March 29, 1966 A. DE FALCO 3,243,541

REED SWITCH WITH MAGNETICALLY RESPONSIVE REED ELEMENTS

Filed Oct. 4, 1963

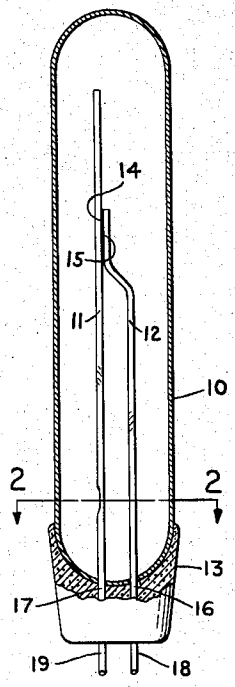


FIG. 1

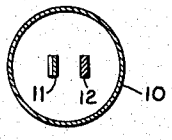


FIG. 2

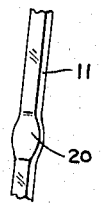


FIG. 3

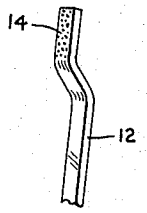


FIG. 4

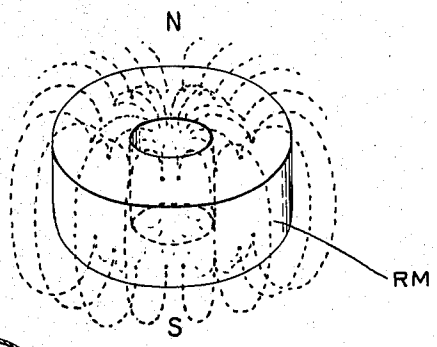


FIG. 5

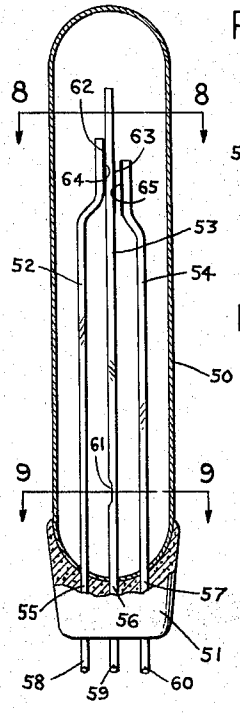


FIG. 7

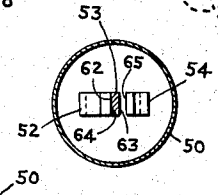


FIG. 8

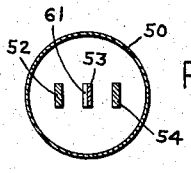


FIG. 9

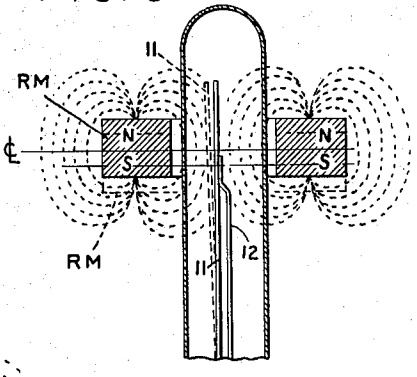


FIG. 6

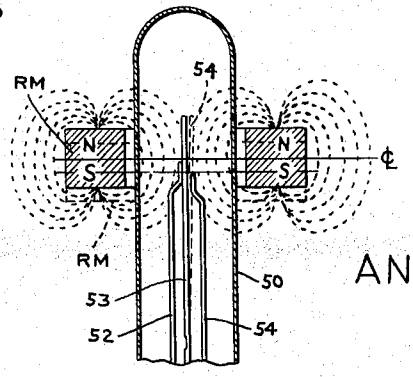


FIG. 10

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3,243,541 REED SWITCH WITH MAGNETICALLY RESPONSIVE REED ELEMENTS

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5 Claims. (Cl. 200—87)

This invention relates to reed switches wherein the reed elements are of materials highly permeable to magnetic lines of force and reactive to such magnetic forces but low in magnetic retentivity.

The prior art reed switch devices generally embody reed elements encapsulated in an envelope of glass or other dielectric material such that each reed element has one respective end connected to opposite ends of the envelope and their free ends extend longitudinally with the envelope in opposite directions so that the free ends overlap each other and on such overlapping ends, cooperating contact means are formed to contact with each other during the actuation of the switch by suitable electromagnetic or permanent magnet actuating means.

It has been found that this type of switch is extremely awkward for various current carrying circuits because of the difficulties met in mounting the oppositely disposed reed elements of the switch into a particular circuit.

Attempts to bend the external lead portions of the reed elements in the absence of a fixture or jig, will in most instances, damage the envelope or affect the hermetic seal and thus the operation or ultimate life of the reed switch itself.

The present invention overcomes this problem by providing a reed switch wherein the reed elements hermetically sealed in a suitable envelope are disposed within the envelope so that each of the respective elements have one end connected to the same point of reference in the envelope and the reed elements extend longitudinally into the envelope in the same direction; the reed elements being further characterized by the fact that one of the elements is longer than the other reed element and at least one of the reed elements will be relatively flexible to provide the coacting switch arrangement when the reed elements are actuated by any suitable magnetic actuating means.

Such device will provide a reed switch which may be easily set for normally open or normally closed operation or when a plurality of reed elements are used can provide a single pole double throw variety of switches as is more fully set forth hereinafter.

Furthermore, the fact that the external lead portions of the reed elements are disposed to extend out of the same point of reference from the envelope will permit optimum magnetic coupling and variations of the magnetic coupling for actuating of the elements.

This improved reed element construction can be disposed to coact with a suitable magnetic arrangement whereby controlled movement of the magnetic actuating means relative to the reed switch elements will produce a simple positive acting switch device which is highly reliable, not subject to normal vibration or shock, and unaffected by high and low ambient temperatures and therefore extremely reliable in operation at either high or low speed conditions.

A simple push button switch utilizing this improved reed switch is shown in my copending United States application, Serial No. 313,881, filed October 4, 1963.

Accordingly, it is the object of the present invention to provide an improved reed type switch.

These and other objects and advantages of the invention will become evident in the following description with reference to the accompanying drawings in which:

FIGURE 1 shows the improved reed switch of the present invention in normally closed position.

FIGURE 2 is a section taken on 2—2 of FIGURE 1.

FIGURE 3 is a partial perspective view of a portion of an elongated reed element, to show one means of providing a flexible element.

FIGURE 4 is a partial perspective of the coacting fixed reed element.

FIGURE 5 shows the magnetic lines of force for a ring magnet.

FIGURE 6 shows the magnetic lines of force for a ring magnet actuator and its coaction with the reed switch of FIGURE 1.

FIGURE 7 is a further form of reed switch in accordance with the present invention, utilizing a plurality of reed elements to provide a single pole double throw switch.

FIGURE 8 is a section taken at 8—8 of FIGURE 7.

FIGURE 9 is a section taken at 9—9 of FIGURE 7.

FIGURE 10 shows the magnetic lines of force for a ring magnet actuator and its connection with the reed switch of FIGURE 8.

Referring to the drawings, FIGURES 1 and 2 show the improved reed switch of the present invention having an envelope **10**, which is an elongated hollow member made of a glass or other dielectric material easily heat sealed and able to withstand the application of vacuum or pressure, depending on the procedure used in hermetically sealing the reed elements **11** and **12** in the envelope **10**.

Reed elements **11** and **12** are mounted in the envelope so that one respective end of each element is connected through the base **13** of the envelope **10**. They extend into the envelope in the same direction substantially parallel to each other and in the longitudinal axis or line of the envelope **10** to permit the sections thereof disposed remote from the connected end to be side by side and to communicate or coact with each other.

As shown in FIGURES 1 and 4, a contact point is struck at **14** on reed element **12** and a contact point **15** is formed on reed element **11**.

Contact point **14** is at the free end of reed element **12**, whereas contact point **15** is intermediate the end of the reed element **11** which element, it will be noted, is longer than the reed element **12** for purposes which will appear clear hereinafter.

The connected ends of the respective reed elements are hermetically sealed as at **16** and **17** and extend externally of the envelope by means of the external leads **18** and **19**. These leads serve to connect the reed switch into the current carrying circuit in which it will be utilized.

While reed element **11** in FIGURE 1 is shown as substantially longer than reed element **12**, this is done primarily to emphasize the characteristic of this improved reed switch which provides the desired operative relation and improved function, and which further permits the elements and their respective external leads to be extended from a substantially single point of reference on the reed switch envelope rather than requiring the opposed mounting of the reed elements as in the conventional type of reed switch known in the art.

In order to clarify the operative relation it is necessary to point out that the reed element **11** need only be slightly larger than the reed element **12**. Thus, for example, if the reed element **11** is as little as $\frac{1}{16}$ of an inch longer than the reed element **12**, the improved operative relation will be achieved.

The reason even this slight degree of lengthening effects the improved operative relation is due to alignment of the magnetic lines of force in the elongated reed element **11** which permits the formation of a difference in polarity between the coacting contacts **14** and **15** of the respective reed elements as is more fully discussed hereinafter.

The reason the reed element **11** is shown as substantially longer by approximately one quarter of the reed element **12** is that magnetic coupling is less critical and of greater magnitude in this relationship and hence operation of the device is more efficient and more reliable.

The reed element **12** is bent adjacent the free end to permit the contact **14** in reed element **12** to coact with the contact **15** on reed element **11**. However, this construction also permits the positioning of the reed elements **11** and **12** in the envelope **10** so as to place the reed element **12** closer to the inner wall of the envelope **10** than the reed element **11**. This offset relationship also produces better magnetic coupling particularly for normally open operation.

In FIGURE 4, the construction of the element **12** is shown with respect to the contact and the bent portion adjacent the free end.

In FIGURE 3, the reed element **11** is shown as having a portion of lesser thickness as at **20** which may be struck or cut or established by any other suitable means so that the element **11** will be relatively flexible compared to the element **12**. Thus when the reed switch coacts with an electro-magnetic actuator or a permanent magnet actuator, the element will flex and be actuated towards or away from the element **12** under the influence of the magnetic forces so that the contacts **14** and **15** can coact with each other. It is obvious that element **12** could be made flexible and element **11** fixed or both elements may be flexible if desired without departing from the scope and spirit of the present invention.

The improved reed switch of the present invention can be used with either an electro-magnetic actuator or a permanent magnet type actuator.

FIGURE 5 illustrates in diagrammatic form the magnetic lines of force for a ring magnet RM and show that these magnetic lines of force form a continuous 360° annular field.

FIGURE 6 shows the operative relation of the magnetic lines of force of such ring magnet with the improved reed switch of the present invention. Thus when the ring magnet is in the position shown in FIGURE 6, the lines of force penetrate the elongated reed element **11** and reed element **12** where, by reason of the magnetic permeability of the respective reed elements, will cause orientation of the magnetic flux lines therein.

In the elongated reed element **11** the intermediate body portion about the contact **15** will have a north polarity and the free end portion of the reed element **11** will have a south polarity. Conversely, in the shorter reed element **12** whose free end lies below the medial transverse lines CL, the magnetic lines of flux produce a south polarity at the free end or at contact **14** and a north polarity in the body, or possibly no effective polarity if the lines of magnetic force are weak in which case operation will depend on the characteristics of the reed elements which make them responsive to magnetic forces.

When the contact points **14** and **15** are initially in normally closed position as shown in FIGURES 1 and 6, the condition of opposite polarity will not change this relationship.

In order to effect a change from normally closed to normally open position of the contacts **14** and **15**, the ring magnet means must be moved or depressed as shown in the dotted lines so that the medial transverse line CL of the ring magnet means passes through some portion of the contact point **14** or the body portion of the reed element **12**. When this occurs the magnetic lines of force in the reed element align themselves so that the contact points **14** and **15** now have like polarity and therefore repel each other thus changing the condition from the contacting relationship to non-contacting relationship.

Conversely if the contact points **14** and **15** of respective reed elements **11** and **12** are in a normally open position during their initial relationship then when the ring magnet means is moved so that the medial transverse line CL of the ring magnet is just slightly above the free end of the reed element **12**, the contact points **14** and **15** will produce by reason of the alignment of the magnetic lines of force a like polarity in the respective contact points **14** and **15** of reed elements **11** and **12** under which conditions by reason of the unlike polarity the contact points **14** and **15** will be moved from non-contacting relationship to contacting relationship.

In regard to normally open or normally closed relationship of the reed elements, it is well known in this art that the reed elements are of a material that can be prestressed so as to place them in a setting as desired. Thus if normally open operation is desired the reed elements **11** and **12** are set so the contacts **14** and **15** are not in contact with each other. Conversely, if a normally closed operation is desired the reeds are stressed so that the contact points **14** and **15** are in normally closed or contacting relationship.

Similarly, the reed element of the present invention can be actuated by an electro-magnetic means (not shown). In this arrangement, when current has passed through the coil of the electro-magnetic actuator, it establishes a magnetic field similar to that above described for the ring magnet means.

By positioning the electro-magnetic actuator so the medial transverse line CL thereof is either above the contact **14** and **15** or disposed to extend through the contact **14** and **15**, and further by presetting the reed elements so their coacting contacts are normally open or normally closed, the electro-magnetic actuating means can be used to actuate the device from either setting.

ANOTHER FORM OF THE INVENTION

FIGURES 7, 8 and 9 show an alternate form of the present invention in which a plurality of reed elements are used to provide a single pole double throw switch.

Thus the reed switch of the form of the invention shown in FIGURES 7, 8 and 9 includes an envelope **50** having a base **51** in which reed elements **52, 53** and **54** are each mounted so that one end is hermetically connected as at **55, 56** and **57** to the base **51** and the respective reed elements extend through the base **51** to form the external leads **58, 59** and **60** for these elements, which leads are adjacent each other and are located in substantially the same external area of the envelope.

The respective reed elements extend from their point of connection to the base **51** into and along the longitudinal line of the envelope, in the same direction and substantially parallel to each other, so that the sections of reed elements **52, 53** and **54** remote from the converted end lie side by side and are free to coact with each other.

The reed elements **52, 53** and **54** are of different length, and this is necessary in order to accomplish the desired operative relation of the parts.

Reed element **53**, the middle element of this plurality of elements, is an elongated element which is longer than the other reed elements **52** and **54**.

The reed elements **52** and **54** are identical with reed element **12**, except that they differ in length by approximately $\frac{1}{8}$" to $\frac{3}{16}$".

Element **53** is substantially identical with element **11** as shown in FIGURE 1 of the drawing, and accordingly includes the struck portion as at **61** to render it flexible. However, because reed element **53** coacts with the other reed elements **52** and **54**, it will have two contact points as at **62** and **63**, which contact points will be spaced relative each other similar to the spacing from the contact points **64** and **65** in the respective reed elements **52** and **54**.

The reed elements **52** and **54** are substantially stationary elements and are disposed on opposite sides of the flexible reed element **53** to permit the desired coaction between the contacts **62** and **64** and **63** and **65**.

When any suitable magnetic actuator is utilized with the form of the invention shown in FIGURE 7, as for ex-

ample with a permanent ring magnet as shown in FIGURES 5 and 11 of the drawings, the elongated reed element **53** may be disposed to move between two positions.

It is obvious that in one position it must be in normally closed position with respect to one of the coactive reed elements and in open position with respect to the other coacting reed element.

In the illustrated form of this invention in FIGURES 7, 8 and 9 the elongated element **53** is in a normally closed position with respect to element **52** and in a normally open relationship with respect to reed element **54**.

In FIGURE 10 with the ring magnet RM disposed in the position indicated, the reed elements will be set for a normally closed and normally open position as shown in FIGURE 7 of the drawings.

However, when the ring magnet is depressed to the position shown by the dotted lines, then the reed element **53** is deflected because of the repelling forces of the contact points from reed element **52** and the attractive forces of the contact points at reed element **54**.

In effect, contact is broken with reed element **52** and made with reed element **54**.

A similar relationship can be obtained with respect to an electro-magnetic actuating means (not shown). In this arrangement when a current is passed through the coil of the electro-magnetic actuator, then the elongated reed element **53** is once again deflected to break contact with element **52** and make contact with element **54**.

The advantages of this form of the invention will be recognized by those skilled in the art because this reed switch provides a single pole double throw switch which is highly reliable under the adverse conditions which these devices are required to meet.

It will be understood that this invention is not to be limited to the specific construction or arrangement of parts shown but that they may be rightly modified within the invention defined by the client.

What is claimed is:

1. A reed switch for a current carrying circuit to be actuated by movable magnetic means comprising:

(a) an envelope,

(b) more than two coacting reed elements each having one respective end mounted in and disposed to extend through said envelope at substantially the same point of reference to facilitate connecting said reed switch into the current carrying circuit,

(c) said reed elements to extend longitudinally into said envelope in the same direction,

(d) said reed elements having the sections thereof remote from the connected end operatively associated to form a switch,

(e) at least one of said reed elements disposed between a pair of oppositely mounted reed elements,

(f) said middle reed element having a length slightly greater than said other reed elements,

(g) at least one of said pair of oppositely mounted reed elements having a length slightly greater than the other reed element of the pair,

(h) coacting contact means on said oppositely mounted reed element and means on said middle reed element to permit it to flex towards and away from the respective oppositely mounted reed elements whereby it moves from operative engagement with one of the said pair of reed elements to the other of said pair of reed elements on movement of said magnetic means in the longitudinal line of said reed switch.

2. In a reed switch as claimed in claim **1** wherein the coacting contact means on said respective oppositely mounted reed elements have their points of contact disposed in planes spaced from each other in a range from ⅛ inch to 3/16 inch.

3. A reed switch for a current carrying circuit comprising:

(a) an envelope,

(b) a first elongated reed element mounted to a point of reference in said envelope,

(c) a second elongated reed element mounted adjacent said point of reference on said envelope on one side of said first reed element,

(d) a third elongated reed element mounted adjacent said point of reference in said envelope on the side of said first reed element opposite the side on which second reed element is mounted,

(e) said first, second and third reed elements disposed to extend through said envelope at substantially adjacent points to facilitate connecting said reed switch into the current carrying circuit,

(f) said reed elements to extend longitudinally into said envelope in the same direction and having the sections thereof remote from the connected end operatively associated to form a switch,

(g) said intermediate first element having a length greater than said oppositely mounted second and third reed elements,

(h) and said second reed element being slightly longer than said third reed elements,

(i) means to permit said reed elements to flex towards and away from each other whereby said intermediate element will move from operative engagement with one oppositely mounted reed element to the other of oppositively mounted reed element on actuation of reed switch,

(j) contact means formed on the respective free ends of said first reed element and said second reed element remote from their connected ends and cooperating contact means on opposite sides of said intermediate first reed elements whereby it moves from operative engagement with one of the said pair of reed elements to the other of said pair of reed elements on actuation of said reed switch.

4. In a reed switch as claimed in claim **3**, wherein the coacting contact means on said oppositely mounted first reed element and second reed element have their points of contact disposed in planes spaced from each other in a range from ⅛ inch to 3/16 inch.

5. In a reed switch as claimed in claim **4** wherein the intermediate first reed element is pretensioned to bias it into contact with said first reed element of the switch.

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