United States Patent

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[33] **Japan**
[31] **44/90181**

[54] **ELECTRIC PUSHBUTTON SWITCH**
7 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **335/2,** 335/205, 335/207
[51] **Int. Cl.** **H01h 3/00**
[50] **Field of Search** 200/63; 335/2, 209, 205, 206, 207

[56] **References Cited**

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ABSTRACT: A pushbutton switch comprising a casing and a base mounted therein for relative movement. The base has thereon a submagnetic pole plate and a Hall element for electrical connection to a switching element. A magnet is mounted in the casing in radial alignment with the Hall element and the pole piece whereby, upon relative movement between the casing and the base, the polarity of the voltage across the Hall element is varied to thereby actuate the switching element. A second magnet is mounted on the base in axial alignment with the first magnet so as to normally hold the latter and the casing floating in the air by virtue of the magnetic repulsing force.

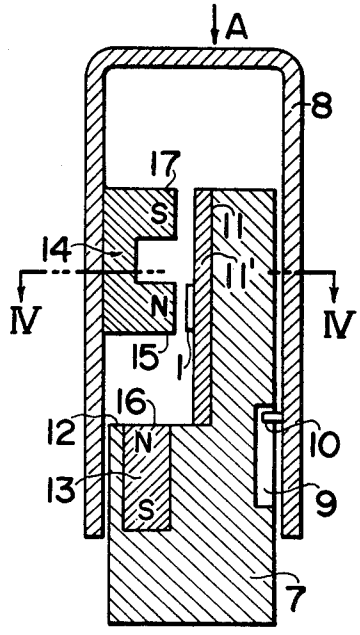


FIG. 1

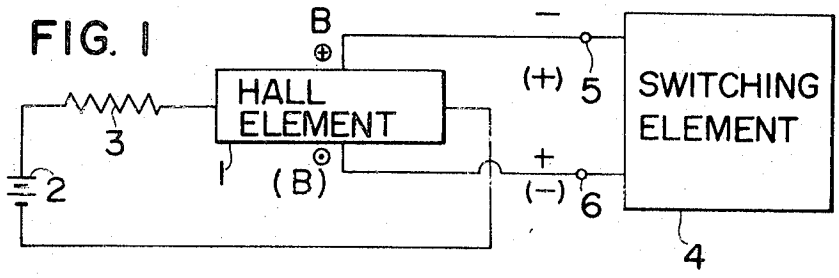


FIG. 2

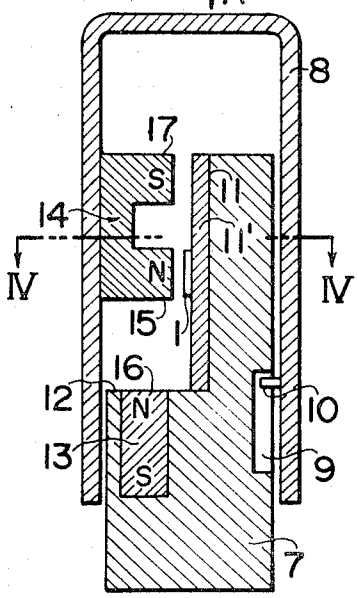


FIG. 3

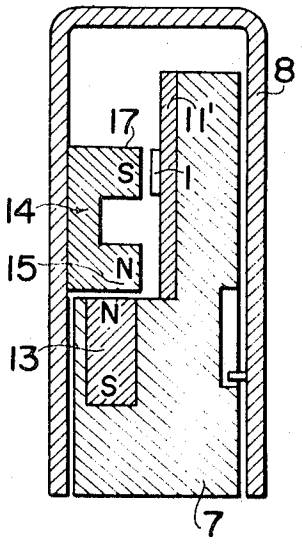
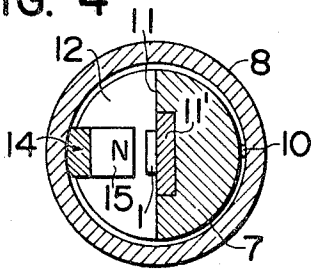


FIG. 4



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ELECTRIC PUSHBUTTON SWITCH

Background of the Invention

The present invention relates to an electric switch and, more particularly, to a contactless electric pushbutton switch adapted for use with a switching element such as a thyristor or a transistor.

A conventional electric pushbutton switch usually employs a pair of contacts which are liable to become damaged in relatively shorter operative time for the reasons self-explanatory to those skilled in the art. It is, therefore, a primary object of the present invention to provide a contactless electric pushbutton switch.

Nowadays, a Hall element is well known to have such an operative characteristic that the polarity of the electrical voltage across the element is varied with the variation in the polarity of the magnetic field applied to the element. It is, therefore, a secondary object of the present invention to provide a contactless electric pushbutton switch which utilizes such characteristic of a hall element.

It is a further object of the present invention to provide a contactless electric pushbutton switch of the class specified in the preceding paragraph and which utilizes a simple arrangement so as to cause the Hall element to perform such characteristic as above stated.

It is a still further object of the invention to provide a pushbutton switch of the class which is specified in the above and which does not necessarily require mechanical biasing means such as a spring so as to automatically restore, after each depression or actuation, the switch to its initial position.

SUMMARY OF THE INVENTION

According to the present invention, there is provided an electric pushbutton switch comprising a first member, a second hollow member receiving said first member for relative sliding movement between first and second positions, magnet member mounted on one of said first and second members, a submagnetic pole plate mounted on the other of said first and second members is opposite relationship to said magnet member, said submagnetic plate having a Hall element mounted on the surface thereof facing said magnet member, said Hall element having its terminals adapted to be electrically connected to a switching element, and means for normally holding said one member and said magnet member in said first position, the arrangement being such that, when said one member is in said first position, one of the magnetic poles of said magnet member is positioned in opposite relationship to said Hall element and, when said one member is moved against said holding means to said second position, the other magnetic pole of said member is positioned in front of said Hall element.

Preferably, the said holding means may be a second magnet member mounted on the said the other member in axial alignment with the first said magnet member. The first and second magnet members may advantageously be so arranged that the poles of both magnet members which are disposed in facing relationship to one another are of the same polarity so that the repulsing force therebetween is operable to normally hold said one member and said first magnet member in said first position. The submagnetic plate may advantageously extend the entire distance over which the first magnet member is reciprocally moved relative to the Hall element for the reason which will become apparent later. The relative movement between the first and second members is guided and limited by guide means which may preferably comprise a projection on one of the first and second members and an elongated groove formed in the other of the members, the projection being engaged in said groove for relative sliding movement. The said first member may be a base or a holder having an axial flat surface on which the submagnetic plate and the Hall element are mounted and a transverse flat surface or a shoulder to which the second magnet member is secured. The said second member may be a substantially cylindrical casing having a closed top and adapted to be pressed down for the actuation of the pushbutton switch, an opened bottom end through which the base extends outwardly when the casing is in its said second position, and an inner surface on which the first magnet is mounted in axial alignment with the second magnet member.

The above and other objects and features of the present invention will become apparent from the following description of a preferred embodiment of the invention with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a circuit diagram illustrating the principle of the present invention;

FIG. 2 is a longitudinal sectional view of an embodiment of the electric pushbutton switch according to the present invention;

FIG. 3 is a similar view to FIG. 2 but illustrating the components of the switch in different or moved positions; and

FIG. 4 is a cross-sectional view of the switch taken along line IV—IV in FIG. 2.

DESCRIPTION OF A PREFERRED EMBODIMENT

Reference will be made first to FIG. 1 of the drawings showing a circuit diagram which illustrates the principle of the present invention. The circuit shown includes a Hall element 1, a power source 2 and a resistor 3. A switching element 4, such as a transistor or thyristor, is electrically connected to the Hall terminals of the Hall element 1. With this arrangement, when a magnetic field B is applied from above the surface of the drawings perpendicularly down to the Hall element 1, the latter is actuated to feed a negative voltage to an input terminal 5 of the switching element 4 while a positive voltage is fed to the other input terminal 6 of the element 4. On the other hand, if a magnetic field B is applied from behind the surface of the drawings perpendicularly up to the Hall element 1, a positive voltage is supplied to the input terminal 5 of the switching element 4 while a negative voltage is given to the input terminal 6 thereof. It is known that the polarity of the voltage across a Hall element is varied with the variation in the polarity of the magnetic field applied to the Hall element in the aforestated manner.

The present invention utilizes a reciprocal movement of a magnet member relative to the Hall element 1 so as to cause the latter to perform the above-stated characteristic. The pushbutton switch according to the present invention will be more specifically described with reference to FIGS. 2 and 4 of the drawings which illustrate the construction of an embodiment of the invention.

A generally cylindrical base or holder 7 is mounted in a cylindrical hollow casing 8 for relative reciprocal sliding movement in axial direction with respect to one another. The casing has a closed top end and an open bottom end as shown. The relative movement is guided and limited by means of an axial elongated groove 9 formed in the cylindrical side face of the holder 7 and a pin 10 mounted on the inner surface of the casing 8 and projecting radially inwardly into the groove 9. In the illustrated embodiment of the invention, the holder 7 is formed therein with a flat axial surface 11 and a flat transverse surface 12 extending radially outwardly from the bottom end of the surface 11 substantially at right angles with respect to the surface 11 to form a shoulder on the holder 7. A flat submagnetic pole plate 11' is secured to and extends over the entire length of the axial surface 11. The Hall element 1 is mounted on the exposed surface of the submagnetic pole 11'.

A permanent magnet 13 is preferably secured to the shoulder of the holder 7. More specifically, the transverse flat surface 12 is formed therein with a recess in which the magnet 13 is fitted in such a manner that one of the pole faces thereof extends in the same plane as the surface 12. Another generally U-shaped magnet 14 is mounted on the inner surface of the casing 8 in axial alignment with the magnet 13 and also in op-

posite relationship to the plate 11'. The magnet 14 has one magnetic pole 15 which is disposed in opposite relationship to the transverse surface 12 and which is of the same polarity as the pole 16 of the magnet 13 facing the magnet 14. In the illustrated embodiment, the opposite magnetic poles 15 and 16 of the magnets 14 and 13 are both north (N) poles which are in repulsing relationship to one another.

By virtue of this repulsing force, the casing 8 is held floating in the air, as will be seen in FIG. 2. When the casing 8 is pushed down in the direction indicated by an arrow A against the repulsing force, the casing has a sliding downward movement relative to the holder 7 as viewed in the drawings. This relative movement is guided and limited by the guide means which, as stated in the above, comprise the groove 9 in the holder 7 and the pin 10 mounted on the inner surface of the casing 8 and engaging with the groove. The assembly is arranged such that, when the assembly is in its rest or inoperative position illustrated in FIG. 2, i.e., when the casing 8 is held floating in the air by virtue of the above-mentioned repulsing force, the pole face of the bottom side pole 15 of the magnet 14 is positioned in opposite relationship to the Hall element 1 mounted on the submagnetic plate 11' so that the magnetic flux from the magnetic pole 15 is applied to and passes through the Hall element 1 and then through the submagnetic plate 11' to the other magnetic pole 17 of the magnet 14 whereas, in the position of the assembly in which the casing 8 is fully moved in the direction of the arrow A against the repulsing force, as shown in FIG. 3, the pole face of the other pole 17 of the magnet 14 is positioned in front of the Hall element 1.

Now, a description will be made with respect to the operation of the pushbutton switch described hereinabove. When the pushbutton is in its FIG. 2 position in which the Hall element is positioned in opposite relationship to the pole 15 of the magnet 14, a voltage of a certain polarity is generated at a Hall terminal (not shown) of the Hall element 1. For the convenience's sake of description, it is assumed that said certain polarity is positive one. On the other hand, when the casing 8 is depressed down to its FIG. 3 position in which the Hall element 1 is positioned in front of the other pole 17 of the magnet 14, a voltage of the reversed polarity, i.e., the negative one, is generated at the terminal of the Hall element 1. Moreover, when the pressure force which has been exerted to the closed end of the casing 8 is removed away therefrom, the casing is returned to the position shown in FIG. 2 by the repulsing force between the magnetic poles 15 and 16. It will be appreciated that, through a single reciprocal movement of the casing 8 relative to the holder 7, the polarity of the voltage across the terminals of the Hall element 1 is first reversed from and then restored to the initial polarity. Thus, the pushbutton switch according to the present invention can be used as means for producing switching signals to the switching element 4, such as thyristor or transistor. It will also be appreciated that the period of time during which the casing 8 is kept depressed as shown in FIG. 3 corresponds to the duration of a switching signal by which the switching element is actuated.

According to the above-described and illustrated embodiment of the invention, since the Hall element 1 is provided on the submagnetic plate which extends the entire distance over which the magnet 14 is reciprocally moved with respect to the Hall element 1, the magnetic flux from the magnet 14 is conveniently distributed over the submagnetic plate 11'. This will ensure that there is caused no variation in the reluctance to the magnetic flux, with a resultant advantage that demagnetization of the magnet 14 is prevented or at least minimized. Moreover, the pushbutton switch according to the present invention can have a prolonged operative life because it employs no contact, as state hereinbefore.

In the aforedescribed and illustrated embodiment of the invention, the magnet 13 only is employed to hold the casing 8 and the magnet 14 floating in the air by virtue of the magnetic repulsing force produced between the magnetic poles 15 and 16. If necessary, however, those skilled in the art may easily think of the use of mechanical biasing means such as spring either in addition to or in substitution for the magnet 13. It will also be appreciated that, although a selected one of the casing 8 and the holder 7 may serve as an actuator for the switch and the other may be mounted on an appropriate support (not shown), the holder 7 may advantageously be secured to such a support because the holder has mounted thereon the Hall element 1 to which electrical conductors are connected.

What is claimed is:

1. An electric pushbutton switch comprising a first member, a second hollow member receiving said first member for relative sliding movement between first and second positions, a magnet member mounted on one of said first and second members, a submagnetic pole plate mounted on the other of said first and second members in opposite relationship to said magnet member, said submagnetic pole plate having a Hall element mounted on the surface thereof facing said magnet member, said Hall element having its terminals adapted to be electrically connected to a switching element, and means for normally holding said one member and said magnet member in said first position, the arrangement being such that, when said one member is in said first position, one of the magnetic poles of said magnet member is positioned in opposite relationship to said Hall element and, when said one member is moved with respect to said the other member against said holding means to said second position, the other magnetic pole of said magnet member is positioned in front of said Hall element.

2. An electric pushbutton switch as defined in claim 1 in which said holding means comprise a second magnet member mounted on said the other member in axial alignment with the first said magnet member, said first and second magnet members having their adjacent magnetic poles which are of the same polarity so that the repulsing force between said adjacent magnetic poles is operable to normally hold said one member in said first position.

3. An electric pushbutton switch as defined in claim 2 in which said submagnetic pole plate extends the entire distance over which said first magnet member is reciprocally moved relative to said Hall element on said pole piece.

4. An electric pushbutton switch as defined in claim 3 further comprising means for guiding and limiting said relative reciprocal movement between said first and second members.

5. An electric pushbutton switch as defined in claim 4 in which said guiding and limiting means comprise a projection on said one member and an elongated groove formed in said the other member, said projection being in slidable engagement with said groove.

6. An electric pushbutton switch as defined in claim 5, characterized in that said first member is a base having an axial flat surface on which said pole piece and said Hall element are mounted and a transverse flat surface to which said second magnet member is secured, and that said second member is a substantially cylindrical casing having an inner surface on which said first magnet member is mounted.

7. An electric pushbutton switch as defined in claim 6 in which said casing has a closed end adapted to be pressed down for the actuation of said pushbutton, said base being adapted to be mounted on a support.

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