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ELECTRIC SWITCH WITH MAGNETIC BIASING

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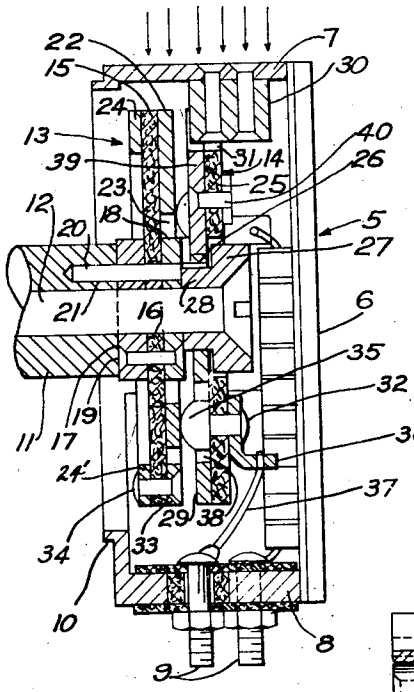


Fig. 2

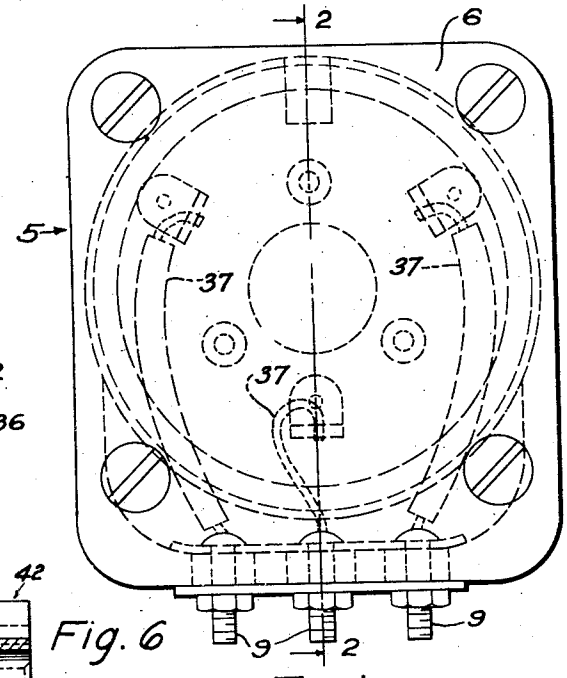


Fig. 1



Fig. 6



Fig. 7

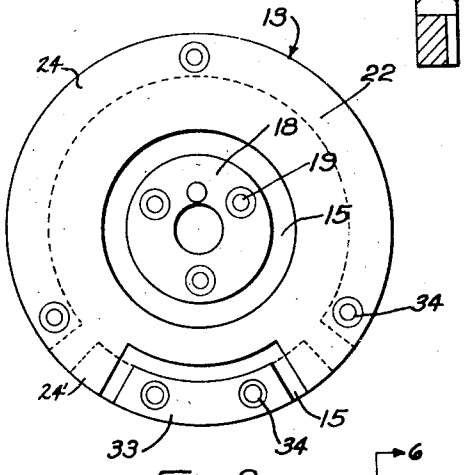


Fig. 3

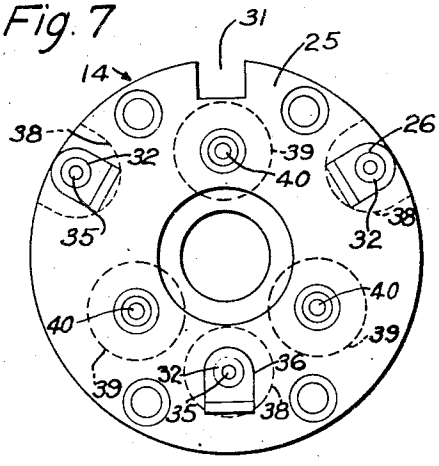


Fig. 4

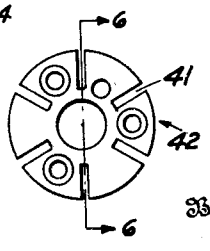


Fig. 5

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ELECTRIC SWITCH WITH MAGNETIC BIASING

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6 Claims. (Cl. 200—87)

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This invention relates to electric switches and is particularly concerned with the problem of providing adequate pressure between meeting surfaces of cooperating contacts to insure good conductivity between such contacts. The invention is intended for use in a switch that is to be positioned in a magnetic field, and is arranged to use energy from such a field to exert pressure upon cooperating contacts to urge them together, thereby establishing good electrical continuity between them. A modification of the invention is effective to use energy from a magnetic field in which the switch is positioned to resist unintended operation of the switch.

The invention is useful in any apparatus that employs a magnetic field and an electric circuit controlled by a switch. Since the arrangement eliminates use of springs to apply contact pressure, the invention is particularly useful in situations where conditions tend to produce rapid deterioration of springs, as in the case of a switch that must be located in a zone of temperature sufficiently high to cause rapid loss of resilience of springs.

The principal object of the invention is the provision of a novel and highly effective device for exerting pressure between relatively movable cooperating switch contacts, such device being arranged for operation in a magnetic field and to utilize energy of such a field for accomplishing its operation.

Another object is the provision of such a device that is capable of withstanding conditions that would tend to cause rapid deterioration of spring elements.

Another object is the provision of a novel magnetic detent device for preventing unintended operation of a switch.

Still another object is the provision of such an arrangement that may be included in a switch assembly without requiring specialized design of the switch and without materially adding to its cost.

These objects are attained by an arrangement that utilizes force from a magnetic field within which the switch is positioned to exert pressure between movable elements of the switch. Specifically, the detent comprises a system of magnetic elements mounted on relatively movable parts of the switch in such arrangement as to exert attractive force between the elements.

In the accompanying drawings:

Fig. 1 is an elevation of a switch exemplifying an application of the invention.

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Fig. 2 is a transverse section on line 2—2 of Fig. 1.

Figs. 3 and 4 are plan views of the relatively movable contact-supporting elements of the switch, illustrating a detailed arrangement that may be employed.

Fig. 5 is a plan view of a modified form of magnetic element that may be used to produce a detent action.

Fig. 6 is a sectional view on line 6—6 of Fig. 5.

Fig. 7 is a sectional view similar to Fig. 6, showing another modified form of magnetic element.

Describing the drawings in detail, the switch illustrated, by way of example and in which the invention may be employed, is a limit switch such as may be used to control the operation of a motor. As indicated in the introduction, the switch is intended to be mounted in a magnetic field.

The switch may be arranged in a suitable housing, designated generally 5, comprising a face plate 6 and a surrounding wall structure 7 a portion 8 of which supports a set of terminals 9. The housing may be open at the side opposite the face plate 6, and the wall structure 7 surrounding the open side arranged for cooperation with a mounting, as by being provided with a flange 10.

A rotatable operating shaft 11 is arranged with its end in the open side of the housing 5. A machine screw 12, which is engaged in a threaded bore disposed coaxially in the shaft, projects beyond the end of the shaft and into the interior of the housing where it serves as a support for the switching mechanism.

The switching mechanism comprises a pair of contact-supporting disk-assemblies 13 and 14, disposed in face to face relation and relatively rotatable to bring contacts that they respectively support into different circuit-controlling combinations. The assembly 13, which is keyed to the shaft 11 for rotation with it, comprises a body 15 of insulating material such as fiber, having a central opening 16 through which the screw 12 is extended. Hub members 17 and 18 are clamped to opposite sides of the disk body 15 by rivets 19 and surround the central opening 16. A pin 20 penetrates the hub structure formed by the members 17 and 18 and projects into a bore 21 in the shaft 11, thereby keying the assembly 13 to the shaft. On the surface of the body element 15 that faces the disk assembly 14 is a metal plate 22 having a central opening 23, the edge of which surrounds and is spaced from

the hub element 18. A segment rim 24 is secured to the other surface of the body 15 adjacent the outer edge of the latter.

The disk assembly 14 comprises a body 25 of insulating material having a central opening 26 through which extends rotatably a head 27 that is secured to the end of the shaft 11 by the screw 12. A metal plate 29 is secured to the surface of the body 25 that is opposed to the disk assembly 13, such plate having a central opening through which the hub of the head 27 is extended. A detent lug 30 secured to the wall of the housing 5 projects into registering notches 31 in the edges of the body 25 and plate 29, thereby holding the assembly 14 against rotation.

The contact system of the switch comprises plural spaced contact elements 32 mounted on the stationary assembly 14, such contacts being insulated from one another and adapted to be interconnected by opposed contact elements of the assembly 13 to form different circuit-controlling combinations. In the illustrated system, one contact element carried by the assembly 13 comprises the metal plate 22. A second contact element is formed by a conductive sector plate 33 that is secured to the body 15 in a cut out of the metal plate 22, from the edges of which it is spaced. Rivets 34 may be used to secure the plate 22, segment 24, and sector plate 33 to the body element 15 in insulated relation.

The contact elements 32 that are mounted on the stationary disk assembly 14 comprise studs 35 riveted through the disk body 25 to connecting lugs 36, the latter being connected to the terminals 9 by suitable leads 37. The studs 35 are located centrally of cutouts 38 in the metal plate 29, being spaced from and therefore insulated from the edges of the plate. The studs 35 project beyond the surface of the plate 29 for contacting the surfaces of opposed contacts carried by the rotatable disk assembly 13. In the system shown, the contact elements 32 are three in number, being spaced angularly about the axis of the shaft 11, and so spaced radially from such axis that one of the contacts rides constantly on the surface of the metal plate 22, while the other two are so disposed that either may contact the surface of the sector plate 33 while the other contacts the metal plate 22, or both may contact the metal plate 22 at one time. By this arrangement, various circuit controlling combinations may be established, depending on which of the contacts 32 are interconnected by simultaneously contacting the metal plate 22 of the assembly 13, which interconnection is determined by the relative angular positions of the assemblies 13 and 14. The switch is intended to automatically stop a motor when a device driven by the motor, such as a valve, has reached either of two limit positions. The shaft 11, may for example, be geared to the motor to accomplish 180° rotation during full travel of the device between its limits, to stop the motor at either limit, while permitting the motor to be started and stopped at any intermediate position by suitable master switches.

The pressure-exerting device comprises a system of magnetic bodies mounted on the respective contact-supporting assemblies 13 and 14 in such relative arrangements as to locally distort a magnetic field, indicated by arrows in Fig. 2, in which the switch is positioned. Such distortion produces attractive forces extending between the disk assemblies 13 and 14, urging the assemblies toward each other and thereby pressing together the surfaces of opposed contact elements carried by the respective assemblies.

In the arrangement illustrated in the drawings the element 18 of the hub is made of magnetic material and is spaced from the surface of the metal plate 29 of the assembly 14 by the bearing of the contact studs 35 upon the surfaces of the opposed contact elements carried by the assembly 13. A series of magnetic bodies 39 is mounted on the stationary disk assembly 14 in such arrangement as to cooperate with the hub member 18 to produce the described attractive forces. The bodies 39 are in the form of iron washers secured to the disk body 25 by rivets 40 in positions angularly spaced about the axis of rotation of the shaft 11, and spaced from that axis at such a distance that their surfaces are partially opposed to the surface of the hub member 18. The washers 39 are mounted in cutouts of the metal plate 29 so that their surfaces are flush with the surface of the plate, and their surfaces are axially spaced from the surface of the member 18 by reason of the projection of the contact studs 35 beyond the surface of the plate 29.

As has been indicated, the switch is intended to be positioned in a magnetic field and it is positioned in such a way that the field extends in a direction indicated by the arrows in Fig. 2, that is to say, generally parallel to the opposed faces of the assemblies 13 and 14. The effect of the system of magnetic bodies 18 and 39 upon the field is a local distortion that directs flux lines of the field to extend between each of the elements 39 and the hub member 18, thereby producing a series of attractive forces that extend between the assemblies 13 and 14 and urge such assemblies toward one another. By the use of a continuous body such as the hub member 18, the forces are exerted in any relative position of the supporting disk assemblies 13 and 14, so that the contact pressure is exerted regardless of the relative position of the switches or the circuit-controlling combination of contacts that may be effective at any particular time.

The illustrated arrangement of the magnetic members and switch contacts comprises an important feature of this invention, to the end that the three magnetic members 39 serve to concentrate the magnetic flux acting between these elements and the hub 18 at three symmetrically spaced regions each of which is positioned within the triangle formed by the lines connecting each of the three contacts. Thus, each of the three magnetic forces acts within the triangle so formed by the three contacts to exert a compressive force on each contact surface. It is apparent that by so arranging the forces to act within the area of the triangle formed by the contacts, unequal magnetic forces can not, in this invention, exert a resultant force which would serve to reduce the pressure at any one contact; or what is more important still would result in a separation of any pair of contacting surfaces. It should be made clear that by employing spaced magnetic forces that fall outside the triangle formed by lines joining the three contacts, the resultant tipping of the plate supporting the magnetic members producing the forces would result in a shortening of the air gap at the greater of the unequal forces, this further increasing this force, and reducing the forces opposing this tipping action.

If as will normally be the case, the three magnetic forces are approximately equal, the symmetrical arrangement of the magnetic bodies rela-

tive to the axis of relative rotation, is also useful in that it locates the center of attractive force at a point substantially coinciding with the axis of rotation and within the geometric pattern of the contacts. This location of the center of attractive force within the pattern of the contacts assures that opposed contacts will be brought into positive engagement, that is to say, the attractive force is so distributed among the cooperating contacts as to press their surfaces together, thereby assuring electrical continuity between them, and the spacing of the magnetic elements 39 from the hub member 18 insures that the attractive force will be exerted upon the opposed contacts of the respective disks.

In the arrangement described above, the pressure exerted between meeting faces of cooperating contacts produces frictional resistance between such surfaces to relative rotation of the contact-supporting disk assemblies 13 and 14, but, due to the continuous annular form of the hub member 18, the magnetic force exerted between such member and the respective magnetic bodies 39 does not of itself resist relative rotation of the disk assemblies. In order to provide a magnetic detent action the arrangement of Figs. 5 to 7 may be employed.

In this arrangement a hub element 42 is substituted for the hub element 18, the element 42 comprising an annular body of magnetic material provided with a series of radial slots 41 opening through the face of the element that is directed toward the stationary disk assembly 14 and the magnetic bodies 39 carried by such assemblies. The slots 41 may be cut completely through the element 42 and their radial extent limited, as indicated in Fig. 6, or they may extend radially completely across the member and be of limited depth, as shown at 43 in Fig. 7. In these arrangements the permeability of the magnetic system changes as the cuts 41 or 43 move past the bodies 39, so that resistance to such movement is set up, and a detent action results which resists rotation of the movable disk assembly 13 relative to the stationary assembly 14. The cuts 41 are arranged with regard to the number of magnetic bodies 39 and the number of different contact-engaging positions of the switch. In the arrangement illustrated, there being three magnetic bodies 39, the number of cuts 41 should be a multiple of three, so that each section of the body 42 between the cuts will act similarly with the three bodies 39. Six slots give six different positions in which the switch tends to lock.

The advantages of the invention will be apparent from the above description. The use of magnetically permeable bodies on relatively movable switch elements provides a simple and effective detent mechanism for preventing unintended operation of a switch that is positioned in a magnetic field. The specific arrangement, in a switch comprising relatively rotatable supports having multiple contacts, of permeable bodies spaced angularly about the axis of rotation not only provides for detent action, but, by reason of the distribution of the attractive forces about the axis insures positive contact between surfaces of cooperating contacts.

We claim:

1. In a switch for use in a magnetic field and comprising a pair of relatively rotatable contact supports having parallel faces adjacent to each other and perpendicular to the axis of relative rotation, and contacts mounted on said faces in angularly spaced relation about said axis for movement into different circuit-controlling combinations by relative rotation of the supports to different positions; a system of magnetically permeable bodies mounted on the respective supports for locally distorting a magnetic field in which the switch is positioned, the arrangements of the magnetically permeable bodies on the respective supports being so related that in each relative position of the supports said bodies produce plural attractive forces spaced angularly around the axis of relative rotation of the supports and extending between the supports to urge together the contacts that cooperate in such position.

2. In a switch for use in a magnetic field and including relatively rotatable contact-supporting disks in spaced face to face relation, and contacts supported on said disks and projecting from at least one of them to bridge the space between them; means for pressing together surfaces of cooperating contacts comprising magnetic bodies mounted on the respective disks and having opposed surfaces spaced apart by engagement of the contacts supported on the respective disks.

3. In a switch for use in a magnetic field and including relatively rotatable contact-supporting disks in spaced face to face relation, and contacts supported on the respective disks and projecting from at least one of them to bridge the space between them; means for pressing together surfaces of cooperating contacts comprising a magnetic body secured to one of the disks in concentric relation to the axis of relative rotation, and a series of magnetic bodies countersunk in the other disk in angularly spaced positions about the axis of relative rotation and having surfaces opposed to the first body and spaced therefrom by engagement of the contacts.

4. In a switch comprising in combination a contact supporting member, at least three electrical contacts supported by said member defining a plane containing the contacting surface thereof, said contacts being spaced radially and angularly about an axis normal to said plane, a second member, a plurality of insulated and spaced conductive surfaces supported by said second member, in a plane parallel and opposed to the plane of said contacts to cooperate therewith, means providing relative rotation between said members about said axis whereby said contacts engage different spaced surfaces to provide different circuit controlling combinations, and means for producing a plurality of magnetic forces at separate regions angularly spaced about said axis for urging together said contacts and confronting surface, said magnetic forces acting within the confines of the closure formed by lines joining each of the adjacent contacts, whereby unequal magnetic forces at said regions will not reduce contact pressure at any one of said contacts.

5. In a switch for use in a magnetic field and including relatively rotatable contact-supporting disks in spaced face to face relation, and cooperating contacts supported on said disks and projecting from at least one of them to bridge the space between them; means for pressing together surfaces of the cooperating contacts comprising magnetic bodies mounted on the respective disks and having opposed surfaces spaced apart by engagement of the contacts supported on the respective disks, and said magnetic bodies being so arranged as to change the permeability of the magnetic system during relative rotation of the contact supports between different circuit controlling positions to thus provide position holding.

6. In a switch for use in a magnetic field and including relatively rotatable contact-supporting

disks in spaced face to face relation, and contacts supported on said disks and projecting from at least one of them to bridge the space between them; a magnetic system for pressing together surfaces of the cooperating contacts, said system comprising plural magnetic bodies mounted on one contact support in angularly spaced concentric relation about the axis of rotation, and an annular magnetic body mounted on the other support concentrically about the axis of rotation, said annular body having radial slots that act to change the permeability of the magnetic system as they pass the magnetic bodies in the other support during relative rotation of the supports to thus provide a position holding.

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