

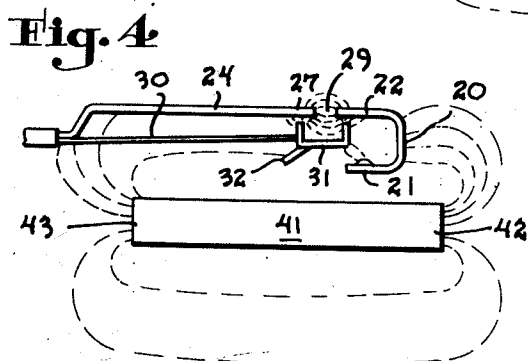
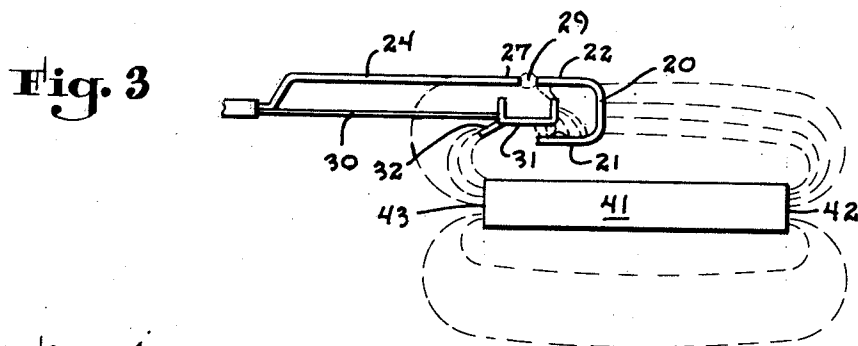
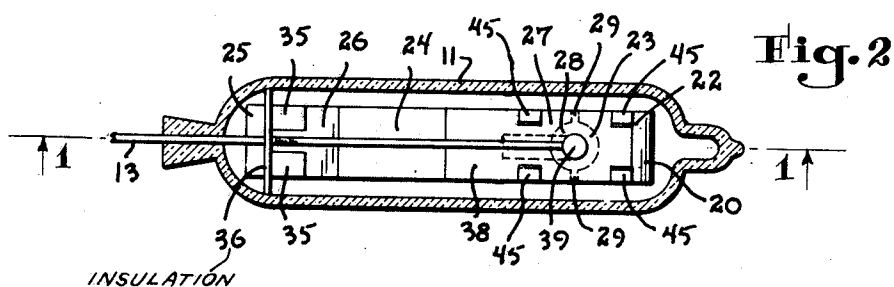
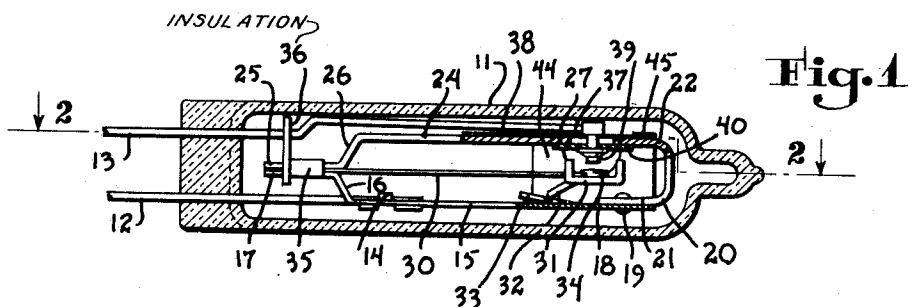
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TUBE SWITCH

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TUBE SWITCH

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This invention relates broadly to a tube switch and more particularly to a tube switch wherein the contacts are opened and closed by means of a magnetic field.

It is generally old to provide a tube switch the contacts of which are operated by a magnet of some sort located outside the tube as disclosed for example in the Bates Patent No. 1,970,412, but in switches of this type where the movable contact operating element is supported on pivots considerable difficulty has been experienced due to wear at the pivot points and the passage of current therethrough:

It is therefore an object of this invention to provide a switch which will obviate the above difficulties.

A further object is to eliminate all sliding friction in a switch of this character.

A further object is to provide a tube switch wherein the contact moving armature is mounted on a flexible element.

A still further object is to provide a tube switch having a flexibly mounted armature wherein the armature is positively attracted either toward or away from the poles of a magnet located outside of the tube, depending upon the position of said magnet longitudinally of the tube.

Another object is to provide a tube switch having a bridge of material having a low magnetic reluctance, said material having a gap therein so that when magnetic flux is passing through the bridge the flux about the gap will attract an armature for operating the switch.

Another object is to provide a switch of the above type wherein the armature is attracted either toward or away from the gap depending upon the relationship between the flux density across the gap and the flux density at the lower portion of the bridge on the other side of the armature.

A further object of this invention is to provide a switch of the above type wherein an adjustable stop is provided to limit the movement of said armature away from said gap.

Other objects and advantages will become apparent when the following specification is read with reference to the accompanying drawing in which:

Figure 1 is a side view of the switch structure, part of the elements being shown in section taken on the line 1—1 of Figure 2 and looking in the direction of the arrows.

Figure 2 is a section taken on the line 2—2 of Figure 1 looking in the direction of the arrows, and

Figures 3 and 4 are diagrammatic views showing the two operating positions of the armature and the relative flux distribution for producing such positions.

The switch mechanism is enclosed in a sealed glass tube 11 which may contain some suitable gas such as air or hydrogen or it may be evacuated if so desired. Sealed into one end of tube 11 are two spaced lead wires 12 and 13. Wire 12 at its inner end is suitably secured as at 14 to a strip of brass 15 extending longitudinally of the tube. To the left of connection 14 as viewed in Figure 1 the brass strip 15 is provided with an upwardly extending portion 16 and a horizontally extending portion 17. Connected to the other end 18 of the brass strip by means of non-magnetic rivets 19 is one part of a two-part bridge element which part is indicated at 20 as being in the form of a U having a lower leg 21 and an upper leg 22. Upper leg 22 has a cut-away portion 23, as best shown in Figure 2, for a purpose which will be disclosed later. The other part 24 of the bridge element has a horizontally extending portion 25 lying over portion 17 of the brass strip 15 and an upwardly extending portion 26 and a second horizontally extending portion, the end 27 of which lies adjacent the end of leg 22 and which is also provided with a cut-away portion 28, best shown in Figure 2. The ends 22 and 27 of the two parts in the bridge element are slightly spaced apart as shown at 29 and the cut-away portions 23 and 28 form a generally circular space.

Mounted between portions 17 and 25 of the brass strip 15 and bridge element 24 is a flexible reed 30 carrying at its end a U-shaped armature 31 which is provided with a downwardly extending lug 32 which is adapted to cooperate with a piece 33 which is struck up from the brass strip 15. This is for the purpose of limiting the downward movement of the armature as viewed in Figure 1 and the piece 33 may be bent to different positions to adjust the amount of this downward travel. Mounted within the U-shaped armature 31 is an electric contact 34. Portion 17 of the brass strip 15 has two laterally extending elements 35 which are bent upwardly and inwardly to securely fasten together the bridge element 24 and brass strip 15. Portions 17 and 25 are additionally supported by means of an insulating piece 36 which insulatingly connects them with the lead-in wire 13. Brass strip 15 also has two laterally extending portions 44 which are bent up on either side of the bridge element and are provided with inturned tabs 45 to space the

two adjacent ends 22 and 27 of the bridge element about the gap. Wire 13 extends longitudinally of the tube over the bridge element 24 resting near its end 37 on a sheet of insulating material such as mica 38 which lies on the bridge element 24. The end 37 of the wire 13 carries a stationary contact element 39 which extends downwardly through the circular opening at 23 and 28 and is steadied by a piece of insulating material such as mica 40 which is suitably secured to the underneath sides of the ends 27 and 22 of the two parts of the bridge element. The contacts 34 and 39 form a switch element and are shown in Figure 1 as being in open position. The armature 31, being mounted on the flexible reed 30, is easily raised so that the contacts may come into engagement and close the circuit between the wires 12 and 13.

The armature 31 is adapted to be operated magnetically and therefore some means of producing a magnetic field must be provided. In Figures 3 and 4 is diagrammatically shown a permanent magnet 41 having poles 42 and 43 for producing a magnetic field. It is to be distinctly understood however, that any type of magnet may be used such as a horseshoe magnet or some type of electromagnet, and it is not essential that the magnet be placed longitudinally of the tube as shown. The switch would work equally as well if the magnet 41 were turned through an angle of 90°. The diagrammatic showings of Figures 3 and 4 are for the purpose of illustration only and many other types of magnets may be used in various different positions with good results.

The structure of this invention provides within the glass tube a portion of two distinct paths for the magnetic flux. As shown diagrammatically in Figure 4, one path is from pole 42 of the magnet through the upper leg 22 of the bridge element across the gap 29, part of which flux also threads through the armature 31, through the bridge element 24 and back to pole 43 of the magnet. The other path as shown in Figure 3 is from pole 42 of the magnet through the lower leg 21 of the bridge element 20 to the armature 31 through leg 32 and back to pole 43 of the magnet 41. The position of the magnet with respect to the switch will determine which of these paths has the lower reluctance. In Figure 3 the magnet is so positioned that the path of lower reluctance is through leg 21 across the gap to the armature and back to pole 43 of the magnet. This means that magnetic material of low reluctance occupies a greater percentage of this path than the other. Therefore the gap between leg 21 and armature 31 will have a greater flux density than the gap 29 and the gap from 22 to the leg of armature 31, and for this reason armature 31 will be attracted downwardly as viewed in Figure 3. By moving the magnet to the left and as illustrated in Figure 4 the path including pole 42, upper leg 22 of the bridge piece, gap 29, armature 31, bridge piece 24 and back to the pole 43 of the magnet will have a lower reluctance than the other path. This path now has the greater percentage of magnetic material. Thus, as shown in Figure 4, the gap 29 will have a flux density greater than the gap between the leg 21 and the armature 31 and for this reason the armature will be attracted upwardly and away from the magnet 41. Therefore it is seen that by moving the magnet longitudinally of the tube the relationship between the flux densities at the two gaps will be varied, thus causing the

armature to be attracted first in one direction and then in the other. It is understood of course that when the armature is attracted upwardly the switch contacts are made and the circuit closed and conversely when the armature is attracted downwardly the switch contacts are separated and the circuit broken. The switch tube is shown in a horizontal position for the purposes of illustration only. The usual operating position is vertical with the armature 31 hanging downwardly.

The magnet has been shown as directly beneath the tube in the above illustration. It will also operate, if the tube is rotated 90° in either direction from the position disclosed. The snapping point of the switch may be varied slightly by such rotation but the armature will still be positively attracted in both directions upon movement of the magnetic field.

It will be seen therefore that I have provided a magnetically operated switch having no sliding parts and one which is positively actuated in both directions by a slight movement of the means producing the magnetic field. The fact that the armature is positively moved in both directions and the fact that the gap from the legs of armature 31 to the bridge elements is very small when the contacts are closed will reduce the tendency of the contacts to chatter which is a decided advantage in a magnetic switch of this type.

Many changes and modifications of this invention will occur to those skilled in the art and it is to be distinctly understood that I am to be limited by the scope of the appended claims and not by the specific embodiment herein disclosed.

I claim as my invention:

1. A switch comprising in combination, a sealed tube, an electric conductor sealed into said tube, a strip of non-magnetic material supported by said conductor within said tube, a two-piece bridge element having a space between the pieces forming a gap, one piece being supported by one end of said strip, the other piece being supported by the other end of said strip, a flexible reed supported at one end between said strip and said bridge element, an armature carried by the other end of said reed, a movable contact carried by said armature, a fixed contact engaging said movable contact when said armature is positioned adjacent said bridge, a lug on said armature, and a piece bent from said non-magnetic strip for cooperation with said lug to limit the movement of said armature away from said bridge, the position of said bent piece being adjustable.

2. A mechanism of the class described comprising in combination, a sealed tube, a bridge element of magnetic material within said tube having a break in one portion thereof forming a first gap, an armature movably supported within said tube between said first gap and a second portion of the bridge, a second gap between said armature and said second portion of said bridge, and means adjacent said tube for producing a magnetic field, the direction of attraction of said armature depending upon the relative densities of the flux at the two gaps, said relationship being variable upon movement of said means longitudinally of said tube.

3. A mechanism of the class described comprising in combination, a sealed tube, a bridge element of magnetic material within said tube having a break in one portion thereof forming a first gap, an armature movably supported within said

tube between said first gap and a second portion of the bridge, a second gap between said armature and said second portion of said bridge, and means adjacent said tube for producing a magnetic field and so positioned that the armature is at least substantially between said first gap and said means, the direction of attraction of said armature depending upon the relative densities of the flux at the two gaps, said densities being variable by movement of said means with respect to said tube.

4. A mechanism of the class described comprising in combination, a sealed tube, a bridge element of magnetic material within said tube having a break in one portion thereof forming a first gap, an armature movably supported within said tube between said first gap and a second portion of the bridge, a second gap between said armature and said second portion of said bridge, means adjacent said tube for producing a magnetic field and so positioned that the armature is at least substantially between said first gap and said means, the direction of attraction of said armature depending upon the relative densities of the flux at the two gaps, said relationship being variable upon movement of said means longitudinally of said tube, and switch means within said tube operated by said armature.

5. A mechanism of the class described comprising in combination, a sealed tube, means outside of said tube for producing a magnetic field, an armature movably mounted within said tube, and means within said tube causing said armature to be attracted away from said magnetic field producing means when said magnetic field producing means is in one position and toward said magnetic field producing means when said magnetic field producing means is in a second position.

6. A mechanism of the class described comprising in combination, a sealed tube, means outside of said tube for producing a magnetic field, an armature movably mounted within said tube, means within said tube causing said armature to be attracted away from said magnetic field producing means when said magnetic field producing means is in one position, and means for causing said armature to be attracted toward said magnetic field producing means when said magnetic field producing means is in another position.

7. A mechanism of the class described comprising in combination, a sealed tube, means outside of said tube for producing a magnetic field, an armature movably mounted within said tube, and means within said tube providing two parallel paths for the magnetic flux, one path having the lower reluctance when said magnetic field producing means is in one position, the other path having the lower reluctance when said magnetic field producing means is in another position, said armature forming a part of each path.

8. A switching mechanism comprising in com-

5 bination, a sealed tube, a bridge element of magnetic material within said tube having a break therein forming a gap, a fixed electric contact within said tube extending down through said gap, an armature mounted for movement within said tube, a movable electric contact normally carried thereby in spaced relation to said fixed contact, and a magnet outside of said tube creating a magnetic field for producing magnetic flux at said gap to cause said armature to be attracted thereto and close the electrical contacts, said armature being substantially between said fixed contact and said magnet.

9. A mechanism of the class described comprising in combination, a sealed tube, an elongated bridge comprising first and second parts mounted within said tube, a gap between said parts, an armature mounted within said tube so as to be capable of movement toward and away from said gap, one of the parts of said bridge being bent so that as said armature moves away from said gap it moves toward said bent portion, and means outside of said tube for producing a magnetic field which in one position of said means passes through said gap to attract the armature thereto, and which in another position of said means passes through the bent part of said bridge to attract the armature thereto.

10. A switch comprising in combination, a sealed tube, a bridge element of magnetic material within said tube, a gap in said bridge element, a stationary contact in said gap, a U shaped armature, means for mounting said armature for movement toward and away from said gap, the legs of the U extending toward said gap and being spaced far enough apart to completely bridge said gap, and a contact carried by said armature at the connecting portion of said U, said contacts engaging as said armature moves toward said gap.

11. An arrangement of the class described comprising in combination, means for producing magnetic lines of force, a movably mounted non-polarized armature, and stationary means directing said magnetic lines of force in such manner that they attract said armature as a whole away from said first mentioned means when said means is in one position, and toward said first mentioned means when said means is in a second position.

12. An arrangement of the class described comprising in combination, means for producing magnetic lines of force, a movably mounted non-polarized armature, and stationary means providing a pair of parallel paths for said lines of force, said armature forming a portion of each path, movement of said first mentioned means back and forth in a line substantially parallel to said paths causing the majority of said lines of force to shift from one path to the other whereby said armature is attracted first in one direction and then the other.

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