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MAGNETIC SWITCHES

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Fig. 1.

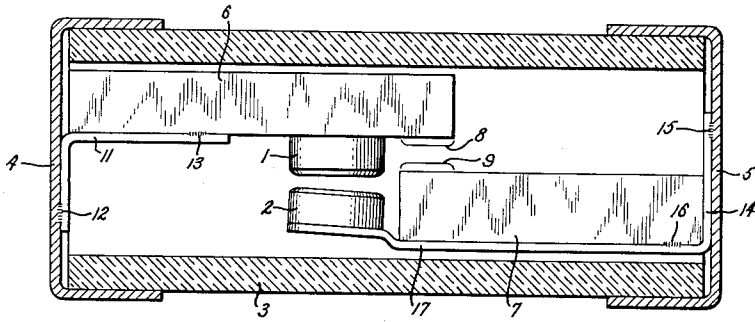
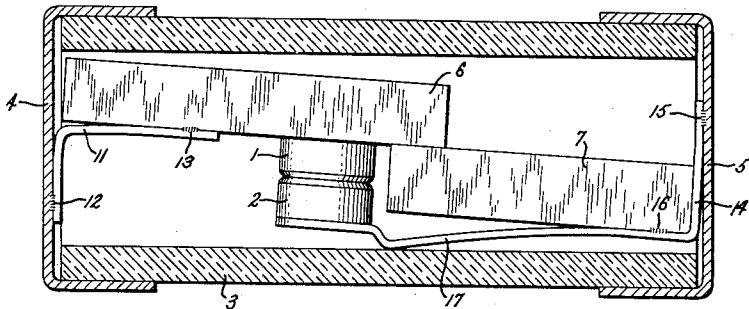


Fig. 2.



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MAGNETIC SWITCHES

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This invention relates to electrical switching devices and, more particularly, to switching devices actuated in response to an externally applied magnetic field.

There is in current use a form of switch known as a reed switch which usually comprises a pair of elongated and overlapping resilient contact members of soft magnetic material sealed within a non-magnetic non-conducting enclosure. The switch is actuated by axially directed components of an induced magnetic field which cause the two contact members to have a mutual attraction. When the induced field becomes strong enough it overcomes the inherent resilience of the contact members and closes the contacts; in like manner when the field strength falls below a certain level, the resilience of the contact members again opens the contacts.

Among the advantages of switches whose contacts are actuated by mutual attraction in response to an externally applied magnetic field is the fact that they may be completely sealed in an airtight enclosure to protect the contacts from the contaminating effect of dirt, moisture, and other incidents of an industrial atmosphere, there being no need for mechanically movable members to penetrate the enclosure. However, such switches, although capable of millions of operations within their current ratings, are generally not employed to carry substantial load currents because of the possible loss of contact fidelity when the contacts are closed and because there is little force available to open the contacts should overcurrents weld the contact tips together.

It is a general object of this invention to provide a reliable magnetically actuated sealed switch capable of carrying and interrupting large load currents with a positive opening and closing operation.

It is a further object of the invention to provide an improved magnetically actuated sealed switch having a scrubbing action between the contact surfaces to insure good contact fidelity.

It is a still further object of the invention to provide an improved magnetically actuated sealed switch whose contacts are hammered apart on opening to break any weld which might have formed between the contact surfaces due to overcurrents.

By way of a brief summary of a preferred embodiment of this invention I provide a switch having a pair of elongated steel armatures contained within a sealed enclosure and having overlapping ends resiliently biased away from each other but movable into contact with each other in response to mutual attraction due to magnetic flux components of sufficient magnitude directed lengthwise of the armatures. Electrical continuity through the switches is made only incidentally through the overlapping mating surfaces of these two magnetic armatures, but primarily through a pair of electrical contacts adjacent the overlapping surfaces. One of these contacts is rigidly mounted on the front surface of one of the armatures short of its end, while the second contact is resiliently mounted closely adjacent the back surface of the other armature to extend beyond its end. Both contacts are positioned to engage each other after the armatures move toward each other but before they actually touch. Consequently, as the contacts close a sliding or scrubbing action takes place between them and as the armatures separate the other armature hammers its resiliently mounted contact away from the first contact.

While the scope of this invention in its broadest aspects

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is not to be limited except by the appended claims, further details of the invention as well as additional objects and advantages will become more apparent with reference to the accompanying drawings in which:

5 FIG. 1 is a plan view partially in section showing a magnetically operated switch constructed in accordance with this invention with its contacts open; and

FIG. 2 is a view similar to FIG. 1 showing the contacts closed.

10 The illustrated magnetic switch includes a pair of cooperating switch contacts 1 and 2 enclosed in an insulating envelope 3 preferably of glass. The envelope is sealed at its ends by a pair of ferrules 4 and 5 which function as terminal members for the switch. Within the enclosure a pair of magnetic armatures 6 and 7 are positioned generally axially of the envelope at opposite ends thereof but with adjacent ends 8 and 9 respectively overlapping. Armature 6 is attached to the ferrule 4 by a leaf spring 11 which is welded at 12 to the ferrule and at 13 to the front side of the armature, the armature 6 being normally biased to the position shown in FIG. 1 by the resilience of its attached spring. In similar fashion another leaf spring 14 welded at 15 to the ferrule 5 resiliently supports armature 7, being attached to the armature by a weld 16 on the back surface of the armature and biasing it normally to the position shown in FIG. 1.

The armatures 6 and 7, when subjected to an external magnetic field having a flux component along their major dimensions, are urged under the force of mutual attraction toward each other against the bias of springs 11 and 14. If the magnetic flux component is sufficiently great, the armatures will pivot into mating engagement between their ends 8 and 9, flexing their mounting springs in the process and bringing contacts 1 and 2 into the switch closing position illustrated in FIG. 2. It is particularly to be noted that, although switch contact 1 is rigidly mounted on the front surface of armature 6 at a position short of the end thereof, the switch contact 2 is resiliently mounted to extend beyond the overlapping end of its armature by a leaf spring extending closely along the back surface of armature 7. This leaf spring 17 may conveniently be an extension of leaf spring 14. It is also to be observed that the distance between contacts 1 and 2 in their normally open position shown in FIG. 1 is less than the distance between the overlapping ends 8 and 9 of the two armatures.

Consequently, after armatures 6 and 7 begin to pivot toward each other, the contacts 1 and 2 first meet and close, after which the armature ends 8 and 9 come together. This two-stage sequential operation of the contact-armature movement causes a sliding or scrubbing motion between the contact surfaces after they have come together and insures good contact fidelity, the scrubbing movement being due partly to the displacement between the pivotal axes of contact 2 and armature 7. In this connection, although the actual movements of armature 7 and contact 2 are a complex composite of rotational and translational displacements, it may be considered that armature 7 pivots about a point somewhere between welds 15 and 16, whereas contact 2 pivots about a point near weld 16.

Another important effect takes place when the contacts are opened. When the magnetic flux component in armatures 6 and 7 falls below a value sufficient to overcome the bias of leaf springs 11 and 14, the overlapping ends 8 and 9 of the armature separate while the contact surfaces 1 and 2 are still engaged. Consequently, in its backward movement armature 7 acquires a certain momentum before it collides with leaf spring 17, and the impact between these two members literally hammers contact 2 away from contact 1. If by chance excessive over-

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load currents through contacts 1 and 2 should have fused the contact tips together, the hammering action of armature 7 breaks the bond between the contacts and gives a positive switch opening operation.

In carrying out this invention according to a preferred form, I employ contact tips of tungsten because of its high boiling point, low vapor pressure, and high specific heat, all of which contribute to the ability of the switch to control significantly large load currents. The magnetic armatures are preferably relatively massive in order to carry sufficient magnetic flux to produce a high contact pressure. Because the leaf springs shown are also current-carrying members, they are preferably formed of beryllium copper to reduce the quantity of heat generated. The leaf spring 17 may be preloaded against the back surface of the armature 7 to inhibit contact bounce.

Magnetically actuated switches constructed according to this invention, although capable of controlling much larger currents, may be used in precisely the same combinations as the so-called reed switches. That is, the externally applied magnetic field to operate them may be supplied by a coil or other electrically controlled source of magnetic flux or by a permanent magnet actuator movable into proximity to the switch.

While I have shown but one preferred embodiment of the present invention it should be clear that this has been illustrative in nature and that certain variations will undoubtedly occur to those skilled in the art to which this invention pertains. I therefore intend to cover by the appended claims all such variations as fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A magnetically actuated switch comprising: an elongated sealed enclosure; a pair of terminal members located at each end of said enclosure having portions on the inside and outside thereof; a pair of rigid relatively massive elongated armatures of magnetic material within said enclosure having adjacent ends overlapping each other in a central part of said enclosure and opposite ends extending to positions adjacent the respective ends of said enclosure; means pivotally supporting at least one of said armatures for rotational movement about a pivot point adjacent its said opposite end and biasing its said adjacent end to a position spaced apart from the adjacent end of said other armature, whereby said overlapping adjacent ends are relatively movable into mutual engagement between front surfaces thereof under the force of mutual attraction due to an externally applied magnetic field; an elongated electrically conducting spring attached to one of said rotatably mounted armatures at its said opposite end and extending closely along a back surface thereof to a position beyond the overlapping end thereof, a point near the attachment of said elongated spring defining a point of pivotal flexure for said spring spaced apart from the said pivot point of said rotatably mounted armature; a first electrical contact surface on the extended end of said elongated spring; and a second electrical contact surface positioned to engage said first contact surface upon relative movement of the overlapping ends of said armatures into engagement with each other, said contacts being electrically connected to said terminal members, the distance between the overlapping ends of said armatures when spaced apart being greater than the distance between said contact surfaces by an amount providing deflection of said elongated spring clear of said back surface for the major portion of the distance between said one end and said point of attachment in response to engagement of said armatures.

2. A magnetically actuated switch comprising: an elongated sealed enclosure; a pair of terminal members located at each end of said enclosure having portions on the inside and outside thereof; a pair of rigid relatively massive elongated armatures of magnetic material within said enclosure having adjacent ends overlapping each other in

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a central part of said enclosure and opposite ends extending to positions adjacent the respective ends of said enclosure; means pivotally supporting at least one of said armatures for rotational movement about a pivot point adjacent its said opposite end and biasing its said adjacent end to a position spaced apart from the adjacent end of said other armature, whereby said overlapping adjacent ends are relatively movable into mutual engagement between front surfaces thereof under the force of mutual attraction due to an externally applied magnetic field; an elongated electrically conducting spring attached to said one armature at its said opposite end and extending closely along a back surface thereof adjacent said enclosure to a position beyond the overlapping end thereof, a point near the attachment of said elongated spring defining a point of pivotal flexure for said spring spaced apart from the said pivot point; a first electrical contact surface on the extended end of said elongated spring; and a second electrical contact surface on said other armature in a position to engage said first contact surface upon relative movement of the overlapping ends of said armature into engagement with each other, said contacts being electrically connected to said terminal members, the distance between the overlapping ends of said armatures when spaced apart being greater than the distance between said contact surfaces by an amount providing substantial clearance between said elongated spring and said back surface in response to engagement of said armatures.

3. A magnetically actuated switch comprising: an elongated sealed enclosure; a pair of terminal members one at each end of said enclosure; a pair of rigid relatively massive elongated armatures of magnetic material within said enclosure having adjacent ends overlapping each other in a central part of said enclosure and opposite ends extending in opposite directions, said armatures being supported for pivotal movement against the restraint of said spring members about points adjacent respective ends of said enclosure, said overlapping ends of said armatures being biased into spaced-apart positions and being movable into mutual engagement between front surfaces thereof under the force of mutual attraction due to an externally applied magnetic flux component directed lengthwise of said armatures; an elongated electrically conducting spring attached to one of said armatures at its said opposite end and extending closely along a back surface thereof to a position beyond the said overlapping end thereof, a point near the attachment of said elongated spring defining a point of pivotal flexure for said spring spaced apart from the pivot point of said one armature; a first electrical contact surface on the extended end of said elongated spring; a second electrical contact surface on said other armature in a position to engage said first contact surface upon movement of the overlapping ends of said armatures into engagement with each other, the distance between the overlapping ends of said armatures when spaced apart being greater than the distance between said contact surfaces by an amount providing substantial clearance between said one armature and said elongated spring in response to engagement of said contacts thereby to cause said one armature to deliver a sharp blow to said elongated spring to hammer said contacts apart in response to separation of said armatures.

4. A magnetically actuated switch comprising: an elongated tubular enclosure open at each end; a pair of end cap terminal members capping and sealing respective ends of said enclosure; a pair of electrically conducting leaf springs each attached at one end to a respective terminal member on the inside of said enclosure and each extending substantially parallel to the inner surface of its associated end cap; a pair of relatively massive elongated armatures of magnetic material having adjacent ends overlapping each other in a central part of said enclosure and having opposite ends attached respectively to the other ends of said leaf springs, said adjacent ends being biased to spaced-apart positions by said leaf springs and

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being movable against the restraint of said leaf springs into mutual engagement between front surfaces thereof about pivot points adjacent the said opposite ends under the force of mutual attraction due to an externally applied magnetic field; an elongated electrically conducting spring attached to one of said armatures at its said opposite end and extending closely along a back surface thereof to a position beyond the said overlapping end thereof, a point near the attachment of said elongated spring defining a point of pivotal flexure for said spring which is spaced apart from the pivot point of said one armature; a first electrical contact surface on the extended end of said elongated spring; and a second electrical contact surface on said other armature in a position to engage said first contact surface upon movement of the overlapping ends of said armatures into engagement with each other, the distance between the overlapping ends of said armatures when spaced apart being greater than the distance between said contact surfaces by an amount providing substantial clearance between said back surface and said elongated spring in response to engagement of said armatures thereby to cause said one armature to deliver a sharp blow to said elongated spring to hammer said contacts apart in response to separation of said armatures.

5. A magnetically actuated switch comprising: an elongated sealed enclosure; a pair of elongated armature members of magnetic material situated within said enclosure at opposite ends thereof and having adjacent ends overlapping in a central part of said enclosure; resilient support means for said armatures biasing their overlapping ends into spaced-apart positions, the overlapping ends of said armatures being movable under the force of mutual attraction due to an externally applied magnetic field into engagement with each other against the bias of said resilient support means; a first contact member rigidly mounted on one of said armatures short of its said overlapping end; an elongated resilient current carrying member extending beyond the said overlapping end of the other of said armatures and affixed to the opposite end of said other armature; a second contact member mounted on said current carrying member beyond the end of said other armature in a position to contact said first contact member when said armatures engage, the distance between said contact members in their open positions being less than the distance between the overlapping ends of said armatures in their spaced-apart positions by an amount providing substantial clearance between said resilient current carrying member and said armature, whereby a scrubbing move-

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ment takes place between said contacts when they close and whereby upon separation of said armatures said other armature delivers a blow to said resilient current carrying member to hammer said contacts apart; and terminal members electrically connected to said contact members and extending outside of said enclosure.

6. A magnetically actuated switch comprising: an elongated sealed tubular enclosure; a pair of end cap terminal members, one at each end of said enclosure; a pair of resilient electrically conducting L-shaped leaf spring members, each attached to a respective one of said terminal members on the inside of said enclosure substantially all of one leg of each of said L-shaped members in its unstressed state extending in contact with the inside surface of its associated end cap; a pair of rigid relatively massive elongated armatures of magnetic material in said enclosure each supported at one end by a respective one of said spring members and having their other ends extending into overlapping relationship in a central part of said enclosure, the overlapping ends of said armatures being biased into spaced-apart positions by said spring members and being movable into engagement with each other against the bias of said spring members under the force of mutual attraction due to an externally applied magnetic field; an elongated electrically conducting spring attached to an end of one of said armatures adjacent one end of said enclosure and extending closely along a back surface thereof to a position beyond the other end of said one armature; a first electrical contact surface on the extended end of said elongated spring; a second electrical contact surface on the front surface of the other of said armatures in a position to engage said first contact when said armatures are engaged, the distance between the overlapping ends of said armatures when spaced apart being substantially greater than the distance between said contact surfaces, whereby a scrubbing motion takes place between said contact surfaces upon movement of said armatures toward each other and whereby after separation of said armatures said one armature collides with said elongated spring to hammer said contacts apart.

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