Jan. 24, 1967 B. A. PAINE ET AL 3,300,594

ELECTRIC SWITCH HAVING A ROTOR WITH A RESILIENTLY DEFORMABLE DETENT BEAM MEMBER

Filed Sept. 20, 1965 2 Sheets-Sheet 1

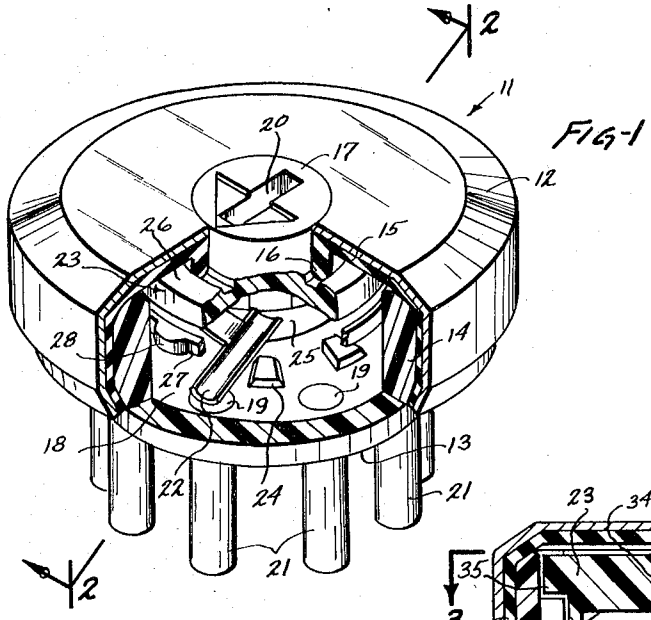
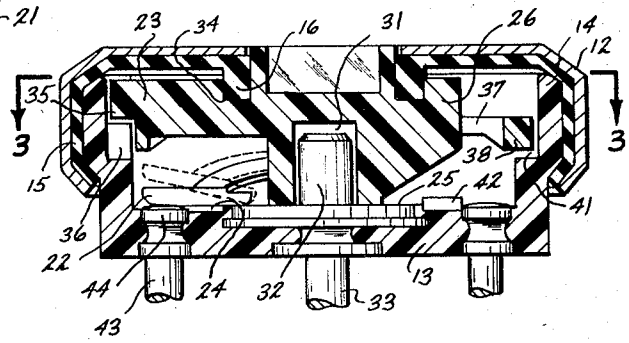


FIG-1

FIG-2



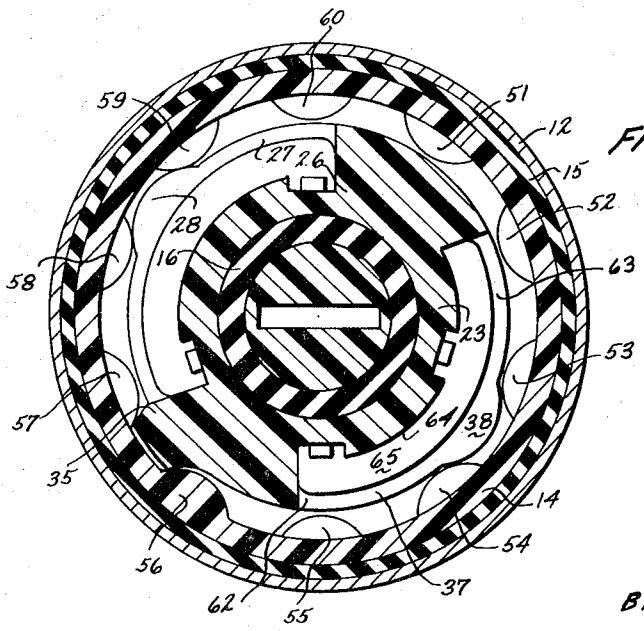


FIG-3

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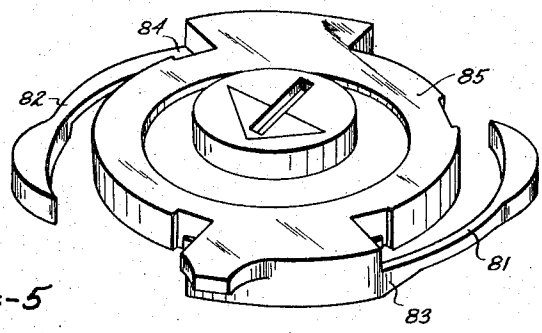


FIG-5

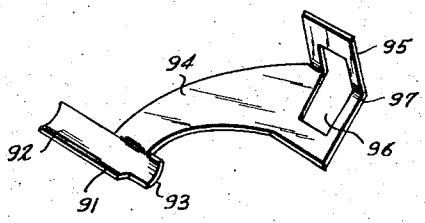
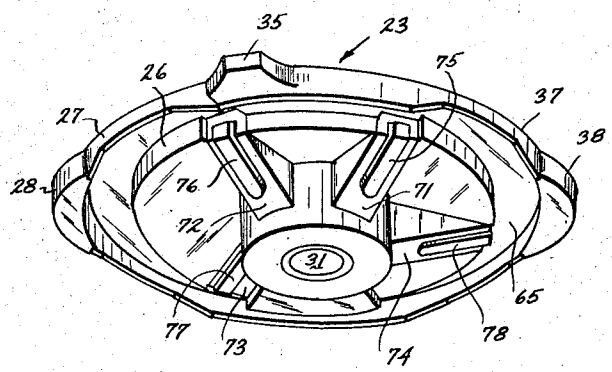


FIG-6

FIG-4



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ELECTRIC SWITCH HAVING A ROTOR WITH A RESILIENTLY DEFORMABLE DETENT BEAM MEMBER

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4 Claims. (Cl. 200—11)

This invention relates generally to switches and more particularly to miniature multi-position rotary switches of the type which are particularly adaptable for use in various applications such as, for example, printed circuits.

Prior art rotary switches for the most part embodied a rotary contact element which travelled through a single continuous plane, the surface of which remains parallel with the plane defined by the contact surface of the stationary contacts within the switch. Such motion of the rotary contact element causes the contact point thereof to slide across the stationary contacts and the base material which holds the stationary contacts in place. Such sliding motion caused an undue wear on the base material and often caused intermittent electrical contact between the movable and stationary contact elements particularly under severe operating conditions.

As a result of the foregoing, a rotary switch embodying a movable contact element eliminating the foregoing problems was developed and is described and claimed in patent application Serial No. 392,227, filed August 26, 1964, and entitled, Miniature Printed Circuit Switch, and is assigned to the same assignee as the present application. As is therein shown and described a plurality of lands and grooves are disposed adjacent the stationary contact elements and the rotary contact element is movably supported within the housing in such a manner as to be in sliding engagement with the lands and grooves. Thus as the rotary contact element is moved it alternately engages a land and a groove in such a manner that electrical continuity is effected only during the time that the rotary contact is resident within a groove. Although such action provides a positive make and break contact between the rotary and stationary contact elements and eliminates the undue and unnecessary wear while providing greater contact force, it has been found under certain operating conditions that it is more desirable to provide a quicker make and break between the movable and stationary contact elements, for example, to permit the switch to handle higher electrical voltages without arcing.

It has long been desirable in all multi-position switches and particularly those having a rotary motion to have a positive position indexing to assure positive electrical continuity in each switch position. Such position indexing has been accomplished in the prior art predominately by the utilization of detent mechanisms such as those employing a ball and spring which engage cam like piece members or alternatively a leaf spring engaging a ball or having a ball like member formed therein which engages cam like piece members. In either event it can be seen that such a structure is quite complex particularly when one is incorporating the same into a miniature switch structure and such a complexity necessarily increases the cost of manufacturing the particular item involved. Furthermore as a result of the complexity and necessarily the large number of parts involved, the reliability of operation of such a switch necessarily decreases. It is well known that the larger the number of parts which are brought together to form a given device the higher the failure probability becomes with respect

to that particular device. It is, therefore, desirable in all apparatus wherein reliability becomes an important factor to have a designed reliability which is as great as possible, i.e., all areas of failure probability are ascertained and the structure is then designed so as to eliminate those failure probable prone areas.

Accordingly it is an object of the present invention to provide a miniature multi-position rotary switch which is inexpensive, extremely small, and yet rugged in construction and which overcomes the prior art problems above referred to.

It is another object of the present invention to provide a miniature multi-position rotary switch which has a relatively long life time, in which low contact resistance is established between the stationary and rotary contacts, and in which arcing between contacts is substantially eliminated. It is a further object of the present invention to provide a miniature multi-position rotary switch which has an extremely rapid make and break between the movable and stationary electrical contact elements.

It is still a further object of the present invention to provide a miniature multi-position rotary switch which contains the fewest number of parts and thus has an extremely high reliability of operation.

Additional objects and advantages both as to organization and method of operation of a miniature rotary multi-position switch in accordance with the present invention will become more apparent from a consideration of the following description taken in conjunction with the accompanying drawing which is presented by way of example only and is not intended as a limitation upon the scope of the appended claims and in which:

FIG. 1 is a perspective view, partially cut away, of a multi-position rotary switch in accordance with the present invention;

FIG. 2 is a cross-sectional view of a switch in accordance with the present invention taken about the lines 2—2 of FIG. 1;

FIG. 3 is a top elevational view of a switch in accordance with the present invention taken about the lines 3—3 of FIG. 2;

FIG. 4 is a bottom perspective view of a rotor mechanism in accordance with one feature of a switch in accordance with the present invention;

FIG. 5 is a top perspective view of an alternative embodiment of a rotor mechanism usable within a rotary switch in accordance with the present invention; and

FIG. 6 is a perspective view of a contact element utilizable in a multi-position rotary switch in accordance with the present invention.

In accordance with the broad feature of the present invention there is provided a multi-position miniature rotary switch having a housing defining a cavity within which there is positioned a plurality of stationary electrical contacts and a rotor member carrying a movable electrical contact element. The rotor member includes a central body portion having fixed thereto and formed integrally therewith a resiliently deformable beam member which carries a detent. As the rotor is actuated, the beam deforms as it leaves one switch position and then the beam applies a pressure causing the detent to snap into place between a pair of registration posts positioned within the cavity thereby positively indexing the switch at a predetermined switching position.

In accordance with another aspect of the present invention there is provided a contact element carried by the rotor member which contact element while in a switch position or station completes an electrical circuit between a stationary contact element and a common electrically

conductive collector element. Positioned between the stationary contact element and the common collector is a plurality of contact actuation members which bear against the contact element during its rotational movement.

Referring now to the drawings and more specifically to FIG. 1 thereof there is therein illustrated a perspective view partially cut away of a miniature rotary switch in accordance with the present invention. As is therein shown a housing **11** includes a cover **12** affixed to a base member **13** which includes an upstanding side wall **14**. The interior portion of the cover **12** is coated with a sealing means such as, for example, a silicone rubber liner **15**. The rubber liner **15** terminates at its inner end in a sealing gland **16** and extends around the upstanding side wall **14** of the base **13** and operates as a seal between the cover **12** and the lower portion of the base member **13** when the cover **12** is crimped into place. An opening is provided in the upper portion of the cover member **12** through which a rotor actuating means such as shaft **17** protrudes as is well known in the prior art.

Positioned within the cavity **18** formed by the base member **13** and the cover **12** are plurality of stationary contact elements **19** which are electrically conductive and are carried externally of the housing by means of pins **21**. A movable contact member **22** is affixed to a rotor member **23** which is actuatable by the shaft **17** and causes a movable contact **22** to break and make electrical continuity with the stationary contact **19**. Actuation of the movable contact **22** to positively cause the make and break of the electrical continuity is generated by a plurality of cams such as that shown at **23** which are positioned peripherally about the base member **13** adjacent to stationary contact elements **19**. It should be noted that the cams **23** are positioned between the stationary contact element **19** and a common collector member **24**. The movable contact element **22** bridges between the stationary contact element at the particular switching station occupied by the movable contact element and the common collector **24**. As is illustrated in FIG. 1, the rotor **23** has a central body portion **26** upon which the movable contact member **22** is carried. A resiliently deformable beam **27** is formed integrally with the central body portion **26** of the rotor and carries with it a detent member **28**.

The particular relationship of each of the parts above referred to will be more fully described hereinbelow and particularly with reference to FIG. 2.

As is more clearly shown in FIG. 2, the central portion **26** of the rotor **23** has a central relief **31** which receives a centrally disposed mounting post **32** extending upwardly from the base **13** of the housing. As is clearly shown in FIG. 2 the mounting post **32** may be integrally formed with the common collector member **25** which may also be integrally formed with an electrically conductive pin member **33** extending outwardly from the housing to thus form a common electrical return for the switch.

As is further seen in FIG. 2 the rotor **23** has provided in the upper surface thereof an annular depression **34** within which the sealing gland **16** is seated to thereby effect a positive seal of contaminants from the interior operating parts of the switch. The rotor **26** also has formed as an integral part thereof a stop member **35** which functions in the well known manner by engaging a stop base **36** formed integrally with the upstanding wall **14** of the base member **13**. A resiliently deformable beam member **37** is also affixed and formed integrally with the central body portion **26** of the rotor **23**. A detent member **38** extends outwardly from the resiliently deformable beam **37** and engages a cam **41** which is also formed integrally with the upstanding side wall **14** of the base **13**.

The switch actuating cams such as illustrated at **24** and **42** are also molded integrally with the base member **13**.

The movable contact member **22** is shown in an operable position whereby electrical continuity is established between an electrical pin member **43** and the common

pin **33**. This electrical continuity is established by having the left side of the contact element **22** (as shown in FIG. 2) in electrical contact with the stationary contact member **44** which is connected to the electrical pin **43**. The right side of the movable contact member **22** is in contact with the common collector member **25**. The intermediate position of the movable contact member **22** then rests between a pair of cam surfaces such as the the ones illustrated at **24** and **42**. As the rotor **23** is then actuated, for example, by placing a screwdriver or similar adjusting tool in the slot **20**, as shown in FIG. 1, the intermediate portion above described of the movable contact element engages the inclined surface of the cam **24** and as the rotor is turned further, for example, in a clockwise direction as viewed in FIG. 2, the intermediate portion of the movable contact member **22** is caused to ride upwardly along the inclined surface thus causing the electrical continuity between the left side of the contact **22** and the stationary contact member **44** to be broken. As the contact element traverses further and is at the top of the cam **24** it occupies the position as shown in dotted lines in FIG. 2. As is illustrated in this position the left side of the electrical contact member as shown in FIG. 2, is higher than the right side thereof. This clearly illustrates that the left portion of the electrical movable contact moves through a longer arc and thus by necessity must move faster than does the right hand portion of the movable contact member **22**. This faster movement is accomplished by spacing the cam **24** further toward the right portion of the movable contact member thus giving a mechanical advantage to the left side. Such faster movement causes a faster breaking of the electrical contact between the movable and stationary contacts thus precluding arcing therebetween when the electrical contact is broken. As the rotor is further moved as above described, the movable contact element **22** will once again occupy a position such as is illustrated in solid lines in FIG. 2 but in the next successive switching position.

The relationship between the rotor and the cam surfaces formed on the upstanding side walls **14** of the base **13** is more fully illustrated in FIG. 3 to which reference is hereby made.

As is illustrated in FIG. 3 the side wall **14** of the base **13** has formed integrally therewith a plurality of inwardly directed detent cam surfaces such as those illustrated at **51** through **60**. Although 10 such cam surfaces are illustrated in FIG. 3, it should be expressly understood that any given number may be formed depending upon the particular application to which the switch may be put. For example, in the event that there is a single pole 10 position switch the structure as illustrated in FIG. 3 would be utilized. Such structure may, of course, be changed in the event that a double pole multi-position or triple pole multi-position switch is desired. Such a structure will become more clearly apparent when the rotor structure is more fully described hereinbelow.

As is further shown in the FIG. 3, the rotor **23** includes the central portion **26** thereof and the resiliently deformable beams **27** and **37**. The beam **27** carries a detent member **28** while the beam **37** carries a similar detent member **38**. It should be noted that the beams and the detents are formed integrally with the rotor **23**. Preferably the entire rotor structure including the beams and detents are molded as a single unit from a plastic material which has been impregnated with fiberglass. Although various plastic materials may be utilized in accordance with the presently preferred embodiment a nylon material is most desirable. As can be seen with particular reference to the resiliently deformable beam **37**, the beam is fixed at each end thereof such as at **62** and **63** to the central body portion **26** of the rotor **23**. As is further seen the central body portion **26** of the rotor **23** has a smaller diameter in the area of the beam **37**, such as is illustrated by the surface **64** thereof. There is thusly formed a slot **65**

between the central body portion and the resiliently deformable beam **38**. The slot **65** provides space within which the beam can move as the rotor is rotated. For example, assuming that the rotor occupies the position illustrated in FIG. 3 and it is desirable to change the switch position and that a movement will be made of the rotor in a clockwise direction. Under these circumstances the detent member **38** leaves the position illustrated between the detent cams **53** and **54** and travels over the detent cam **54** into a position between the detent cams **54** and **55** wherein it will be indexed to the next successive position in a clockwise direction. As the rotor is thus moved from one position to the next position of the switch, the resiliently deformable beam is moved radially inwardly as the detent member **38** passes over the detent cam **54**. A similar operation occurs with respect to the beam **27** and the detent member **28** as it passes over the detent cam **59**.

The particular construction of the rotor and the manner in which the electrical contact members are affixed thereto may be further ascertained from FIG. 4 to which reference is hereby made. As is illustrated in FIG. 4, the central body portion **26** of the rotor **23** contains a plurality of platforms **71** through **74** each having a tab **75** through **78** respectively extending outwardly therefrom. Each of the tabs **75** through **78** is adapted to receive an opening provided within the movable contact element. After the movable contact element is thus positioned upon one of the tabs **75** through **78**, heat and pressure may be applied to the tab causing it to deform and thus rigidly affix the movable contact member to the underside of the rotor. As is illustrated in FIG. 4 a plurality of contact elements may be affixed to a rotor if such is desired. For example, if a single pole switch is to be constructed a contact element would be affixed to the tab **77**, if a two pole switch is to be constructed then contact elements would be affixed to tabs **75** and **77**, since they are positioned upon the rotor 180° apart. In the event, however, that a three pole switch is desired movable contact elements would be affixed to tabs **76**, **77** and **78** respectively since these are positioned 120° apart, thus leaving tab **75** vacant under these conditions.

It should also be noted that the stop **35** positioned upon the rotor is vertically displaced upwardly from the detents **28** and **38**. Thus, by reference to FIGS. 2 and 3 it can be seen that the detent cams **51** through **60** operate either as detent cams or as a stop member depending upon the vertical height thereof along the side wall **14**. For example, the stop **36** which cooperates with the stop member **35** as illustrated in FIG. 2 extends upwardly substantially the entire distance along the side wall **14** while on the other hand, the detent cam such as illustrated at **41** in FIG. 2 extends only upwardly in a vertical direction to a distance substantially the same as the height of the detent **38**. It should thus become clear that a plurality of stops may be utilized along with a similar plurality of detents in accordance with any given switch construction desired for a particular application depending upon whether a single pole, a double pole or a triple pole switch is desired and whether stops will be utilized or whether the operation will be continuous in a rotary fashion.

Referirng now to FIG. 5, an alternative embodiment of a unitized rotor constructed in accordance with the present invention is illustrated. As is therein shown the structure of the rotor is similar in all features with the exception that the resiliently deformable beam members **81** and **82** are affixed only at one end thereof such as at **83** and **84** respectively and are thus cantilevered from the central body portion **85** of the rotor mechanism. It should thus become clear that any particular structure of the resiliently deformable beams which is desired may be utilized without departing from the spirit or scope of the present invention.

By reference to FIG. 6, the particular configuration of the movable contact element may be more fully realized. As is therein shown, the electrical contact portion of the movable contact element is illustrated at **91** and has a forwardly extending portion **92** and a rearwardly extending portion **93**. A connector arm **94** extends from the contact portion of the contact element to a mounting portion **95** thereof which has an opening **96** provided therein. As is shown, mounting portion **95** is bent about a line **97** thereof in order to conform to the mounting tabs **75** through **78** as shown in FIG. 4 formed upon the bottom side of the rotor mechanism. It should be noted that the arm **94** is connected to the electrical contact portion **91** of the movable contact element at a point closer to the rear section **93** thereof than to the forward section **92**. It is in this manner that the operation described in conjunction with FIG. 2 hereinabove is obtained. Although a movable contact element in the configuration illustrated in FIG. 6 and above described provides excellent operating features not heretofore present in prior art devices, it should be expressly understood that various geometrical configurations of electrical contact elements may be utilized in conjunction with the remainder of the structure of a switch in accordance with the present invention without departing from the spirit or scope thereof.

There has thus been disclosed a multi-position rotary switch in various embodiments. Although these various embodiments have been illustrated and described in some detail, such detailed description and illustration is for purposes of example only and shall not be taken as a limitation upon the scope of the claims which define the invention and which are appended hereto.

What is claimed is:

1. A miniature rotary switch comprising:

(A) housing means defining a cavity and including
  (1) a base having a plurality of stationary contacts thereon,
  (2) a side wall having inwardly directed detent cams, and
  (3) a cover defining an opening therethrough,

(B) unitary rotor means centrally positioned within said cavity and formed of electrically non-conductive molded plastic material, said unitary rotor means including
  (1) a central body portion having a shaft extending through said cover for actuation thereof,
  (2) a resiliently deformable beam affixed at each end to said central body portion and having a radially outwardly extending thickened portion forming a detent, said detent extending into engagement with said detent cams, and
  (3) a plurality of pad means extending outwardly from said central body portion;

(C) a movable electrical contact member secured to one of said pad means and extending into engagement with said stationary contacts.

2. A switch as defined in claim **1** in which said rotor is sandwiched between and engaged by said cover and said base and said cover includes sealing gland means received by said rotor for effecting a seal from the atmosphere about said shaft.

3. A switch as defined in claim **1** which further includes a stationary common ring contact positioned radially inwardly of said plurality of stationary contacts, said movable electrical contact having a contact portion with the outward section thereof in contact with a stationary contact and the inward section thereof in contact with said common ring contact, an actuating cam on said base between said stationary and common contacts and arranged to engage said contact portion closer to the inward section thereof, whereby a fast movement of said outward portion out of contact with said stationary contact is effeced upon movement of said shaft.

4. A switch as defined in claim **1** in which there are at least four of said pad means, three of said pad means

being spaced 120° apart and 2 of said pad means being diametrically opposed.

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