Sept. 30, 1969 S. SCHNEIDER ET AL 3,470,333

MULTIPOSITION ROTARY SWITCH

Filed June 20, 1967 2 Sheets-Sheet 1

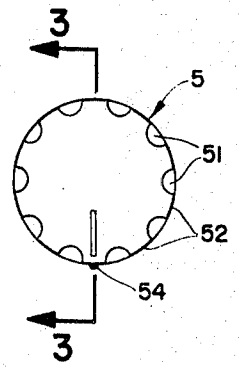

FIG. 1

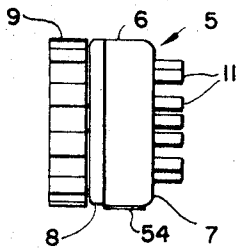

FIG. 2

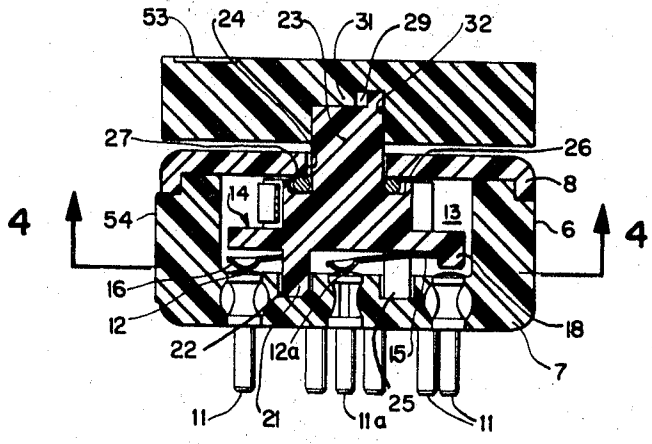

FIG. 3

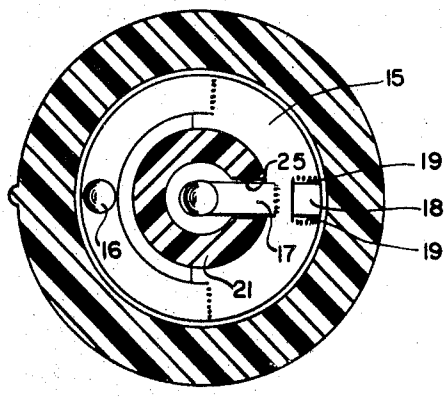

FIG. 4

INVENTORS
ROBERT L. FERRELL
STANLEY SCHNEIDER

BY Herd L. Mellhoff
ATTORNEY

Sept. 30, 1969 S. SCHNEIDER ET AL 3,470,333

MULTIPOSITION ROTARY SWITCH

Filed June 20, 1967 2 Sheets-Sheet 2

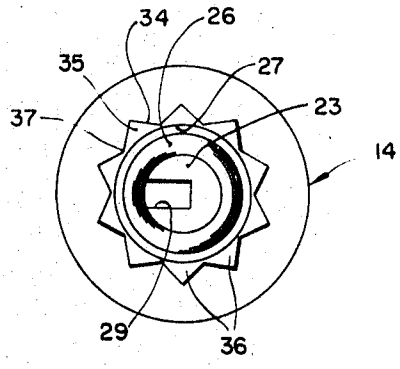

FIG. 5

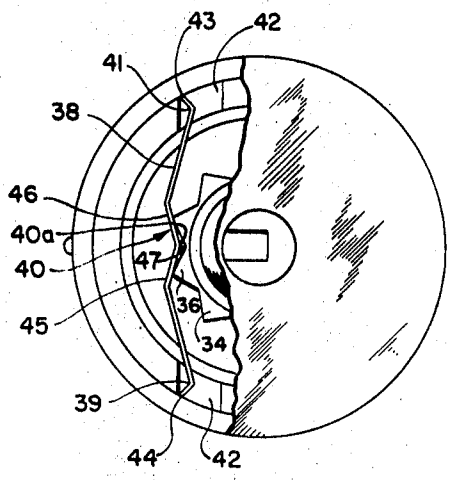

FIG. 6

INVENTORS
ROBERT L. FERRELL
STANLEY SCHNEIDER
BY Gerd L. Mellhoff
ATTORNEY

United States Patent Office 3,470,333
Patented Sept. 30, 1969

3,470,333

MULTIPOSITION ROTARY SWITCH

Stanley Schneider, Newport Beach, Calif., and Robert L. Ferrell, Bothell, Wash., assignors to Beckman Instruments, Inc., a corporation of California

Filed June 20, 1967, Ser. No. 647,498
Int. Cl. H01h 19/58, 21/78
U.S. Cl. 200—11 3 Claims

ABSTRACT OF THE DISCLOSURE

A multiposition rotary switch including an array of contact elements connecting with stationary terminals positioned through a base of a housing member enclosing a cavity. The contact carrying rotor is mounted within the cavity and adapted to move an electrically conductive wiper into contact with successive contact elements. In order to provide detent action and to positively locate the position of the wiper with regard to the contact elements there is provided a detent means including a camming surface on the rotor having a plurality of protruding teeth arranged around the camming surface with depressions therebetween and a spring member having a convex-shaped section mounted within the housing and forced against the teeth of the camming surface so that the convex-section of the beam spring tends to center itself between two adjacent teeth of the rotor camming surface.

The present invention relates generally to multiposition rotary switches and is more particularly directed to a precise detent indexing mechanism and mounting arrangement for the rotor of such a switch.

The trend toward smaller and smaller electronic components has created a need for a very precise multiposition rotary switch mechanism having a very positive indexing means for positioning and precisely locating the switch components. As a rotary switch becomes smaller and smaller the electrical contacts forming the switch elements are arranged closer and closer together and the detent arrangement for positioning and locating the movable switching contact must be very precise. It must locate on the contact elements with little or no back-lash and must be precisely held in position once located.

Accordingly, it is an object of the present invention to provide a new and improved rotary switching mechanism having a detent arrangement designed to virtually eliminate back-lash and movement of the switching contact after a switching operation.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention wll be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of the invention reference may be had to the accompanying drawings in which:

FIGURE 1 is a plan view of a multiposition rotary switch;

FIGURE 2 is a side view of the rotary switch of FIGURE 1 illustrating the housing having terminal elements extending therefrom;

FIGURE 3 is an enlarged cross-sectional view taken essentially along line 3—3 of FIGURE 1;

FIGURE 4 is an enlarged cross-sectional view taken along line 4—4 of FIGURE 3 and illustrating the lower

side of the rotor and its electrically conductive contact member;

FIGURE 5 is an enlarged plan view of the upper surfaces of the rotor; and

FIGURE 6 is an enlarged plan view of the switch with a portion of the rotary knob and cover lid broken away to show the detent mechanism.

Referring now to the drawings, there is shown in FIGURES 1 and 2 a miniature rotary switch of a type adapted to be mounted on a circuit board or the like. The switch is generally denoted by the reference numeral **5**, and includes a housing **6** formed of a base section **7** and a cover lid **8**. Mounted parallel to the cover lid **8** for actuating the electrical components mounted within the housing cavity is a rotatable knob **9** which may be indexed to any of a plurality of positions.

As may best be seen in FIGURES 2 and 3, a plurality of stationary terminals **11** are mounted in an array within the base section **7** of the housing. Each of the terminals **11** and a center post terminal **11*a*** are preferably molded into the base member **7** with one end thereof forming a contact pad or element **12** (**12*a*** on the end of center terminal **11*a***) exposed on the inner surface of the base member within the cavity **13**. In the embodiment illustrated, the terminals **11** are concentrically located in a circle around the base terminal **11*a*** which forms a common terminal for the switching mechanism. The terminals are preferably fabricated of a gold plated nickel or other suitable electrically conductive material. Base section **7** is preferably molded of a plastic material such as glass-filled nylon or the like which is easily molded into the requisite shape with the terminals embedded therein. This material provides a number of advantages, such as appropriate self-lubricating qualities, non-conductivity, and is comparatively inexpensive.

Rotatably mounted within the cavity **13** is a rotor, generally designated by the reference numeral **14**. The rotor carries an electrically conductive contact member **15** including a first movable contact or wiper **16** which is resiliently biased into contact with the contact elements **12**. Wiper contact is disposed to engage successive contacts during rotation of the rotor within the cavity. The contact member **15** also includes at least one common resilient wiper **17** which is biased into electrical contact with the contact element **12*a*** of the central terminal post **11*a*** and remains in electrical contact therewith during rotation of the rotor. The common wiper **17** and its contact element **12*a*** and terminal **11*a*** form a convenient means for connecting the contact member **15** into an external electrical circuit. The contact member **15** is preferably formed of a one-piece construction, which may be stamped or otherwise formed from a sheet of spring-like material such as beryllium copper, or other suitable material. The contact member is preferably gold plated to assure good electrical contact or conductivity with the contact elements.

As may best be seen in FIGURE 4, the contact member **15**, in the illustrated embodiment, is held in place on the rotor **14** by means of a protrusion **18** extending from the rotor over which edges **19** are bent outwardly when the wiper is assembled on the rotor. Edges **19** "bite" into the protrusion **18** of the rotor and retain the contact member **15** in place against the bottom surface of the rotor. In order to locate the contact member with respect to the rotor, the member is shaped to straddle a cylindrical flange **21** which extends downwardly from the rotor. As

will be seen in FIGURE 3, the wiper element **16** is positioned externally of the downwardly extending cylindrical flange **21** and the common contact element **17** is positioned so that it extends within the confines of the cylindrically shaped flange **21** through a slot or opening **25** formed through the wall of the flange.

Means are provided for supporting the rotor **14** within the cavity **13** for rotation about an axis substantially normal to the base member **7**. These means comprise, as may best be seen in FIGURE 3, the cylindrical flange **21** which extends into a mating circular groove or slot **22** formed in the base section **7**. Groove **22** confines the rotor within the cavity and forms a bearing support for rotation of the rotor. The rotor **14** is also rotatably supported and axially retained in position within the cavity **13** by the cover lid **8** of the housing. The cover lid is positioned above the rotor **14** and includes an opening **24** opposite from the base member through which the shaft **23** of the rotor extends. The cover lid is positioned over the exterior portions of the base member and securely attached thereto by means of an epoxy cement, or by ultrasonic welding techniques or other suitable means well known in the art. Beneath the surface of the cover lid **8** is positioned an "O" ring **26**, which is positioned around the rotor shaft and recessed in a gland **27** formed in the upper surface of the rotor. The "O" ring **26**, in cooperation with the gland **27**, and the lower surface of the lid **8** seals the housing cavity **13** against environmental ingress and provides a certain amount of torque resistance to rotational movement of the rotor. Note that the cover lid **8** depresses the "O" ring **26** within the gland **27** so that a certain amount of downward pressure is exerted thereon.

The rotor shaft **23**, which is an integral part of the rotor **14**, extends through the opening **24** and is attached directly to the knob **9**. For this purpose a slot (see FIGURE 5) **29** is formed in the upper surface of the rotor shaft **23** which mates with a raised bar or shoulder **31** formed in a shaft hole **32** formed in the knob **9**. The rotor shaft **23** is inserted in the knob opening **32** so that the raised bar **31** keys into the slot **29**. The parts are then attached by means of a suitable cement, ultrasonically welded, or otherwise joined together.

A significant feature of the invention is a detent or indexing means for locating and retaining the contact member in any one of a plurality of predetermined positions with the movable wiper **16** in engagement with one of the contact elements. As will best be seen in FIGURES 3, 5 and 6, this mechanism comprises a camming surface or toothed wheel **34** see FIGURE 5) which is an integral part of the rotor. The toothed wheel **34**, as shown in FIGURE 5, comprises a plurality of triangular shaped teeth **36** separated by depressions or indentations **37** formed around the outer surface of the upper portion of the rotor. The apexes of the triangular shaped teeth **36** extend outwardly and engage a beam spring **38** during rotation of the rotor **14**.

The beam spring **38**, as may be seen in FIGURE 6, is preferentially fabricated of a material such as beryllium-copper alloy or the like. The spring is formed with a central convex-shaped section **40** disposed so that it is convex in a direction toward the camming surface or toothed wheel **34** of the rotor. In the preferred embodiment illustrated, the convex section **40** of the spring is V-shaped with the apex **40***a* of the spring directed toward the camming surface. Note also that the outer sections **39** and **41** of the beam spring are also substantially V-shaped and that the very tips or end portions of the beam spring are mounted within or captured by slots **42** formed in the housing. The V-shaped sections **39** and **41** function to maintain indexing accuracy by allowing the spring tips **43** and **44** to remain in essentially the same position, even while the spring is distorted, thereby eliminating any translational movement of the spring with respect to its mounting points.

The central convex section **40** is preferably formed so that the opposite sides or legs **45** and **46** thereof are swept back at a substantial angle and engaged by the tips or apexes of two adjacent triangular shaped teeth **36**. As will be seen in the illustrated embodiment of FIGURE 5 the apex **40***a* of the V-shaped section **40** is normally directed inwardly toward an indentation **47** between the respective teeth when the camming surface is properly seated. Preferably, the spring section is formed at an obtuse angle slightly greater than the angle formed by connecting sides of the two adjacent teeth **36** of the camming surface. This permits the side legs **45** and **46** to be engaged by two adjacent teeth without the apex **40***a* of the central spring section **40** touching the camming surface. This construction eliminates back-lash and causes the camming surface to seek a centrally located position between the adjacent teeth **36** in contact with the respective sides of the central V-shaped section.

As the rotor **14** is turned, the tip or apex of one tooth **36** moves along a side leg **45** or **46** (depending upon the direction of rotation) of convex section **40** and raises it until the tip passes the apex **40***a* of the spring section. Then the resilient force of the spring forces the apex **40***a* of the central section **40** into the identation or notch, such as notch **47**, and advances the contact wiper **16** to the center of a contact element **12**. By employing the illustrated embodiment of the mechanism, wherein the convex section **40** is V-shaped, it is virtually impossible for the contact wiper to become lodged between switch positions.

Any number of different contact position indicators may be employed with the device of the invention. For example (but in no way limiting), the knob **9** may be provided with notches **51**, as shown in FIGURE 1. Notches **51** facilitate knob rotation as well as divide the knob edge into any number of sections **52** which are equivalent to the number of the switch positions for the content element array formed within the device. A shallow slot **53**, formed in the top of the knob **9**, may be used to indicate the actual position of contact wiper **16**. The pointer or index mark **54** on the side of the base member **7** may also be employed as a reference point to indicate the particular position in which the wiper contact **16** is electrically contacting one particular contact element **12**.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A multiposition rotary switch comprising:

a housing defining a cavity and including a base having a circular groove formed therein and an array of equidistantly spaced stationary terminals positioned therethrough externally of said circular groove and having contact elements exposed within said cavity, said housing having an opening through a wall thereof opposite said base;

a non-conducting rotor disposed within said cavity and having a shaft extending through said opening in said housing, said rotor including a projecting cylindrical flange extending into said circular groove in said base and supporting said rotor for rotation about an axis of rotation extending through said circular groove and said shaft protruding through said opening in said housing, said flange having a slot formed in side wall thereof;

a central terminal post extending through said base and having a contact element exposed within said cavity on the surface of said base substantially surrounded by said circular flange;

a contact member attached to said rotor and having a resilient wiper contact disposed to engage said contact elements and a second resilient wiper contact extending through said slot in said cylindrical flange and engaging said contact element of said central post;

detent means for locating and retaining said contact member in any one of a plurality of predetermined positions with said contact member engaging a contact element comprising:

a camming surface on said rotor with a plurality of protruding triangular shaped teeth arranged concentrically around the axis of rotation of said rotor with triangular shaped depressions between each adjacent pair of said teeth;

a beam spring member having a V-shaped section disposed substantially centrally thereon and supported at both ends thereof in a side wall of said housing, said V-shaped section of said spring having side legs thereof bent at an angle greater than said angle of said apex of said triangular shaped teeth, said V-shaped section being resiliently retained against said teeth of said camming surface with the apex of said V-shaped section directed toward said teeth and depressions of said camming surface so that the side legs of said V-shaped spring section tend to center the apex of said V-shaped section between two adjacent triangular shaped teeth of said rotor camming surface.

2. The multiposition rotary switch defined in claim 1 in which said beam spring is supported at both ends thereof in slots formed in the side wall of said housing and with the only portion of said spring engaging said slots being the tips thereof.

3. The multiposition rotary switch defined in claim 2 in which said beam spring member is formed substantially in the shape of a central V-shaped section and two outer V-shaped sections attached on opposite sides of said central V-shaped section with said outer leg of said outer V-shaped sections engaging the side wall of said slots and with the central V-shaped section adapted to extend into the depression formed between two adjacent teeth of said rotor camming surface.

References Cited

UNITED STATES PATENTS

3,255,319	6/1966	Paine	200—11.11
3,283,105	11/1966	Locke et al.	
3,301,971	1/1967	Johnson	200—11.23

ROBERT K. SCHAEFER, Primary Examiner

M. GINSBURG, Assistant Examiner

U.S. Cl. X.R.

200—166

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3470333 Dated September 30, 1969

Inventor(s) Robert L. Ferrell and Stanley Schneider

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4, line 63 -- "non-conducting" should be -- non-conductive --

Column 6, line 12 -- "leg" should be -- legs --

SIGNED AND
SEALED
JAN 6 - 1970

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents