MAGNETICALLY OPERATED ENCLOSED SWITCH

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.
The invention relates to electrical switches of the type in which all moving parts are wholly enclosed in an evacuated or gas-filled envelope, the switches being designed to be operated by magnetic forces transmitted to the operating parts through the said envelope from external electro-magnetic means.

It is an object of the invention to provide a structure of this class which is not affected by shock, vibration, momentum, centrifugal or gravitation forces tending to produce sporadic and accidental opening or closing of the switch contacts.

It is an object of the invention to provide a switch which may readily be operated by externally applied magnetic forces in a positive fashion and with sufficient contact pressure. It is an object of the invention to provide a switch structure which can be operated by a simple external solenoid with a housing providing a path for magnetic lines of force. It is an object to provide a structure in which gaps in the paths of the magnetic lines of force are reduced to a minimum, and a structure in which the lines of force are concentrated at an adjacent element of opposite polarity within the switch itself.

It may take other shapes for special purposes. The envelope is normally of glass, although other non-magnetic substances may be employed if desired. A suitable conductor or is sealed into the envelope at each end. Preferably this is done by means of flares 5 or 6 as described in the copending application of Albert E. Gerth, Serial No. 605,121, and entitled Mounting for Electrodes in Glass Vessels. Such flares have the effect of thermally isolating the conductors 2 and 3 from the glass envelope, enabling the switch to carry greater amounts of current and higher frequencies without affecting the integrity of the glass-to-metal seal. The rims of the flares are sealed to the glass of the vessel as will be evident from a consideration of Figure 1.

Where the bodies of the flares are dome-shaped or conical as illustrated at 6, they provide a rigid support for their conductors. Where as illustrated at 5 the bodies of the flares are flat and disc-like, some dimensional adjustment is afforded, since the conductors 2 may be slightly tilted or moved axially in and out, the flat flare bodies permitting this by flexing. When the desired adjustment has been obtained, a filling or layer of solder or brazing substance may be joined to the flare body maintaining it in the flexed position and hence maintaining the adjusted position of the conductor. The skilled worker in the art will understand that the flares will be of a metallic material suitable for fusion type joints with the envelope, such as Kovar. The conductors may be of similar substance though other metals will do. Needless to say, the conductors will be joined to the bodies of the flares in a gas-tight fashion, as for example by hydrogen brazing. In the exemplary structure the conductor 2 is made hollow so as to communicate with the interior of the envelope. Where a vacuum is drawn within the sealed envelope, this is done by pumping the contained air out through the tubular conductor 2, after which the conductor is flattened and spot-welded, as at 2a, and may be given an interior fill of brazing or soldering material fused in place.

The conductor 3 rigidly supports a stationary pole element indicated generally at 7. This pole element has an enlarged central portion which has a circular cross-section when the envelope is circular in cross-section, but may have other shapes with other envelopes. The diameter of the enlarged portion is such that its outer surfaces approach the adjacent inner surfaces of the glass envelope as closely as is possible with reasonable manufacturing tolerances. The purpose here is to diminish the air gap between the pole element 7 and the magnetic housing of the external solenoid.

In order to brace the stationary pole element in the envelope, and to shorten gaps in the magnetic circuit, there are provided resilient magnetic elements 9 as illustrated in Figures 8 and 9. These comprise a base 9a adapted for attachment to either of the halves of the pole element 7, as by spot welding, and extending spring fingers 9b which contact the envelope 1.

The pole element 7 also has reduced and flattened end portions, and (as will be most clearly seen in section in Figure 2) is formed from a pair of stampings 7a and 7b made of some magnetic material such as iron or suitable magnetic alloy. The parts comprising the reduced end are so shaped as to embrace the conductor 3 to which they will be spot-welded, brazed, or otherwise fastened so that the pole element becomes rigid with the conductor. At the opposite reduced end, the parts are flattened, and brazed or welded together, this end thus becoming a pole piece at which the magnetic lines of force are concentrated. The two stampings 7a and 7b need not be fastened together excepting at their ends as described; but by reason of their shape, they will provide a very rigid structure. If desired an orifice 11 may be
provided in one or both of the stampings to permit ready egress of gas from the interior of the pole element.

At the inner end of the pole element 7, a rod or wire-like supporting element 12 is rigidly attached. This element 12, as a continuation of the support 3; but in practice it is usually preferable to make it separately and to braze or weld one end to the reduced end of the pole element as at 12a. The supporting structure 12 is bent intermediate its ends so as to provide an upwardly extending part 12b, a downwardly extending part 12c, and an outer end portion 12d which extends upwardly at a small angle to the horizontal. The supporting structure is of metal, and is non-magnetic. A second pole element, next to be described, is mounted in a pivotal fashion with respect to this rod.

The second pole element 13, like the first, is made up of two hollow metal stampings 14 and 15 with flattened ends, as most clearly shown in Figure 7. The stamping 14 has a hole 14a through which the rod-like supporting element 12 can extend so that its end 12d lies inside the pole element. For the sake of balance, a similar hole may be made as at 14b on the other side of the enlarged central portion 16 of the stamping.

The other stamping 15 may have a similar shape and may, if desired, be provided with similar holes. One of the stampings (14 in the form shown) is provided with ears 17 having pinhole-receiving holes 18; and the other stamping is cut away at 19 to accommodate the ears.

A yoke member 20 of semi-circular cross-section, best shown in Figure 5, has its central portion welded or otherwise attached to the end 12d of the rod-like supporting element 12. The yoke member has turned feet 21, 22; and is also provided with holes as at 23 for the passage of the pintle 24. A flat spring 25 (Figure 6), preferably of beryllium copper or other non-magnetic material, is passed through the yoke, its central portion engaging above the feet 21, 22, and below the pintle 24 (Figure 4). The spring may be welded if desired to the yoke, but this is not necessary if the engagement is tight enough to insure good electrical contact.

The stampings 14 and 15 are assembled to the spring 25, the ends of the latter lying between the flattened ends 26 and 27 of the stampings. The stampings are spot-welded, brazed, riveted or otherwise fastened together; but the ends of the spring should not be fastened to them. Rather, the spring should be slidably mounted between the ends of the stampings. Thus, the stampings should be welded together off the edges of the spring. Another construction is illustrated in Figure 10 where the end portion of the upper stamping 14 has tongues 14c bent over beneath the corresponding part of the stamping 15; the spring lying slidably between them.

The general assembly will be most readily appreciated from Figures 2, 3 and 4. The one flat end 26 of the second pole element 13 forms a pole piece lying opposite the pole piece 10 of the other pole element 7. The two pole pieces are normally separated as shown because of the bias of the spring 23. The enlarged central portion 16 of the second pole piece approaches the glass envelope as closely as manufacturing tolerances permit.

If now the structure is slipped inside a magnetic operator as shown in Figure 1, this operator comprising a hollow magnetic winding 27 within a hollow, can-like magnetic housing element 28, with a cover element 29b, both having inwardly directed flares adjacent the envelope, as shown, and if the winding be energized by being connected to a source of current, the two pole elements 7 and 13 herefore described will form part of a magnetic circuit. The pole pieces 10 and 26 will be attracted toward each other. This attraction will be strengthened by the fact that the pole pieces are nearly closed except for the spaces between the enlarged central parts of the pole elements and the flares of the housing.

The effect of the magnetic attraction will be to rock the pole element 13 on the pintle 24 as an axis, against the resilience of the spring 25. When the winding is de-energized, the spring will return the second pole element to the position to which it is held. The magnetic housing 28 is made of suitable electromagnetic metal in such a way that it can be assembled about the winding 27. The switch structure illustrated need only be passed through the central opening of the winding and housing, where it may be held frictionally or otherwise as desired.

The conductor 2, in the form illustrated, bears a contact 29 which coacts with a contact 30 riveted or welded at one end of the spring 25, one of the flat portions of the stamping 14 being cut away to expose the contact. At the other end of the movable pole element a balancing counterweight may be located as at 32. In the form shown, the switch contacts are arranged to be separated, i.e. the switch circuit will be broken when the winding 27 is energized. The skilled worker will understand that by reversing the positions of the contacts, the opposite result may be accomplished.

After the assembly of the switch elements described, the flares elements 5 and 6 are sealed to the envelope, and the envelope may be evacuated, as set forth above. The last traces of atmosphere in the envelope may be eliminated, as is understood in the art, by supporting a getter substance on a wire element 31 and firing it by inductive heating.

The switch construction of this invention is simple and compact. The parts, especially the moving part, are light in weight. The spring bias on the moving part can be overcome by comparatively little counter force, yet is positive. At the same time, the effectiveness of the available magnetic force is greatly increased by the nearly complete magnetic circuit described. Because of the completely balanced construction of the moving pole element 13, the structure is not liable to accidental operation from shocks, jars, sudden movement in any direction, or centrifugal or other external forces. The construction is relatively inexpensive, simple, and relatively small in size.

Modifications may be made in the invention without departing from the spirit of it. The invention having been described in an exemplary embodiment, what is claimed is new and desired to be secured by Letters Patent.

1. In a magnetic vacuum switch, an elongated evacuated envelope, an electrode sealed in said envelope at one end, a magnetic element rigidly supported within said envelope by said electrode having connection therewith at one end, said magnetic element having a relatively flat pole piece at its opposite end, a supporting element attached to said magnetic element at its pole piece end, a second magnetic element supported for movement on said supporting element by means of a biasing element, said second magnetic element having a pole piece lying substantially opposite the pole piece of said first magnetic element and normally spaced therefrom because of the biasing action of said biasing means, an electrical contact element on the opposite end of said second magnetic element, a second electrode sealed in the opposite end of said envelope, and an electrical contact element supported by said second electrode within said envelope and connecting with the electrical contact on said magnetic element.

2. The structure claimed in claim 1 wherein said magnetic elements have enlarged central portions approaching the interior walls of said envelope so as to shorten a magnetic circuit with an external magnetizing coil.

3. The structure claimed in claim 1 wherein said magnetic elements are of light weight and are formed by fastening together hollow metal stampings, and in which central portions of said magnetic elements are formed with
enlarged diameters approaching the walls of said envelope.

5. The structure claimed in claim 4 in which said biasing means is a spring member extending longitudinally of the hollow interior of said second magnetic element, and in which said supporting means attached to the first magnetic element is of irregular shape, its forward portion extending into the hollow interior of said second magnetic element through a perforation therein and affixed to said spring member substantially centrally by means of a yoke.

6. A magnetic element for the structure described comprising a pair of sheet metal bodies, each body having at least one flat end portion and hollowed central portions, said bodies fitting together in reversed position to form said hollow magnetic element and having their flat end portions attached to each other, said attached flat portions forming an outwardly projecting magnetic pole piece.

7. The structure claimed in claim 6 wherein said magnetic element is substantially circular in central cross section.

8. In a magnetic vacuum switch, an elongated evacuated envelope, a pair of light, hollow sheet metal electromagnetic elements substantially end-to-end within said envelope, said elements on their adjacent ends having co-acting pole pieces which will be attracted toward each other in a magnetic field, means for rigidly supporting a first one of said magnetic elements and making electrical contact therewith, means for supporting the second one of said magnetic elements for rocking movement substantially about its center and for resiliently biasing it to a position such that the said pole pieces are separated, and means for making electrical contact with the second of said magnetic elements.

9. The structure claimed in claim 8 in which the second of said magnetic elements is supported by a supporting means extending forwardly from the first of said magnetic elements and making electrical contact with the second of said magnetic elements.

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