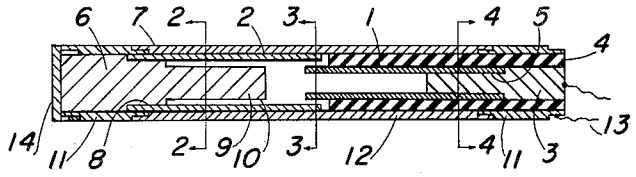
March 13, 1962 E. MEDAL 3,025,371

SHOCKPROOF MAGNETIC REED SWITCH

Filed May 5, 1961

Fig. 1



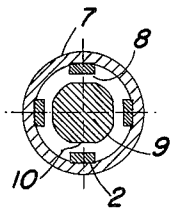


Fig. 2

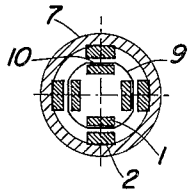


Fig. 3

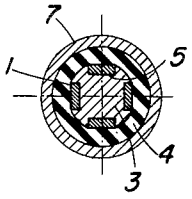


Fig. 4

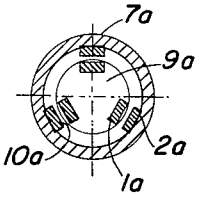


Fig. 6

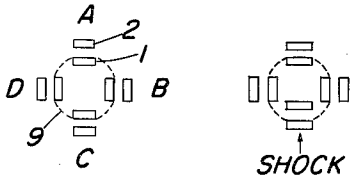


Fig. 5a

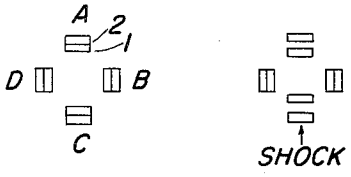


Fig. 5b

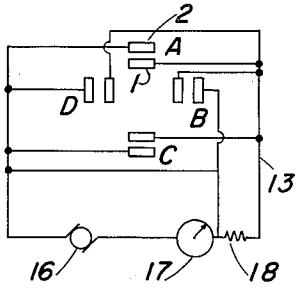


Fig. 7

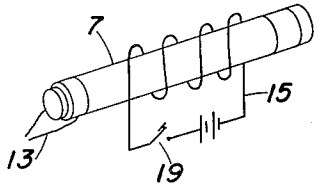


Fig. 8

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SHOCKPROOF MAGNETIC REED SWITCH

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8 Claims. (Cl. 200—87)

This invention relates generally to magnetic reed switches and more particularly to such a switch the function of which is not affected by sudden shock.

Magnetic reed switches have been developed for opening and closing electrical circuits by the action of a magnetic force in the vicinity of the switch which induces the movement of at least one of the reed elements into contact with the other. The switches are usually of the single pole, single throw type and are sealed within a protective envelope, which may be an insulating material such as glass. Commercially available reed switches are subject to malfunctioning in that they exhibit a chattering when subjected to shock. If the switch is in the open position, the contacts will come together and close the circuit momentarily. Conversely, if the switch is in the closed position, the contacts will separate thereby breaking the circuit and interrupting the operation of the controlled device. The switches are also subject to chattering even when under the influence of a vibrating force of lesser magnitude than heavy shock.

There is a great need for shockproof switches in many fields today. For example, components in nuclear reactors for naval vessels must be able to withstand a prescribed amount of shock without malfunction.

It is an object of this invention to provide a magnetic reed switch which is completely shockproof in that any tendency through shock to inadvertently open or close the switch is nullified.

It is a further object of this invention to provide an improved magnetic reed switch having greatly improved reliability compared to commercially available switches of this type, and which will not malfunction under the influence of a vibratory force.

The above objects and features of the invention, in addition to other objects and features, will become more apparent from the following detailed description when taken in conjunction with the drawings wherein:

FIG. 1 shows a longitudinal cross sectional view of a magnetic reed switch in accordance with the invention:

FIG. 2 shows a cross-sectional view taken on line 2—2 of FIG. 1;

FIG. 3 shows a cross-sectional view taken on line 3—3 of FIG. 1;

FIG. 4 shows a cross-sectional view taken on line 4—4 of FIG. 1;

FIG. 5*a* shows a schematic illustration of shock effects on the switch of the invention in the open position, and

FIG. 5*b* shows the shock effects for the closed position;

FIG. 6 shows a cross-sectional view similar to FIG. 3 of a second embodiment of the invention, corresponding parts having corresponding numbers;

FIG. 7 is a schematic wiring diagram of a typical circuit utilizing the switch of this invention; and

FIG. 8 shows in elevation one mode of operating the switch.

The components of the switch of the invention and their relative relationships are best illustrated in FIGS. 1–4. The switch includes a plurality of pairs of contacts, in this case four, which are designated as inner contacts **1** and outer contacts **2**. The contacts are flexible magnetic reeds made, for example, of an alloy of 48% nickel and 52% iron, being rectangular in cross section and having a substantially greater length than width. The reeds may be plated with a suitable contact metal, such as silver, either throughout their entire lengths or only at the contacting surfaces, if desired. The reeds **1** are mounted in cantilever fashion at the ends adjacent one end of the switch, between an inner plug member **3** of electrical conducting magnetic material in the shape of a cylinder and an outer annular insulating member **4**. The plug **3** has parallel circumferentially spaced slots **5** in its outer surface, best shown in FIG. 4, for receiving the ends of reeds **1**. The outer reed members **2** are also cantilever supported at their outermost ends adjacent the other end of the switch between inner cylindrical plug member **6** and an outer tubular member generally indicated at **7**. Member **6** has parallel circumferentially spaced slots **8** for receiving the outer ends of reeds **2** for holding them in place, and a reduced section **9** having flats **10**, as best shown in FIG. 2, parallel to the contacting surfaces of the reeds. The reeds are secured in slots **5** and **8** in good electrically conductive relationship with plugs **3** and **6** as by welding or riveting, for example. Reed members **1** and **2** extend toward each other and the innermost ends overlap an amount sufficient to enable good electrical connection when these ends contact each other. Reduced section **9** of plug **6** extends toward the overlapping ends of the reeds and has a diameter, width across flats, and length of appropriate dimensions to serve as a backup member to limit the radial inward travel of reeds **2** to a predetermined amount which prevents inadvertent closing of the switch in the event of shock, which function will become more apparent by the description of operation given below. Of course the flats could be omitted, if desired, but serve the useful purpose of preventing twisting of reeds **2** when they come into contact with backup member **9**. These dimensions of reduced section **9** are interrelated and, in addition, depend upon the length and resiliency of the reeds, the desired gap between the contacts, and the overall size of the switch, which will vary according to the needs of any particular apparatus utilizing these switches.

The switches are hermetically sealed within tube **7**, which is comprised of end sections **11** and central section **12**. End sections **11** are made of electrically conductive magnetic material. Central section **12** should be nonmagnetic for optimum sensitivity and may be made of copper or aluminum, for example, annular member **4** may be made of any suitable electrical insulating material and extends from the end of the switch at which plug **3** is disposed toward the middle to a point which is in closely spaced relationship with the inner ends of reeds **2**. Member **4** has an outer diameter of such a size as to provide a tight fitting sealing engagement within tube **7** and firmly supports plug member **3** in concentric spaced relationship within tube **7**. Reeds **1** contact the inner surface of member **4** for almost their entire length and thus are prevented from moving radially outwardly although they are free to move radially inwardly since they are not backed up in that direction.

Plug member **6** is made of electrically conductive magnetic material and is in tight contacting engagement with the inner surface of tube **7** for good electrical conductivity. Reed members **2** contact the inner surface of tube **7** throughout their entire length and thus are prevented from moving radially outwardly. A cap **14** is placed over the opposite end of the assembly and is sealed at its rim to tube **7**. Electrical lead wires **13** for the switches are connected to plug **3** and tube **7**, the switch assembly per se constituting an electric circuit wherein all pairs of reeds, designated A, B, C, and D, are connected in parallel, as illustrated in FIG. 7, with all reeds **1** having the same polarity and all reeds **2** having the same polarity, the polarities of reeds **1** and **2** being opposite. FIG. 7 also shows a manner in which the switch may be series connected in a circuit containing a source of electrical

potential 16, a current indicating meter 17 and a controlled element such as a load 18. It will be observed that upon closing of any pair of reeds the circuit will be closed. The components of the switch are all made of magnetic material, except the insulating sleeve 4 and the center section 12 of tube 7 which are non-magnetic, to provide a low reluctance path for the magnetic flux which operates the reed contacts.

The operation of the device will now be described. Since the reed members are cantilever supported at their outermost ends, the innermost ends, which overlap, are free to move due to the flexibility of the reeds. None of the reed members can move radially outwardly however, since they are backed up by sleeve 4 and tube 7. The reeds are free to move radially inward except that reeds 2 are limited in their travel by reduced section 9 on plug member 6.

When the switch assembly is placed in a field of magnetic flux, such as when inserted in the central bore of an annular permanent magnet, or within an electrical coil 15 which is energized by closing switch 19, as illustrated in FIG. 8, the respective pairs of reed contacts close due to the radial inward movement of reeds 2 into engagement with reeds 1, thus closing the circuit in which the switch is operatively connected.

FIGS. 5*a* and 5*b* show schematically the shockproof operation of the switch in the open and closed positions, respectively. When a shock is experienced in the direction of the arrow, with the contacts in the open position, since a shock is unidirectional, reed pairs B and D are unaffected in the direction of closing, whereas reed pairs A and C will have a tendency to close. The reeds of pair A will not move as they are backed up by the insulating sleeve and outer tube. The inner reed 1 of pair C will deflect inwardly. The outer reed 2 of pair C will deflect inwardly until it comes into contact with the inner end of section 9, the length and diameter of which have been predetermined to positively prevent reed 2 from accidentally contacting its mating inner reed. Thus, even under the most severe shock, no reed pairs will make contact and consequently no spurious signal will occur.

When the switch is in the closed position, as when coil 15 is energized, and a shock is experienced, as indicated in FIG. 5*b*, again contacting pairs B and D will be unaffected. However, reed pairs A and C may open momentarily, although the circuit will not be broken since pairs B and D remain closed.

The direction of shock illustrated is the most severe and any shock occurring at a different angular relationship with respect to the switch will have less effect on its operation. For example, a shock occurring at 45° with respect to that illustrated by the arrows will tend, in the case of the open position, to close two adjacent pairs of reeds such as B and C. However, the force acting on each pair in the direction of opening and closing will be only the resultant force of the shock which would be in a direction at 45° with respect to the direct line of shock and consequently will be far less than the shock force acting colinearly with the direction of opening and closing. In either case, the design of the switch will prevent accidental closing of the switch and the resultant force will be insufficient to accidentally open the switch when in the closed position.

The switch may also be designed to have three poles as shown in FIG. 6, rather than four poles as previously described. This three pole switch would have the same operating characteristics and accordingly, would also be shockproof. In addition to the above advantages, the presence of 6 or 8 reeds as compared to 2 reeds in an ordinary switch makes this a three or four pole-switch with the attendant increase in reliability.

It is important to note that the switch in order to be shockproof must have at least two pairs of reeds positioned so that their directions of opening and closing are substantially between 90 and 120 degrees with respect to each other. This angular relationship prevents a shock in any one direction from having the same effect on all the contact elements.

The above description is of the preferred embodiments of the invention and various changes may be made in the material, size, and arrangement without departing from the spirit and scope of the invention.

We claim:

1. A shockproof magnetic reed switch comprising a plurality of pairs of contacts of magnetic, electrical conducting material, each said pair comprising two flexible reed contacts arranged in longitudinal parallel spaced relationship with only two ends adjacent and overlapping, means for mounting said reeds at the remote ends so that the adjacent overlapping ends are free to move into contacting engagement with each other, said pairs being arranged in circumferential spaced relationship with at least two pairs substantially between 90 and 120 degrees with respect to each other, an outer tubular jacket hermetically sealing the pairs of reeds therewithin and electrical lead wires connected to said reeds.

2. A shockproof magnetic reed switch comprising a plurality of pairs of flexible contacts arranged in circumferential spaced relationship within an outer tubular member, each said pair comprising two elongated flexible magnetic reed contacts arranged in longitudinal parallel radially spaced relationship with two ends being adjacent and overlapping and the other ends being remote with respect to each other whereby the reeds are arranged in radially innermost and outermost groups, means for mounting the reeds at their remote ends only so that the overlapping ends are free to contact each other, the radially outermost reeds contacting the inner wall of said tube along their entire length, insulating means spacing the radially innermost reeds from the tube, and means operable when the switch is subjected to shock to prevent the pairs of reeds from accidentally closing when the switch is in the open position and for maintaining at least one pair of reeds closed when the switch is in the closed position.

3. The switch as claimed in claim 2 wherein the insulating means comprises an annular sleeve having an outer diameter equal to the inner diameter of said tube and a length to extend from one end of the tube to a point closely spaced from the overlapping ends of the outermost reeds, the means for mounting the inner reeds comprises a first cylindrical plug made of electrically conductive material disposed at said one end of the tube having an outer diameter equal to the inner diameter of the insulating sleeve and slots in its outer surface for receiving the inner needs, the means for mounting the outer reeds comprises a second cylindrical plug of electrically conductive material disposed at the other end of the tube having an outer diameter equal to the inner diameter of the tube and slots in its outer surface for receiving the outer reeds, and means for securing the reeds in their respective slots in good electrically conductive relationship with said plugs.

4. The switch as claimed in claim 3 wherein the tube has end portions of magnetic, electrically conductive material and a central portion of non-magnetic material surrounding at least the overlapping ends of the reeds.

5. The switch as claimed in claim 3 wherein the means for preventing accidental closing of the pairs of reeds comprises the insulating sleeve which extends close enough to the overlapping ends of the inner reeds to substantially prevent radial outward displacement thereof and a cylindrical extension on said second plug extending toward the overlapping ends of the reeds and having an outer diameter and length to limit radial inward displacement of the outer reeds to a predetermined amount which will permit normal contacting of the reeds when intended but prevent accidental contacting when not intended.

6. The switch as claimed in claim 5 wherein the means

for maintaining at least one pair of reeds closed comprises circumferentially spacing the pairs so that at least two pairs are substantially between 90° and 120° with respect to each other.

7. The switch as claimed in claim 5 wherein there are four pairs of reeds spaced at substantially 90° intervals, all said pairs being electrically connected in parallel, and means to induce a magnetic flux on the switch to operate the contacts.

8. The switch as claimed in claim 5 wherein there are three pairs of reeds spaced at substantially 120° intervals, said pairs being electrically connected in parallel and means to induce a magnetic flux on the switch to operate the contacts.

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