June 23, 1959 A. C. DUCATI 2,892,052

MAGNETICALLY OPERATED SEALED SWITCH APPARATUS

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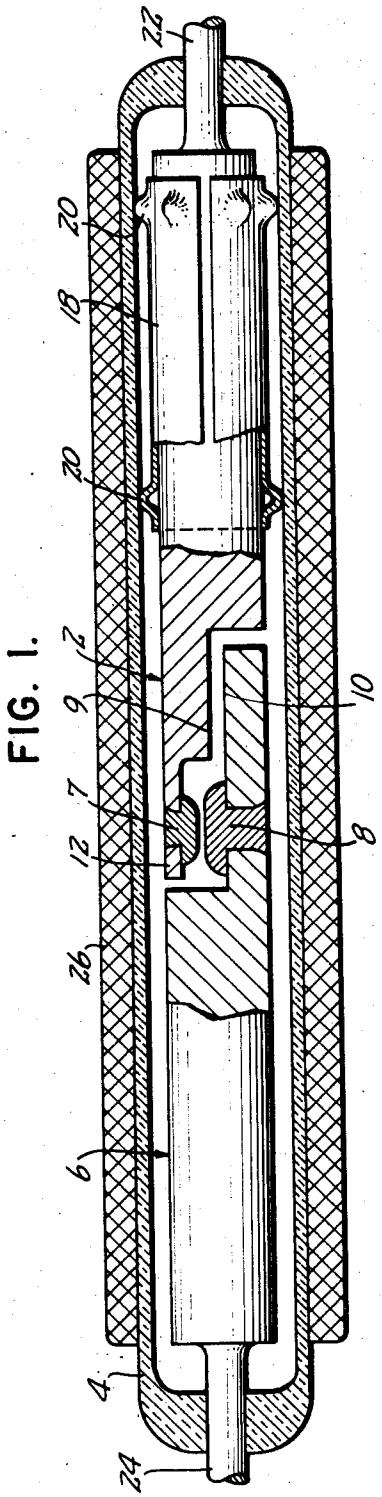


FIG. 1.

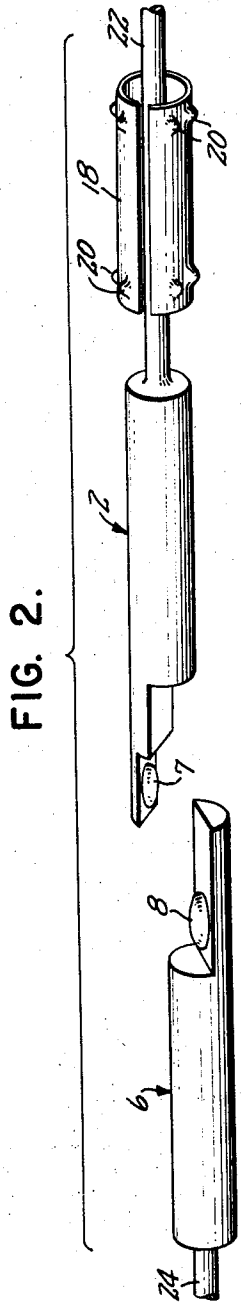


FIG. 2.

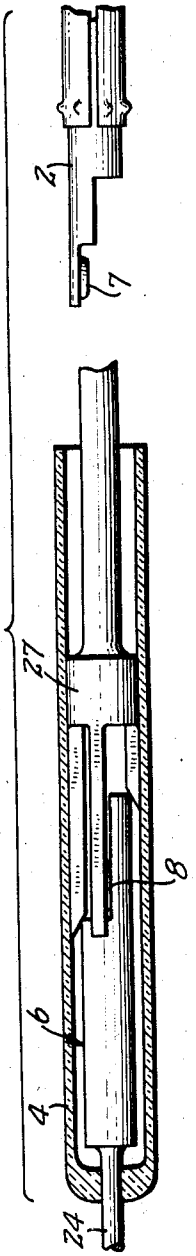


FIG. 3.

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FIG. 4.

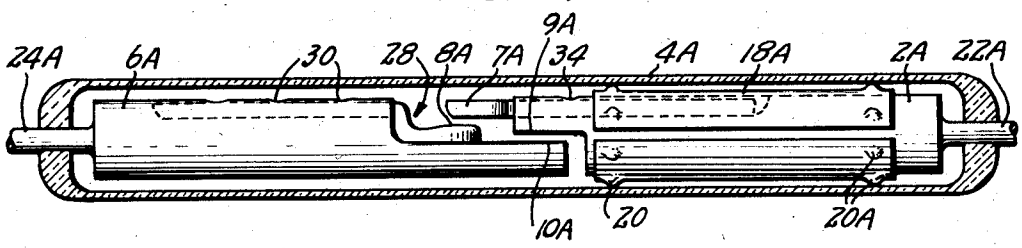


FIG. 5.

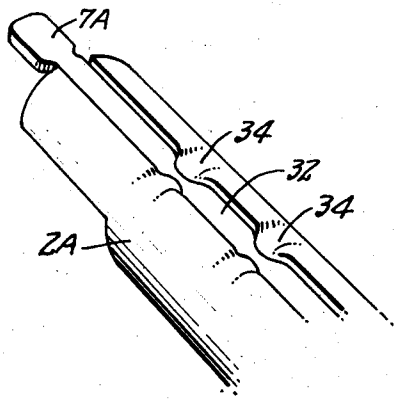


FIG. 6.

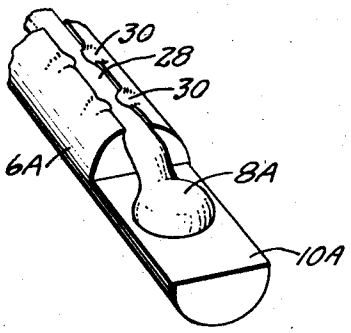


FIG. 7.

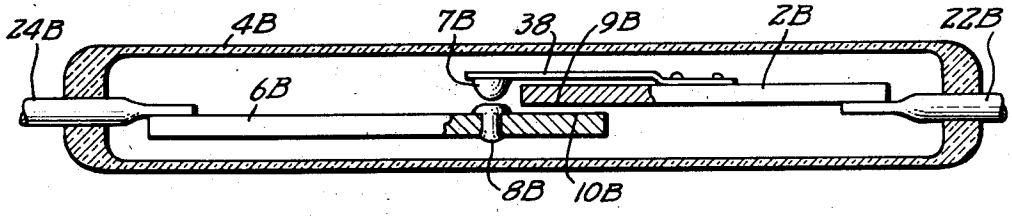
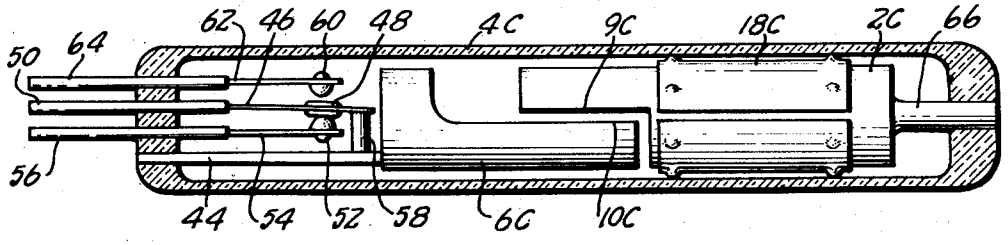


FIG. 8.



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MAGNETICALLY OPERATED SEALED SWITCH APPARATUS

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FIG. 9.

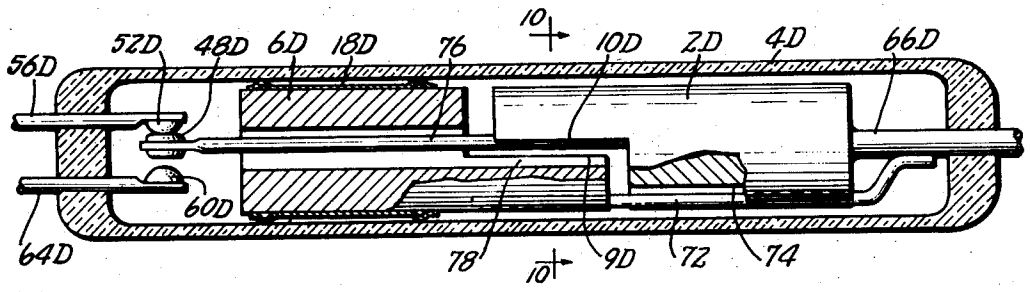


FIG. 10.

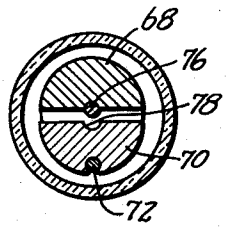


FIG. 11.

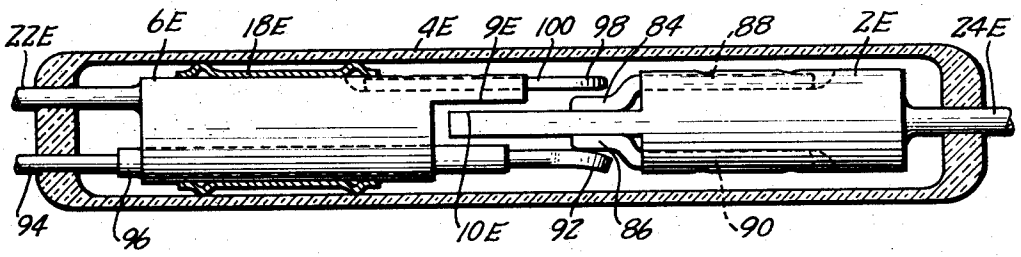
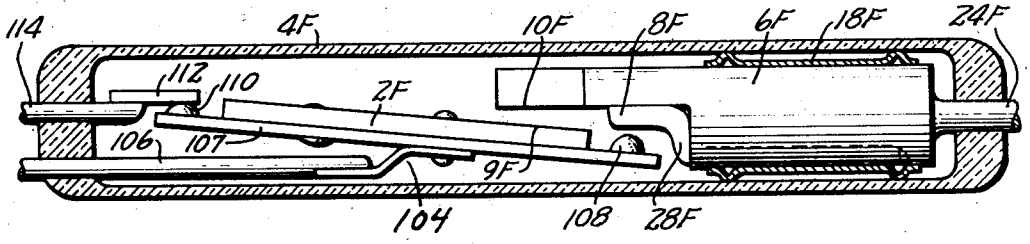


FIG. 12.



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FIG. 13.

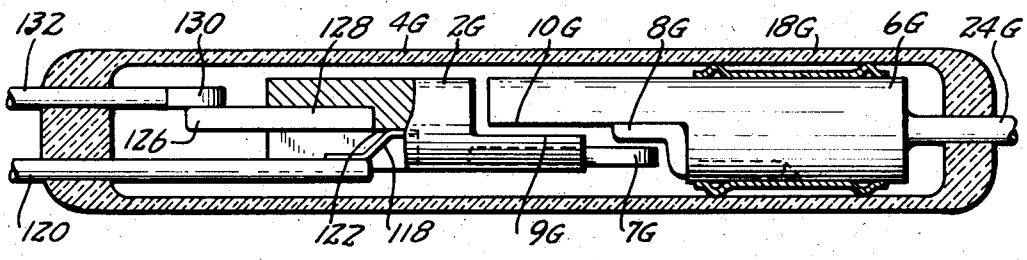


FIG. 14.

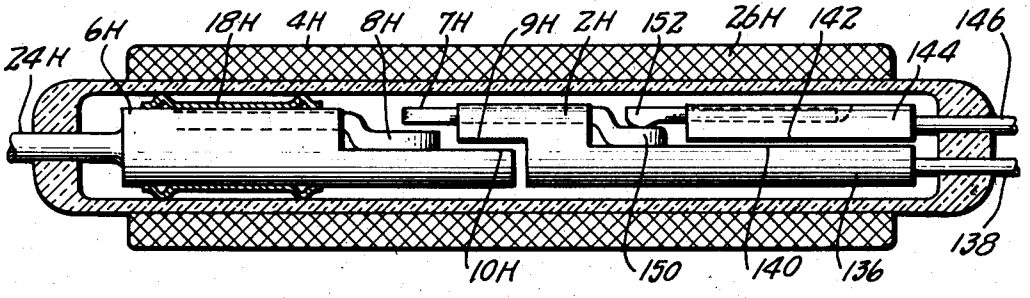


FIG. 15.

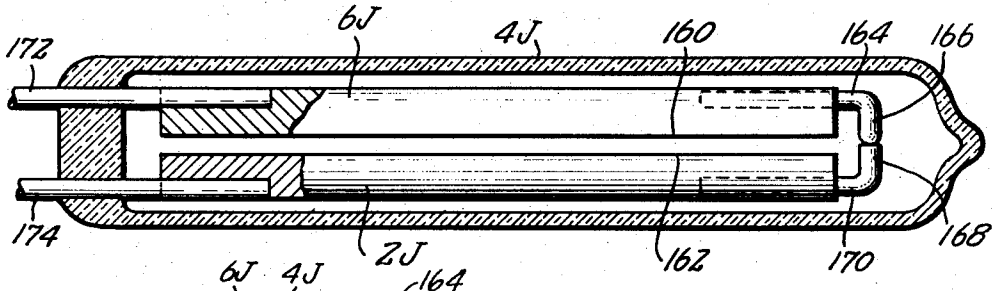
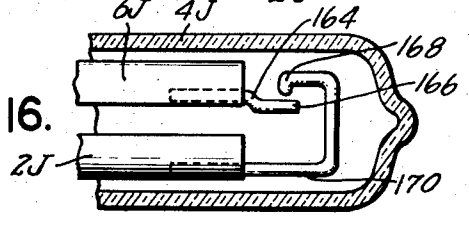


FIG. 16.



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United States Patent Office 2,892,052
Patented June 23, 1959

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MAGNETICALLY OPERATED SEALED SWITCH APPARATUS

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Application February 15, 1956, Serial No. 565,606

2 Claims. (Cl. 200—87)

This invention relates to sealed magnetically operated switches. More particularly, it relates to the type of switch in which two magnetic members within a sealed non-magnetic envelope are arranged so that when subjected to a magnetic field they are caused to move to complete or interrupt an electrical circuit. Switches of this general type are described, for example, in U.S. Patent No. 2,289,830 and in co-pending patent applications Serial No. 485,205 filed January 31, 1955, and Serial No. 515,983 filed June 16, 1955.

Such sealed switches have a number of important advantages: the contacts are sealed from the atmosphere, thus substantially reducing corrosive action and assuring long life and reliable operation; the switches are small in size; the sealed envelope can be pressurized to minimize arcing; and a number of switches can be actuated by a common magnetic field.

However, even though the contacts are sealed, it has been found that the ferromagnetic material, usually iron, which makes up the magnetic members does not provide the best contact surface. In general, better electrical contact is obtained and more reliable operation assured if those portions of the magnetic contact members which serve as contact areas are plated with high-conductivity, corrosion-resistant metal such as platinum, tungsten, silver, or the like. However, such a coating or layer must be very thin or it will interfere with proper operation of the switch. That is, the ferromagnetic portion of the members must be spaced further apart to allow room for the layer of non-magnetic contact material.

Moreover, trouble has been encountered with switches, even sealed switches, in which the electrical circuit is completed by contact of areas near the pole of magnetic members because of microscopic particles of iron dust which form or are accumulated during use and are picked up by the magnet. These metallic particles prevent intimate contact between the contact elements and increase the electrical resistance of the switch connection. This effect takes place even though the contact area is coated with a noble metal.

The switches embodying this invention may be used in relays or in other magnetically operated circuit control devices.

The present invention provides a sealed switch having separate contact elements which are activated by, but are not part of the magnetic circuit. This arrangement prevents magnetic dust from interfering with the effectiveness of the switch connection and makes it unnecessary to provide a noble contact metal in the gap between the magnetic members.

The improved switch construction permits maximum flexibility in the contact structure and insures rapid clean switching action. In the more usual construction of sealed relay switches, the magnetized contact members are attracted with increasing force as the gap between them narrows. When the two surfaces come together, they immediately "bounce" apart and are then attracted

again. Usually this "bouncing" is repeated a number of times with decreasing amplitude before final steady contact is made. When the two contact members are attracted directly by magnetic action, this bouncing is particularly bad because both magnetic contact members act as if they were essentially rigid members at the moment of impact so that the flexibility or damping action necessary to the elimination of bouncing is not present. By using separate non-magnetic contact members, advantage can be taken of the flexibility of these members to eliminate bouncing in the switch circuit even though there may be a certain amount of bouncing between the magnetized elements.

The various objects and advantages of the invention will be apparent from the following description of several switches embodying the invention and a description of the method of making these and other types of switches considered in conjunction with the accompanying drawings, in which:

Figure 1 is a longitudinal cross-section of a relay switch embodying the invention;

Figure 2 is an exploded perspective view of the parts of the switch shown in Figure 1;

Figure 3 illustrates one method of assembling the switch shown in Figures 1 and 2;

Figure 4 shows another switch construction having separate contact elements, one of which is flexible;

Figure 5 is a partial perspective view of one of the magnetic members of the switch shown in Figure 4;

Figure 6 is a partial perspective view of the other magnetic member of the switch shown in Figure 4;

Figure 7 shows still another switch construction utilizing two flat reeds and having separate contact elements, one of which is fixed to the reed and the other of which is supported by a flexible element;

Figure 8 shows an arrangement of double-throw contact elements which are actuated by an electrically independent magnetic element.

Figure 9 shows a switch, partly in section having another contact arrangement with a moving magnetic member arranged to actuate separate double-throw contacts;

Figure 10 is a sectional view taken along line 10—10 of Figure 9;

Figure 11 shows an arrangement in which one moving magnetic member actuates either of two flexible contact elements;

Figure 12 illustrates another double-throw switch in which a movable balanced magnetic member actuates separate contact elements;

Figure 13 shows another arrangement in which the moving balanced magnetic member actuates separate flexible contact elements;

Figure 14 shows still another double-throw switch in which one fixed and two moving members are combined to actuate separate contact elements by magnetic attraction and repulsion forces;

Figure 15 shows still another switch construction having separate contact elements which are actuated by magnetic repulsion of the magnetic members; and

Figure 16 is a partial sectional view showing a modification of the switch of Figure 15.

As shown in Figure 1, a magnetic member 2, formed of easily magnetizable material, such as soft iron, is positioned lengthwise within an envelope 4 which in this example is formed of glass but which can be made from any other suitable impervious non-magnetic material such as copper, aluminum, or the like. A second magnetic member 6 is positioned in the envelope 4 in axial alignment with the member 2. The members 2 and 6 are each provided with a button contact element, shown at 7 and 8, respectively. The button contacts are rela-

tively thick and are formed of silver or other suitable contact material. If the magnetic materials of said members which are to be attracted were separated by the thickness of the button contacts, the switch would require a very strong magnetic field to actuate it and the force maintaining the electrical contact would be substantially reduced. For this reason, the magnetic members are shaped as shown in Figure 1 to provide two closely-spaced actuating portions indicated at **9** and **10**, respectively. The main body of the magnetic member **6** is circular in cross section, but near its free end the cross section is a segment of a circle providing a planar upper surface which carries the contact **8** and forms the actuating area **10**. This area **10** is arranged to overlap a similar planar actuating surface **9** on the magnetic member **2**. A still thinner end portion **12** carries the contact button **7**.

The contact buttons **7** and **8** are secured to the magnetic members **2** and **6** by riveting, as illustrated, but any other fastening means which will provide good electrical contact can be used.

The member **2** is held in fixed position within the envelope **4** by means of a tubular centering sleeve **18**. This centering sleeve is formed of spring metal curved to form an almost completely closed cylinder. It is provided with a number of outwardly extending dimples or projections, as indicated at **20**, which bear against the inner surface of the envelope **4**. These projections **20** can be formed by swaging the metal of the sleeve **18** outwardly at spaced points around the periphery near each end of the sleeve. If desired, a series of holes can be drilled in the sleeve and the metal around these holes swaged outwardly by a tapered punch. If additional spring tolerance is desired, one or more radial cuts can be made around the openings. The sleeve **18** fits snugly around the member **2** to hold it firmly in fixed position within the envelope. Member **2** is connected by means of a lead **22** welded thereto and sealed through the glass envelope **4**.

The other magnetic member **6** is fixed longitudinally within the envelope **4**, but is resiliently supported so that its free end can move laterally, although normally held by a resilient supporting lead **24** welded to its end and sealed through the end of the envelope **4**. The resiliency of the lead **24** permits the desired freedom of movement for operation of the switch contacts.

A magnetic field is provided, for example, by means of a winding **26** around the envelope **4**. When a magnetic field is present, e.g., by virtue of the winding **26**, the magnetic members are attracted, bringing the two contact portions **7** and **8** into engagement.

It will be noted that adequate room is provided for the separate contact buttons which may have substantial thickness, thus assuring good electrical contact and long life. Even with relatively thick contact buttons, the actuating surfaces **9** and **10** on the ferromagnetic pole parts of the members **2** and **6** may be positioned as closely together as desired. Thus, the sensitivity of the switch is not decreased by the use of separate contact members. In addition, it will be noted that the adjacent surfaces of the contact buttons **7** and **8** may be arranged to engage before the surfaces **9** and **10** come together. This results in a number of advantages. First, it assures that good contact will always be made because the closing motion will not be limited by engagement of the magnetic members per se. In addition, because the electrical contact is made through the separate contact elements of non-magnetic material, they are not held together by their own attraction. The magnetic members may then be designed for instant release when the magnetic field is interrupted.

In manufacturing a relay with switch as shown in Figures 1 and 2, the following method is preferred and is made possible by the use of one fixed magnetic member and the centering sleeve **18**. The lead **24**, which may be formed of Kovar or other metal that can be sealed to glass, is first welded to the end of the member **6**, which is then positioned within the glass envelope **4** and held by a centering sleeve or other device inserted into the envelope from the opposite end. The end of the glass envelope **4** is then sealed around the lead **24** and the centering sleeve or other device removed, leaving the member **6** resiliently supported in the center of the envelope.

The other member **2**, welded to a lead **22**, of Kovar or metal adapted for fused seals to the glass tube, is fitted into the centering sleeve **20**. The entire assembly is then slid into the open end of the envelope **4** and rotated until its contact **7** is positioned adjacent the contact **8**. The envelope **4** is then sealed to the lead **22** to form the completed switch structure. This method of construction is illustrated in Figure 3 which shows the magnetic member **6** being held in position by a removable centering sleeve **27**. The other member **2** and permanent centering sleeve **20** are shown ready for insertion in the envelope **4** after the temporary centering sleeve **27** is removed.

In the various illustrations which are referred to below, similar numbers have been used to designate corresponding parts serving the same function as in the foregoing description or the description of preceding embodiments. In some instances these parts are identical, whereas in other instances they are similar parts performing the same or similar functions.

Figures 4, 5 and 6 illustrate another switch construction incorporating a flexible contact member. In these drawings, parts generally similar to those in earlier views are indicated by corresponding numbers followed by the suffix A.

A movable magnetic member **6A** is resiliently supported by a lead **24A** in an envelope **4A**. A fixed member **2A** is held in central position in the envelope by a centering sleeve **18A** and is connected to the lead **22A**.

A portion of the member **6A** near its free end is reduced in thickness and its cross section forms a segment of a circle, on the flat side of which is a contact member **28**, which in this instance is in the form of a wire of non-corrosive, non-magnetic metal such as silver. One end of this wire is shaped to form a contact button **8A** and the remainder of the wire is positioned in a groove, the edges of which are staked over the contact member **28** at spaced points, as at **30**.

The planar surface **10A** beyond the button **8A** serves as the actuating area and is spaced slightly from a corresponding planar actuating surface **9A** on the other member **2A**.

The other contact element **32** is also in the form of a wire, of silver or other suitable material, which is positioned in a groove in the upper surface of member **2A** and extends beyond its end where it is shaped to form a contact button **7A**. This wire is also staked in the groove as indicated at **34**, but a considerable length of wire extends between the button **7A** and the first stake **34** to provide a resilient support for the contact element. Thus, when the surfaces **9A** and **10A** are attracted by the magnetic forces, the contact buttons **7A** and **8A** engage and the element **32** is deflected upwardly (as viewed in the drawing) so that a slight sliding action takes place between the contact buttons which helps to keep the contacts clean and assures a good electrical connection. It will be noted also that the deflection of the contact button **7A** maintains a downward pressure on the member **6A**, which helps to push the magnetic members apart upon the removal of the magnetic field even against some residual magnetism.

In the foregoing embodiments, the magnetic members have been circular in cross section, so that the ferromagnetic material fills most of the cross section of the envelope, thus providing maximum efficiency in the magnetic circuit. However, if desired, reed-type members can be used. One such arrangement is shown in Figure

7, in which certain of the parts corresponding to those in preceding embodiments are indicated by the same numerals followed by the suffix B.

A first flat reed member 6B, formed of iron or other magnetizable material, is welded to a supporting lead 24B, which is sealed into the end of the envelope 4B. A contact button 8B, of suitable non-magnetic contact material, is riveted or otherwise secured to the member 36 a short distance from the end. The other contact button 7B is positioned adjacent the contact 8B and is secured by soldering or other means to a supporting strip 38 of electrically conductive metal which has an offset portion near its opposite end that is secured by riveting to the other flat reed magnetic member 2B, welded to a supporting lead 22B sealed in the end of the envelope 4B. The free end of the member 2B, beyond where the strip 38 is attached to it, overlaps the member 6B so that its actuating surface area 9B is normally spaced from and opposite the actuating portion 10B.

When the switch is subjected to a magnetic field, the actuating portions 9B and 10B are attracted, bringing the contact buttons 7B and 8B into engagement to complete the electrical circuit between the leads 22B and 24B. When the contact buttons are engaged, the strip 38 is deflected away from the member 2B. The strip has sufficient spring-like quality to maintain firm pressure on the contact buttons and to return to the position shown in Figure 7 when the magnetic field is removed.

Another contact element arrangement is shown in Figure 8 in which certain parts corresponding to similar parts of earlier embodiments are designated by the same numbers followed by the suffix C.

A soft iron member 2C of circular cross section is held in fixed position in the envelope 4C by a centering sleeve 18C and has an end portion of substantially semi-circular cross section forming the actuating surface area 9C. The other magnetic member 6C, also of soft iron, has a circular cross section at one end, the remaining portion being nearly semi-circular in cross section to form the actuating area 10C overlapping and spaced from the actuating portion 9C.

Member 6C is resiliently supported by a flexible flat reed support 44 sealed into the end of the envelope 4C. A movable contact member 46,in the form of a flat resilient metal reed, carries a double-sided contact button 48 near its free end and at the other end is secured to a lead 50 sealed into the envelope 4C.

When no magnetic field is present, the contact button 48 engages a contact button 52 that is secured by a metal supporting strip 54 to a lead 56 sealed through the end wall of the envelope 4C. When a magnetic field is applied to the switch, the actuating portions 9C and 10C are drawn together, causing a pin 58, extending laterally from the strip 44, to move the end of the contact-supporting strip 46 separating the contact buttons 48 and 52 and moving the contact button 48 into engagement with a contact button 60. The contact 60 is supported by a metal strip 62 connected to a lead 64 sealed through the end of the envelope 4C.

Thus, when the switch is not energized, a circuit is completed between the leads 50 and 56, and when the switch is energized an electrical circuit is completed between the leads 50 and 64. In this instance the magnetic member 2C is anchored in position by a member 66 welded thereto, but which does not serve as an electrical connection.

Figures 9 and 10 show another arrangement in which both magnetic members are anchored to a common support and in which certain parts corresponding to parts in earlier views are indicated by the same numerals followed by the suffix D.

A movable magnetic member 2D, of soft iron, is supported by a wire 66D sealed into one end of the envelope 4D. The main body of the member 2D is circular in cross section and has a reduced end portion that is nearly semi-circular in cross section which forms the actuating area 10D.

A fixed soft-iron member 6D, held in centered position by a centering sleeve 18D, also has a main body portion of circular cross section and a semi-circular end portion forming the actuating area 9D. It is anchored against longitudinal movement by a member 72, formed of non-magnetizable metal, which is soldered or otherwise secured in an opening in the end of member 6D and extends through a longitudinal clearance opening 74 in the member 2D and is welded to the supporting member 66D.

The main body of the member 6D has a central longitudinal clearance opening through which extends a movable contact member 76 of non-magnetizable metal. One end of this member 76 is secured to the free end of member 2D in a groove in the flat actuating surface 10D. The other end of the member 76 carries a double-sided contact button 48D which normally engages a contact button 52D supported by a lead 54D sealed through the end of the envelope 4D.

Thus, when the switch is not subjected to a magnetic field, an electrical circuit is completed from the lead 56D through the contact buttons 52D and 48D, the contact member 76 and the member 2D to the support lead 66D.

When the switch is energized by a suitable magnetic field, the actuating portion 10D moves toward the actuating portion 9D of the fixed member causing the contact button 48D to separate from the contact button 52D and engage a contact button which is supported by a lead 60D sealed through the end wall of the envelope 4D. A longitudinal groove 78 (Figure 10) in the flat actuating portion 9D accommodates the exposed portion of the contact element 76 when the magnetic members are drawn together. The electrical circuit is then completed between the lead 64D and the lead 66D.

Figure 11 shows an arrangement in which one moving magnetic member actuates two flexible contact elements, and in which certain parts corresponding to parts in earlier views are designated by the same numerals followed by the suffix E. A soft iron member 6E, having a main body of circular cross section, is held in central position in the envelope 4E by the centering sleeve 18E. One end of this member is welded to a lead 24E sealed through the end of the envelope 4E. Its other end is of reduced section and has a cross section forming a segment of a circle and a flat actuating area 9E.

A cooperating soft iron member 2E is also of circular cross section and is supported by a lead 24E welded to its end and sealed through the end wall of the envelope 4E. The free end of the magnetic member 2E is of reduced section and is in the form of an extending blade having a substantially rectangular cross section except for the slightly rounded edges and has a maximum width equal to the diameter of the main body of the member 2E. This blade extension provides a flat actuating area 10E overlapping and spaced from the actuating portion 9E of the electrode 80.

The member 2E carries on its opposite sides contact members 88 and 90, having, respectively, two contact buttons 84 and 86, each of which may be identical with the contact button 8A shown in Figure 6.

In the absence of magnetic flux through members 2E and 6E, the contact button 86 engages a contact button 92 formed on the end of a flexible support lead 94. The lead 94 passes longitudinally through an opening in the member 6E, being insulated from it by tubular insulating material 96, and is sealed into the end of the envelope 4E.

When the switch is magnetized, the actuating surface 10E moves toward the surface 9E, separating the contact buttons 86 and 92 and moving the contact button 84 on the opposite side of member 2E into engagement with a contact button 98 formed on the free end of a flexible supporting wire 100 secured to the member 6E. This

contact member may be identical with the contact member 7A of Figure 5 and secured to the electrode in the same way.

In Figure 12, in which certain parts corresponding to similar parts in earlier views are designated by the same numerals followed by the suffix F, a double-throw contact arrangement is actuated by a balanced magnetic member.

The magnetic member 6F and its contact button 8F and connecting member 28F may be identical in construction with the member 6A of Figure 4. In this instance, however, the member 6F is fixed in position in the envelope 4F by the centering sleeve 18F.

The other magnetic member 2F is in the form of a soft iron bar of rectangular cross section which is riveted near its center to a flexible metal strap 104 that is welded or otherwise secured to a rigid supporting lead 106 that is sealed through the end wall of the envelope 4E. The member 2F carries along one side a non-magnetic metal strap 107 which extends beyond it at each end and carries two contact buttons 108 and 110 of suitable contact material. The contact button 110 normally engages a contact 112 carried by a lead 114, to complete a connection between the lead 114 and the lead 106.

When the switch is magnetized, the actuating portion 9F of the magnetic member 2F moves into engagement with the actuating portion 10F of the member 6F, separating the contacts 110 and 112 and bringing the contact 108 into engagement with the contact 8E to complete the circuit between the lead 106 and the lead 24E.

The point of support for the member 2F by the strap 104 is selected so that the member and its associated parts are dynamically balanced. The switch can then be made to operate reliably even while subject to rapid acceleration or deceleration.

Figure 13 shows a switch operationally similar to the one shown in Figure 12 except that the moving balanced magnetic member is circular in cross section and the contact buttons are flexibly supported. In this embodiment, certain parts corresponding to similar parts in earlier views are designated by the same numerals followed by the suffix G.

A fixed soft-iron member 6G carries a contact button 8G and is held in position by a centering sleeve 18G. This member and associated contact element may be identical with the member 6E of Figure 12 except that the main body is somewhat shorter.

The moving magnetic member 2G is formed of soft iron and has a main body portion of circular cross section. This is supported by a flexible strap 118 secured to a rigid supporting lead 120 sealed through the envelope 4G. In order to secure the strap 118 to the dynamic balance point of the member 2G a groove 122 is provided from the end along one side, and the strap 118 extends into this groove and is welded or otherwise secured to the member.

At the opposite end of the member 2G a contact button 7G is resiliently supported by a lead similarly as for the contact button 7A in Figures 4 and 5. Another contact button 126 is similarly supported by a flexible lead 128 extending from the opposite end of the member 2G and normally engages a fixed contact 130 supported by a lead 132 sealed through the end of the envelope 4G.

The member 2G has a reduced portion with the cross section of a segment of a circle and a flat actuating surface area 9G. When the members are magnetized, the actuating portion 9G of the member 2G moves into engagement with the actuating area 10G of the member 6G, causing the strap 118 to flex and allow the member to pivot around this strap. The contacts 7G and 8G thus close to complete the circuit between the lead 120 and the lead 24G while the contacts 126 and 130 are opened.

In the embodiment shown in Figure 14, in which certain parts corresponding to parts shown in earlier views are identified by the same numerals followed by the suffix H, advantage is taken of magnetic repulsion forces as well as forces of attraction.

A soft-iron member 2H has a central body portion of circular cross section. A long semi-circular portion 136 extends in one direction from the main body portion and is supported at the end by a lead 138 sealed through the envelope 4H. The flat surface of this portion 136 forms an actuating surface area 140 which is positioned in spaced face-to-face relationship with a corresponding flat actuating surface area 142 of another soft-iron member. This latter member has a cross section forming a segment of a circle and is supported at one end by a lead 146 sealed through the wall of the envelope 4H.

The magnetic member 2H has another actuating portion 9H formed by the flat face of a semicircular extension from the end of its main body portion opposite the extension 136.

A fixed member 6H is identical with the member 6A of Figure 4 including a corresponding contact button 8H and actuating portion 10H. The member 6H is held in fixed position by the centering sleeve 18H and is welded to a lead wire 24H sealed through the envelope 4H.

The movable magnetic member 2H carries two contact buttons 7H and 150. The contact button 7H may be identical with the contact 7A of Figure 5 and the contact button 150 is generally the same construction as the contact 8H. A contact button 152 extends from the free end of the member 144 and normally engages the contact 150 of the member 2H to complete a circuit between the leads 138 and 146.

When the switch is magnetized, as by energizing the winding 26H, the actuating portions 9H and 10H are attracted, causing the magnetic member 2H to move laterally toward the member 6H and close the contacts 7H and 8H. The contacts 150 and 152 open at the same time and this action is assisted by the magnetic repulsion between the actuating portions 140 and 142. This repulsion occurs because the two actuating portions are magnetized with similar polarities.

Figure 15 shows a normally-closed relay switch in which certain parts corresponding to parts shown in earlier views are identified by the same numerals followed by the suffix J.

Two soft-iron members 2J and 6J, each having a semicircular cross section, are positioned in an envelope 4J with their flat surfaces in spaced face-to-face relationship. These flat faces form the actuating portions 160 and 162, respectively. A non-magnetic wire 164 is secured to the free end of the member 2J and is shaped at its end to form an inwardly-extending contact button 166 which normally engages a contact button 168 formed on the end of a wire 170 secured to the free end of the member 6J.

These magnetic members, 2J and 4J, are supported respectively by lead wires 172 and 174 which are sealed into the envelope 4J in such direction as to apply spring bias holding the contacts 166 and 168 in engagement.

When the switch is subjected to a magnetic field, the magnetic members are magnetized with similar poles directly opposite each other, resulting in a magnetic repulsion between these members. The free ends of the members are thus caused to move apart, separating the contacts 166 and 168.

In the switch of Figure 16, which operates on the same principles as that of Figure 15 and is generally similar to that of Figure 15, the contact button 168A is positioned relatively on the opposite side of the contact button 166A from their positions in Figure 15. Thus, the switch of Figure 16 is a normally-open switch which is closed by repulsion action when the magnetic members 6J and 2J are magnetized.

In all of the embodiments described, the envelope may be evacuated or it may be pressurized with an inert gas such as helium or the like. In all the switch may serve

as a relay by locating in the field of an electromagnet (as in Figure 14) or they may be operated by manually or mechanically, or otherwise, moving the switch or a magnet (permanent or electromagnet) relative to each other; or, as disclosed in a copending application, Serial No. 55,166 filed December 23, 1955, one may bring the magnetic flux to the switch by establishing a magnetic path, e.g., of soft iron, to the vicinity of the switch from a magnetic source.

What is claimed is:

1. A switch of the type adapted to be operated by the application of an external magnetic field comprising a sealed envelope formed of non-magnetic material, a first elongated switch member formed of electrically conductive material and having an actuating portion formed of magnetizable material and having a first contact portion separate from said actuating portion, a second elongated switch member of electrically conductive material and having an actuating portion formed of magnetizable material and having second and third contact portions separate from said actuating portion, means supporting said first member in fixed position lengthwise within said envelope, means resiliently supporting said second member lengthwise in said envelope with its actuating portion in overlapping spaced face-to-face relationship with the actuating portion of said first member and said first and second contact portions positioned adjacent each other, and a fixed contact member positioned in said envelope and having a fourth contact portion normally engaging said third contact portion.

2. A switch of the type adapted to be operated by the application of an external magnetic field comprising a sealed envelope formed of non-magnetic material, a first magnetic member formed of electrically conductive material and having an actuating portion formed of magnetizable material and having a contact portion separate from said actuating portion, a second elongated magnetic member of electrically conductive material and having an actuating portion formed of magnetizable material and having second and third contact portions positioned at opposite ends of said second member, means supporting said first member in fixed position lengthwise within said envelope, a rigid supporting member, resilient support means connected near the center of gravity of said second member and carried by said rigid supporting member, the respective actuating portions of said magnetic members being in overlapping spaced face-to-face relationship and said first and second contact portions being normally spaced apart, and a contact member having a contact portion normally engaging said third contact portion.

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