Nov. 3, 1964 E. W. WERTS 3,155,792

MAGNETIC REED SWITCH DEVICE

Filed Aug. 7, 1962

FIG. 1.

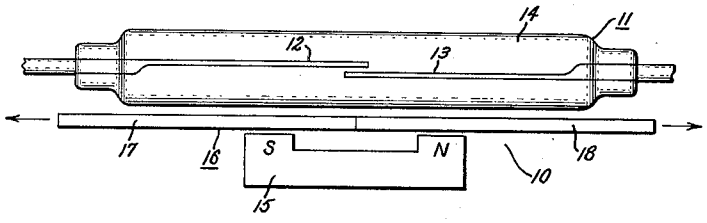


FIG. 2.

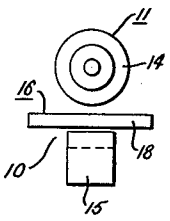


FIG. 3.

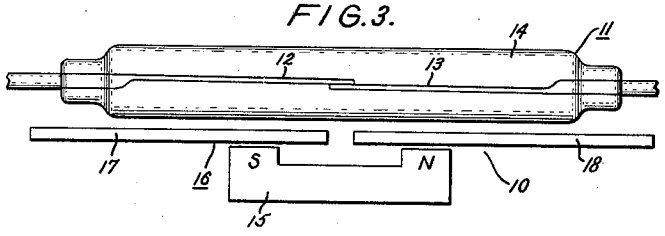


FIG. 4.

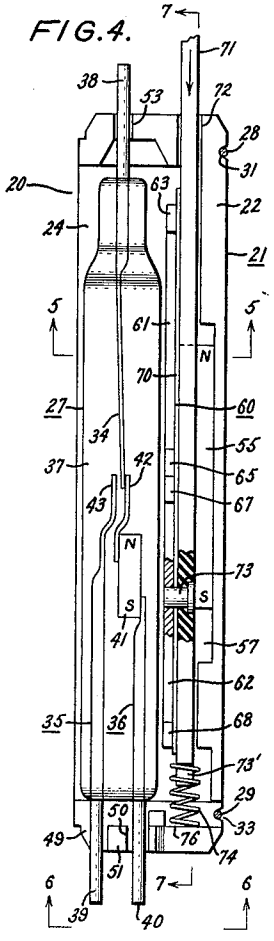


FIG. 7.

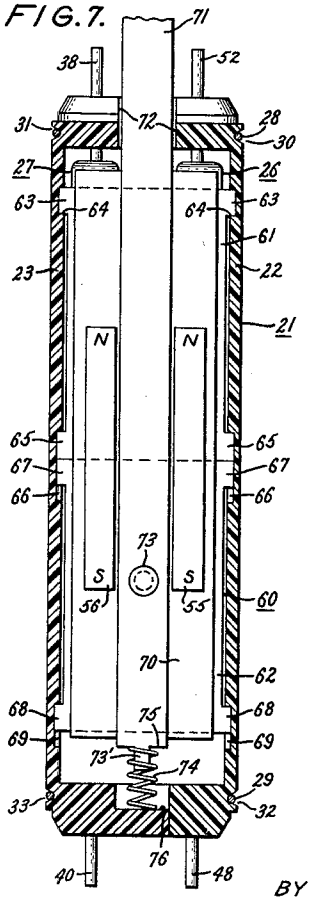


FIG. 5.

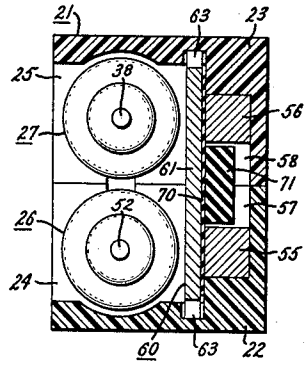
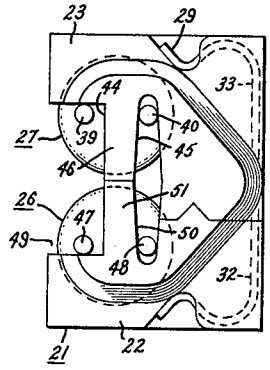


FIG. 6.



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3,155,792

MAGNETIC REED SWITCH DEVICE

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6 Claims. (Cl. 200—87)

This invention relates to switch devices and has particular relation to switch devices which include magnetic switches such as magnetic reed switches.

Switch devices which incorporate magnetic reed switches have recently found a wide variety of application, and such devices include in addition to the reed switch a flux producing means for operating the contacts of the reed switch. Typically, the flux producing means has either been in the form of a permanent magnet positioned adjacent the reed switch or a winding surrounding the reed switch which is selectively energized and deenergized in order to open and close the reed switch contacts.

In those installations wherein the magnetic fields of permanent magnets have been employed to operate reed switches, various arrangements have been utilized to produce the change in the magnetic field at the reed switch which is required to cause the switch contacts to open and close. For example, means have been provided to move the permanent magnet relative to the reed switch to change the strength or direction of the magnetic field at the reed switch to operate the switch contacts. As a further example, a magnetic shield has been provided which is movable between the magnet and the switch to effect variation of the magnetic field from the magnet influencing the switch. With such arrangements, however, the magnetic field at the reed switch changes slowly in relation to the movement of the magnet or shield so that a relatively large differential movement is required to produce the change necessary to cause the switch contacts to open and close. This is due to the wide dispersion of the magnetic field in the space around a permanent magnet.

Inasmuch as reed switches find wide application in installations wherein space is at a premium, it can be appreciated that the comparatively large movement of the reed switch actuating means in many cases cannot be tolerated, and it is very desirable that provision be made for reducing such movement to a minimum amount. It is also desirable that the actuating means be capable of operating the reed switch accurately and consistently in response to small movements of a mechanism without the employment of motion-multiplying levers which are bulky and which have numerous parts.

It is therefore a primary object of the present invention to provide an inexpensive and compact switch device including a magnetic switch with novel and improved means for operating the contacts of the magnetic switch.

It is another object of the invention to provide a novel and improved switch device including a magnetic switch having contacts operable in response to variations in a magnetic field and including a unique magnetic shutter for varying the magnetic field.

It is a further object of the invention to provide a novel and improved switch device including a magnetic switch having contacts operable in response to variations in a magnetic field and including a magnetic shutter having a movable part for varying the magnetic field applied to the switch in response to a very small amount of movement of the part.

In carrying out the invention in one preferred form a switch device is provided including a magnetic reed switch having overlapping magnetic contacts which are operated in response to variations of the magnetic field produced by a permanent magnet adjacent the switch.

The magnetic field produced by the magnet at the reed switch contacts is varied by means of a magnetic shunt in the form of a shutter having two magnetic plates positioned between the permanent magnet and the reed switch. The shunt preferably consists of a fixed plate and a movable plate which is moved relative to the fixed plate between two positions wherein it is respectively in butt engagement with the fixed plate and spaced from the fixed plate.

When the magnetic plates are in butt engagement, magnetic flux from the magnet is effectively shunted through the plates away from the reed switch and when the plates are spaced from each other, the magnetic flux from the magnet is applied to the reed switch. In the preferred form the reed switch is a double throw reed switch having a movable reed positioned between two fixed contacts and normally in engagement with one fixed contact in the absence of applied external magnetic flux. The arrangement is such that when the plates of the magnetic shutter are in butt engagement, the movable reed is in engagement with the one fixed contact, and when the magnetic plates are separated by a small distance, the movable reed is displaced into engagement with the other fixed contact.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawing in which:

FIG. 1 is a diagrammatic representation of a switch device constructed in accordance with the present invention and showing the contacts of the reed switch open;

FIG. 2 is a diagrammatic representation of the device of FIG. 1 with parts shown in end elevation;

FIG. 3 is a diagrammatic representation of the device of FIG. 1 showing the contacts of the reed switch closed;

FIG. 4 is a view in elevation showing a switch device of different construction than the device of FIG. 1 with a portion of the housing therefor removed;

FIG. 5 is a view taken along the line 5—5 of FIG. 4 with the housing portion added;

FIG. 6 is a view taken along the line 6—6 of FIG. 4; and

FIG. 7 is a view taken along the line 7—7 of FIG. 4.

Referring now to the drawings there is illustrated in FIGS. 1–3 a switch device represented generally by the numeral 10 and constructed in accordance with the present invention. The device 10 consists of a magnetic switch 11 shown in the form of a magnetic reed switch having elongated parallel-extending and overlapping flat magnetic contacts 12 and 13 mounted within a sealed capsule 14. Operation of the contacts 12 and 13 is controlled by means of a flux-producing means shown in the form of a generally U-shaped permanent magnet 15 which produces magnetic flux for influencing the contacts 12 and 13 and which has north and south magnetic poles designated respectively by the letters N and S.

The switch 11 is designed so that when a magnetic flux component from the magnet 15 traverses the contacts 12 and 13, the contacts 12 and 13 are closed, and in the absence of such flux component the contacts 12 and 13 are open as shown in FIG. 1.

According to the present invention novel and improved means are provided for controlling the path of magnetic flux emanating from the magnet 15 to control the operation of the contacts 12 and 13. In the embodiment of FIGS. 1–3 the improved control means consists of a magnetic shunt 16 shown in the form of a shutter comprised of a pair of magnetic plates 17 and 18 lying in a common plane between the magnet 15 and the switch 11. The common plane is parallel to the planes of the flat contacts 12 and 13 and perpendicular to the direction of overlap of the contacts.

In FIG. 1 the edges of the plates 17 and 18 of the shunt 16 are shown in butt contact at an area included in a plane which is adjacent the area of overlap of the contacts 12 and 13 of the reed switch 11 and which intersects the switch contacts. The contacting plates 17 and 18 provide a low reluctance short circuit path for the flux of magnet 15 thereby effectively shielding the reed switch 11 and its contacts from the magnetic field whereby the contacts 12 and 13 are open. In order to vary the magnetic field at the switch 11 to close the contacts 12 and 13 the present invention contemplates that one or both of the plates 17 and 18 be moved so as to space the plates from each other as shown in FIG. 3.

In the embodiment under discussion both of the plates 17 and 18 are moved in the directions of the arrows parallel to the direction of extension of the contacts 12 and 13 to separate the plates which greatly increases the reluctance of the magnetic path through the shunt. This results in variation of the magnetic field at the switch 11 in such a manner that magnetic flux from the magnet traverses the contacts 12 and 13 to close these contacts as shown in FIG. 3. The variation in the magnetic field of the magnet 15 necessary to operate the contacts 12 and 13 is produced by a very small movement of the plate 17 and 18 of the shunt 16. Such movement is observed to be considerably less than that required of a magnet or of a magnetic shield positioned between a magnet and a switch to operate the contacts of the switch.

Referring now to FIGS. 4–7, there is shown a modified form of switch device represented generally by the numeral 20 and including a two-part housing 21 which contains the operating parts of the switch. In FIG. 4 one housing part 22 only is shown with the other complimentary housing part 23 being removed in FIG. 4 and being shown in FIGS. 5–7. The plane of separation of the housing parts in FIG. 4 is parallel to the plane of the paper and in FIGS. 5 and 6 is a generally horizontal plane perpendicular to the plane of the paper.

As best shown in FIG. 5, the housing parts 22 and 23 are of generally L-shaped cross section and include respectively recesses 24 and 25 extending substantially the full length thereof for receiving magnetic switches 26 and 27. While two magnetic switches are shown in the embodiment under discussion, the housing 21 can accommodate but a single magnetic switch as will presently appear.

The housing parts 22 and 23 are secured together by generally U-shaped spring clips 28 and 29 positioned at the ends of the housing in communicating grooves formed in the housing parts. For this purpose the upper ends of the housing parts 22 and 23 as viewed in FIG. 7 have formed therein grooves 30 and 31 which receive the U-shaped spring clip 28, and the lower ends of the housing parts as viewed in FIG. 7 contain grooves 32 and 33 which receive the spring clip 29.

The switches 26 and 27 may be of any suitable type and in the embodiment illustrated in FIGS. 4–7, the switches 26 and 27 are illustrated in the form of doube-throw magnetic reed switches of a design set forth in my application S.N. 190,274 filed April 26, 1962 and entitled "Magnetic Reed Switches." The switches 26 and 27 are of similar construction and therefore the switch 27 alone will be described.

Briefly, the switch 27 includes a movable electrode or reed 34 having a flattened contact portion overlapping and located between a pair of fixed electrodes 35 and 36, the electrodes 34, 35 and 36 being supported by and mounted within a sealed capsule 37. The reed 34 includes a cylindrical terminal 38 extending externally of the capsule 37 at the upper end thereof as viewed in FIG. 4, and the electrodes 35 and 36 include respectively cylindrical terminals 39 and 40 projecting outside the capsule 37 at the lower end thereof as viewed in FIG. 4. Electrical conductors (not shown) are connected to the terminals 38, 39 and 40 to conduct current controlled by the switch.

The fixed electrode 36 is of two-part construction with the terminal part thereof supporting a permanent magnet 41 which in turn has attached thereto a flattened contact 42 which is spaced from the flattened contact 43 of the other fixed electrode 35. The north and south poles of the magnet 41 are designated by the letters N and S respectively.

In the illustrated embodiment the induction of magnet 41 is set so that its magnetic flux is sufficient to normally attract the reed 34 into engagement with the contact 42 of electrode 36 as shown in FIG. 4 to establish normally closed contacts. When an external magnetic field is applied to the switch 27 acting in opposition to the field emanating from magnet 41, the reed 34 will be displaced out of engagement with the contact 42 and into engagement with contact 43 to open the normally closed contacts and to close the normally open contacts. Such displacement results from the cancellation of flux from the magnet 41 through the normally closed contacts, flux from the external field traversing the normally open contacts, and the spring force of the contact 34 urging it toward contact 43. Removal of the external field will result in displacement of contact 34 back into engagement with contact 42. Further details of the construction and operation of the switch 27 may be found in the above-identified application.

In order to mount the switches 26 and 27 in operating positions within the housing 21, the housing sections 22 and 23 include a plurality of slots for receiving the various terminals of the switches 26 and 27. For this purpose the housing section 23 includes slots 44 and 45 in one end wall thereof which are separated by a vertically extending projection 46 (FIG. 6) and which receive respectively the terminals 39 and 40 of the switch 27. The terminal 38 of the switch 27 is received within a slot (not shown) formed in the other end wall of the housing section 23. The switch 26 includes terminals 47 and 48 corresponding respectively to the terminals 39 and 40 of the switch 27 which are received within recesses 49 and 50 located in one end wall of the housing section 22 and separated by a vertically-extending projection 51 (FIG. 6) which abuts the projection 46 when the housing sections are secured in position. The switch 26 includes a terminal 52 (FIG. 7) which corresponds to the terminal 38 of switch 27 and which is positioned within a slot 53 formed in the other end wall of the housing section 22. When the housing sections are secured together, the slot 53 in the section 22 communicates with the corresponding slot (not shown) formed in the section 23. It is thus seen that with the described mounting arrangement the switches 26 and 27 are held in operating positions against substantial displacement by means of the housing sections 22 and 23.

In order to provide a magnetic field for operating the contacts of the switches 26 and 27 magnetic flux producing means, shown in the form of a pair of permanent magnets 55 and 56, is located adjacent the switches 26 and 27. The magnets 55 and 56 are illustrated in FIG. 7 in the form of parallel extending elongated bar magnets having north poles designated by the letter N and south poles designated by the letter S located respectively at the upper and lower sections of the switch device. The magnets 55 and 56 are located in a common plane and are positioned respectively within recesses 57 and 58 formed in the housing sections 22 and 23. As best shown in FIG. 5, the magnets 55 and 56 are spaced transversely of their lengths so as to be substantially aligned with the associated switches 26 and 27, and the plane of the magnets is generally parallel to the planes of the flattened contacts of the switches.

In order to control the path of magnetic flux emanating from the magnets 55 and 56 to thereby control the operation of switches 26 and 27 the present invention pro-

vides a unique magnetic shunt 60 in the form of a shutter comprised of two magnetic members 61 and 62. The shunt 60 may have various configurations and in the illustrated embodiment, the magnetic members 61 and 62 are in the form of flat plates arranged in a common plane which is generally parallel to the plane of the magnets 55 and 56 and which is between the magnets 55 and 56 and the switches 26 and 27.

The magnetic plates 61 and 62 of the embodiment shown in FIGS. 4–7 correspond to the magnetic plates 17 and 18 shown in FIGS. 1–3. It will be recalled in the discussion of FIGS. 1–3 that one or both of the plates 17 and 18 may be moved in order to provide either butt engagement or separation of the plates. In FIGS. 1–3 both of the plates 17 and 18 are movable and in the embodiment of FIGS. 4–7 only one of the plates is movable with respect to the other which is fixed against movement.

The plates 61 and 62 are mounted by the housing sections 22 and 23 so that the plate 61 is fixed against movement and the plate 62 is movable with respect to the plate 61 in directions generally parallel to the directions of extension of the electrodes of the switches between two positions wherein the plate 62 is in butt contact with the plate 61 and wherein the plate 62 is separated from the plate 61. For this purpose, the fixed plate 61 includes opposed laterally-extending ears 63 at its upper end as viewed in FIG. 7 which are located within slots 64 formed in the side walls of the housing sections 22 and 23 respectively. The ears 63 and the slots 64 are configured so that the plate 61 cannot be moved relative to the housing 21 in vertical directions as viewed in FIG. 7. The lower end of the plate 61 as viewed in FIG. 7 is provided with an additional pair of opposed laterally extending ears 65 projecting into elongated slots 66 which are formed in the side walls of the housing sections 22 and 23 and which also receive opposed laterally-extending ears 67 provided at the upper end of the movable plate 62. The ears 67 and the slots 66 are configured to permit limited movement of the plate 62 in vertical directions relative to the housing 21 as viewed in FIG. 7. Opposed laterally-extending ears 68 are formed at the lower end of plate 62 and project into opposed slots 69 which are formed in the side walls of the housing sections 22 and 23 and which are elongated to permit the desired vertical movement of the plate 62 relative to the housing.

A thin sheet of insulation 70 is preferably positioned between the magnetic shunt 60 and the permanent magnets 55 and 56. The magnets 55 and 56 overlap the two plates 61 and 62 and are maintained in their operative positions by the magnetic attraction established between the magnets and the magnetic shunt 60. The plates 61 and 62 preferably make butt contact along a plane which intersects each contact of each of the switches 26 and 27, or which is very close to intersecting such contacts.

In order to effect movement of the plate 62 relative to the plate 61 for controlling operation of the switches 26 and 27, the present invention provides an actuator which is mounted for reciprocation by the housing 21 and which is operatively connected to the plate 62. The actuator is shown in the form of a rod 71 which is mounted within cooperating grooves 72 of the housing sections 22 and 23 and which extends externally of the housing for reciprocation in vertical directions as viewed in FIGS. 4 and 7. A pin 73 is attached to the rod 71 and extends through an elongated opening in the insulation 70 and an opening in the plate 62 for operatively connecting the rod 71 and the plate 62. As best shown in FIG. 7 the rod 71 extends along a central axis of the housing 21 through the space between the magnets 55 and 56 and includes a reduced lower end portion 73' which is partially surrounded by a coil spring 74 having its ends engaging respectively a shoulder 75 on the rod 71 and an end wall 76 of the housing.

The rod 71 may have its upper end as viewed in FIG. 7 attached to a push button actuator (not shown) and when the rod 71 is depressed downwardly as viewed in FIG. 7, the spring 74 is compressed and the plate 62 is moved downwardly away from the plate 61 so that the plates become separated to establish a small air gap therebetween which greatly increases the reluctance of the magnetic path through the shunt 60. When this occurs, magnetic flux from the magnets 55 and 56 traverses the normally closed, movable and fixed contacts 34 and 42 of the switch 27, and the corresponding contacts of switch 26, in opposition to flux emanating from the magnet 41 of switch 27, and the corresponding magnet of switch 26, whereby the movable contacts are moved into engagement with the normally open fixed contacts (contact 43 of switch 27). Stated in other words, when the plates 61 and 62 are separated, the magnetic field at the switches 26 and 27 changes sufficiently to cause the normally closed contacts to open and the normally open contacts to close.

When the rod 71 is released, it is moved upwardly as viewed in FIG. 7 under the action of the expanding spring 74 and also under action of the attractive force established between the plates 61 and 62. This force increases as the plate 62 is moved closer to the plate 61 and actually results in a snap action movement of the plate 62 into butt contact with the plate 61. When the plates are in butt contact, the shunt 60 forms a very low reluctance path for magnetic flux from the magnets 55 and 56 whereby the movable contacts of the switches are moved out of engagement with the normally open fixed contacts (contact 43 of switch 27) back into engagement with the normally closed fixed contacts (contact 42 of switch 26).

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, intend in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

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

1. In a switch device, a pair of magnetic switches each having a pair of generally parallel extending and overlapping magnetic contacts, at least one contact of each switch being movable for establishing with the other contact respectively contact closed and contact open conditions, magnetic flux-producing means spaced from the switches for producing magnetic flux for controlling movement of said one contact of each switch, said flux-producing means comprising a pair of bar permanent magnets longitudinally extending in parallel relation and spaced in a transverse direction from each other, a magnetic shutter positioned between the switches and the magnets for controlling the path of magnetic flux from the magnets, said shutter comprising a first fixed magnetic member and a second magnetic member mounted for movement relative to the first member, and means for effecting movement of the second member relative to the first member between a first position wherein the second member engages the first member to shunt magnetic flux from the magnets away from the contacts of each switch and a second position wherein the second member is spaced from the first member to establish an air gap permitting magnetic flux from the magnets to traverse the contacts of each switch, said last-named means comprising an actuating rod extending through the space between said bar magnets and connected to said second member, and resilient means biasing said rod so that the second member normally engages said first member.

2. A switch device as defined in claim 1 wherein said first and second members are in the form of flat plates lying in a common plane perpendicular to the direction of overlap of the contacts of each switch.

3. A switch device as defined in claim 1 wherein said first and second members engage at an area included in a plane which intersects the contacts of each switch.

4. In a switch device, a housing including two detachably mounted sections, a magnetic switch within the housing having a pair of generally parallel extending and overlapping magnetic contacts, at least one of said contacts being movable for establishing with the other contact respectively contact closed and contact open positions, a permanent magnet within the housing and spaced from said switch for producing magnetic flux for controlling the movement of said one contact, a magnetic shutter positioned between the switch and the magnet for controlling the path of magnetic flux from the magnet, said shutter comprising a first member having parts projecting into slots formed in the housing sections so as to be fixed to said housing, and a second member having parts projecting into elongated slots formed in the housing so as to be mounted for movement relative to the housing and to the first member between a first position wherein the second member engages the first member to shunt magnetic flux from the magnet away from said contacts and a second position wherein the second member is spaced from the first member to establish an air gap for permitting magnetic flux from the magnet to traverse the contacts, an actuating rod conneced to said second member and mounted for reciprocation by said housing for effecting movement of said second member relative to the first member, and a coil spring arranged for biasing the rod to a position wherein the second member engages the first member.

5. In a switch device, a pair of magnetic switches each having a pair of generally parallel extending and overlapping flat magnetic contacts, at least one contact of each switch being movable for establishing with the other contact respectively contact closed and contact open conditions, magnetic flux-producing means spaced from the switches for producing magnetic flux for controlling movement of said one contact of each switch, said flux producing means comprising a pair of permanent magnets longitudinally extending in parallel relation and spaced in a transverse direction from each other, a magnetic shutter positioned between the switches and the magnets for controlling the path of magnetic flux from the magnets, said shutter comprising two magnetic plates lying in a common plane which is parallel to the planes of said flat contacts and which is perpendicular to the direction of overlap of the contacts of each switch, and means including a part extending through the space between the magnets for effecting relative movement between the first and second plates to effect butt contact between the plates so that the plates shunt magnetic flux from the magnets away from the contacts of each switch and to effect spacing between the plates permitting magnetic flux from the magnets to traverse the contacts of each switch.

6. In a switch device, a housing, a pair of magnetic switches within the housing each having a pair of generally parallel extending and overlapping flat magnetic contacts, at least one contact of each switch being movable for establishing with the other contact respectively contact closed and contact open conditions, said contacts having terminals extending outside said housing, a pair of bar permanent magnets within the housing for producing magnetic flux for controlling movement of said one contact of each switch, said bar magnets extending longitudinally of the housing in parallel relation and spaced in a transverse direction from each other, a magnetic shutter in the housing positioned between the switches and the magnets for controlling the path of magnetic flux from the magnets, said shutter comprising a first magnetic plate fixed to the housing, and a second magnetic plate mounted by the housing for movement relative to the first plate, said plates lying in a common plane which is parallel to the planes of the flat contacts and which is perpendicular to the direction of overlap of the contacts, an actuating rod mounted by the housing for reciprocation and extending through the space between said magnets and connected to said second plate, said rod including an actuatable portion extending outside the housing and effective when depressed inwardly of the housing to move the second plate relative to the first plate from a first position wherein the plates are in butt contact to shunt magnetic flux from the magnets away from the contacts of each switch and a second position wherein the second plate is spaced from the first plate to establish an air gap permitting magnetic flux from the magnets to traverse the contacts of each switch, and resilient means biasing said rod so that the second plate is normally in butt contact wih said first plate.

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