the linear constraint provided by tube 20, the ends of the shorter trajectory of the driven magnet 31 are limited by the contact buttons 34, while the ends of the longer overlapping trajectory of magnet 30 is limited by the intersection or abutment of handle 25 against the outer end of tube 20. It is the relative positioning of the end stops which guarantees the overlap of the driving trajectory of magnet 30 at each end of the driven trajectory of magnet 31.

Referring now to the push button switch of FIGURE 5, it may be seen that this design is substantially identical to that of FIGURE 1 except for the substitution of a non-magnetic push button member 37 in place of parts 25, 26, 28, and 29 and for the addition of non-magnetic return spring 38, and assembly rivet 39.

Push button 37 is retained within tube 20 by a rolled-over lip 36.

The magnetic operation of the switch of FIGURE 5 is identical to that of FIGURE 1, the only difference being in the mechanical substitution of the opposing forces supplied by spring 38 and button 37 for the tensile and compressive forces, respectively, in link 28.

Referring to the lamp-socket switch shown in FIGURE 6, a plastic insulating moulded body 40 is provided with cavities which retain and guide the two mutually repulsive permanent magnets 30 and 31 whose functions are the same as in the foregoing switches. Inner cylindrical magnet 30 is contained within and secured to a first "on" push button non-magnetic member 41. A second "off" push button non-magnetic member 42 is in turn secured to member 41, so that parts 30, 41 and 42 form an integral sliding magnetic switch control. Annular outer magnet 31 is slideably mounted on the sleeve portion of "on" button 41 so that when button 41 is depressed it will cause magnet 31 with its attached contact ring 33 to snap to the right, thereby contacting and completing the circuit between a lower metal line lug 43 and an upper bulb contact metal lug 44, both of which are secured to the body 40. A second line lug 45, also secured to body 40, connects one side of the line to a female lamp screw shell 47 to which lug 45 is secured by a rivet 46. Lugs 43 and 45 are provided with line terminal screws 48.

The outer casing consists of upper shell 49 and lower shell 50 which are insulated from the inner parts by fiber shells 51 and 52 respectively.

When the "off" button 42 is depressed the ring magnet 31 then snaps to the position shown in FIGURE 6, thereby opening the circuit between lugs 43 and 44.

Referring to the toggle switch design of FIGURE 7 it may be seen that the foregoing magnetic repulsion over

center principle has been incorporated by mounting a first permanent ceramic magnet of high coercivity in the form of a rectangular parallelepiped on a toggle handle 54 which is pivoted on an insulating case 55 by means of a pin 56. A second permanent magnet 57, which may be identical to magnet 53, is secured to a conductive switching member 58 which in turn is pivoted relative to case 55 by a conductive pin 59.

Pin 59 is journaled in a metal lug bracket 60 secured to case 55. Switching member 58 is provided with switching contact buttons 61 one of which can contact either a stationary contact button 62 or a button 63, which are mounted on contact lugs 64 and 65 respectively.

The magnetization of magnets 53 and 57 is in a direction parallel to the adjacent faces of these magnets, and of a polarity such as to cause like repulsive poles to be closest to one another.

Under these circumstances the mutual repulsion between magnets 53 and 56 gives the handle 54 a clockwise biasing torque in the position shown in FIGURE 7, while at the same time providing also a clockwise biasing torque on switching member 58 thereby pressing together contact buttons 61 and 63. The foregoing magnetic repulsion force also has a component which radially loads bearing pin 59 for better electrical contact.

As handle 54 is moved to the opposite or counter-clockwise position from that shown in FIGURE 7, the repulsive force vector between the adjacent poles of magnets 53 and 57 will approach parallelism with the plane containing parallel pins 56 and 59. At the instant that this parallelism is exceeded the biasing torques on members 54 and 58 will abruptly reverse, and switching member 58 will rapidly rotate counter-clockwise until closure between contacts 61 and 62 has been made.

Conversely, the reverse action of handle 54 will return member 58 to the position shown.

FIGURE 8 discloses a variation of the design of FIGURE 7 in which handle 54 has been secured to it an elongated ceramic magnet 66 of high coercivity, while switching rotor 58 has a similar magnet secured to it so that the elongated ends of magnets 66 and 67 are closely adjacent to one another. As in the previous designs disclosed, the magnetization of magnets 66 and 67 is in a direction parallel to one another and of a polarity such that like or repulsive poles are adjacent to one another. However, with the geometry shown in FIGURE 8 only one pole in each magnet furnishes the dominant repulsive force.

In the toggle switches of FIGURES 7 and 8, the handle 54 and pivot 56 form the restraint which limits the motion of either magnet 53 or 66 to its arcuate trajectory, while the member 58 and pivot 59 form the restraint which limits the motion of either magnet 57 or 67 to its arcuate trajectory. Similarly, the contacts 62 and 64 form the end constraints of the driven magnet's shorter trajectory, while the intersection of handle 54 with the case 55 forms the end constraints of the driving magnets longer overlapping trajectory.

What is claimed is:

1. A switch comprising:

- a cup of non-magnetic material;
- a first permanent magnet moveably located within and guided by the wall of said cup;
- a second moveable permanent magnet surrounding and guided in motion by the wall of said cup;
- said first and second magnets being each magnetized parallel to the axis of said cup and in the same direction of polarization;
- a bell crank pivoted on an axis transverse to said cup-axis;
- link means connecting one of said permanent magnets and said bell crank;
- displacement means comprising said bell crank and link to move one of said magnets through a first translational actuating displacement parallel to the axis of said cup;
- stop means to limit the motion of the other of said mag-

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nets to a second translational actuated displacement less in magnitude than and positioned to be within the first translational displacement; and said stop means comprising switch contacts for at least one end of said second displacement.

2. A switch comprising:

- a cup of non-magnetic material;
- a first permanent magnet moveably located within and guided by the wall of said cup;
- a second moveable permanent magnet surrounding and guided in motion by the wall of said cup;
- said first and second magnets being each magnetized parallel to the axis of said cup and in the same direction of polarization;
- a push button guided for motion parallel to the axis of said cup and bearing on the actuating one of said magnets;
- a spring bearing on the face of said actuating magnet opposite from said push button;
- displacement means comprising said push button and said spring to move one of said magnets through a

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first translational actuating displacement parallel to the axis of said cup;

stop means to limit the motion of the other of said magnets to a second translational actuated displacement less in magnitude than and positioned to lie within the first translational displacement; and said stop means comprising switch contacts for at least one end of said second displacement.

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