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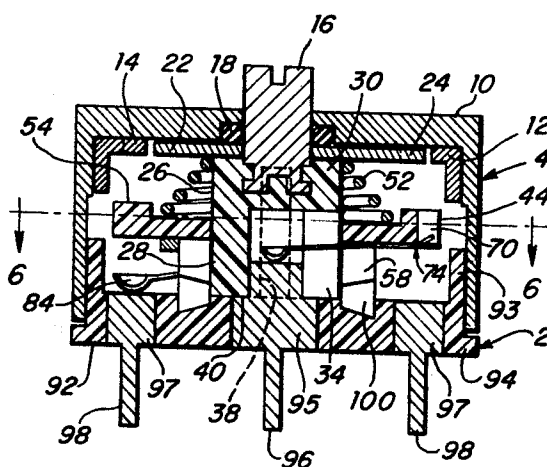
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[54] **ROTARY SWITCH WITH DETENT**
9 Claims, 7 Drawing Figs.

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200/166 SD, 74/527
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H01h 19/58
 [50] Field of Search..... **200/11, 166**
SD; 74/527

ABSTRACT: A miniature rotary switch having a detent mechanism comprising cooperating sets of triangular teeth and a wiper contact that undergoes lifting and lowering with respect to a series of fixed contacts as it is rotated from one to another of said fixed contacts.



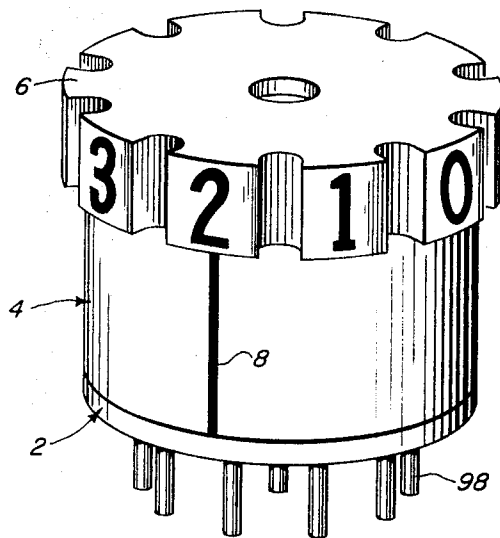


FIG. 1.

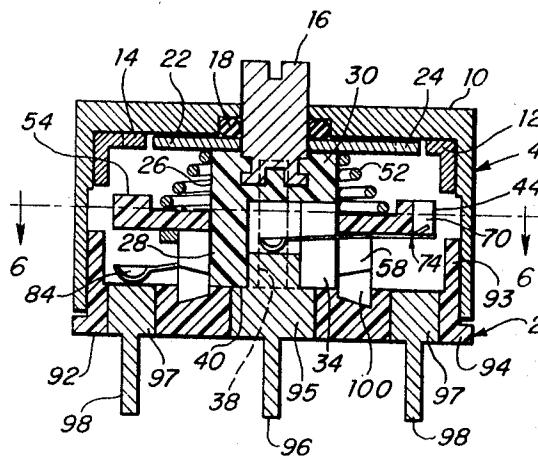


FIG. 2.

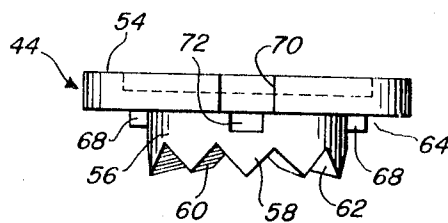
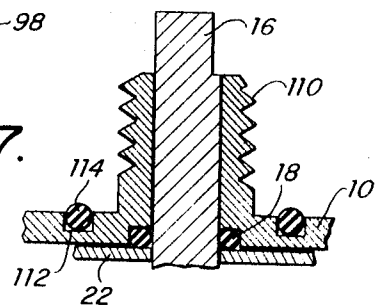


FIG. 5.

FIG. 7.



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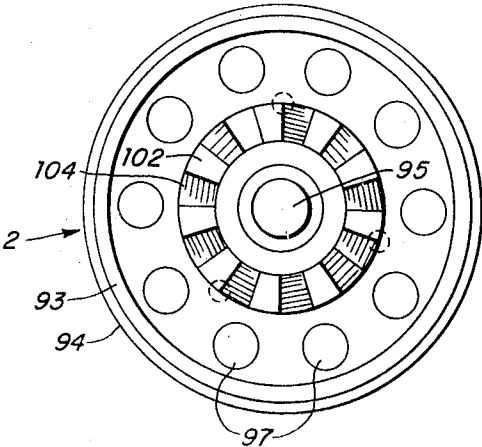


FIG. 3.

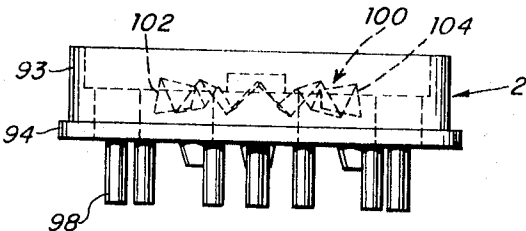


FIG. 4.

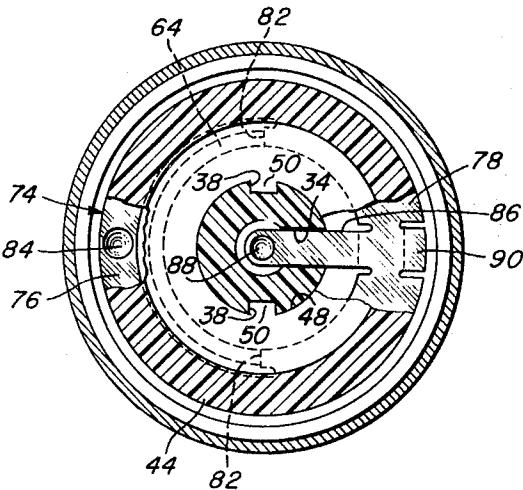


FIG. 6.

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ROTARY SWITCH WITH DETENT

This invention related to rotary electric switches and more particularly to miniature multiposition rotary switches.

The primary object of this invention is to provide an improved miniature multiposition rotary switch.

A more specific object of this invention is to provide a miniature rotary switch designed to meet the space and operational requirements of modern solid state electronic equipment. These requirements include small size, reliability of behavior under varying atmospheric conditions, long life, ease of manufacture and assembly, and low cost.

Another important rotary switch requirement is provision of detent means for restraining the operating shaft of the switch so that it will hold a given switch position until actuated and then will index to another switch position by a reliable snap action. A particular problem has been to provide an adequate detent while keeping the overall size of the switch housing to within predetermined limits, e.g. to a length and breadth in the order of one-half inch or less. Still another important requirement is that the moveable contact make firm engagement with each stationary metal contact while at rest so as to minimize contact noise but exert relatively light pressure thereon as it indexed so as to minimize contact wear and prevent tracking of metal between contacts and resulting leakage.

Accordingly, another specific object is to provide a rotary multiposition switch having a new and improved detent mechanism which not only provides the requisite detent action but also minimizes contact wear while assuring adequate contact pressure to eliminate noise from contact bounce or vibration.

The foregoing objects are achieved by a switch comprising a plurality of stationary contacts, a rotatable operating shaft, a detent mechanism made up of a first circular array of teeth carried by the switch housing and a second circular array of teeth on a detent plate mounted for rotation with the operating shaft, and a contact member mounted so as to be rotatable with said shaft and to engage successive ones of said stationary contacts as the shaft is rotated. The detent plate is moveable axially relative to the operating shaft and spring means are provided for urging it so that its teeth engage the teeth carried by the housing. As the shaft is turned, the engaged teeth produce a camming action that together with the force exerted by the spring means causes the detent plate to reciprocate axially of the shaft without at the same time being cammed sideways. Because of this reciprocal axial movement of the detent plate, the moveable contact member moves laterally of the plane of the stationary contacts, first away from and then back toward that plane as it rotates with the shaft from one stationary contact to another stationary contact. The two sets of teeth and the spring means coact to produce snap action indexing of the operating shaft.

Other features and many of the attendant advantages of this invention are described or rendered obvious from the following detailed specification when considered together with the accompanying drawings wherein:

FIG. 1 is a perspective view of a 10-position switch constituting a preferred embodiment of the invention;

FIG. 2 is a vertical sectional view;

FIG. 3 is a plan view of the base of the same switch unit showing the stationary teeth that mate with the teeth on the detent plate;

FIG. 4 is a side elevation of the base;

FIG. 5 is a side elevation of the rotary-toothed detent plate;

FIG. 6 is a sectional view taken along line 6-6 of FIG. 2; and

FIG. 7 is a fragmentary view of another embodiment of the invention.

Turning now to FIG. 1, the illustrated unit is a miniature 10-position switch designed for mounting on a printed circuit board. The switch comprises a base 2 from which project terminal pins hereinafter described, a housing in the form of a case 4 which is secured to the base and encloses the working

components shown in FIGS. 2-6, and a knurled knob 6 provided with numerals as shown which when aligned with a reference line 8 on the case 4 indicate the setting of the switch.

Referring now to FIG. 2, the case 4 is made of metal and is constructed so that it is open at one end and has an end wall 10 at the other end. The end wall is provided with a center opening as shown. Mounted within the case 4 is a metal stop ring 12 in the form of an annulus of L-shaped cross section. Stop ring 12 engages end wall 10 and is secured in place by a press fit. It also may be cemented to case 4 by an epoxy or other suitable cement. Stop ring 12 has an inwardly projecting stop tab 14. Mounted in the center opening in end wall 10 is a metal operating shaft 16 which is surrounded by a resilient O-ring 18 that is seated in a counterbore on the inner side of the end wall. Carried by shaft 16 within case 4 is a circular metal stop plate 22 having a radially extending stop finger 24 which stops short of the inner edge of stop ring 12 but projects far enough to be intercepted by the latter's stop tab 14 so as to limit rotation of shaft 16. Although the stop plate is formed as an integral part of shaft 16, it may also be formed as a separate member and affixed to the shaft by welding or other suitable means.

Molded onto the inner end of shaft 16 as an axial extension thereof is a plastic rotor 26. Circumferential and diametral grooves on the inner end of shaft 16 assure that a secure mechanical interlock is made with the rotor when the latter is molded in place. Rotor 26 comprises a cylinder 28 closed off at one end by an end wall 30 in which the end of shaft 16 is embedded. As seen in FIGS. 2 and 6, the wall of cylinder 30 has an axially extending slot 34 and also two diametrically opposed grooves 38 that are displaced 90° degrees from slot 34. Grooves 38 function as keyways for detent plate 44 hereinafter described. The other end of rotor 26 terminates in a flat end face 40.

Positioned on rotor 26 is a detent plate 44 made of a suitable plastic or plastic composite, e.g. nylon reinforced with glass fibers. As seen in FIGS. 2, 5 and 6 the detent plate is an annulus. The center opening defined by its surface 48 is just large enough to accommodate rotor 26 and to permit the detent plate to slide axially on the rotor. However, detent plate 44 also has two diametrically opposed axially extending ribs or keys 50 on its inner surface 48 that slidably interlock with grooves 38 to prevent relative rotation between the detent plate and the rotor. The detent plate is urged away from stop plate 22 by a compression spring 52. The detent plate has a circularly extending rib 54 at its margin on the side that faces stop plate 22 which acts to limit lateral movement of spring 52.

Detent plate 44 also has an axial extension in the form of a hub 56 on the side opposite rib 54. Hub 56 has the same internal diameter but a smaller external diameter than plate 44 and terminates in a circular track or array of teeth 58. There are 10 teeth 58, each comprising sides 60 and 62 that are inclined so that the angle between them is 90°. Additionally, the teeth are formed so that their bases (the tooth base is the junction line of the side 60 of one tooth and the side 62 of the next tooth) slope away from the plane of the detent plate with decreasing diameter and their apexes (the tooth apex is the junction line of the two sides 60 and 62 of the same tooth) slope toward the plane of the detent plate with decreasing diameter. The base lines and apex lines of teeth 58 meet at the center of rotation of the detent plate. Another feature of detent plate 44 is a rib 64 formed on the same side as teeth 56. Rib 64 extends through an angle of about 180° and terminates in flat end faces 68 (see FIG. 5). Rib 64 serves to facilitate proper mounting of a wiper contact unit hereinafter described that is carried by the detent plate. In this connection it is to be noted that the detent plate is provided with a vertical slot 70 in its outer surface 46 plus a rectangular opening 72 in its hub 56. Opening 72 is aligned radially with slot 70 and also with the slot 34 of rotor 26.

The wiper contact unit is shown in FIGS. 2 and 6. It consists of an annular member 74 made of a suitable spring metal or alloy, e.g. beryllium-copper. One-half 76 of the annular member 74 has a greater internal diameter than the other half 78, with the inner surface of the latter terminating in a pair of aligned radially extending shoulders 82. Annular member 74 is bent along a line substantially coincident with shoulders 82 so that the half 76 extends at an angle to the half 78. The half 76 of annular member 74 is formed with a button contact 84 displaced 90° degrees from shoulders 82. The wider half 78 of annular member 74 is formed with a finger 86 that extends inwardly and has a button contact 88 formed at its extremity. Finger 86 is bent so as to be at an angle to the plane of the wider half 78 of annular member 74. The latter also is slit to form a tab 90 which is aligned with finger 86 and button contact 84. The angle of bend between the two halves of annular member 74 is such as to permit the button contact 84 to engage the stationary switch contacts as described hereinafter. The annular member 74 is disposed so that its tab 90 fits in slot 70 of the detent plate 44, its finger 86 extends through opening 72 of the detent plate and slot 34 of rotor 26, and its shoulders 82 engage the end faces 68 of rib 64. Its wider half 78 is cemented to the detent plate, with additional cement being applied to secure tab 90 in slot 70.

The base 2 is made of plastic and comprises a disc 92 having a cylindrical extension 93 sized to make a snug fit within case 4 and a peripheral flange 94 that overlaps the end of the case. Disc 92 has a center hole plus 10 additional holes arranged in a circular array concentric with the center hole. Secured in the center hole is a contact 95 made of conductive metal and having at one end a terminal pin 96 that projects out of the base. The other end of contact 95 projects from the inner side of base 2 and is undercut so as to provide an annular shoulder that engages the end face of rotor 26 and a round center portion that fits within the rotor and is engaged by the button contact 88 on the end of finger 86. It is to be noted that finger 86 is bent sufficiently so that when the base is secured in place the center portion of contact 95 bears against button contact 88 with enough pressure to assure continuous contact even under shock or vibration. Secured in 10 other holes in base 2 are additional contacts 97 having flat inner end surfaces that are flush with the inner face of the base. Contacts 97 have terminal pins 98 that project from the outer face of the base. Contacts 97 are located so that they will be engaged in turn by bottom contact 84 of the wiper as shaft 16 is rotated.

In addition to carrying the aforesaid contacts, the base 2 is formed with a circular array or track of teeth 100 that are equal in number to and mate with teeth 58. The bases of teeth 100 are partially within the disc 92. The sides 102 and 104 of teeth 100 are inclined so that the angle between them is 90°. Additionally, teeth 100 are formed so that their bases slope toward the plane of the outer, i.e. bottom, face of the base (FIGS. 2 & 4) with increasing diameter and their apexes slope toward the plane of the inner, i.e. top, face of the base with decreasing diameter. Stated otherwise, as seen in FIG. 2, the bases of teeth 100 slope upward and their apexes slope downward with decreasing diameter. Accordingly, the teeth 100 are identical to teeth 58 except that they point up instead of down in FIG. 2. The base is inserted into the base with slight pressure of contact 95 against rotor 26 such as to slightly compress the O-ring 18. The detent teeth simply mesh under this condition as a result of the pressure of spring 52. The base 2 is secured to case 4 by a suitable cement such as an epoxy cement.

The unit is completed by attaching the knob 6 to shaft 16, the knob having a center hole which is sized to make a snug fit in the shaft. The knob may be secured in place by means of a suitable cement or alternatively by means of one or more set screws.

FIG. 7 shows another modification of the invention adapted for panel mounting. Here the end wall 10 of case 4 is formed with an extension in the form of a threaded bushing 110 and the shaft 16 is made long enough to project out of the bushing.

Additionally, the end wall 10 is formed with a groove 112 concentric with bushing 110 and a rubber O-ring 114 is mounted in groove 112. In practice this modification is attached to a panel by inserting the bushing through a hole in the panel and screwing a nut on the bushing. The O-ring 114 provides a humidity seal between the switch case and the mounting panel. The switch is operated by a knob (not shown) attached to shaft 16. Alternatively, the outer end of the shaft may be kerfed to permit it to be rotated with a screwdriver.

In both embodiments described above, the mode of operation is the same. The switch completes a circuit between one of the contacts 97 and the contact 95 via wiper contacts 84 and 88. The gear teeth in the base are disposed so that when they are fully engaged by the teeth on detent plate 44, the button contact 84 of the wiper is centered on and is pressing against one of the stationary contact 97. Then when the knob 6 is turned in one direction or another, the teeth 100 act on the teeth 58 to cam the detent plate axially away from the base against the pressure of spring 52. As soon as the apexes of teeth 58 ride over the apexes of teeth 100, the pressure of spring 52 on the detent plate causes the teeth 58 to return to full meshing engagement with teeth 100 by 45° camming action that turns detent plate 44 and operating shaft 16 so as to center the wiper's button contact 84 on the next stationary contact 97. The axial movement of the detent plate away from the base is enough to lift the bottom contact off of the base as it turns with the detent plate. Because of the 45 degree slope of the sides of the teeth, the pressure exerted by the button contact 84 on the stationary contact 97 on which it has been resting drops as soon as the detent starts to rotate. Similarly as the button contact moves over the next stationary contact, its pressure thereon does not reach a maximum until the teeth on the base again are fully engaged by the teeth on the detent plate. This action offers the advantage of avoiding tracking of metal from one contact to another which is bad because it produces electrical leakage between contacts that shortens the life of the switch. It is to be noted that finger 86 is formed with a bend sufficient for its button contact 88 to remain in contact with center contact 95 while the detent plate is being cammed away from the base 2. However, it is to be appreciated that finger 86 could be bent so that when the wiper is being advanced to another switch position the button contact 88 would break and remake contact with contact 95. This latter mode of operation is permissible provided the contact pressure exerted by button contact 88 (and also contact 84) is sufficient to prevent contact bounce when the switch is at rest and at the beginning and ending of an indexing operation.

It is to be noted that the number of teeth on the detent plate need not equal the number of teeth in the base 2. It is sufficient if one set of teeth equals the number of desired switch positions, while the other set of teeth may total the same or a lesser number provided there are enough to key in mutually perpendicular directions. Of course, the teeth should be shaped to mesh properly with one another, which is insured in the illustrated embodiment by having the apex and base lines meet at the center of rotation.

From the foregoing description it is believed obvious that the invention provides a multiposition switch that is easy to assemble, has a dependable detent with a space requirement that is small in an axial direction, indexes with a discrete snap action and is adaptable for panel mounting or can be made as a plug in module for printed circuit boards. Because of the way they are shaped, the teeth 58 and 100 cooperate to prevent the detent plate from moving laterally of its axis of rotation. Holding the detent plate against lateral movement is important because it prevents corresponding movement of the wiper contact under shock or vibration. It also is to be noted that the number of stationary contacts can be varied and also that the mechanical stop can be modified to limit rotational movement of the operating shaft according to the number of switch positions in the unit. Other advantages will be obvious to persons skilled in the art.

What I claim is:

1. A rotary switch comprising a housing that is open at one end and has an end wall with an opening at the other end, a base plate secured to said housing and closing off said one open end thereof, said base plate having a circular array of stationary switch contacts exposed to the interior of said housing and terminal means for said stationary switch contacts accessible for circuit connections outside of said housing, said base plate also having a circular track of first teeth exposed to the interior of said housing, a shaft rotatably mounted in said opening in said end wall, said shaft having an axial extension within said housing, a detent plate mounted on said axial extension, means coupling said detent plate to said axial extension so that said detent plate will rotate with said axial extension but is slidable as a whole longitudinally of said axial extension, a circularly extending array of second teeth carried by said detent plate so as to rotate therewith, said second teeth facing said first teeth, a compression spring surrounding said axial extension and urging said detent plate longitudinally of said axial extension toward said base plate so as to hold said second teeth in engagement with said first teeth, and a wiper unit connected to said detent plate, said wiper including a first electrically conductive member disposed so as to engage each stationary switch contact in turn as said shaft is turned, said base plate having another stationary contact exposed to the interior of said housing with terminal means accessible for a circuit connection outside of said housing, said wiper unit including a second electrically conductive contact member conductively connected to said first contact member and engaging said another stationary contact, said first and second teeth and said compression spring cooperating in the absence of an applied turning force to lock said detent plate and shaft against rotation, said first and second teeth and said compression spring also cooperating when said shaft is rotated by means of an applied turning force to produce reciprocal sliding motion of said detent plate axially of said axial extension so that as said first contact member moves from one switch contact to another it also reciprocates first away from and then back to said array of switch contacts.

2. A rotary switch according to claim 1 wherein one end of said axial extension engages said base plate.

3. A rotary switch according to claim 1 wherein said axial extension is hollow and said another stationary contact projects within said axial extension, and further wherein said second contact member extends into said axial extension through a side opening in said axial extension for engagement with said another stationary switch contact.

4. A rotary switch according to claim 1 further including stop means for limiting rotation of said shaft, said stop means comprising a first projection rotatable with said shaft and a

second projection attached to said housing and positioned to intercept said first projection as it rotates with said shaft.

5. A rotary switch according to claim 1 wherein the spacing of said first teeth is the same as the spacing of said second teeth and further wherein the base to apex height of said teeth increases with increasing distance from the axis of rotation of said shaft.

6. A rotary switch according to claim 5 wherein the apexes and the bases of said first and second teeth extend along radial lines at oblique angles to the axis of rotation of said shaft.

7. A rotary switch according to claim 6 wherein the apexes of said first teeth and the bases of said second teeth extend at one oblique angle and the bases of said first teeth and the apexes of said second teeth extend at a second oblique angle to the axis of rotation of said shaft.

8. A rotary switch comprising a housing, a circular array of stationary switch contacts in said housing, terminal means for said stationary switch contacts accessible for circuit connections outside of said housing, a stationary circular track of first teeth within said housing, a shaft rotatably mounted in one end of said housing, said shaft having an axial extension within said housing, a detent plate mounted on said axial extension, means coupling said detent plate to said axial extension so that said detent plate will rotate with said axial extension but is slidable axially of said axial extension, an array of second teeth carried by said detent plate so as to rotate therewith, a compression spring surrounding said axial extension and urging said detent plate in a direction to hold said second teeth in engagement with said first teeth, a wiper connected to said detent plate, said wiper including a contact member disposed so as to engage each stationary switch contact in turn as said shaft is turned, another stationary contact with terminal means accessible for a circuit connection outside of said housing, and means providing an electrical connection between said wiper and said another stationary contact, said first and second teeth and said compression spring cooperating in the absence of an applied turning force to lock said detent plate and shaft against rotation, said first and second teeth and said compression spring also cooperating when said shaft is rotated by means of an applied turning force to produce reciprocal sliding motion of said detent plate axially of said axial extension so that as said contact member moves from one switch contact to another it also reciprocates first away from and then back to said array of switch contacts.

9. A rotary switch according to claim 1 further including stop means for limiting rotation of said shaft, said stop means comprising a first projection rotatable with said shaft and a second projection attached to said housing and positioned to intercept said first projection as it rotates with said shaft.