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ENCAPSULATED MAGNETIC SWITCH

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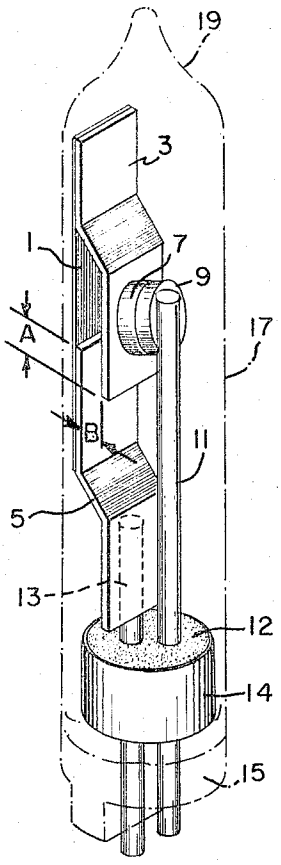

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ENCAPSULATED MAGNETIC SWITCH

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This invention relates to magnetic switches. Conventional magnetic switches leave much to be desired; those are encapsulated usually contain mercury or an expensive contact medium such as gold and platinum whereas those which are not encapsulated usually have short life cycle characteristics. Conventional magnetic switches usually have very low current capacity and usually have terminals at each end thereof.

Thus a primary object of this invention is to provide a magnetic switch which is relatively simple in construction, reliable in operation and inexpensive to manufacture.

Another object is to provide a magnetic switch which possesses long life characteristics.

A further object is to provide a magnetic switch having increased power capacity and having the terminals located at one end thereof.

These and other objects, advantages and features are attained, in accordance with the principles of this invention, by the use of magnetic materials in association with spring materials and companion contacts encapsulated in glass, whereby a permanent magnet or simple D.C. coil will transfer contacts, thereby acting as simple "On-Off" switch, relay, circuit protective device or limit switch.

In the accompanying drawing, the single figure is a perspective view of a specific embodiment of the invention, with the switch envelope shown in phantom.

As shown in the accompanying drawing, the switch comprises a spring strip **1**, to which an armature **3** and a pole piece **5** are attached. The armature **3** and the pole piece **5** overlie the spring strip **1** and segments thereof are in register with one another to define a predetermined overlap A. The segments of the armature **3** and the pole piece **5** which are in register are also normally spaced from one another a pre-determined distance to define a gap B. The switch includes a pair of normally closed electrical contacts **7** and **9**, the former being attached to the armature **3** and the latter being secured to a lead-in wire **11**. Lead-in wire **13** supports the pole piece **5**. The switch assembly just described is supported by a glass bead **12** preferably reinforced by a metal band **14**. Lead-in wires **11** and **13** are sealed in and extend through a press **15** formed on one end of a tubular glass envelope **17**. The other end of the envelope **17** is necked down and, after processing, is hermetically sealed or tipped off to form exhaust tip **19**. This processing includes evacuation of the envelope **17** and the introduction of a filling of helium gas to prevent oxidation of the electrical contacts, to provide heat transfer from the metal components of the switch to the glass envelope and to increase the breakdown voltage capacity of the switch.

Operation of the switch may be accomplished by passing a magnetic flux through the armature and pole piece in the direction of the axis of the switch. Operation may also be accomplished by direct attraction of the armature by a higher strength magnet with its axis at right angles to the sensitive portion of the switch. In the former case, the operation may be activated by placing the switch in an electromagnetic solenoid. In each case, the magnetic portions of the switch, i.e., the armature and the pole piece, being made of a high permeability material, iron, steel or their alloys, cause the magnetic lines of flux to become concentrated in the iron and in the controlled gap between the two pieces. Assuming

the north end of the magnet to be placed opposite the lower end of the switch, the flux through the pole piece and armature will produce north poles at the top of the pieces and south poles at the lower ends. This will produce a south and a north pole respectively at the opposite sides of the gap and consequently the two pieces will be mutually attracted. The mechanical arrangement of the switch components allows the armature to move toward the pole piece and thus open the normally closed electrical contacts. The mass of the switch components is low enough so that the switch will transfer within a period of a few milliseconds with the flux applied of the order of or somewhat less than twice the "just operate" flux.

The magnetic components of the switch should be materials having a high magnetic permeability when a sensitive device is desired. The better the permeability, the more lines of flux are directed into the armature-pole piece system and thus the greater the attraction between the two magnetic components. This attraction may also be regulated by the amount of overlap of the armature and pole piece. At zero overlap, i.e., when the armature just clears the pole piece, the attraction is minimum for a practical system, rising rapidly to a maximum when the overlap is of the order of about one-half of the width of the magnetic members and falling off 10%–20% as the overlap is increased to twice width or more. Thus, for a practical system, the overlap is preferably designed so that, after allowance for manufacturing tolerances, the overlap will fall between the maximum sensitivity point and greater overlap rather than falling on the steep slope toward the zero overlap point.

The spacing of the gap is also significant and determinate. A narrow gap is desirable to prevent fringing of the lines of flux and thus reduce the effectiveness of the iron paths. On the other hand, the gap should be kept large enough to prevent sparking across or arc maintenance at the contacts on make and break respectively. If the gap is too great, the attraction tends to be a direct attraction with the magnetic force balancing the spring force until the point described earlier is reached, from which point the snap takes place.

The operation of the switch is snap action. As the flux builds up to a value that produces a mechanical attraction that just exceeds the holding force of the spring strip, the armature starts to move, thus reducing the gap. With the gap reduced, the force increases as the square of the reduction of the gap and the force increases to speed of the movement. Thus, the armature snaps into engagement with the pole piece.

Most sensitive operation is obtained when the length of the permanent magnet used is of the order of the length of the magnetic components of the switch. This allows the most efficient coupling of the magnetic flux into the switch since the lines of flux pass from the ends of the magnet into the switch by the shortest and most direct path. A longer magnet becomes relatively heavier and more expensive without producing much extra sensitivity whereas a shorter magnet does not produce an adequate spread of lines to pass efficiently through the switch, in addition to producing fewer lines.

In one application, the switch of this invention may be employed as a refrigerator light switch. In this application, the switch could be mounted in the front section of the refrigerator and a permanent magnet aligned therewith but mounted in the door panel. When the refrigerator door is closed, the switch is opened; when the refrigerator door is opened, the switch is closed—this being accomplished by the movement of the permanent magnet near to and away from the switch.

Another application would be to use the switch as an automobile door switch to control dome or internal lights.

In the refrigerator light switch application, good results were obtained using .003" tungsten steel for the spring strip. The thin tungsten steel (6–8% W) spring strip was resilient and offered the least resistance to contact force as all of the switches were adjusted or biased normally closed. Other suitable spring materials such as high carbon (.5–.3%) may also be used.

As indicated above, the magnetc portions of the switch are preferably made of high permeability materials, such as iron, steel or their alloys. For example, good results have been obtained with iron-nickel alloys where the nickel content varied from 40%–80%. Even basic cold-rolled steel may be employed.

Although a simple single pole, single throw magnetic switch is shown in the accompanying drawing illustrating a specific embodiment of the invention it will be appreciated by those skilled in the art that a number of different modifications thereof may be designed without departing from the spirit of this invention. For example, nitrogen, Freon, or other gases or mixtures of gases may be employed instead of the helium mentioned in the description of the specific example, provided they possess the functional characteristics noted above. On the other hand, a vacuum switch is quite satisfactory in applications for example where heat transfer is not a significant problem. Although, in the specific examples set forth above, tungsten steel was indicated as the spring strip material, other spring materials may also be employed satisfactorily; non-magnetic materials such as Phosphor-bronze and beryllium-copper for example may also be used.

What we claim is:

A magnetic switch comprising: an hermetically sealed envelope; a pair of lead-in wires sealed in and extending from said envelope; a spring strip; a magnetic armature secured to said spring strip near one end thereof; a pole piece secured to said spring strip near the other end thereof, the adjacent ends of said armature and said pole piece overlying one another and being normally spaced from one another, said overlap being of the order of about one-half of the width of said armature and said pole piece, and said pole piece also being secured to one of said lead-in wires; an electrical contact secured to said armature; and an electrical contact secured to the other of said lead-in wires, said electrical contacts being normally closed with respect to one another.

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