

Aug. 23, 1966

R. J. KELLER ETAL

3,268,684

MECHANICALLY OPERABLE MAGNETIC REED SWITCH

Filed April 28, 1964

4 Sheets-Sheet 1

FIG. 1

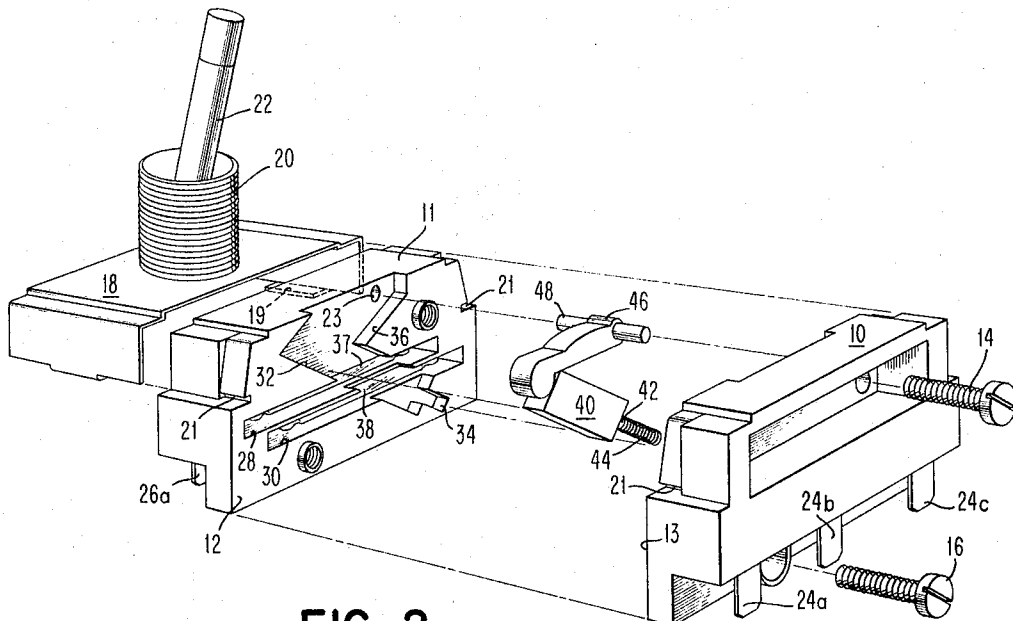
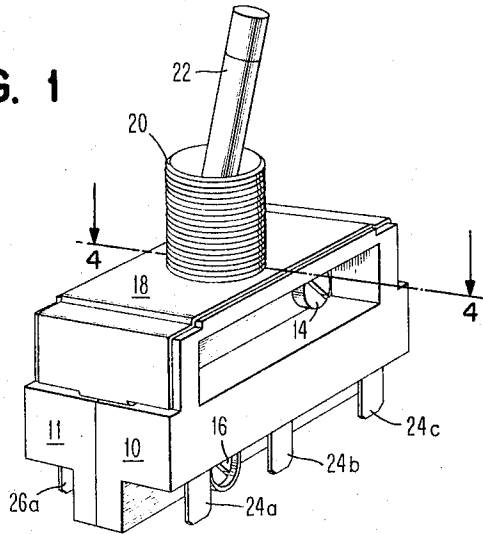


FIG. 2

INVENTORS

RONALD J. KELLER
JAMES M. McKEON

BY *Richard H. Smith*
AGENT

Aug. 23, 1966

R. J. KELLER ETAL

3,268,684

MECHANICALLY OPERABLE MAGNETIC REED SWITCH

Filed April 28, 1964

4 Sheets-Sheet 2

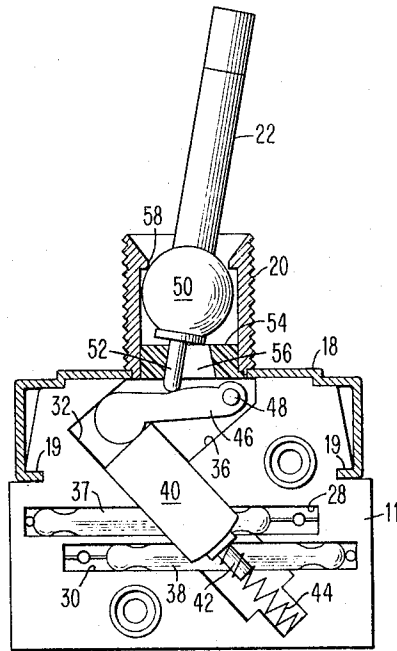


FIG. 3a

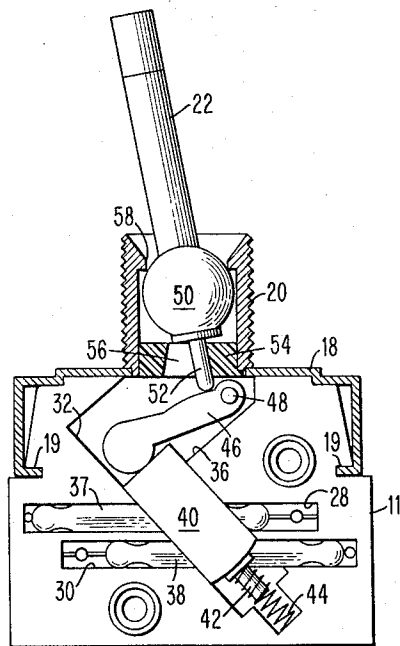


FIG. 3b

Aug. 23, 1966

R. J. KELLER ET AL

3,268,684

MECHANICALLY OPERABLE MAGNETIC REED SWITCH

Filed April 28, 1964

4 Sheets-Sheet 3

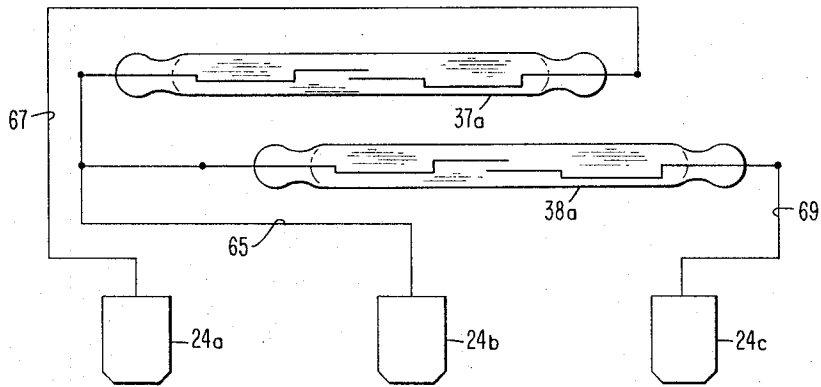


FIG. 6a

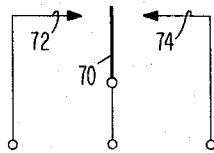


FIG. 6b

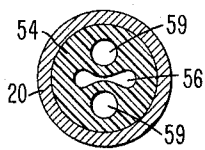


FIG. 4

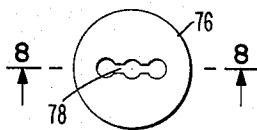


FIG. 7



FIG. 8

Aug. 23, 1966

R. J. KELLER ETAL

3,268,684

MECHANICALLY OPERABLE MAGNETIC REED SWITCH

Filed April 28, 1964

4 Sheets-Sheet 4

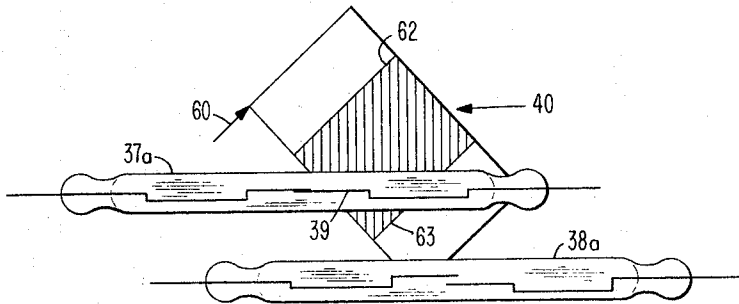


FIG. 5a

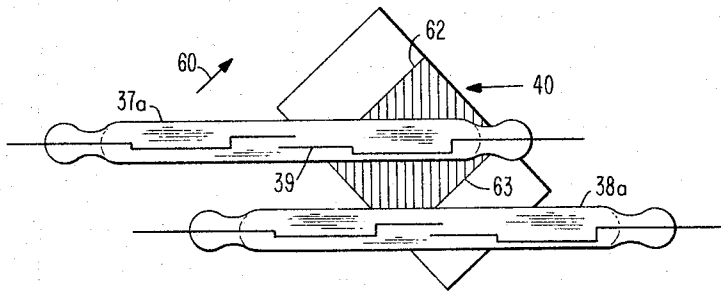


FIG. 5b

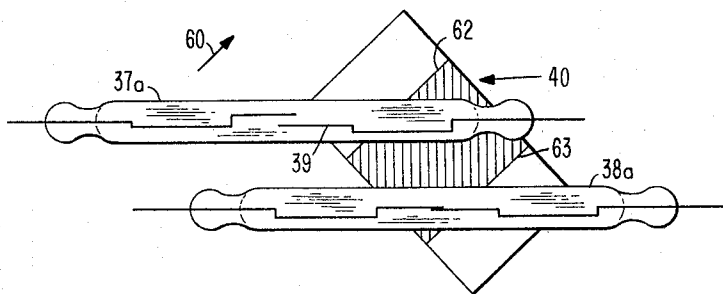


FIG. 5c

1

2

3,268,684

MECHANICALLY OPERABLE MAGNETIC REED SWITCH

Ronald J. Keller and James M. McKeon, Rochester, Minn., assignors to International Business Machines Corporation, New York, N.Y., a corporation of New York

Filed Apr. 28, 1964, Ser. No. 363,090
12 Claims. (Cl. 335-154)

This invention relates to magnetic reed switch elements and, more particularly, to a unitized mechanically operable switch module which permits convenient and inexpensive usage of such switch elements in a variety of standard switching arrangements.

Magnetic reed switches are well known in the electrical switching art. Each switch comprises a pair of ferromagnetic, electrically conductive reeds sealed within a glass enclosure tube which is filled with an inert gas. The reeds extend in cantilever fashion from the ends of the tube to approximately the center thereof, where their free ends are suspended in close proximity to each other. The ends are normally kept apart by the natural spring force of the reeds. The portions of the reeds which project outside of the tube are used for making electrical contact with an external circuit to be switched.

A magnetic field is used to bring the reeds together to close the switch. When a sufficient amount of magnetic flux from an external source is conducted through the reeds, the ends of the reeds opposing one another in the tube are caused to become induced magnetic poles of opposite sign. The force of attraction exerted therebetween overcomes the spring bias of the reed elements and they are drawn together, establishing electrical contact. Removal of the magnetic field opens the switch.

The advantages associated with such switches are their very small size (the enclosure tube is approximately one inch long and is less than 1/8 inch in diameter) and their extreme durability and reliability. The latter is due primarily to the fact that the contact elements are placed in a stable, non-corrosive atmosphere and are closed off completely from nearly all outside influences of a physical or chemical nature.

Until now, however, a unitized magnetic reed switch module capable of performing a variety of common switch functions such as single-pole double-throw (SPDT) and double-pole double-throw (DPDT) operations in response to mechanical stimulus (e.g., manual, etc.) has not been available. Because of this use of magnetic reed contact switches in those areas where manual and other forms of mechanical switching are required (e.g., switchboards, instrument panels, etc.) has been severely limited.

It is therefore an object of the present invention to provide a unitized magnetic reed switch module that is adapted to perform, through mechanical (e.g., manual, etc.) actuation, a variety of common switch functions, including SPDT and DPDT operations.

Still another object is to provide such a unitized, double-throw magnetic reed switch module that is highly compact, low in cost and reliable in operation.

In accordance with one aspect of the present invention, a switch module is provided wherein a source of magnetic flux is arranged to be moved past at least a pair of magnetic reed switches so that a closing amount of flux is conducted across first one and then the other of the switches, thereby providing a double-throw switch function. Further, the switches are so positioned in relation to the path of movement of the flux source that a reliable break-before-make action is achieved with a minimum amount of movement of the flux source. In accordance with another aspect of the invention, simple, low cost means are provided for moving the flux source through a

reed actuating path. These means include a pivotable actuator bearing against one surface of the flux source and a biasing spring bearing against another surface of the source to maintain it in contact with the actuator. The actuator is adapted to be operated by such means as a toggle lever, pushbutton, etc.

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawing.

In the drawings:

FIG. 1 is a perspective view of an assembled switch module in accordance with a preferred embodiment of the present invention.

FIG. 2 is an exploded view of the switch module of FIG. 1 showing the several operating elements.

FIGS. 3a and 3b are elevation views, partially in section, of one of the body halves of the switch module of FIG. 1.

FIG. 4 is a sectional view taken along the line 4-4 of FIG. 1 and illustrates a first embodiment of a toggle detent in accordance with the invention.

FIGS. 5a, 5b, and 5c are schematic diagrams illustrating the operating relationship between the actuating magnet and two reed switch elements in accordance with the principles of the invention.

FIGS. 6a and 6b are schematic diagrams illustrating the functional equivalence between one switching arrangement in accordance with the invention and a conventional form of single-pole double-throw switch.

FIG. 7 is a top plan view of a second embodiment of a toggle detent.

FIG. 8 is a sectional view taken along the line 8-8 of FIG. 7 and shows elevational details of the central aperture of the detent.

Referring to FIG. 1, there is shown an assembled switch module in accordance with a preferred embodiment of the present invention. The module comprises a pair of body halves 10 and 11 joined together by a pair of fastening elements 14 and 16 (the latter not shown). A clip-on bracket 18 straddles the tops of the body halves 10 and 11 and supports a threaded neck 20. The external threads on the neck 20 may be used for the purpose of mounting the switch module on, for example, an instrument panel. A toggle lever 22 is pivotally mounted by means of a ball and socket mechanism (to be described subsequently) housed within the neck 20. Two sets of terminals 24A, 24B, and 24C, and 26A, 26B, and 26C (the latter two not shown) provide electrical access in a manner hereinafter described to magnetic reed switch elements contained within the body halves 10 and 11.

In FIG. 2 the switch module of FIG. 1 is exploded, showing the internal elements of the switch as well as the manner in which the body halves 10 and 11 and the clip-on bracket 18 are assembled. A pair of parallel recesses 28 and 30 extend inwardly from the inner face 12 of body half 11. A pair of conventional magnetic reed switches 37 and 38, such as the type marketed by the IBM Corporation under Part No. 765,460, is contained within the recesses 28 and 30. A more shallow recess 32 runs diagonally across the face 12, intersecting the recesses 28 and 30 at preferably, but not necessarily, a 45° angle. A recess 36 extends the upper portion of recess 32 to the top of body half 11. Appended to the lower end of recess 32 is a small recess notch 34.

The inner face 13 of the body half 10 contains a network of recesses identical to those just described for the body half 11. The recesses on the two faces 12 and 13 are mirror images of each other so that they match up when the body halves are joined together. A pair of reed switches 37A and 38A (not shown; see FIG. 5) are contained in the body half 10 in a manner iden-

tical to that in which the elements 37 and 38 reside in body half 11. The body halves are preferentially constructed of a molded plastic material such as "Nylatron."

A permanent magnet 40 slides within the diagonal recess 32. The magnet may be made of any highly magnetizable material, such as sintered "Alnico 2," and is magnetized so as to have poles at its upper and lower ends. A compression spring 44 is supported at its lower end in the recess notch 34 and exerts an upward force on the magnet 40. A small pin 42 may be set in the lower end of the magnet to serve as a guide to keep the spring in a proper position against the magnet.

A cam arm 46 is pivotally mounted on a pivot pin 48 which is supported in a pair of holes 23 in the body halves 10 and 11. Rotation of the cam arm 46 causes the magnet 40 to slide up and down in the recess 32, passing immediately adjacent the four reed switch elements 37, 38, 37A, and 38A in a manner to be described in more detail subsequently. It is preferred, although not essential, that the cam arm 46, pivot pin 48, spring 44 and guide pin 42 be made of non-magnetic materials in order to confine the flux field associated with the magnet to the area immediately adjacent the four reed switch elements.

The clip-on bracket 18 has a pair of tabs 19 protruding from its lower ends. These tabs are adapted to fit into notches 21 in the body halves 10 and 11, providing a secure attachment of the threaded neck 20 and the mechanism contained therein to the body of the switch.

Referring now to FIGS. 3A and 3B, the toggle mechanism, which enables actuation of the magnet 40, will be described. A ball 50 and camming pin 52 are attached to the lower end of the toggle lever 22. The camming pin 52 engages an upper surface of the cam arm 46. A collar 58 protrudes from the inner walls of the neck 20 and serves as a bearing seat for the ball 50. The upward force exerted by the spring 44 through the frictionally engaged elements 40, 46, and 52 keeps the ball 50 seated against the collar 58.

As the toggle lever 22 is moved from right to left (FIG. 3A to FIG. 3B), the camming pin 52 cams against the upper surface of the arm 46, forcing the arm to rotate in a counterclockwise direction. This moves the magnet 40 from the upper position of FIG. 3A to the lower position of FIG. 3B, against the bias of the spring 44. Operation of the lever 22 in the opposite direction permits the spring 44 to return the magnet 42 to its upper position.

A resilient detent plug 54 is pressed in a slight force fit into the lower end of the neck 20. The camming pin 52 extends through a central aperture 56 in the plug 54. This aperture, shown in FIG. 4, is in the shape of a slot having widened end portions and a narrow center portion. The end portions are of a width sufficient to accommodate the camming pin 52 so that the pin may be held in either of the two operating positions illustrated in FIGS. 3A and 3B. Application of lateral force to the lever 22 causes the pin 52 to be forced through the narrow center portion of the aperture 56, thus enabling an operator to change the switch from one operating position to the other. A pair of holes 59 in the plug 54 increase the "give" of the material so that a suitable switch "feel" is obtained. The resiliency of the plug 54 prevents the camming pin 52 from residing in any position other than the two operating positions illustrated. That is, if an operator moves the toggle lever 22 to a center position and then lets go of it, the resiliency of the side walls of the aperture 56 will force the camming pin 52 into one of the two positions shown in FIGS. 3A and 3B.

In order to allow free rotation of the ball 50, there is a clearance space provided between the upper surface of the plug 54 and the ball. Thus the plug does not

function as a bearing seat for the ball. The detent plug is made preferably, but not essentially, of polyurethane.

Operation

With reference now to FIGS. 5A, 5B, and 5C the exact coaction between the reed switch elements and the magnet 40 will be described. FIG. 5A shows an enlarged view of the reed switches 37A and 38A (contained in the body half 10) while behind them is shown the magnet 40 located, as in FIG. 3A, in its upper operating position. The arrow 60 marks this position. For purposes of illustration, a pair of lines 62 and 63 are marked one quarter of the way in from each end of the magnet. These lines are hereinafter referred to as "quarter-lines." The bulk of the flux emanating from the magnet and capable of being conducted longitudinally along the switch reeds extends between the quarter-lines 62 and 63. The cross-hatched portion of the magnet between these lines, therefore, represents the "operative" segment of the magnet (i.e., that which is capable of operating the switch elements). Thus if the gap between the reeds of a switch element does not lie substantially between the quarter-lines 62 and 63, there will not be sufficient flux conducted longitudinally along both reeds of the switch in order to induce a closing attraction between them.

In FIG. 5A (upper operating position of the magnet), the gap between the two reeds of the element 37A lies substantially between the quarter-lines 62 and 63. Sufficient flux is therefore conducted across the reed gap and longitudinally along the reeds to induce a closing attraction between the reeds. Since the reed gap of the element 38A is outside the operative area, those reeds remain apart.

When the magnet assumes the center operating position (toggle lever 22 in a vertical position) of FIG. 5B, the reed gaps of both the elements 37A and 38A lie outside of the quarter-lines and therefore remain open. Even though the gaps of the elements are only slightly beyond the quarter-lines, their opening is assured by the presence of the reed 39 which, because it offers an uninterrupted, low-reluctance path from one quarter-line to the other, acts to shunt or "short circuit" most of the operative flux away from the gaps. The presence of such a shunt path is instrumental in achieving a compact switch design wherein the required movement of the magnet is minimized.

When the magnet is moved to the lower operating position diagrammatically illustrated in FIG. 5C, the reed gap of the lower element 38A is placed within the area between the quarter-lines and thus closes.

Therefore, as the magnet 40 is caused to move from its upper operating position through the center position to the lower operating position by movement of the toggle lever 22 from right to left (FIGS. 3A and 3B), the reed switches 37A and 38A change, respectively, from closed-open to open-open to open-closed. Naturally, when the magnet is moved back to its upper position this switching sequence is reversed. The switches thus operate in a "break-before-make" fashion. By moving the magnet at an angle past the reed switch elements (approximately 45° is illustrated) and by locating the upper reed gap near an edge of the magnet and the lower reed gap somewhat in from the edge, the displacement of the magnet necessary to effect the closure of both switches is minimized and an extremely reliable and compact configuration is achieved.

When, as shown in FIG. 6A, one reed of each of the elements 37A and 38A is connected by common conductor 65 to the center terminal 24B (FIG. 1) and the other reeds of the elements are connected, respectively, to the terminals 24A and 24C by the conductors 67 and 69, the switch of the present invention gives a single-pole double-throw (SPDT) switching function. This is read-

5

ily seen by comparing the standard schematic illustration of a SPDT switch shown in FIG. 6B with the switches of FIG. 6A operated in the previously described sequence. With the magnet 40 in its upper operating position the circuit between terminals 24A and 24B is closed while that between terminals 24B and 24C is open. This is equivalent to placing the pivot arm 70 of the SPDT switch of FIG. 6B in contact with the pole 72. Likewise, placement of the magnet 40 in its center operating position is equivalent to the placement of the pivot arm 70 in the vertical position shown, while placement of the magnet in its lower operating position is equivalent to contacting the pivot arm 70 to the pole 74. It is to be noted that the center terminal 24B is shown in FIG. 6A as the common terminal only for purposes of ready comparison with the switch of FIG. 6B. Of course, design convenience may require the selection of one of the outer terminals 24A or 24C as the common terminal.

It is readily appreciated that since each of the body halves 10 and 11 of the switch module of the present invention contain a pair of reed switches which coact with the magnet 40 in the above-described manner, the switch module of the present invention may also be utilized when a double-pole double-throw switching function is required.

FIGS. 7 and 8 show a second type of toggle detent plug. As will be noted the central aperture 78 of the plug 76 has a center stop detent in addition to the end detents of the previously described detent plug 54. The plug 78 thus additionally provides the switch with a "center off" position for maintaining all of the reed switch elements in an open state.

If preferred, the toggle mechanism including the lever 22, ball 50, pin 52, and detent plug may be replaced by a push button actuator adapted to slide vertically within the neck 20. A camming pin, such as the pin 52, provided on the lower end of such a push button causes the cam arm 46 to slide the magnet 40 to its lower operating position when the push button is depressed. The bias force of the spring 44 is sufficient to return the push button, when released, to its up position. It is desirable to place a shoulder in the button to mate with the collar 58 so that the upward travel of the button is arrested when the cam arm 46 reaches its upper limit (FIG. 3A).

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A double throw switch, comprising:

a first pair of flexible, ferromagnetic electrical contacts; a second pair of flexible, ferromagnetic electrical contacts in a fixed location relative to said first pair of contacts;

a movable source of magnetic flux;

means for supporting said source in an initial position proximate to said first contacts whereby a sufficient amount of said flux is conducted across said first contacts to cause them to close; and

means for moving said source from said initial position to an intermediate position and then to a final position, said movement from said initial position to said intermediate position causing the removal of said sufficient amount of flux from across said first contacts by causing substantially all of said sufficient amount of flux to be shunted through one of said first contacts, thereby opening said first contacts, and said movement from said intermediate position to said final position causing the conduction across said second contacts of an amount of flux sufficient to close said second contacts.

2. A double throw switch, comprising:

first and second magnetically operable reed switch ele-

6

ments, each said element including a pair of flexible, ferromagnetic, normally open electrical contacts; a permanent magnet movably mounted adjacent said reed switch elements;

means for supporting said magnet in an initial position proximate to said first switch element whereby a sufficient portion of the flux associated with said magnet is conducted longitudinally along the contacts of said first switch element and across the gap therebetween, causing those contacts to close; and

means for moving said magnet from said initial position to an intermediate position and then to a final position, said movement from said initial position to said intermediate position causing the removal of said sufficient portion of said flux from across the gap between the contacts of said first switch element by causing substantially all of said sufficient portion of flux to be shunted through one of said contacts, thereby opening said contacts of said first switch element, and said movement from said intermediate position to said final position causing the conduction of said flux longitudinally along the contacts of said second switch element and across the gap therebetween, causing said contacts of said second switch element to close.

3. The double throw switch of claim 2, additionally comprising:

third and fourth magnetically operable reed switch elements mounted adjacent said magnet on a side thereof opposite said first and second switch elements, said third and fourth elements being substantially identical to said first and second elements and being adapted to coact with said magnet in the same manner as said first and second elements.

4. The double throw switch of claim 3, additionally comprising:

spring means cooperating with said moving means for returning said magnet from said final position to said initial position.

5. A double throw switch, comprising:

a first pair of magnetic reed contacts; a second pair of magnetic reed contacts substantially coplanar with said first pair of contacts; a bar magnet slidably supported adjacent said reed contacts, said magnet having poles at its ends and being reciprocable along a line joining said poles, said line lying substantially parallel to said plane of said reed contacts; and

means for moving said magnet from an initial position, where said magnet biases said first pair of reed contacts closed, to a final position, where said magnet biases said second pair of reed contacts closed, the gap between said first pair of reed contacts being located, when said magnet is in said initial position, between two parallel planes, each said plane intersecting said magnet perpendicular to said line at a point substantially midway between and end and the middle of said magnet, and the gap between said second pair of reed contacts being located between said two parallel planes when said magnet is in said final position.

6. The double throw switch of claim 5 wherein said line along which said magnet is reciprocable is oriented at substantially at 45 degree angle to said reed contacts.

7. A double throw switch, comprising:

a first pair of magnetic reed contacts; a second pair of magnetic reed contacts substantially coplanar with said first pair of contacts; a bar magnet slidably supported adjacent said reed contacts, said magnet having poles at its ends and being reciprocable along a line joining said poles, said line lying substantially parallel to said plane of said reed contacts; and

means for moving said magnet from an initial position, where said magnet biases said first pair of

7

reed contacts closed, to an intermediate position, where both said pairs of reed contacts are open, and then to a final position, where said magnet biases said second pair of reed contacts closed, the gap between said first pair of reed contacts being located, when said magnet is in said initial position, between two parallel planes, each said plane intersecting said magnet perpendicular to said line at a point substantially midway between an end and the middle of said magnet, the gap between said second pair of reed contacts being located between said two parallel planes when said magnet is in said final position and neither of said gaps being located between said two parallel planes when said magnet is in said intermediate position.

8. The double throw switch of claim 7 wherein said line along which said magnet is reciprocable is oriented at substantially a 45 degree angle to said reed contacts.

9. A magnetic switch, comprising:

- a casing;
- a pair of magnetic reed contacts mounted in said casing;
- a slidable source of magnetic flux positioned adjacent said reed contacts;
- a camming bar pivotally connected at one end to said casing and having its other end in frictional engagement with said source;
- a spring biasing said source against said camming bar; and
- a manually operable lever pivotally connected to said casing, a first end of said lever slidably engaging said camming bar and the other end of said lever being free for manual operation, whereby the pivoting of said lever rotates said camming bar about its pivot, causing movement of said source past said reed contacts to open and close the same.

10. The switch of claim 9 further comprising:
resilient detent means cooperating with said lever to maintain said source in selected positions when said lever is released from manual actuation.

11. A double throw switch comprising:

- a casing;
- a first pair of magnetic reed contacts mounted in said casing;
- a second pair of magnetic reed contacts mounted in said casing;

8

a permanent magnet slidably positioned adjacent said first and second pairs of reed contacts;

a camming bar pivotally connected at one end to said casing and having its other end in frictional engagement with said magnet;

a spring biasing said magnet against said camming bar;

a manually operable lever pivotally connected to said casing, a first end of said lever frictionally engaging said camming bar, the other end of said lever being free for manual operation, whereby the pivoting of said lever rotates said camming bar about its pivot, causing said magnet to slide past said first and second pairs of reed contacts to open and close the same; and

detent means resiliently cooperating with said manually operable lever to hold said lever in selected positions upon release of the latter from manual actuation, a first said selected position being such that said magnet is located to hold said first pair of reed contacts, only, closed and a second said selected position being such that said magnet is located to hold said second pair of reed contacts, only, closed.

12. The double throw switch of claim 11 wherein said detent means is adapted to maintain said lever in a third selected position upon release of the latter from manual actuation, said third selected position being such that both said first and said second pairs of reeds contacts are open.

References Cited by the Examiner

UNITED STATES PATENTS

2,916,592	12/1959	Campe	200—168
2,962,572	11/1960	Duffield	200—166
2,973,414	2/1961	Bossemeyer	200—87
3,087,030	4/1963	Shebanow	200—87
3,155,955	11/1964	Davidson et al.	200—87
3,176,097	3/1965	Wood	200—87
3,198,903	8/1965	Chafee	200—93

References Cited by the Applicant

UNITED STATES PATENTS

2,877,361 3/1959 Chase.

BERNARD A. GILHEANY, *Primary Examiner*.

B. DOBECK, *Assistant Examiner*.