

March 22, 1960

M. S. SHEBANOW

2,929,895

SWITCHING DEVICE

Filed Dec. 27, 1956

FIG. 1

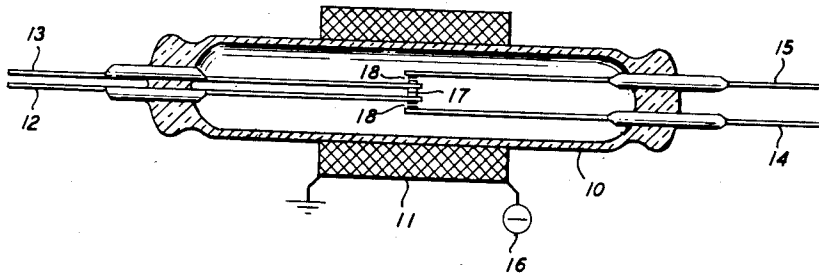


FIG. 2

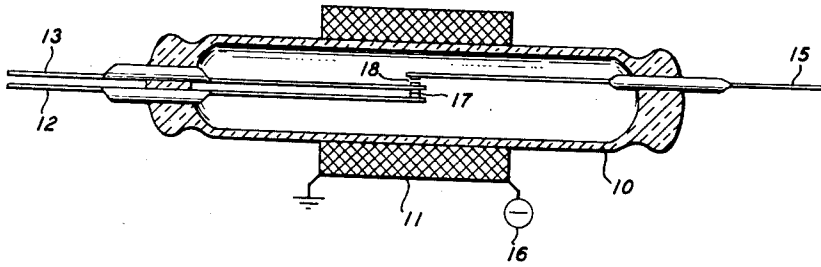


FIG. 3

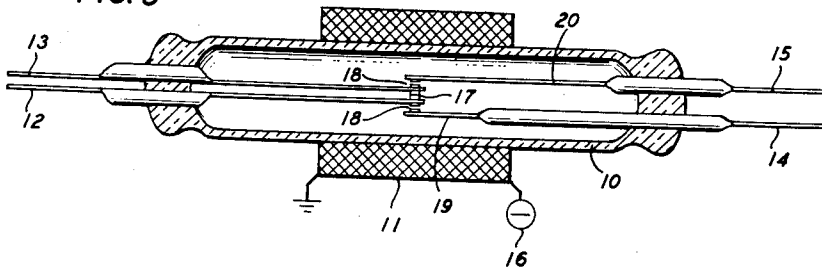
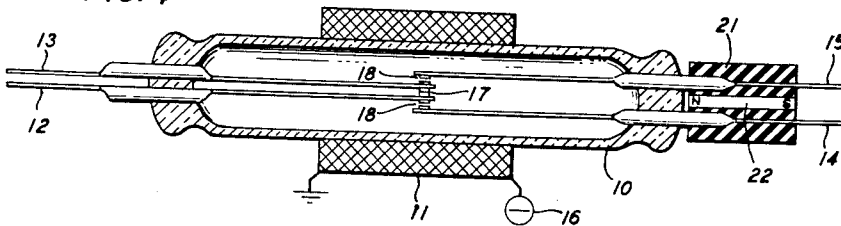


FIG. 4



INVENTOR
M. S. SHEBANOW
BY *John C. Morris*
ATTORNEY

1

2,929,895

SWITCHING DEVICE

Michael S. Shebanow, Brooklyn, N.Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N.Y., a corporation of New York

Application December 27, 1956, Serial No. 630,806

8 Claims. (Cl. 200—87)

This invention relates to switching devices and more particularly to devices for controlling a plurality of electrical circuits.

Circuit controlling devices employing a pair of overlapping magnetizable electrodes or elements sealed in a glass-tight vessel and having a coil outside of the vessel to cause the electrodes to control electrical circuits have been described before, e.g., see Patent 2,289,830 issued July 14, 1942, to W. B. Ellwood. These switches employ a pair of movable and often flat magnetic elements sealed in a vessel containing an inert atmosphere of neon, helium, argon or some other non-corrosive gas. The elements or reeds as they are sometimes called, perform the dual function of switching an electrical circuit and acting as flexible armatures in the magnetic circuit of the switch.

Conventionally, these magnetic elements have been supported at opposite ends of a glass-tight vessel so as to take advantage of an attractive force between their overlapping portions whenever the external coil is energized. Contrariwise, in a few instances, the elements have been supported at one end only so as to take advantage of a repelling force between them whenever the coil is energized, see, e.g., British Patent 536,695 which issued May 23, 1941.

While each type of reed switch has constituted a distinct advance in the switching device field, neither has most efficiently utilized the potentials of such switch structures.

Therefore, an object of the present invention is to better utilize the potentials of such structures by reducing the power requirements for each contact pair provided.

Another object of the invention is to provide a more versatile electromagnetic operated switching device which is contained in a single vessel.

In accordance with one feature of the invention, a plurality of reeds are supported within an envelope in such a manner that advantage is taken of both repelling and attracting forces whenever a magnetic field is established.

Another feature of the invention pertains to the provision of a plurality of movable magnetic elements which overlap within an envelope enclosing means to provide a variety of contact combinations in accordance with the first feature. For example, the philosophy of the present invention can be incorporated into reed switches including many contact combinations; e.g., makes and breaks; simple, continuity and sequential transfers; latching makes, breaks and transfers, etc.

More particularly, a feature of the invention pertains to means for supporting a plurality of magnetic elements at the ends of an enclosing vessel so that any two of the elements which have a third element interposed between them are supported at opposite ends of the vessel.

Specifically, a feature of the invention pertains to supporting the elements in accordance with the prior requirement and at the same time in planes substantially

2

parallel to the lines of maximum induced flux and in a common plane with each other.

These and other objects and features of the present invention may be more readily understood when the following detailed description of four embodiments thereof is read with reference to the drawing in which:

Fig. 1 is a cross-section of a switch showing a first embodiment of the invention wherein a single break and two make contacts are provided;

Fig. 2 is a cross-section of a switch illustrating a second embodiment of the invention wherein a simple transfer contact is provided;

Fig. 3 is a cross-section of a switch depicting a third embodiment wherein a single break and sequential make contacts are provided; and

Fig. 4 is a cross-section of a switch showing a fourth embodiment designed to lock-up after operation on current of one polarity and to release on the application of current of an opposite polarity.

Referring more specifically to Fig. 1, it can be observed that a pair of magnetizable elements or reeds 12 and 13 are sealed in one end of a tubular glass envelope 10 and another pair of elements 14 and 15 are sealed in the other end. All of the elements overlap within the glass vessel and elements 12 and 13 have their overlapping ends interposed between the overlapping ends of elements 14 and 15. The elements 12, 13, 14 and 15 are formed from tubular members of magnetizable material by flattening both ends of each element, the enclosed flattened portion providing the requisite flexible armature and the external portion acting as a terminal. The remaining tubular portion is sealed to the glass vessel. This construction is quite common since the tubes are used to fill the vessel with inert gas after the glass seals are attained. However, it should be understood that the flat armature portions of the elements could just as well be obtained in other ways, e.g., by welding them to the tubular members. No claim is made to any of this construction, including the use of tubular members rather than wires, since numerous alternative construction techniques are well known.

A coil 11 is provided with one terminal connected to negative battery 16 and the other capable of being grounded in order to establish a magnetic field for the reed switch.

Contacts or contacting surfaces 17 are provided on the facing sides of reeds 12 and 13. These contacts 17 normally form a break contact pair. Contacts or contacting surfaces 18 are provided on the other sides of reeds 12 and 13, i.e., those facing reeds 14 and 15, and similar contacting portions are provided on the cooperating areas of the reeds 14 and 15. In the normal case, the elements 12 and 14 form one make contact and the elements 13 and 15 form another.

Upon energization of coil 11, the reeds 12 and 13 tend to repel one another under the influence of the established magnetic field while reeds 12 and 13 tend to attract reeds 14 and 15, respectively. Thus, under the combined repelling and attracting forces established by the orientation of the elements in the magnetic field, elements 12 and 13 separate and then each respectively engages elements 14 and 15.

A pair of make contacts only can be provided in the single envelope easily and with the same configuration if contacts 17 were replaced by insulating studs. In this situation, reeds 12 and 14 and reeds 13 and 15 would form make contact pairs.

Another construction feature of the embodiment depicted in Fig. 1 is that the reeds lie in planes substantially parallel to the longitudinal axis of the coil 11, otherwise, the longitudinally induced lines of flux will not have

3

their maximum impact in determining selected repelling and attracting forces between the reeds. The transfer efficiency of ampere-turns to flux to repelling and attractive forces decreases as the parallelism between the reeds decreases. Of course, as in other reed switches, the contacting portions of the reeds should overlap to provide a sufficiently broad contacting area and, in furtherance of providing this overlapping area, they usually lie in a common plane.

In one laboratory model of a switch built in accordance with Fig. 1 to embody the principle of reed orientation herein proposed, one of the two make contact pairs operated on approximately 63 ampere-turns and the other on approximately 107 ampere-turns. Refinements and manufacturing care should substantially reduce the number of ampere-turns required. But even these figures compare favorably with one commercial reed switch containing a single make pair which is designed to operate on 90 ± 12 ampere-turns. The laboratory model utilized a 15 to 30 gram initial force between the break contact pair (reeds 12 and 13) in order to insure a low resistance path therethrough.

Referring to Fig. 2, which illustrates a transfer switch embodying the principles of the present invention and wherein like parts are identified by the same numbers as they are in Fig. 1, the reeds 12, 13 and 15 are supported in a manner similar to the switch depicted in Fig. 1. The only difference between the two structures is the omission of reed 14. In the same operative way, as discussed with regard to the structure of Fig. 1, energization of coil 11 causes reeds 12 and 13 to repel each other and reeds 13 and 15 to attract each other thereby switching reed 13 out of normal engagement with reed 12 and into engagement with reed 15.

Figs. 3 and 4 represent other variant reed switches possible without departing from the novel concept of the present invention. Fig. 3 shows a structure similar to that of Fig. 1 wherein the flexibility of reed armature 14 is reduced as compared to that of reed armature 15. This is accomplished by reducing the length of the flattened portion 19 of reed 14 as compared to the flattened portion 20 of reed 15. In this way, upon the establishment of a magnetic field, the contacts on reeds 13 and 15 will come together before those on reeds 12 and 14, due to the greater ease of flexing the pair comprising 13 and 15. There will be supplied, therefore, a pair of sequential make contacts. Judicious proportioning of the relative flexibility of the various reeds, either as proposed here or by the use of different materials or different size reeds, etc., will provide a multiplicity of contact combinations of the sequential and continuity types.

Fig. 4 illustrates one simple expedient for converting the reed switch of Fig. 1 into a polarized or latching switch. An insulated supporting member 21 holds a permanent magnet 22 juxtaposed between the terminal portions of elements 14 and 15. The permanent magnet 22 is poled as indicated by the N and S thereon. The magnet 22 could be encapsulated or merely supported in its proper position. Upon energization of the coil 11 by current of one polarity, reeds 12 and 13 engage reeds 14 and 15, respectively, to provide two electrical circuit paths through the switch. Upon the removal of this magnetic field (by deenergization of the coil), these circuit paths are maintained intact as a result of the magnetic field established by permanent magnet 22. The application of a current of opposite polarity to coil 11 will overcome the holding or latching action of permanent magnet 22 and cause the reeds to return to their normal positions.

Though the latching technique is illustrated in connection with the embodiment depicted in Fig. 1, it could be applied as successfully to other contact combinations as, e.g., the embodiments depicted in Figs. 2, 3 and 4.

The versatility of switches employing the concept herein disclosed and claimed can be extended within the

4

spirit of the invention. For example, the switch disclosed in Fig. 1 might have one or more additional reeds supported in the common plane of the existing ones. If one more reed were formed in the switch of Fig. 1, it would be possible to have two transfer combinations (employing five reeds). Additional reeds in the stacked array would present further combinational possibilities. The only limitation on the number of additional reeds is one of controlling the size of the envelope, provided, however, irrespective of how many reeds are employed, any two reeds which have another reed interposed between them (at their overlapping ends) are supported at opposite ends of the vessel.

Not only may a reed be added in the common plane, but a plurality of groups of reeds supported as shown in Fig. 1 could be formed within a single envelope. Though mutual attractive and repelling forces as between reeds in different groups would exist, due to the large separation between such reeds and to the relative inflexibility of the reeds about their edges, such intergroup forces would not present a problem.

It is apparent from the foregoing, that the above-illustrated embodiments are only representative of the application of the principles of the present invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A magnetically operated switch comprising; in combination; at least three magnetic elements, each of which has a contacting portion thereon; means for supporting said elements so that said contacting portions overlap; and means for inducing lines of flux through said elements to cause said elements to perform a switching function; said supporting means disposing said elements with respect to each other whereby any element whose contacting portion is interposed between the contacting portion of two other elements is mutually attracted by one and mutually repelled by the other, the other two reeds being at opposite ends of the supporting means.

2. A magnetically operated switch comprising; in combination; an envelope; a coil adjacent said envelope; at least three magnetic elements, each of which has a contacting portion thereon; means for holding said elements so that said contacting portions overlap within said envelope; and means for energizing said coil to operate said switch; said holding means supporting at one end of said envelope two elements whose contacting portions are externally overlapped by the contacting portion of the other element supported at the other end of the envelope.

3. A magnetically operated switch comprising; in combination; an envelope having a longitudinal axis; a coil adjacent said envelope; at least three movable magnetic elements lying in planes parallel to said axis, each of which has a contacting portion on one end; means for supporting said elements so that said contacting portions overlap within said envelope; and means for energizing said coil to operate said switch; said supporting means orienting said elements with respect to each other whereby any element whose contacting portion is interposed between the contacting portion of two other elements is mutually attracted to one and mutually repelled by the other, the two other reeds being supported at opposite ends of the envelope.

4. A magnetically operated switch comprising; in combination; an envelope having a longitudinal axis; a coil surrounding said envelope; at least three movable magnetic reeds, each reed having a contacting portion on one end; and means for supporting said reeds within said envelope whereby said one ends overlap; said reeds lying in planes substantially parallel to said axis and arranged whereby, upon the energization of said coil, any one of said reeds whose contacting portion is interposed between the contacting portions of two other reeds is mutually attracted by one of the two reeds and mutually repelled by the

5

other, the two other reeds being supported at opposite ends of the envelope.

5. A magnetically operated switch comprising; in combination; an envelope having a longitudinal axis; a coil surrounding said envelope; at least three movable magnetic reeds, each reed having a contacting portion on one end; and means for supporting said reeds in a common plane at opposite ends of said envelope and in planes substantially parallel to said longitudinal axis and with said contacting portions overlapping within said envelope; said reeds arranged in said common plane so that upon the energization of said coil any one of said reeds whose contacting portion is interposed between the contacting portions of two other reeds is mutually attracted to one and mutually repelled from the other, the two other reeds being supported at opposite ends of the envelope.

6. A magnetically operated switch comprising; in combination; a tubular glass envelope having a longitudinal axis; a coil surrounding said envelope; two pairs of movable flat magnetic reeds; each reed having a contacting portion on one end; means for supporting said pairs at opposite ends of said envelope in overlapping relation within said envelope and in planes substantially parallel to said longitudinal axis and with said reeds lying in a common plane and with the overlapping portions of said reeds lying in a plane transverse to said longitudinal axis and with the overlapping portions of the reeds of one of said pairs intermediate the contacting portions of the reeds of the other pair; and means for energizing said coil to cause the reeds of said one pair to engage respective cooperating reeds of said other pair.

6

7. A magnetically operated switch comprising in combination an envelope; a coil adjacent said envelope; a first reed supported at one end of said envelope; a pair of reeds in parallel planar relationship supported at the other end of the envelope, said first reed overlapping the pair of reeds; a second reed supported at the other end of the envelope, said pair of reeds overlapping the second reed; and means for energizing the coil to cause each reed of the pair to repel from each other and be attracted to the adjacent reed supported at the other end of the envelope.

8. A magnetically operated switch comprising in combination an envelope; a coil adjacent said envelope; a first reed supported at one end of said envelope; a pair of reeds in parallel planar relationship supported at the other end of the envelope, said first reed overlapping the pair of reeds; a second reed supported at the other end of the envelope and having a relative stiffness different than that of the first reed, said pair of reeds overlapping the second reed; and means for energizing the coil to cause each reed of the pair to repel from each other and be sequentially attracted to the adjacent reed supported at the other end.

References Cited in the file of this patent

UNITED STATES PATENTS

2,245,391	Dickten	June 10, 1941
2,264,022	Ellwood	Nov. 25, 1941
2,286,800	Gustin	June 16, 1942
2,397,123	Brown	Mar. 26, 1946