March 29, 1966 P. M. MAXWELL 3,243,543

MAGNETICALLY POSITIONED ELECTRICAL SWITCH

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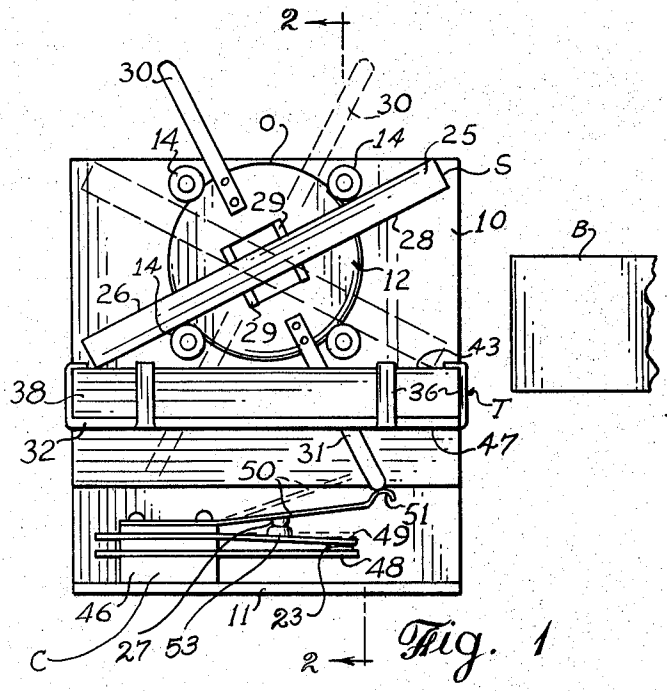


Fig. 1

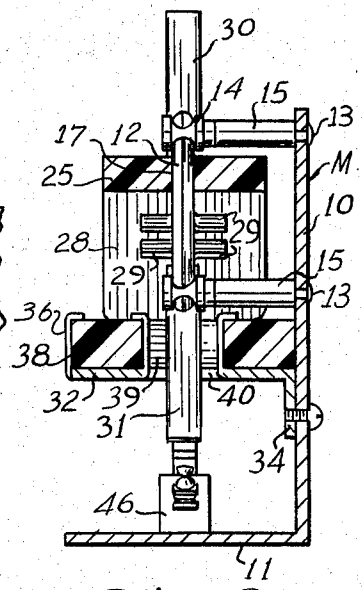


Fig. 2

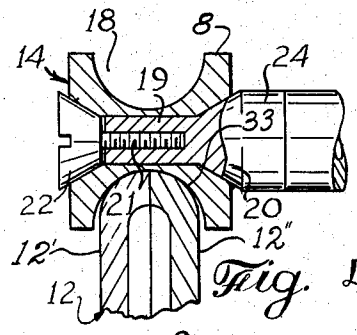


Fig. 4

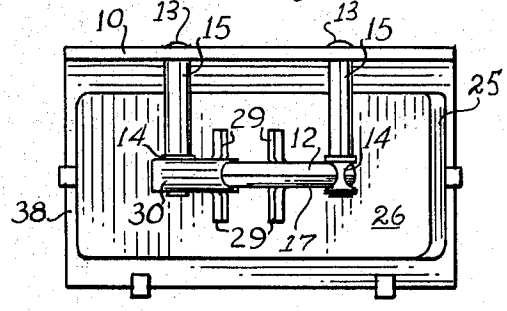


Fig. 3

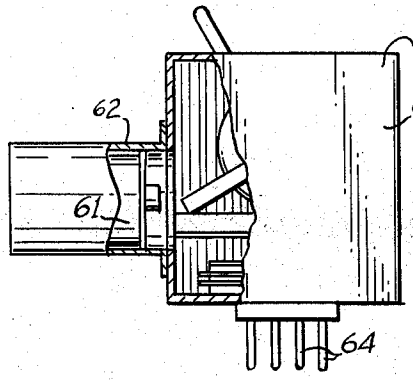


Fig. 5

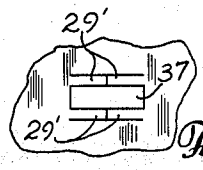


Fig. 6

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3,243,543 MAGNETICALLY POSITIONED ELECTRICAL SWITCH

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This invention relates to switching mechanisms and more particularly to an electrical switch which can be operated by a magnetic field.

Previous electrical switches have generally been characterized by a large number of moving parts and by the use of relatively expensive materials. This has caused previous electrical switches to be relatively expensive to manufacture. In addition, previous electrical switches have frequently been characterized by relatively complex switching motions which have tended to reduce their reliability. Moreover, when previous efforts have been made to provide an electrical switch responsive to the flow of an electrical current, the cost and complexity of previous electrical switches have been further increased by the various elaborate arrangements used.

The electrical switch disclosed herein substantially eliminates these and other problems and limitations associated with previous electrical switches. It has a switching mechnism which serves to open and close the electrical contacts of the electrical switch and which is operable either manually or by a magnetic field. The magnetic field which operates the switching mechanism may be the magnetic field of a permanent magnet or that of an electromagnet. Moreover, when the magnetic field is that of a solenoid fixedly positioned adjacent to the switching mechanism, the electrical switch is responsive to the flow of current in the solenoid and provides a simple, relatively inexpensive current responsive switch.

These and other improvements in electrical switches are provided by an electrical switch having a switching mechanism comprising a movable member rotatable about an axis with respect to a stationary member. The movable member provides a movable magnet and the stationary member provides a stationary magnet. The relationship between the movable magnet and the stationary magnet causes the movable member to be in either of two positions with respect to the stationary member. In one position of the movable member, the switching mechanism closes the electrical contacts and in the other position of the movable member, the switching mechanism permits the electrical contacts to open.

A magnetic field moved into the vicinity of the electrical switch causes the movable member to rotate about its axis from one position to another and the field of a solenoid fixedly positioned adjacent to the switching mechanism causes a similar response of the movable member. The movable member is also manually movable from one position to the other.

Thus, the electrical switch described herein may be operated either magnetically or manually and may be made responsive to the current in a solenoid. These operating characteristics are provided without complex switching motions and with a simple construction which is relatively inexpensive to manufacture and durable in use.

These and other features and advantages of the present invention will be more clearly understood from the following detailed description and the accompanying drawings in which like characters of reference designate corresponding parts in all figures and in which:

FIG. 1 is a side elevational view of a specific embodiment of the electrical switch.

FIG. 2 is a cross-sectional view of the specific embodiment of the electrical switch shown in FIG. 1 taken in line 2—2 in FIG. 1.

FIG. 3 is a top plan view of the specific embodiment of the electrical switch shown in FIG. 1.

FIG. 4 is an enlarged detail view showing the means for mounting the movable member of the switching mechanism for rotational motion with respect to the stationary member.

FIG. 5 is a side elevational view of a second embodiment of the electrical switch with the housing partially broken away.

FIG. 6 is a fragmentary view of one side of the disc of the movable member before its insertion into the stationary magnet.

These figures and the following detailed description disclose a specific embodiment of the invention but the invention is not limited to the details disclosed since it may be embodied in other equivalent forms.

The electrical switch disclosed herein is best understood as comprising a mounting member M on which a switching mechanism S and a contact member C are mounted. The switching mechanism S has a movable member O which is manually or magnetically movable with respect to a stationary member T. The contact member C has a plurality of contacts **23** which are opened and closed by an actuator arm **31** as the movable member O of the switching mechanism S moves. Thus, manually or magnetically induced motion of the movable member O with respect to the stationary member T of the switching mechanism S causes the plurality of contacts **23** of the contact member C to open and close.

In more detail, the mounting member M has a backplate **10** and a baseplate **11** integral with the backplate **10** at the lowermost edge of the backplate **10**. It is on the backplate **10** of the mounting member M that the switching mechanism S is mounted and it is on the baseplate **11** below the switching mechanism S that the contact member C is mounted.

The movable member O of the switching mechanism S comprises a disc **12** and movable magnet **25**. The movable member O is mounted on the backplate **10** of the mounting member M by rotatably supporting the disc **12** with a plurality of guide rollers **14**. The guide rollers **14** are held outwardly of the backplate **10** and over the baseplate **11** by a plurality of spacers **15** and in the specific embodiment of the invention described herein, there are four guide rollers **14** spaced approximately ninety degrees apart around the peripheral edge **33** of the disc **12**. This spacing of the guide rollers **14** is sufficient to position the disc **12** for rotation about a fixed axis while at the same time permitting a lever **30** extending from the peripheral edge **33** of the disc **12** between adjacent guide rollers **14** to be used to rotate the disc **12** through almost ninety degrees of rotation motion.

The disc **12** is made of two plates **12'** and **12''** welded or otherwise joined together to form the disc **12**. The disc **12** formed is hollow and the peripheral edge **33** of the disc **12** is rounded as best shown in FIG. 4. The disc **12** is made of aluminum or other material which does not readily become permanently magnetized for reasons which will become apparent when the operation of the electrical switch disclosed herein is understood.

All of the guide rollers **14** are identical and the construction of a guide roller **14** is best seen in FIG. 4 Each guide roller **14** has a sheave **15** with a groove **18** around its circumference. The groove **18** resembles a semicircle in cross-section and is of the size and shape to receive the peripheral edge **33** of the disc **12** as shown in FIG. 4. The sheave **8** of each guide roller **14** is rotatably carried by a hub **19** having its inner end flaring outwardly to provide a conical stop **20** and having a screw **21** threadably inserted into its outer end so that the head of the screw **21** serves to provide a conical stop **22** on the opposite side of the sheave **8** from the conical stop **20**. Thus,

the sheave 8 of each guide roller 14 is rotatable on a hub 19 between a conical stop 20 and a conical stop 22.

A shank 24 is integral at one end with the conical stop 20 of each guide roller 14 and is fixedly attached at its other end to the extending end of one of the plurality of spacers 15 extending from the backplate 10. The spacers 15 are attached to the backplate 10 by extending screws 13 through the backplate 10 into the innermost ends of the spacers 15.

All of the spacers 15 and all of the shanks 24 are of equal length, and the result of the foregoing arrangement is that the plurality of guide rollers 14 are uniformly spaced from the backplate 10 and serve to position the disc 12 in a fixed plane of rotation parallel to the backplate 10. It will be understood that it is the sheaves 8 of the guide rollers 14 which engage the peripheral edge 33 of the disc 12 and that the rotation of the sheaves 8 about the hubs 19 permits the disc 12 to be freely rotatable about a fixed axis perpendicular to its plane of rotation.

The disc 12 is inserted through a slot 17 in the movable magnet 25. The movable magnet 25 is fixedly positioned with respect to the disc 12 by a plurality of fingers 29 extending outwardly from the disc 12 above and below the movable magnet 25. The fingers 29 are easily and conveniently provided by cutting the plates 12′ and 12″ as shown in FIG. 6 so as to provide four tabs 29′. Two of the tabs 29′ are above and two of the tabs 29′ are below a slot 37 which separates the tabs 29′ above the slot 37 from the tabs 29′ below the slot by a distance equal to the thickness of the movable magnet 25. When the disc 12 is inserted through the slot 17 in the movable magnet 25 so as to place the movable magnet 25 over the slots 37 in the plates 12′ and 12″, the tabs 29′ are bent outwardly from the plates 12′ and 12″ to form the fingers 29 above and below the movable magnet 25.

The movable magnet 25 is a flat rectangular block providing two flat rectangular surfaces 26 and 28 substantially parallel to each other and when the disc 12 is inserted in the slot 17 in the movable magnet 25 as described above, the flat rectangular surfaces 26 and 28 of the movable magnet 25 are on opposite sides of the axis of rotation of the disc 12 as it rotates within the guide rollers 14. The movable magnet 25 may be made of any known suitable permanently magnetizable material. However, it has been found that a hard, relatively tough plastic impregnated with particles of iron or iron oxide provides an excellent material for the movable magnet 25. This is because such a material permits the movable magnet 25 to be molded and permanently magnetized using known techniques while at the same time being relatively light in weight.

It will be understood from the foregoing description that the movable member O of the switching mechanism S provides a movable magnet 25 which rotates about an axis with the disc 12. The stationary member T of the switching mechanism S comprises a stationary magnet 38 and a shelf 32 for fixedly positioning the stationary magnet 38 with respect to the backplate 10 of the mounting member M. The shelf 32 extends from the backplate 10 parallel to and substantially coextensive with the baseplate 11 and at its innermost edge, the shelf 32 has a downwardly extending flange 34. The flange 34 is attached to the backplate 10 by extending screws 35 through the backplate 10 and into the flange 34. The shelf 32 is positioned using the flange 34 so that the shelf 32 is below the movable member O of the switching mechanism S.

The stationary magnet 38 resembles the movable magnet 25 in that it is a flat rectangular block having two flat rectangular surfaces 43 and 47 substantially parallel to each other and parallel to the axis of rotation of the movable member S when the stationary magnet 38 is positioned on the shelf 32. An elongated hole 39 extends through the stationary magnet 38 and the shelf 32 beneath the disc 12 of the movable member O of the switching mechanism S and the actuator arm 31 extends radially from the peripheral edge 33 of the disc 12 through the hole 29.

The stationary magnet 38 is positioned on the shelf 32 by extending a plurality of fingers 36 upward from the shelf 32 along the sides and over the top of the stationary magnet 38. Similar to the movable magnet 25, the stationary magnet 38 may be made of any suitable permanently magnetizable material. However, it is most convenient to make the stationary magnet 38 of the same hard, relatively tough plastic impregnated with particles of iron or iron oxide as is used for the movable magnet 25.

It will now be understood that the switching mechanism S provides a movable magnet 25, a stationary magnet 38, and an actuator arm 31 which extends downwardly below the stationary magnet 38 and which moves as the movable magnet 25 moves with respect to the stationary magnet 38. It will also be understood that the movable member O of the switching mechanism S moves between a position in which one end of the movable magnet 25 is engaging the stationary magnet 38 and a position in which the other end of the movable magnet 25 is engaging the stationary magnet 38. It is by motion of the movable member O with respect to the stationary member T between these two positions, that the switching mechanism S opens and closes the contacts 23 of the contact member C.

The contact member C has a support block 46 from which an upper contact leaf 49 and a lower contact leaf 48 extend substantially parallel to each other. Above the upper contact leaf 49 is an actuating leaf 50 having a cam surface 51 formed at its extending end. The length and position of the actuating leaf 50 and the length of the actuating arm 31 of the switching mechanism S are selected so that when the movable member O of the switching mechanism S is in that position which places that end of the movable magnet 25 above the support block 46 in contact with the stationary magnet 38, the actuating arm 31 is engaging the cam surface 51 and forcing the actuating leaf 50 downward as shown in FIG. 1.

When the movable member O of the switching mechanism S is rotated in a counterclockwise direction as viewed in FIG. 1, the movable member O moves to that position in which the other end of the movable magnet 25 is engaging the stationary magnet 38 and in which the actuator arm 31 no longer engages the cam surface 51. The actuator leaf 50 is of resilient material and when the cam surface 51 is disengaged by the actuator arm 31, the actuator leaf 50 moves upward. Thus, in one position of the switching mechanism S, the actuator arm 31 depresses the actuating leaf 50 and in the other position of the switching mechanism S, the actuator arm 31 permits the actuating leaf 50 to move upward.

When the actuating leaf 50 is depressed, a button 27 extending from its underside engages a button 53 extending upwardly from the upper contact leaf 49 and causes the upper contact leaf 49 to be depressed toward the lower contact leaf 48. The result is that the depressing of the actuator leaf 50 by the actuator arm 31 causes the contacts 23 at the extending ends of the contact leaves 48 and 49 to be pressed together to close an electrical circuit in the manner well understood in the art. When the actuating leaf 50 is released and permitted to move upward as described above, the contacts 23 on the extending ends of the contact leaves 48 and 49 are no longer pressed together and the electrical circuit is opened in a manner well known in the art.

Thus, it will be seen that when the movable magnet 25 is in that position with respect to the stationary magnet 38 shown in solid line in FIG. 1, the contacts 23 are engaged and when the movable magnet 25 is in that position with respect to the stationary magnet 38 shown in dashed line in FIG. 1, the contacts 23 are not engaged.

It will be understood that the electrical switch disclosed herein opens and closes contacts **23** simply by shifting the position of the movable member O with respect to the stationary member T.

The movable magnet **25** is permanently magnetized in known manner so that the surface **28** has a particular polarity and the surface **26** has the opposite polarity. Similarly, the stationary magnet **38** is permanently magnetized in known manner so that the surface **43** has the same polarity as the surface **28** of the movable magnet **25** and the surface **47** has the opposite polarity from the surface **43**. Thus, the surface **28** of the movable magnet **25** and the surface **43** of the stationary magnet **38** both have either a north or a south polarity. It has been found that when the movable magnet **25** and the stationary magnet **38** are polarized in this manner, the movable magnet **25** tends to remain in a position in which one of its ends is in contact with the stationary magnet **38**. Thus, the movable magnet **25** tends to hold the movable member O in the position which closes the contacts **23** or in the position which opens the contacts **23** as described above.

The movable magnet may be moved between these two positions by the lever **30** extending upwardily and radially from the peripheral edge **33** of the disc **12**. However the position of the movable magnet **25** with respect to the stationary magnet **38** is responsive to a magnetic field adjacent the switching mechanism S. For example, if the surface **28** of the movable magnet **25** and the surface **43** of the stationary magnet **38** both have south polarity, a magnetic field of south polarity such as that of the south pole of a bar magnet B will cause that end of the movable magnet **25** nearest to the bar magnet B to engage the stationary magnet **38**. Thus, if the south pole of the bar magnet B is placed adjacent to the left end of the switching mechanism S as viewed in FIG. 1, the switching mechanism S simply remains in the position shown in solid line in FIG. 1. However, if the south pole of the bar magnet B is placed adjacent to the right end of the switching mechanism S as viewed in FIG. 1, the south polarity of the bar magnet B causes the movable magnet **25** to move downward to engage the stationary magnet **38**. This results in rotation of the movable member O about its axis into the position shown in dashed line in FIG. 1 and in the actuator arm **31** opening the contacts **23**.

A magnetic field of north polarity from a magnetic source such as the bar magnet B causes a response of the movable magnet **25** with respect to the stationary magnet **38** opposite to that described above in connection with a magnetic field of south polarity. Thus, if a north magnetic field is brought close to the left end of the switching mechanism S as viewed in FIG. 1, the movable member O rotates in a clockwise direction as viewed in FIG. 1 into the position shown in dashed line in FIG. 1. Similarly, if the north magnetic pole is placed adjacent to the right end of the switching mechanism S as viewed in FIG. 1, no rotation of the switching mechanism S will occur unless the movable member O of the switching mechanism S has been previously rotated into the position shown in dashed line in FIG. 1.

It will now be understood that the electrical switch disclosed herein is magnetically operated by a magnetic field placed at those ends of the switching mechanism S on opposite sides of the axis of rotation of the movable member O. The response of the switching mechanism S to a magnetic field will depend upon the polarity of the magnetic field and if the polarity of the magnetic field is the same as the polarity of the surface **28** of the movable magnet **25** and the surface **43** of the stationary magnet **38**, the movable magnet **25** continues to engage or move to engage the stationary magnet **38** at that end of the switching mechanism S nearest the magnetic field. If the polarity of the magnetic field is opposite the polarity of the surface **28** of the movable member **25** and the surface **43** of the stationary magnet **38**, the movable magnet **25** continues to engage or moves to engage the stationary magnet **38** at that end of the switching mechanism S most remote from the magnetic field.

This response of the switching mechanism S to a magnetic field permits the electrical switch to be operated by alternately placing a magnetic field of constant polarity at opposite ends of the switching mechanism S or by placing a magnetic field alternating between north and south polarity at one end of the switching mechanism S. In this connection, it will be understood that when the surface **28** of the movable magnet **25** and the surface **43** of the stationary magnet **38** both have north polarity, the switching mechanism S will respond in a manner opposite to that described above to magnetic fields of north polarity and south polarity.

In FIG. 5 is shown a second embodiment of the electrical switch disclosed herein in which the magnetic field required to change the position of the switching mechanism S is induced by a solenoid **61**. In this embodiment of the electrical switch disclosed herein, the mounting member M' is a housing **60** in which the switching mechanism S and the contact member C are mounted in substantially the same fashion as they are mounted on the mounting member M. The solenoid **61** is fixedly positioned at one end of the housing **60** by attaching a solenoid housing **62** to the housing **60**. The position of the solenoid **61** is such that it will induce either a magnetic field of north polarity or a magnetic field of south polarity at that end of the switching mechanism adjacent to which it is positioned depending upon the direction of current flow in the solenoid **61**.

The solenoid **61** induces magnetic field with current flow in known manner and it will be understood from the above description of the specific embodiment of the invention shown in FIG. 5 that with alternately reversing current flow in the solenoid **61**, the switching mechanism S will move back and forth between that position in which it closes the contacts **23** and that position in which it opens the contacts **23**. A plurality of prongs **64** joined in known manner through the contact leaves **48** and **49** and the solenoid **61** permit that embodiment of the electrical switch shown in FIG. 5 to be easily placed in operating condition as a complete unit by simply plugging it into a receptacle (not shown) of known type.

It will be obvious to those skilled in the art that many variations may be made in the embodiments chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claims.

What is claimed as invention is:

1. An electrical switching mechanism operably responsive to a magnetic field comprising a first stationary member having an upper surface, a second member rotatably mounted immediately adjacent the upper surface of the first member with the plane of rotation substantially perpendicular to the upper surface of the first member, the rotatable mounting located mid-way between the ends of the second member, the second member having a lower surface facing the upper surface of the first member, the upper surface of the first member and the lower surface of the second member having the same magnetic polarity, throughout their respective areas, and means responsive to the rotational movement of the second member for opening and closing an electrical circuit.

2. An electrical switching mechanism operably responsive to a magnetic field comprising a stationary magnet having a substantially flat upper surface, a second magnet rotatably mounted immediately adjacent the upper surface of the first magnet with the plane of rotation substantially perpendicular to the upper surface of the first magnet, the rotatable mounting located mid-way between the ends of the second member, the second magnet having a substantially flat lower surface facing the upper surface of the first magnet, the upper surface of the first magnet

and the lower surface of the second magnet having the same magnetic polarity throughout their respective areas, and means responsive to the rotational movement of the second magnet for opening and closing an electrical circuit.

3. An electrical switching mechanism operably responsive to a magnetic field comprising a stationary magnet having a substantially flat upper surface, a second magnet having a substantially flat lower surface mounted immediately adjacent the upper surface of the first magnet and rotatable in a plane perpendicular to the upper surface of the first magnet between a first position wherein one end of the second magnet engages the corresponding end portion of the stationary first magnet and a second position wherein the other end of the second magnet engages the other corresponding end portion of the stationary first magnet, the upper surface of the first magnet and the lower surface of the second magnet having the same magnetic polarity, and means responsive to the rotational movement of the second magnet between its first position to its second position for opening and closing an electrical circuit.

4. A electrical switching mechanism operably responsive to a magnetic field comprising a stationary magnet having a substantially flat upper surface and a designated length, a second magnet having a substantially flat lower surface mounted immediately adjacent the upper surface of the first magnet and rotatable in a plane perpendicular to the upper surface of the first magnet between a first position wherein one end of the second magnet engages the corresponding end portion of the stationary first magnet and a second position wherein the other end of the second magnet engages the other corresponding end portion of the stationary first magnet, the upper surface of the first magnet and the lower surface of the second magnet having the same magnetic polarity, a third magnet located spaced from but adjacent one end of the first magnet and the corresponding end of the second magnet for inducing rotational movement in the second magnet by magnetic forces, and means responsive to the rotational movement of the second magnet between its first position to its second position for opening and closing an electrical circuit.

5. An electrical switch comprising a mounting member having a back plate; a shelf extending from said back plate substantially perpendicular to said back plate; a disc substantially parallel to said back plate; a plurlity of spacers extending from said back plate; a plurality of sheaves rotatably positioned at the outer ends of said spacers and positioned to support said disc for rotation about an axis; an actuating arm carried by said disc; a magnetized first plate carried by said disc, said first plate having magnetized opposite fiat faces perpendicular to the plane of the disc; a magnetized second plate mounted on said shelf, said second plate having magnetized opposite flat faces perpendicular to the plane of the disc; said first plate and said second plate being positioned to place the faces having similar magnetic polarity adjacent each other and to place one end of the first plate against the corresponding end portion of the second plate when the actuating arm is in a first position and the opposite end of the first plate against the corresponding opposite end portion of the second plate when the actuating arm is in a second position; and means for opening an electrical circuit when the actuating arm is in the first position and for closing the electrical circuit when the actuating arm is in the second position.

6. An electrical switch comprising a mounting bracket having a back plate and a base plate extending from the lowermost edge of said back plate; a shelf extending from said back plate substantially parallel to and spaced from said base plate; a plurality of rotatable guide rollers positioned above said base plate and shelf; a disc having its outer periphery engaging said guide rollers and supported by said guide rollers for rotation about an axis in a plane substantially parallel to said back plate; an actuating arm carried by said disc, said actuating arm extending through an opening in said shelf and terminating between said shelf and said base plate; a magnetized first plate carried by said disc, said first plate having magnetized opposite flat faces perpendicular to the plane of the disc; a magnetized second plate positioned on said shelf and having an opening therein through which the actuating arm extends, said second plate having magnetized opposite flat faces perpendicular to the plane of the disc, said first plate and said second plate being positioned to place the faces having similar magnetic polarity spaced from and adjacent each other; means responsive to motion of the actuating arm between the shelf and base plate for opening and closing an electrical circuit.

7. An electric switch comprising a rotatable disc; an actuating arm carried by said disc and extending radially therefrom; a plurality of contacts positioned to engage and disengage in response to motion of the actuating arm as the disc rotates; and means for rotating said disc, said means having a first magnet carried by said disc and a second magnet mounted in a stationary manner below the disc for engagement by the opposite ends of the first magnet, the faces of the first and second magnets which are adjacent each other having the same magnetic polarity.

8. An electrical switch comprising a movable magnet having parallel sides of opposite magnetic polarity and a slot extending through said sides; a disc inserted through said slot and having a plurality of fingers bent outwardly to engage the said sides of the movable magnet; means for mounting the disc for rotation about its axis; a stationary magnet positioned below said disc and having an upper side facing the lower side of the movable magnet, both said upper side and said lower side having the same magnetic polarity and; means responsive to motion of the movable magnet relative to the stationary magnet for opening and closing an electrical circuit.

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