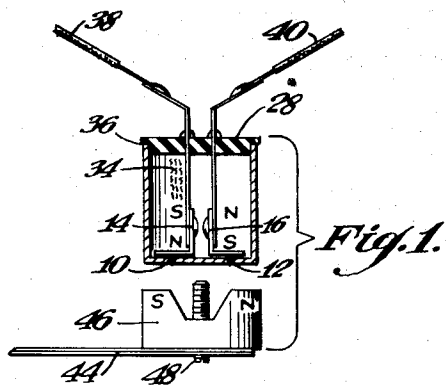
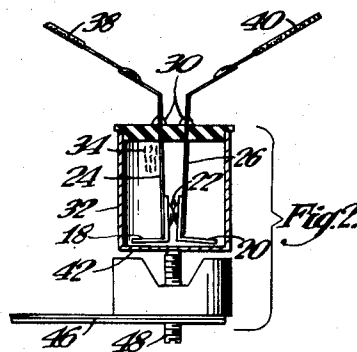
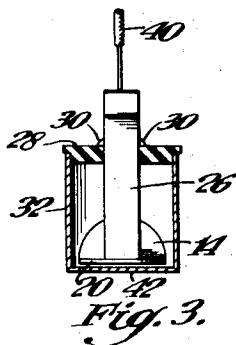
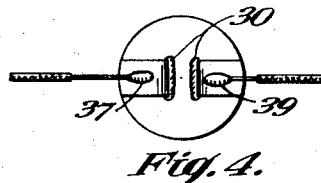
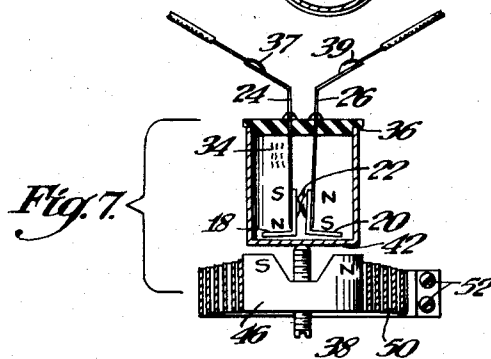
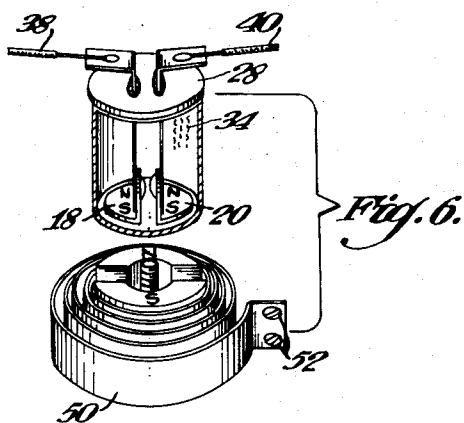


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MAGNETIC SWITCHES
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MAGNETIC SWITCHES

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This invention relates to electrical switches and more particularly to a magnetically operated electrical switch for use in thermostats and other condition responsive control devices.

It is an object of this invention to provide a switch having a relatively large force holding the contacts in closed position and yet allowing the switch contacts to be opened by the application of a relatively small operating force.

It is another object of this invention to simplify field adjustments by maintaining the operating force at a lower value than the contact force at any position of adjustment of the forces.

It is still another object of this invention to employ a solid contact switch which is independent of the tilt of the mechanism and the production problems involved in the use of a mercury switch.

It is a still further object of this invention to provide a small, light weight switch which is easily assembled and simple to adjust.

It is still another object of this invention to minimize contact bounce and resistance due to oxidized contacts, grime, etc.

In the preferred embodiment of this invention, a pair of magnetizable members, each having an electrical contact thereon, are resiliently mounted within a capsule by a pair of leaf springs. A resilient bimetal is provided with a magnetizing member mounted thereon which induces magnetism in the magnetizable members. The magnetizing member is attracted by the magnetizable members and the bimetal in response to a predetermined temperature moves the magnetizing member to a position where the attracting force overcomes the bias of the bimetal. The magnetizing member then moves with a snap action toward the magnetizable members. This movement causes a sufficient attraction between the pair of magnetizable members to overcome the bias of the leaf springs thereby closing the electrical contacts.

Other objects and advantages of this invention will become apparent from the following detailed description taken in connection with the accompanying drawings wherein:

Fig. 1 is an elevation view, partially in section, of the switch embodying this invention in the inoperative position;

Fig. 2 is a view similar to Fig. 1 showing the switch in the operative position;

Fig. 3 is a side elevation view of a detail of the switch shown in Fig. 1;

Fig. 4 is a plan view of a portion of the switch shown in Fig. 1;

Fig. 5 is a bottom view of a detail of the switch shown in Fig. 1;

Fig. 6 is a perspective view of an embodiment of this invention shown in the inoperative position; and

Fig. 7 is an elevation view, partially in section, of the embodiment shown in Fig. 6 in the operative position.

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Referring more particularly to the drawings, a pair of disc-shaped members 10, 12 are punched from a piece of magnet iron and bent along a diameter thereof to form substantially right-angular configurations. The right-angular configurations comprise contact legs 14, 16 and armature legs 18, 20 of members 10 and 12, respectively. A protrusion or contact 22 is formed on the outer portion of each contact leg 14, 16. The members 10, 12 are silver-plated and the inner portion of each contact leg 14, 16 is attached by suitable means to a slender rectangular-shaped leaf spring 24, 26, respectively. Member 10 and leaf spring 24 and member 12 and leaf spring 26 form two identical sub-assemblies and the leaf springs 24 and 26 are projected through a resilient self-sealing cap member 28 with the right-angular configuration of members 10 and 12 aligned back to back and protrusions 22 thereon in directly opposed relation. Seals 30 may be installed between the leaf springs 24, 26 and the cap member 28 to insure a tight connection therebetween.

The sub-assemblies are inserted in a cup-shaped capsule 32 and the cap 28 which is of circular configuration is adapted to close the open end thereof. The cup-shaped capsule 32 may be filled with an inert gas 34 to inhibit arcing between the contacts 22 which tends to burn the same, and to prevent the formation of O₃ gas, which has a highly oxidizing effect on the contacts 22 and other switch components. A seal 36 may be provided between the cap 28 and the capsule 32 to hermetically seal the gas 34 within the capsule and to protect the switch against dust, corrosion and explosive atmospheres.

The ends of leaf springs 24, 26 which protrude through the cap 28 are bent to accommodate connecting wiring 38, 40, respectively, which is attached directly thereto by solder 37, 39. The length of the leaf springs 24 and 26 extending within the capsule 32 is such that the armature legs 18 and 20 of members 10 and 12 which are attached to the leaf springs 24, 26, respectively, are suspended immediately above the bottom 38 of the capsule.

Means is provided for passing a magnetic field through members 10 and 12 to induce magnetism therein. More particularly, a resilient bimetallic member 44 has one end attached to a suitable support (not shown) and a permanent magnet 46 mounted on the other end. The permanent magnet 46 is disposed beneath the bottom 42 of capsule 32 and is movable toward and away from the bottom 42 by bimetal 44 in response to variations in temperature. A screw 48 is threadably mounted on the bimetal 44 and extends through the central portion of permanent magnet 46 and protrudes beyond the extremities of the magnet 46 to engage the bottom 42 of capsule 32 for limiting the movement of magnet 46 in that direction.

In operation of the embodiment shown in Figs. 1-5, the permanent magnet 46 is held away from the capsule 32 by the bimetal 44 and the contacts 22 with the capsule 32 are open as shown in Fig. 1. The permanent magnet 46 induces magnetism in the members 10 and 12. As shown in Fig. 1, the armature leg 18 is over the south pole of magnet 46 and the armature leg 20 is over the north pole. Therefore, the armature leg 18 becomes an induced north pole, whereas the contact leg 14 becomes an induced south pole. In like manner, the armature leg 20 becomes an induced south pole and the contact leg 16 becomes an induced north pole. Thus, a magnetic attraction exists between the contact legs 14 and 16, and as part of the same magnetic circuit, attraction also exists between the magnet 46 and the armature legs 18 and 20. This attraction is counteracted by the bias

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of leaf springs 24 and 26 and the bias of bimetal 44 to maintain the elements in the position shown in Fig. 1.

As the bimetal 44 carries the magnet 46 toward the capsule 32 in response to a temperature change, the field intensity on armature legs 18 and 20 increases. When this magnetic attraction between the magnet 46 and the armature legs 18 and 20 overcomes the resistive force of the bias of bimetal 44, the magnet 46 snaps toward the capsule 32, bending the bimetal 44 in the process, until screw 48 engages the bottom 42 of capsule 32. During the free motion of magnet 46 as it snaps toward the capsule 32, the increasing attraction between the contact legs 14 and 16 eventually overcomes the bias of leaf springs 24 and 26 and the two contacts snap together. The switch is then closed as shown in Fig. 2 and the contact force between contacts 22 is instantly at its maximum and remains constant until the instant of the contact opening.

The contact force or the closing force on the contacts is the difference between the magnetic attractive force between contact legs 14 and 16 and the resistive force exerted by the bias of leaf springs 24 and 26. The leaf springs 24 and 26 are chosen so that the bias thereof is substantially less than the attractive force between the contact legs 14 and 16 to insure a high contact force. The resiliency of the bimetal 44 is such that the magnet 46 moves over a relatively great distance upon snapping motion toward capsule 32 to store a larger retractive force in the bimetal 44 than that stored in leaf springs 24 and 26. In other words, the selection of leaf springs 24 and 26 and the resiliency of bimetal 44 results in a large force holding the contacts 22 in closed position and only a small force holding the magnet 46 in operative position. With this arrangement, only a small temperature change is required to move magnet 46 away from capsule 32. Only when the magnet 46 snaps away from capsule 32 will the magnetic attraction between contact legs 14 and 16 be reduced below the value of the retractive forces in leaf springs 24 and 26 to allow contacts 22 to snap open.

To adjust the contact force and the operating force, the screw 48 is merely rotated with respect to its bimetal mounting. Since the screw 48 engages the bottom 42 of capsule 32, this adjustment of screw 48 varies the approach of magnet 46 thereby changing the magnetic attractive force between the magnet 46 and the armature legs 18 and 20 and changing the magnetic attractive force between the contact legs 14 and 16. Thus, adjustment of the contact force and the operating force may be obtained while still maintaining the same ratio of high contact force to low operating force at all adjustments.

Adjustment of the contact force alone may be made before the sub-assembly is inserted in the capsule 32. This is accomplished merely by bending the leaf springs 24, 26 permanently to change the distance of travel of the leaf springs 24, 26 required to close the contacts 22.

In addition to the manual adjustment of screw 48, the contact force and operating force may be determined initially by varying the thickness of the silver plating on the right-angularly bent discs 10 and 12. The plating acts as a non-magnetic spacer between the contacts 22 and since the contact gap is a part of the total magnetic circuit, the plating thickness determines the magnetic attractive force between magnet 46 and armature legs 18 and 20 and the mutual attractive force between contact legs 14 and 16. It is apparent that the thickness of the silver plating may greatly vary the contact force and the operating force since in this portion of the curve of magnetic attraction versus the distance between contacts 22, the difference of a few thousandths of an inch in distance creates a large difference in magnetic attractive force. In addition, the silver plating acts as an electrical conductor to decrease the electrical resistance at the point of contact.

Another feature of this invention resides in the fact

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that contacts 22 are formed adjacent the ends of contact legs 14 and 16. Snap acting switches by their very nature tend to exhibit contact bounce on closure. To eliminate contact bounce in the present switch, the contacts 22 are placed adjacent the end of contact legs 14 and 16 so that the center of magnetic attraction between the contact legs 14 and 16 occurs at the contacts 22 and the center of mass of the members 10 and 12 occurs some distance below the contact points. On closure, the contacts 22 tend to roll over one another since the inertia of members 10 and 12 act through a moment arm, while magnetic attraction holds the contacts 22 together at the fulcrum. Also, as a further result of this feature, the wiping and rolling action between the contacts 22 serves to clean the contacts for better electrical connection.

In the embodiment of this invention shown in Figs. 6 and 7, the structure is similar to that shown in Figs. 1-5 except that the resilient bimetallic member 44 has been replaced by a spiral coil 50. The bimetallic coil 50 circumscribes permanent magnet 46 and has its inner end attached thereto. The coil 50 is positioned slightly below the bottom 42 of capsule 32 by a pair of screws 52 which attach the outer end of coil 50 to a suitable support (not shown).

In operation of the embodiment of the invention shown in Figs. 6 and 7, the contacts 22 are initially open and the poles of magnet 46 are at right angles to the contact legs 14 and 16 as shown in Fig. 6. It is apparent that members 10 and 12 are permeated by the magnetic flux. However, since each armature leg 18 and 20 is centrally positioned over both the north and south poles of magnet 46, the contact legs 14 and 16 are in equilibrium magnetically and do not attract one another.

As the magnet 46 is rotated by the bimetal 50 in response to a temperature change to eventually reach the position shown in Fig. 7, the armature leg 18 becomes more and more subjected to the south pole and the armature leg 20 is likewise subjected to the north pole. Therefore, a magnetic attraction is developed between armature legs 18 and 20 and the magnet 46, and the contact legs 14 and 16 develop a mutual attraction as before. As the attractive force between armature legs 18 and 20 and the magnet 46 increases, the force overcomes the resistive force to twisting of the bimetal 50 and the magnet 46 snaps toward capsule 32 until screw 48 engages the bottom 42. During the free motion of magnet 46 as it snaps toward the capsule 32, the increasing attractions between the contact legs 14 and 16 eventually overcomes the bias of leaf springs 24 and 26 as in the embodiment shown in Figs. 1-5 and the two contacts 22 snap together. The switch has now attained the closed position as shown in Fig. 7. It is now apparent that the same relationship of high contact force and low operating force as illustrated in the embodiment of Figs. 1-5 are attained with rotary movement of magnet 46.

While only two embodiments of this invention have been shown and described, it is apparent that there may be many changes in structure and operation without departing from the scope of this invention. For example, it is possible to build essentially the same switch with one armature mounted on a non-resilient post and only the other armature free to move in response to the magnet 46.

I claim:

1. In a switch, the combination comprising magnetizable means including a pair of members each arcuately bent to form an armature leg and a contact leg, a contact formed on each of said contact legs, magnetizing means, and means for moving said magnetizing means toward said armature legs to induce magnetism in said magnetizable means, said induced magnetism causing said contact legs to move substantially at right angles to the movement of said magnetizing means to close said contacts.

2. In a switch, the combination comprising a pair of magnetizable members each arcuately bent to form a

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contact leg and an armature leg, a contact formed on the contact leg of each of said members, and means operable to magnetize said members to cause said armature legs to attract said means and said contact legs to attract each other to close said contacts.

3. In a switch, the combination comprising a pair of magnetizable members each having a substantially right angular configuration, an electrical contact mounted on one leg of each of said members, leaf springs resiliently mounting each of said magnetizable members in spaced relation, and condition responsive means having a permanent magnet attached thereto and being operable in response to a predetermined condition to move said magnet relative to said pair of magnetizable members to magnetize the same whereby the other leg of each of said magnetizable members attracts said magnet and said one leg of each of said magnetizable members attract each other to close said contacts.

4. In a switch, the combination comprising a pair of magnetizable members each having a contact thereon, a first resilient means mounting at least one of said magnetizable members, a condition responsive member forming a second resilient means and having a magnetizing member thereon, said magnetizing member being movable against the bias of said condition responsive member in response to a predetermined condition to magnetize said magnetizable members whereby said magnetizable members attract each other to close said contacts, said first resilient means having a bias less than said second resilient means to maintain the force holding said contacts closed at a greater value than the force required to move said magnetizing member to a non-magnetizing position.

5. The switch of claim 4 having means on said condition responsive member to simultaneously adjust the force holding said contacts closed and the force required to move said magnetizing member to a non-magnetizing position.

6. In a switch, the combination comprising a pair of magnetizable angular members each having a contact leg and an armature leg, a contact formed on each of said contact legs, a first resilient means mounting at least one of said magnetizable members, a condition responsive member forming a second resilient means and having a magnetizing member attached thereto, said magnetizing member being movable against the bias of said condition responsive member in response to a predetermined condition to induce magnetism in said magnetizable members whereby said armature legs attract said magnetizing member and said contact legs attract each other to close said contacts, said second resilient means having a bias greater than said first resilient means to maintain the contact force of said contacts greater than the force required to move said magnetizing member to a non-magnetizing position, a capsule enclosing said magnetizable members, and a screw mounted on said condition responsive member and being engageable with said capsule to maintain a distance between said magnetizing member and said

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magnetizable members, said screw being adjustable to vary said distance thereby adjusting the contact force of said contacts and the force required to move said magnetizing member to a non-magnetizing position.

7. In a switch, the combination comprising a pair of magnetizable members each having a substantially right angular configuration, a contact formed on one leg of each magnetizable member, a first resilient means mounting at least one of said magnetizable members, a condition responsive member forming a second resilient means and having a magnetizing member thereon, said magnetizing member inducing magnetism in said magnetizable members to cause snap action movement of said magnetizing member toward the other leg of each of said magnetizable members in response to a predetermined condition, said magnetizing member also causing attraction between said one leg of each of said magnetizable members to close said contacts with a snap action in response to the snap action of said magnetizing member.

8. The switch of claim 7 wherein said contacts are formed adjacent the outer end of said one legs whereby the point of magnetic attraction of said one legs differs from the center of mass of said magnetizable members to cause one contact to roll over the other upon closure thereby minimizing contact bounce and producing a wiping effect to clean said contacts.

9. In a switch, the combination comprising a pair of magnetizable members each having a substantially right angular configuration, a contact formed on one leg of each of said members, a first resilient means mounting at least one of said members, a coil having magnetizing means mounted on an end thereof, the poles of said magnetizing means being spaced centrally of said magnetizable members thereby producing magnetic equilibrium, said coil causing rotation of said magnetizing member in response to a predetermined condition to induce magnetism in said members whereby the other leg of each of said magnetizable members attracts said magnetizing member and said one leg of each of said members attract each other to close said contacts.

10. The switch of claim 9 wherein said coil is spaced from said magnetizable members and is axially stressed upon attraction of said magnetizing member by said other leg of each of said magnetizable members to effect snap action movement of said magnetizing member.

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