Jan. 24, 1961 C. W. MITCHELL 2,969,445

MAGNET OPERATED SWITCH

Filed June 19, 1958

FIG. 1

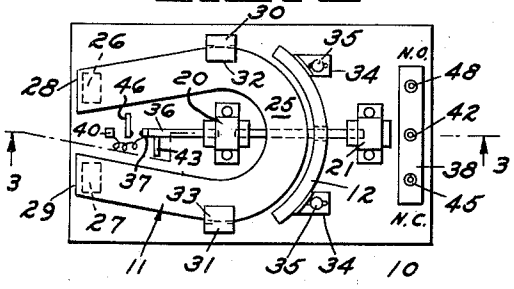


FIG. 2

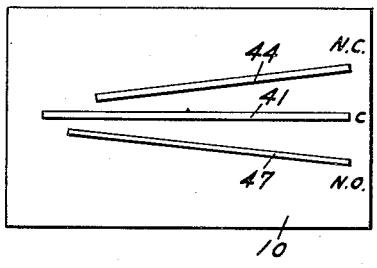


FIG. 3

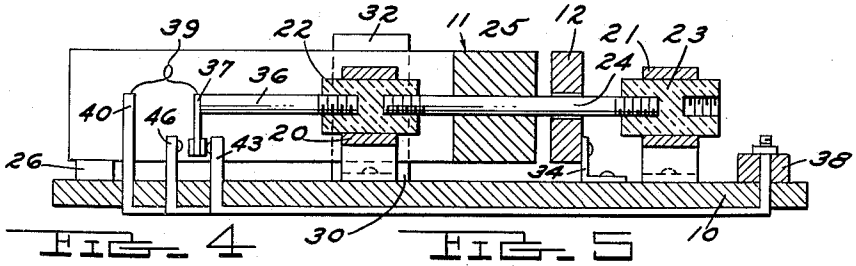


FIG. 4

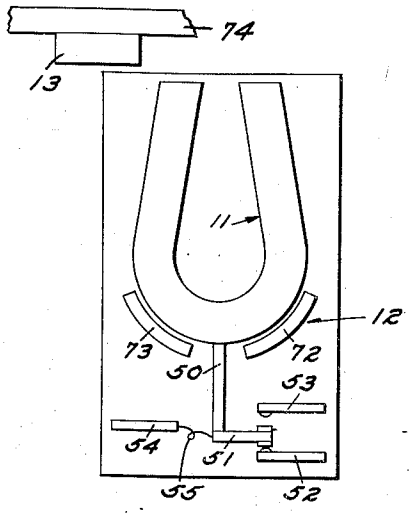


FIG. 5

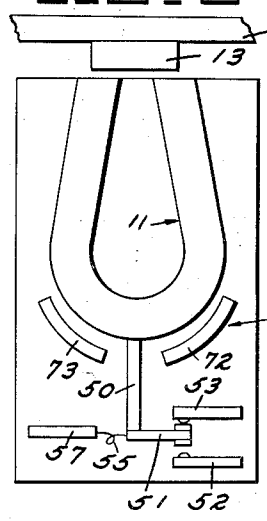


FIG. 7

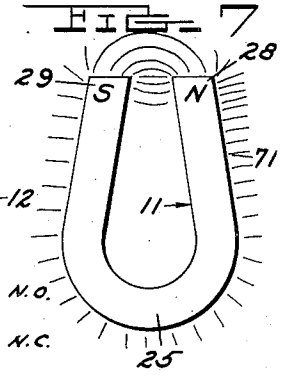
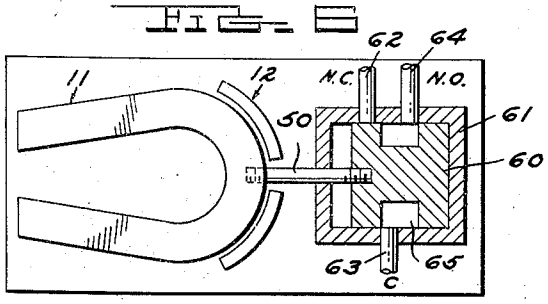


FIG. 6



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MAGNET OPERATED SWITCH

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8 Claims. (Cl. 200—87)

This invention relates to magnet operated devices and more particularly pertains to a device wherein the magnet itself moves from one position to another and returns to its normal position under the power of its own magnetic field forces based on armature developed force differential between the relatively strong primary field at the poles and the relatively weak secondary field of the magnet between the poles.

Magnet operated devices have been employed heretofore to actuate switches and valves, however, the several devices of the prior art have not proven entirely satisfactory inasmuch as the magnet is stationary and springs or other elements usually move an arm on an arcuate path in one direction with the magnet moving the arm in an arcuate path in the other direction, and also because the prior art devices are complicated in design and construction, expensive to manufacture, difficult to use, and unsatisfactory as far as maintaining good performance in sustained use.

With the foregoing in view, the primary object of the invention is to provide a magnet operated device which is simple in design and construction, inexpensive to manufacture, easy to use, and which maintains quality performance in sustained use over long periods of time.

An object of the invention is to provide a switch or valve operating device actuated by the movement of the magnet itself between a self locating and maintained retracted normal position adjacent a secondary armature to an advanced self locating and maintained position adjacent a primary armature on proximity of a primary armature with the magnet self locating and maintaining itself in either position on the differential between the strength of its primary and secondary magnetic fields.

An object of the invention is to provide an armature reacted magnet operated device which moves from its normal retracted position with its loop located adjacent the secondary armature to an advanced position due to the proximity of a primary armature relative to the primary field of the magnet adjacent north and south pole ends which primary field force when armature reacted overcomes the secondary armature reacted magnetic force causing the magnet to move to its advanced position.

An object of the invention is to provide a magnet which is located in its normal retracted position by suitable means and moves itself from its normal position to its advanced position due to the proximity of a primary armature lying within the primary field of the magnet at its north and south pole ends and wherein the means move and locate the magnet in its normal retracted position when the primary armature is removed from proximity to the primary magnetic pole field.

An object of the invention is to provide a magnet operated device wherein the magnet moves from its normal position to its advanced position under the magnetic force of the magnet itself reacting to the proximity of an armature.

An object of the invention is to provide a proximity

operated device which is rugged, stable, and durable and which is not distractively affected by vibration.

An object of the invention is to provide a proximity switch which does not employ electronic sensing devices thereby eliminating the expense of electronic tubes and equipment, and also thereby eliminating the use of sensitive and vibration destructive elements of electronic proximity switches now being commercially used.

An object of the invention is to utilize the differential between the relative strong primary magnetic pole field armature reaction forces of a magnet and the relatively weak secondary magnetic loop field armature reaction forces of a magnet so as to normally locate the magnet in its retracted position by secondary armature magnetic force reaction when the primary armature is remote from the primary field which secondary force is overcomable by the proximity of a primary armature in the primary magnetic pole field reacting the more powerful magnetic forces to cause the magnet to move under its own power from its normal retracted position to its advanced position.

An object of the invention is to effect snap-action magnet movement in that the release of one force permits the uncontrolled magnet movement to the other force.

An object of the invention is to provide a magnet operated device wherein the magnet preferably moves lineally along an axis to eliminate arcuate or angular movement in the device so that when the magnet is operating a switch between its positions that the points are flatly abutted on contact rather than angularly abutted by arcuate movement of an arm.

These and other objects of the invention will become apparent by reference to the following description of the devices embodying the invention taken in connection with the accompanying drawing in which:

Fig. 1 is a top plan view of the inventive moving magnet device incorporated with an electric switch for purposes of illustration.

Fig. 2 is a bottom plan view of the device seen in Fig. 1.

Fig. 3 is an enlarged cross-sectional view of the device seen in Fig. 1 showing the bearings upon which the magnet is slidably mounted relative to the base plate and the switch details.

Fig. 4 is a top plan view of a device similar to that seen in Fig. 1 showing the magnet in its normal retracted position adjacent the secondary armature.

Fig. 5 is a view similar to Fig. 4 showing the magnet moved to its advanced position due to the proximity of the primary armature wherein the magnet moved away from the secondary armature.

Fig. 6 is a view similar to Fig. 4 showing the device operating a fluid valve of the spool type; and

Fig. 7 is a top plan view of a magnet showing the primary field between the north and south poles by interconnecting dense lines and the secondary relatively weaker field shown in the loop area of the magnet by extending sparse lines.

Referring now to the drawing wherein like numerals refer to like and corresponding parts throughout the several views, the moving magnet operated device disclosed therein to illustrate the invention comprises a base plate 10, a magnet 11 bi-directionally slidably mounted on the plate 10, a fixed secondary armature 12 adjacent the magnet loop portion secondary magnetic field adapted to normally position the magnet by providing reaction to the magnet secondary field to cause the magnet to move and locate itself adjacent to the secondary armature 12, and a selectively movable primary armature 13 adapted to selectively lie remote or proximate to the primary field between the north and south pole ends of the magnet so that when the primary armature 13 is remote from same

the magnet moves to and lies adjacent the secondary armature 12 as seen in Fig. 4 and, conversely, when the primary armature 13 is proximate to the primary field the magnet moves by magnetic reaction thereto toward and adjacent to the primary armature 13 at its advanced position and which primary armature magnetic force reaction overcomes the magnetic force between the secondary field and the secondary armature.

More particularly, the inventive moving magnet device comprises a base plate 10 upon which is mounted a front bearing collar 20 and a rear bearing collar 21 which house the slide members 22 and 23 respectively which are in turn connected to the shaft 24 which is fixedly connected to the magnet 11 in its loop area 25 so that the magnet is slidably supported relative to the plate 10 by being suspended on the shaft 24 and bearings 22 and 23 in the collars 20 and 21 in spaced relationship to the plate 10.

Slide blocks 26 and 27 are respectively located under the magnet north and south pole ends 28 and 29 respectively and slide arms 30 and 31 having projecting guides 32 and 33 overlying the top of the magnet 11 cooperate with the slide blocks 26 and 27 to prevent the magnet from pivotally moving about the shaft 24 axis regardless of the angular position of the base plate 10 as integrated with machinery or other equipment. Obviously other anti-rotational or stabilizing means can be used to guide the magnet such as key connections between the collars 20—21 and the bearings 22—23. The magnet and armatures are ferrous and the other parts are non-ferrous and dielectric as is well understood in the art. The brackets 34 support the armature 12 and are adjustably supported on the base plate 10 so that the secondary armature 12 can be adjusted to the magnet secondary field magnetic force.

The bearing 22 supports arm 36 which carries the center pole 37 of a switch which is connected to the terminal block 38 via the loop 39, arm 40, lead 41, and post 42; the normally closed switch pole 43 being connected via the lead 44 to the post 45; and the normally open pole 46 being connected via the lead 47 to the post 48 on the terminal block 38.

The switch points are preferably located between the magnet ends 28 and 29 to dispose them within the primary magnetic field as it has been found that this field reduces arcing between the points upon make and break occurring therebetween so that the points last longer and maintain optimum performance longer than when arcing occurs, however, it is obvious that the switch can be located back of the magnet loop area as seen in Figs. 4 and 5 with the arm 50 supporting the center pole 51 between the normally closed pole 52 and normally open pole 53 with the center pole 51 being connected to the lead 54 via the lead loop 51.

Fig. 6 shows a fluid valve operated by the movement of the magnet 11 wherein the arm 50 is connected to the spool 60 within the housing 61 with the spool normally closing the port 62 and permitting communication between ports 63 and 64 when the magnet is in its retracted normal position adjacent the secondary armature 12 whereas when the magnet 11 moves away from the armature 12 the spool 60 moves to a position in the left of the housing 61 closing communication to the port 64 and permitting communication between the ports 62 and 63 via the communication chamber 65 of the spool.

Referring to Fig. 7, it will be noted that the primary magnetic field of force lies between the north pole end 28 and the south pole end 29 as illustrated by the close-packed arcuate lines 70 and that this primary magnetic field 70 is relatively and substantially stronger than the secondary field illustrated by the projecting lines 71 which radiate around the loop portion of the magnet between the ends 28 and 29 with the secondary field being strongest adjacent the north pole and diminishing around the loop portion 25 to the weakest portion adjacent the south pole end 29. It has been found preferable to separate the secondary magnet 12 in the area of the magnet loop 25 into two sections 72 and 73 as shown in Figs. 4 and 5; the primary armature 13 may be located on a moving machine part 74 or upon a manually actuated arm or slide as desired to move the primary armature 13 from the position seen in Fig. 4 to the position seen in Fig. 5 and out of the position seen in Fig. 5 to permit the magnet to return to its normal position adjacent the secondary armature 12. In this connection it is to be particularly noted that the primary armature 13 can be mounted on a highly vibratory machine due to the fact that it is separate mechanically and structurally from the magnet, plate, switch, or valve that no vibration of the machine or arm 74 is imparted to the switch directly and that the armature 13 does not contact the device or magnet but rather lies proximate to the primary magnetic field 70 to move the magnet to its advanced position or lies remote from the field 70 to permit the magnet to move to and lie in its normal retracted position adjacent the secondary armature 12.

In operation, the device shown in the drawings and heretofore described is installed in an electric or fluid circuit with the proper leads connected to the normally closed, normally open, and center taps to operate the circuit as desired, and the primary armature 13 mounted on an arm or moving machine part 74 for selectively locating the armature 13 proximate to and remote from the magnet primary field 70.

Assuming that the primary armature 13 is mounted on a moving machine part so that the magnet operated device reacts thereto as a proximity and/or limit switch in conjunction with the movement of the part 74 carrying the armature 13 or a series of armatures 13 which may be of any desired length to maintain the magnet in its advanced position for any desired amount of time or movement, it will be understood that when the primary armature 13 is remote from the field 70 that the secondary armature 12 provides reaction to the magnet secondary field 71 effecting force to cause the magnet to move via the power of the secondary field 71 to a point adjacent to the secondary armature 12 and to lie adjacent thereto.

When the primary armature 13 enters and remains in the primary field 70 between the north and south pole ends 28 and 29 of the magnet 11, this relatively substantially stronger field provides a relatively substantially stronger force reaction to cause the magnet 11 to move from its retracted normal position adjacent the secondary magnet 12 to its advanced position adjacent the primary armature 13 effecting a break between the points of the normally closed switch poles and effecting a make between the switch center pole and the switch normally open pole, and this condition exists as long as the magnet is in its advanced position occasioned by the magnetic field 70 primary force stronger reaction to the proximity of the primary armature 13.

Upon the primary armature 13 being moved from proximity to a position remote from the primary field 70, this primary magnetic force loses its reaction and the secondary armature 12 magnetic force reaction then is the only active force and the magnet moves in response thereto to its retracted normal retracted position. Thus the movement of the magnet in both directions is actuated by the force of the magnet's own magnetic fields.

Thus it can be seen that the magnet as shown and described moves on a lineal path between its first and second positions along its longitudinal axis such as the axis of the rod 24 so that the points of the switch arms are flatly contacted against one another without any pivotal or arcuate movement thereby eliminating gradual or angular contact.

The secondary magnetic field 71 maintains contact between the normally closed points until the proximity of the primary armature provides reaction to the primary

field 70 whereupon the magnet moves with snap action to its advanced position and will remain there until the primary armature 13 is remote from the primary magnetic field 70 whereupon the magnet will move with snap action under the reaction to the secondary armature 12 to suddenly break the contact with the normally open side of the switch and to suddenly make contact with the normally closed side of the switch thereby eliminating gradual movement and inherent arcing. This is also true of the valve actuating device seen in Fig. 6 where the spool will lie in either its normally open or normally closed position and will suddenly move therebetween with snap-action due to the fact that either one field or the other completely controls the position of the magnet so that the magnet will move from one position to the other as only the primary field or only the secondary field will absolutely control the position, location, and movement of the magnet. This is true even when the primary field overcomes the secondary field or when the primary field loses control to the secondary field as the governing reaction occurs only when the controlling field is in the governing relationship.

While the magnet has been shown as lineally moving, it is obvious that the magnet can be pivotally mounted such as adjacent its loop portion with the secondary armature adapted to pivot the magnet in one direction and the primary armature adapted to pivot the magnet in the other direction if desired, and this is definitely considered to be within the purview of the invention as disclosed and described as there is no prior art device known that operates with the magnet moving due to the relative force differential between its primary and secondary magnetic fields.

The inventive device with these features constitutes a compact, durable, neat appearing switch or valve actuating mechanism which is easily installed as original or replacement equipment without the necessity of changing the machine control panels. It is also to be noted that as the device is operated by the proximity of the armature 13 that the device operates as a proximity switch due to the presence of an armature of any type such as a piece of material in a machine or a moving part on a machine. The device operates as a limit switch due to the presence or movement of a workpiece or a machine part, and since the primary armature can be of any length it is obvious that the switch can be maintained in its advanced position by the duration of primary armature proximity occasioned either by time duration or length of travel.

Although but a few embodiments of the invention have been shown and described in detail, it is obvious that many changes may be made in the size, shape, detail, and arrangements of the elements of the invention within the scope of the appended claims for any adaptation or use.

I claim:

1. A device having a bi-directionally moving magnet moved in both directions by the force of its own magnetic fields comprising a horseshoe magnet having adjacent ends defining the primary magnetic field interconnected by a loop portion defining the secondary magnetic field, a base plate slidably supporting said magnet on an axis of movement between said magnet primary field ends and said magnet secondary field loop portion, a primary armature selectively movable relative to said magnet adjacent ends primary field so as to be either inactively remote therefrom or actively proximate thereto; a secondary armature fixed on said base plate adjacent said magnet loop position secondary field providing reaction to said secondary field so that said secondary field moves said magnet toward said secondary armature to said magnet's retracted normal position when said primary armature is remote from said primary field, said magnet ends primary field when said primary armature is actively proximate thereto overcoming said secondary field and armature reaction to cause said magnet to move from its normal retracted position to its advanced position by the primary field magnetic force reaction to said primary armature; said secondary field and armature reaction moving said magnet to its normal position when said primary armature moves from a proximate to a remote position relative to said primary field; and means operated by the movement of said magnet such as an electric switch or a fluid valve.

2. A bi-directionally magnet operated device occasioned by the movement of the magnet itself wherein magnet movement in both directions is effected by magnetic force, comprising a horseshoe magnet having adjacent north and south pole ends and an intermediate connecting loop portion; said magnet primary magnetic field lying between said ends and its secondary magnetic field lying in said loop; said magnet having a longitudinal axis extending from a point between said ends to a point at the center of said loop; said magnets primary field being relatively stronger than its secondary field; a non-ferrous base plate assembly slidably supporting said magnet for bi-directional movement along its longitudinal axis, a secondary armature fixed on said plate adjacent said magnet loop within said magnet secondary magnetic field; said magnet moving and locating in its retracted position by means of its loop secondary field magnetic force reacting with said secondary armature so as to normally lie with its loop portion adjacent said secondary armature; a primary armature selectively movably disposed relative to said magnet ends primary field so as to be capable of entering and leaving said magnet primary field; said magnet moving and locating in its advanced position by means of its adjacent ends primary field magnetic force reaction with said primary armature with the reaction between the primary field and proximate armature overcoming the secondary field and armature reaction.

3. A magnet operated device comprising a base plate, a magnet slidably disposed along its longitudinal axis on said base plate; said magnet at one end having a primary relatively strong magnetic field and at the other end having a secondary relatively weak magnetic field; a secondary armature fixed on said base plate within said magnet secondary field providing secondary reaction thereto normally to cause said magnet to move along its axis toward and lie adjacent to said secondary armature, a movable primary armature adapted to move into and out of said magnet primary field providing primary reaction thereto to cause said magnet to move along its axis toward and to lie adjacent to said primary armature; said primary reaction being adapted to overcome said secondary reaction to move said magnet toward said primary armature; said secondary reaction being adapted to move said magnet in the absence of said primary reaction toward said secondary armature; and means operated by the movement of said magnet such as an electric switch or a fluid valve.

4. A magnet operated switch comprising a base plate, a magnet movably disposed on said base plate between a first and a second position; said magnet having a secondary relatively weak magnetic field adjacent the second position and a primary relatively strong magnetic field adjacent the first position; a primary armature movably disposed relative to said magnet so as to move into, lie within, and move out of said magnet primary field providing primary reaction to said primary field to cause said magnet to move into and lie in its first position; a secondary armature fixed on said plate adjacent said magnets second position providing secondary reaction to said secondary field to cause said magnet normally to move into and lie in its second position; said primary reaction being adapted to overcome said secondary reaction when said primary armature is proximate to said primary field; and means operated by the movement of said magnet such as an electric switch or a fluid valve.

5. A moving magnet operated device comprising a base plate, a magnet having a relatively strong magnetic field primary end and a relatively weak magnetic field

secondary end movably disposed on said plate, a secondary armature on said plate adjacent said magnet secondary end; said magnet normally being adapted to move toward said secondary armature and to normally locate itself adjacent said secondary armature; and a primary armature movably disposed relative to said magnet primary end magnetic field so as to either lie within or without said field as desired; said magnet being adapted to move toward said primary armature and lie adjacent thereto when said primary armature enters said field and in so doing to overcome said secondary field and secondary armature force reaction; said secondary field and armature being capable of moving said magnet toward said secondary armature when said primary armature is remote from said magnet primary field.

6. A device bi-directionally operated by the movement of a magnet having a primary field and a secondary field comprising a magnet movably disposed between two positions, a secondary armature lying within said magnet secondary field normally reactively causing said magnet to move toward said secondary armature to bias said magnet toward and to locate said magnet at its one position by the magnetic force of said secondary field to said secondary armature, a primary armature selectively movable relative to said magnet primary field so as to lie selectively reactively proximately within and remotely non-reactively outside said magnet primary field; said magnet primary field and armature reaction being capable of overcoming said magnet secondary field and armature reaction to cause said magnet to move to its other position toward and to lie adjacent to said primary armature when said primary armature and field are proximate; said secondary field and armature when said primary armature and field are remote causing said magnet to move to its one position; and means operated by the movement and position of said magnet.

7. A device operated by the movement of a magnet having primary and secondary fields comprising a magnet movably disposed between two positions, means including a secondary armature reacting with said magnet secondary field normally causing said magnet to move toward one position to bias said magnet toward and to locate said magnet at its one position, a primary armature selectively movable relative to said magnet primary field so as to lie selectively reactively proximately within at certain times and remotely non-reactively outside said magnet primary field at other times; said magnet primary field and armature reaction being capable of overcoming said means to cause said magnet to move to its other position toward and to lie adjacent to said primary armature when said primary armature and field are proximate; said means when said primary armature and field are remote relative to each other causing said magnet to move to its one position; and mechanism operated by the movement and position of said magnet.

8. A device operated by the movement of a magnet having a primary field and a secondary field comprising a magnet movably disposed between two positions, a secondary armature constantly lying within said magnet secondary field normally reactively causing said magnet to move toward said secondary armature to bias said magnet toward and to locate said magnet at its one position at all times by the magnetic force of said secondary field to said secondary armature, a primary armature selectively movable to said magnet primary field so as to lie selectively reactively proximate within at certan times and remotely outside said magnet primary field at other times; said magnet primary field and armature reaction being relatively strong and capable of overcoming said magnet secondary field and armature reaction relatively weak to cause said magnet to move to its other position toward and to lie adjacent to said primary armature when said primary armature and field are proximate; said secondary field and armature when said primary armature and field are reactionwise remote causing said magnet to move to its one position; and means operated by the movement of said magnet; one said field and armature reaction being controlling to position and locate said magnet at either position until the other said field and armature overbalances the other to assume control to cause said magnet to move from one position to another with a sudden snap action.

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