

[54] **OPERATING MEANS FOR HERMETICALLY SEALED DOUBLE-THROW DOUBLE-POLE SWITCH**

[75] Inventor: **Joseph LaRue Lockard**, Harrisburg, Pa.

[73] Assignee: **AMP Incorporated**, Harrisburg, Pa.

[22] Filed: **Feb. 27, 1974**

[21] Appl. No.: **446,260**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 364,779, May 29, 1973, abandoned, which is a continuation-in-part of Ser. No. 325,480, Jan. 22, 1973, abandoned.

[52] U.S. Cl. **200/16 D, 200/16 R, 200/17 R, 200/153 L, 200/291, 200/302, 200/303, 200/329, 200/336, 200/339**

[51] Int. Cl. **H01h 15/06, H01h 3/32**

[58] Field of Search **200/16 R, 16 C, 16 D, 16 F, 200/17 R, 18, 153 P, 158, 302, 303, 324, 330, 332, 335-337, 339, 291, 153 L**

[56] **References Cited**

UNITED STATES PATENTS

2,686,851	8/1954	Sanda	200/16 D
3,196,223	7/1965	Hartsock	200/18 X
3,223,791	12/1965	Wanlass	200/16 D X

3,482,064	12/1969	Osika	200/16 D
3,501,599	3/1970	Horecky	200/16 D
3,512,113	5/1970	Kirkendall	200/303 X
3,592,982	7/1971	Deltoer	200/158 UX
3,614,346	10/1971	Gudaitis	200/16 D
3,639,706	2/1972	Purdy	200/153 P X

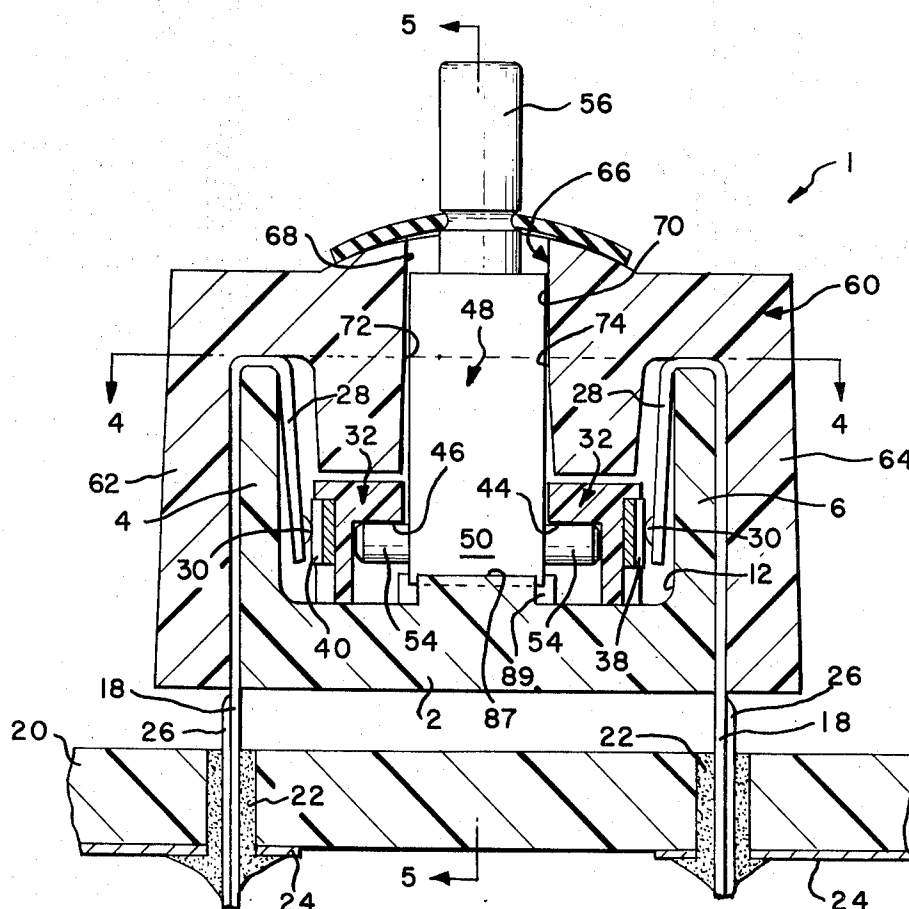
Primary Examiner—James R. Scott

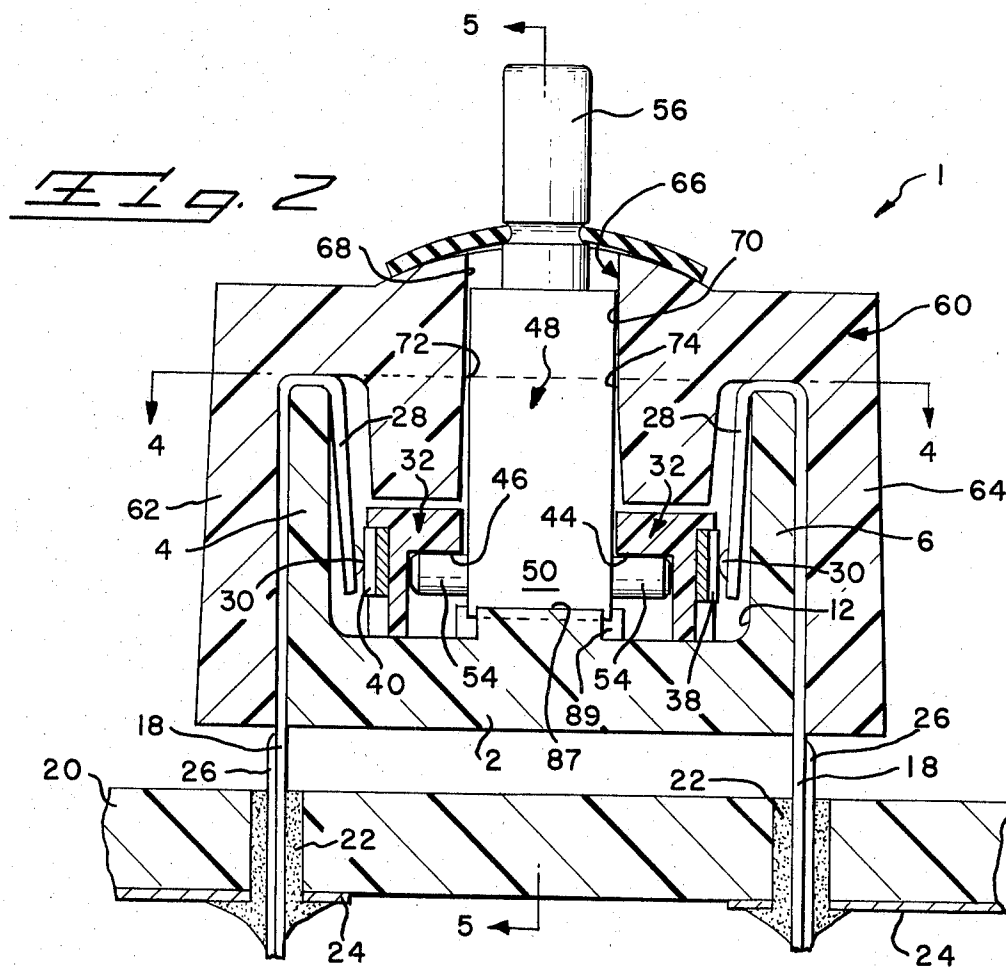
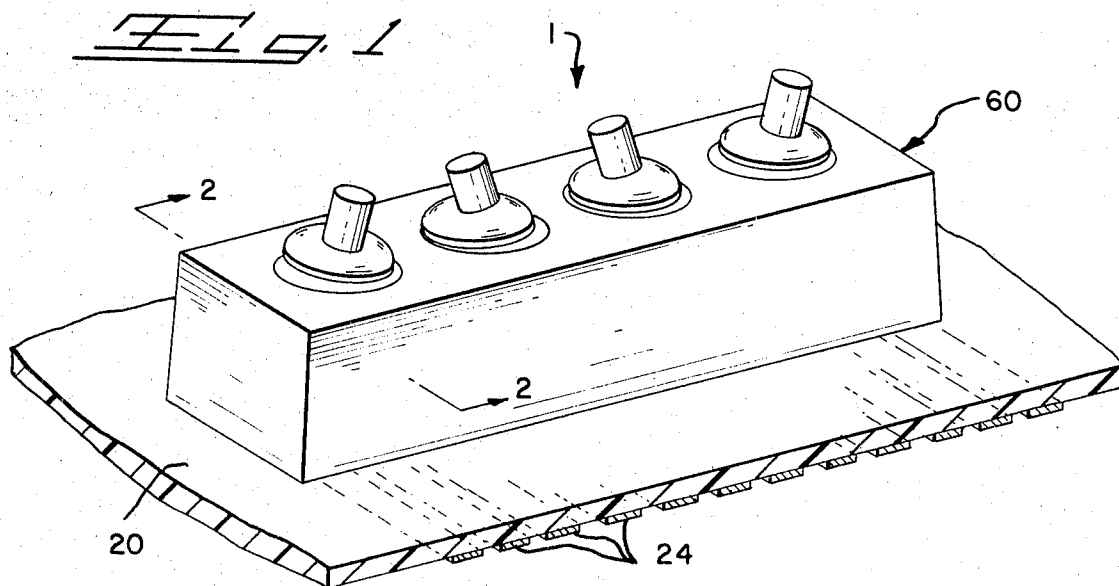
Attorney, Agent, or Firm—Gerald K. Kita

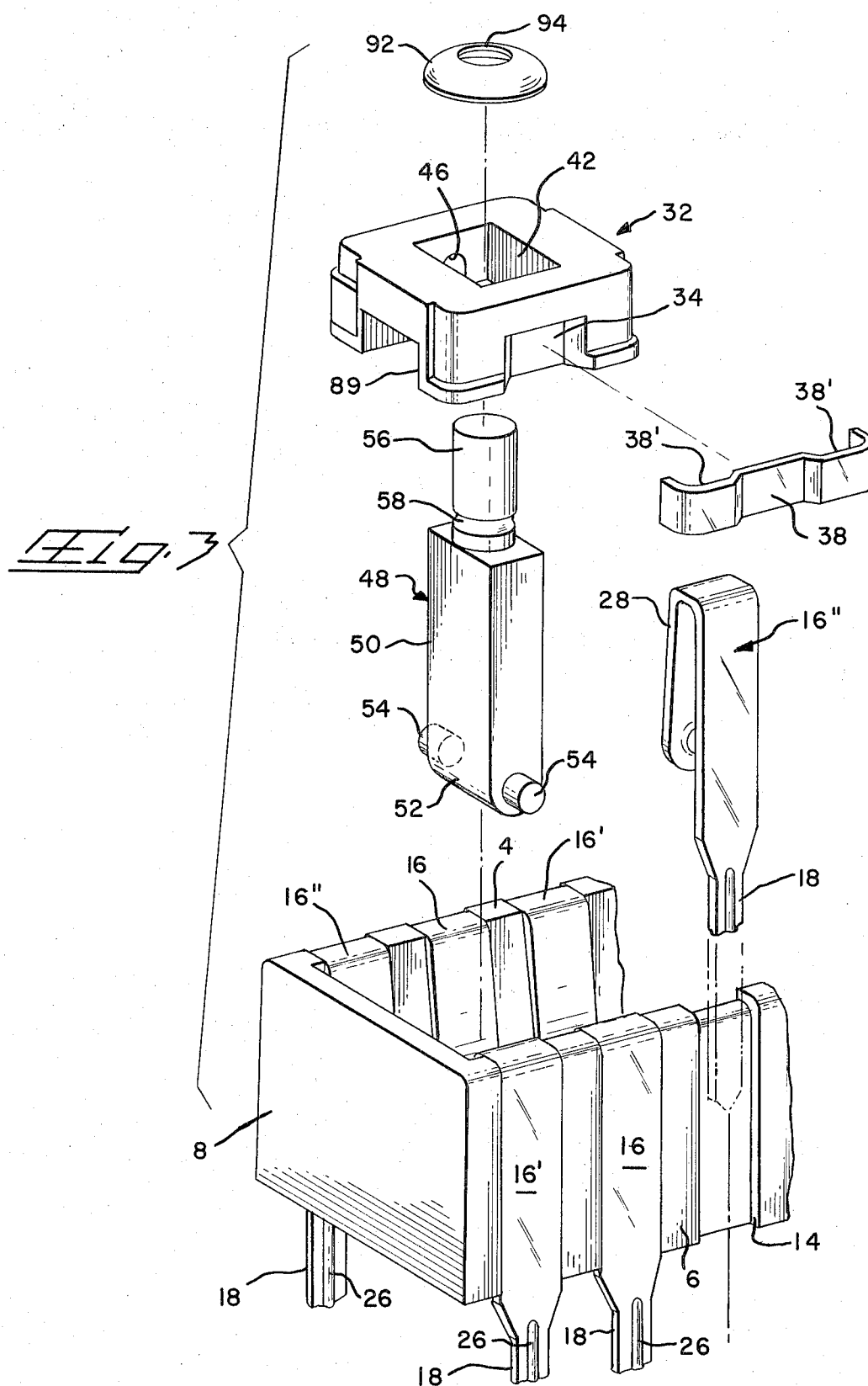
[57] **ABSTRACT**

The present invention relates to a double-throw double-pole switch the design of which requires but a minimum number of parts and a minimum requirement for fasteners, adhesives and the like thereby facilitating ease in manufacture. The switch is additionally well adapted for miniaturization in the form of a microelectronic component known as dual-in-line package (DIP). The poles of the switch are in the form of electrical contacts aligned to provide the well-known opposed pairs of electrical leads for the DIP. A lever or cam for actuating the switch is assembled without the need for conventional fasteners, such as screws or adhesives and the like, thereby permitting rapid manufacture of the switch without the time consumption and skill otherwise required for assembly using such conventional fasteners.

15 Claims, 16 Drawing Figures







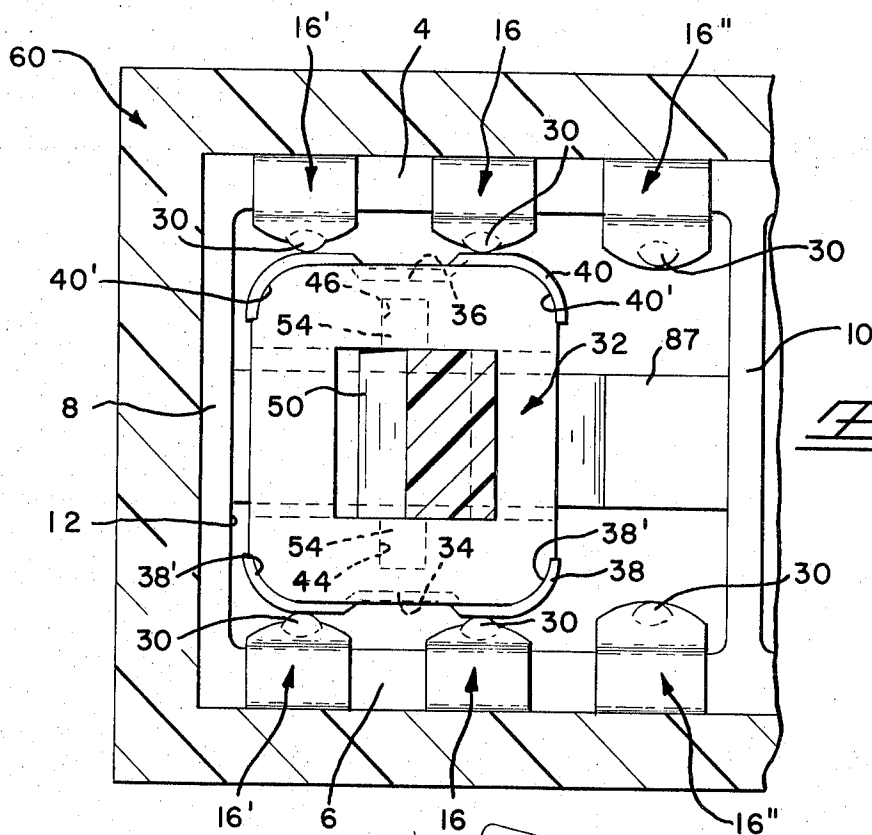


Fig. 4

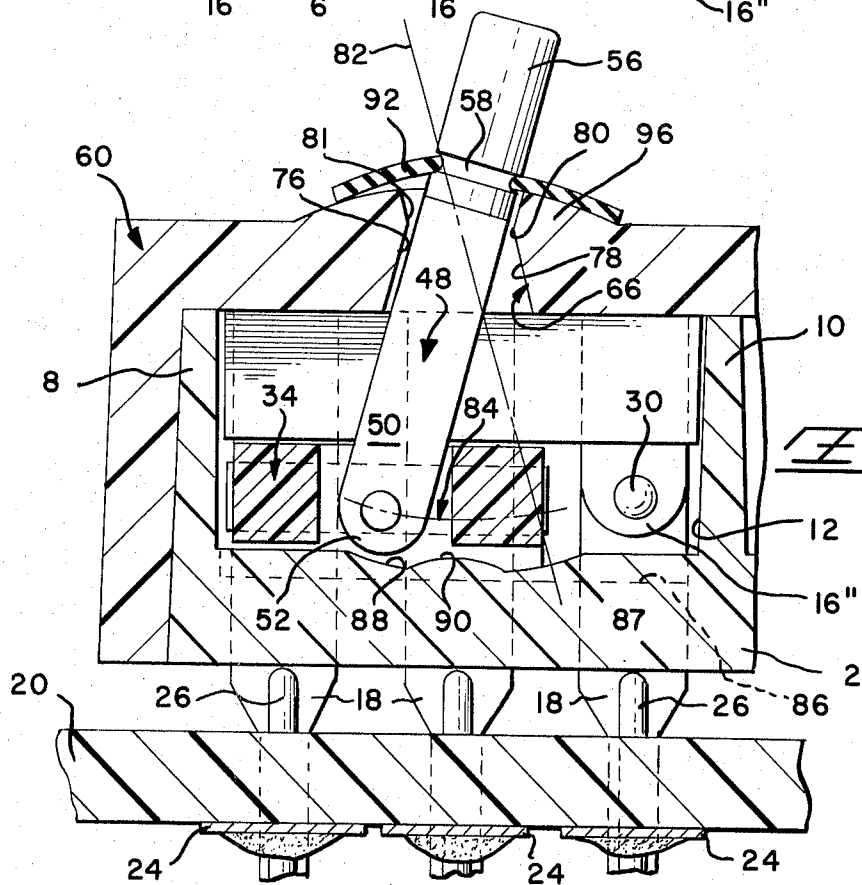
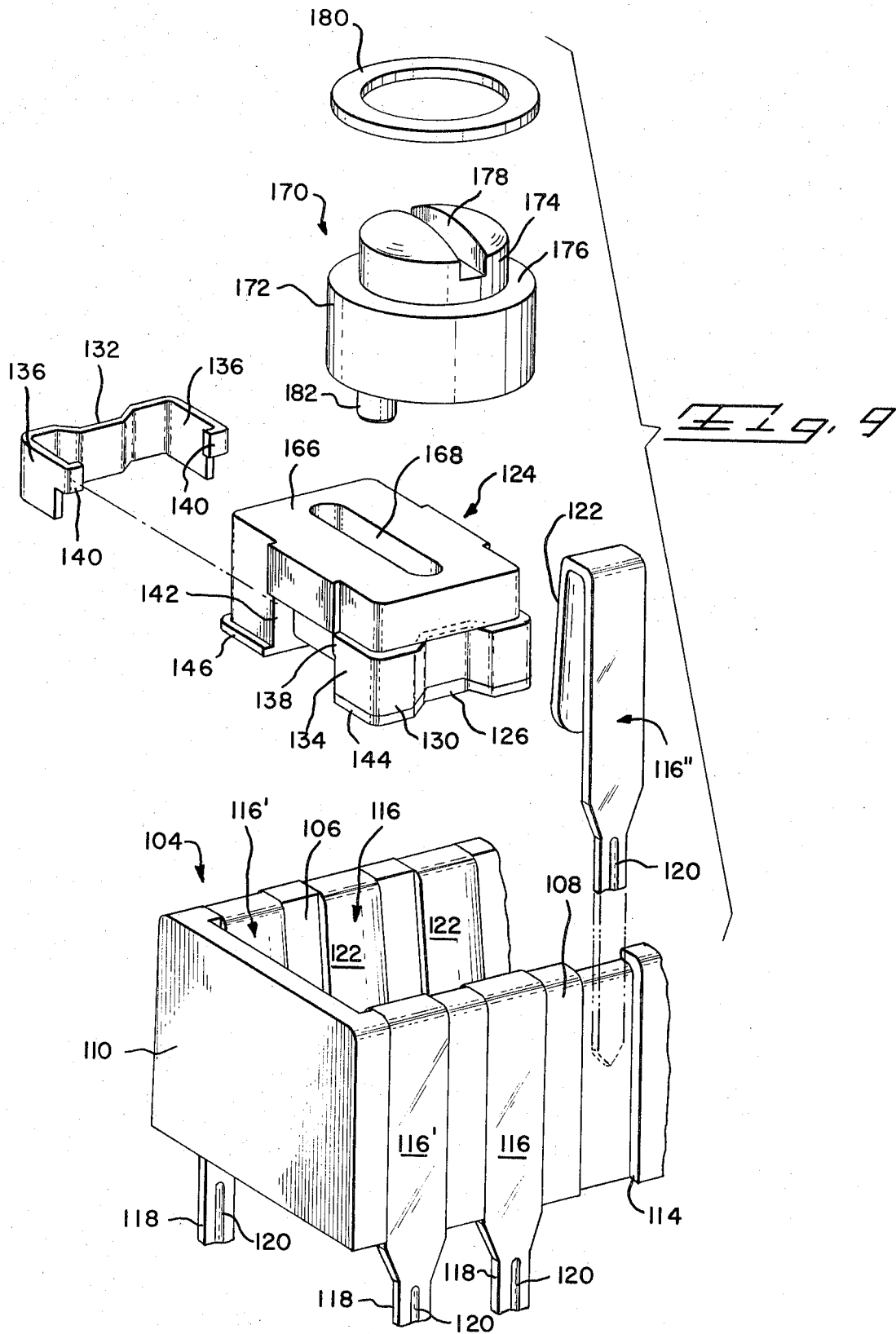
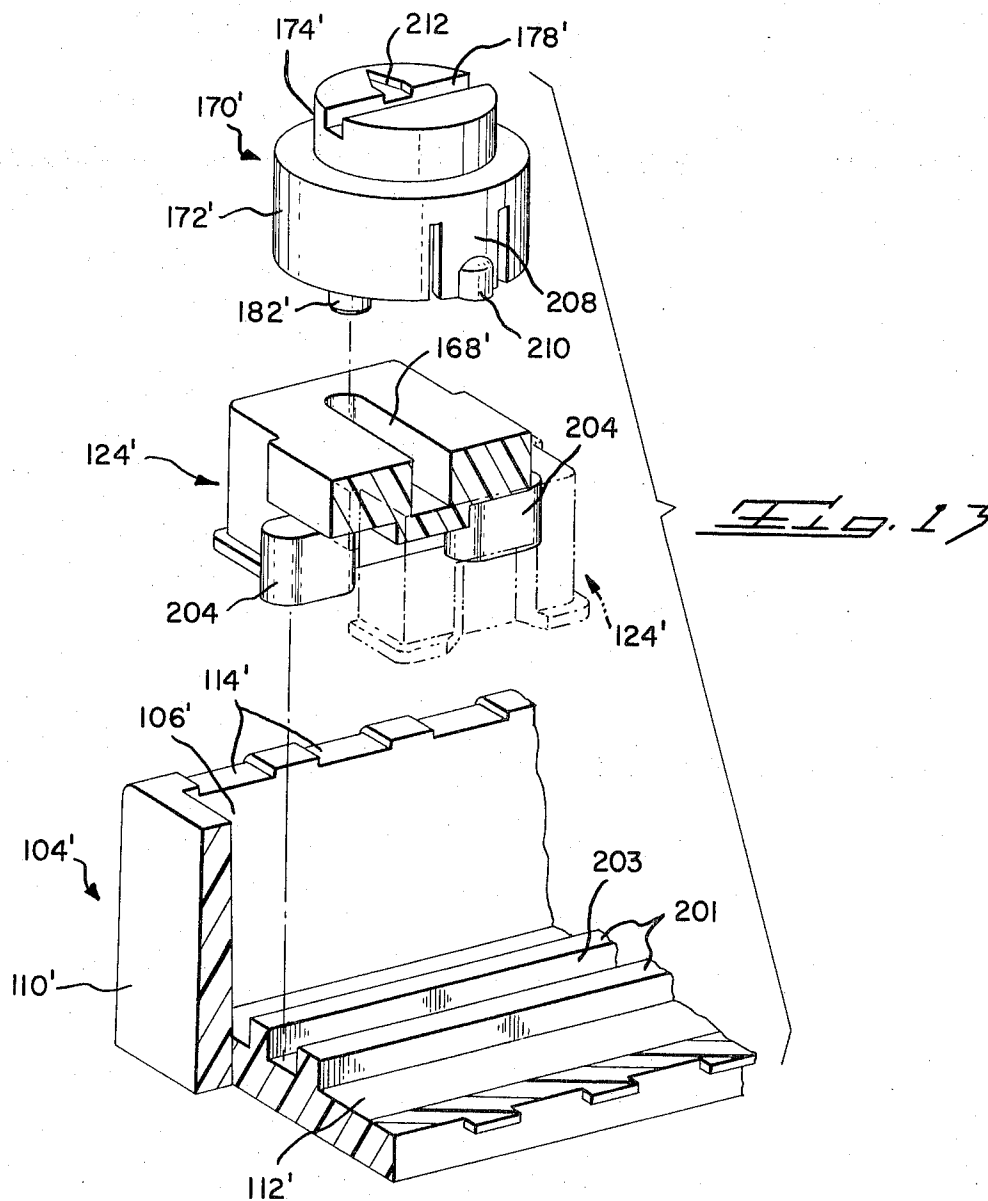


Fig. 5





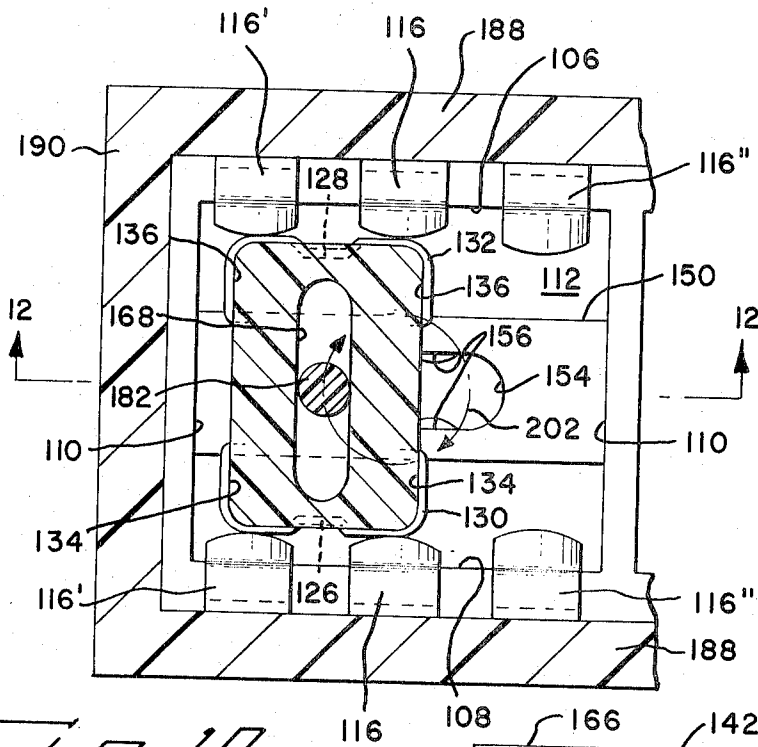


Fig. 10

Fig. 11

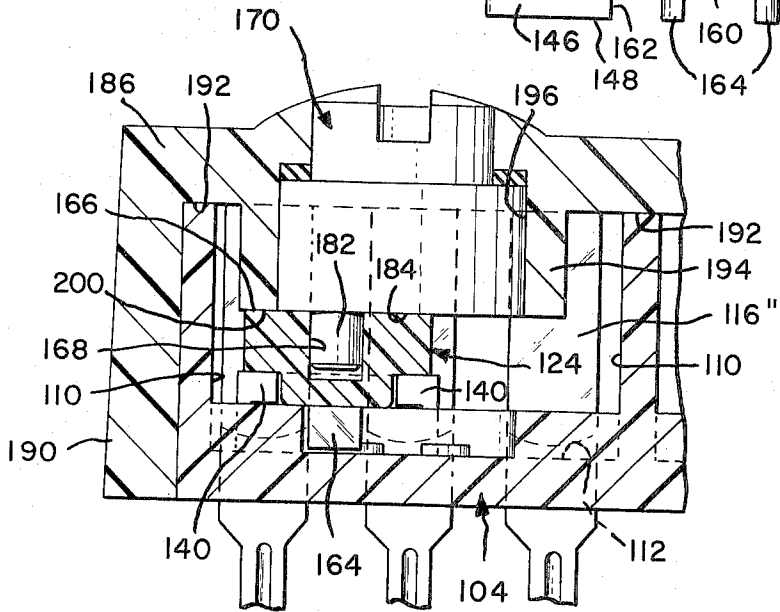
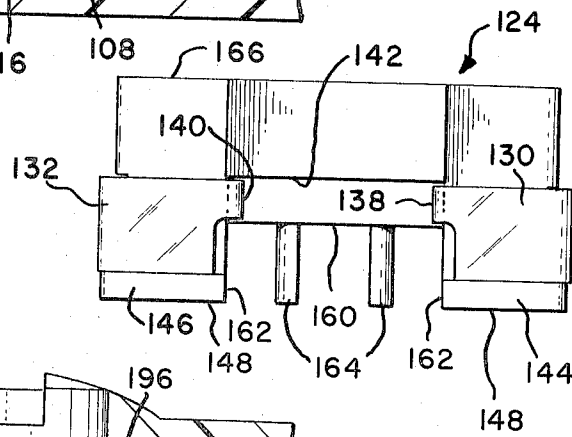


Fig. 12

Fig. 6

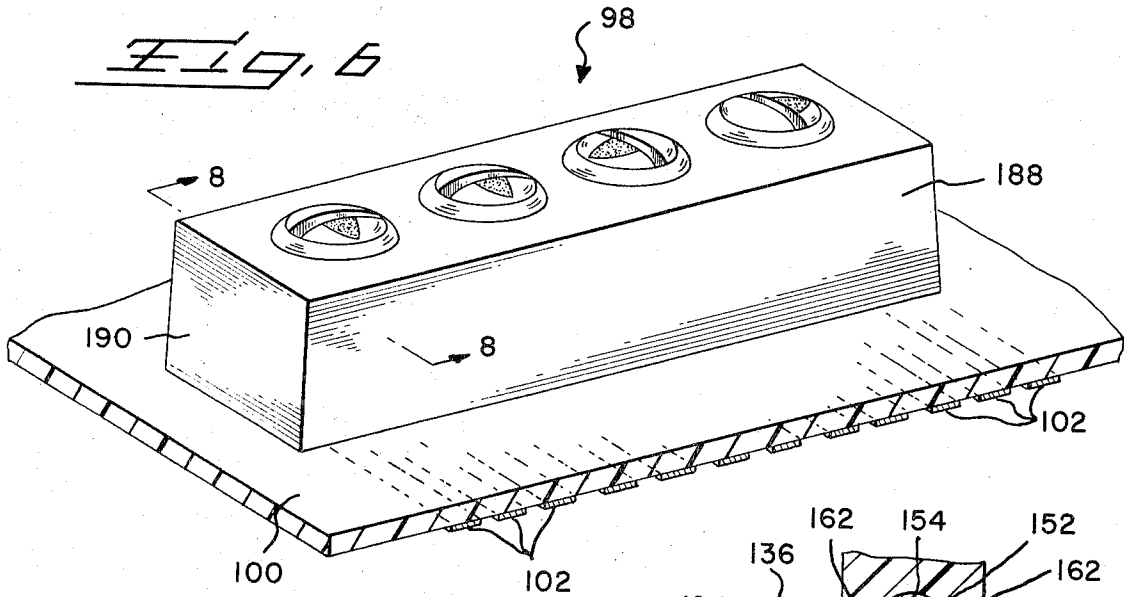


Fig. 7

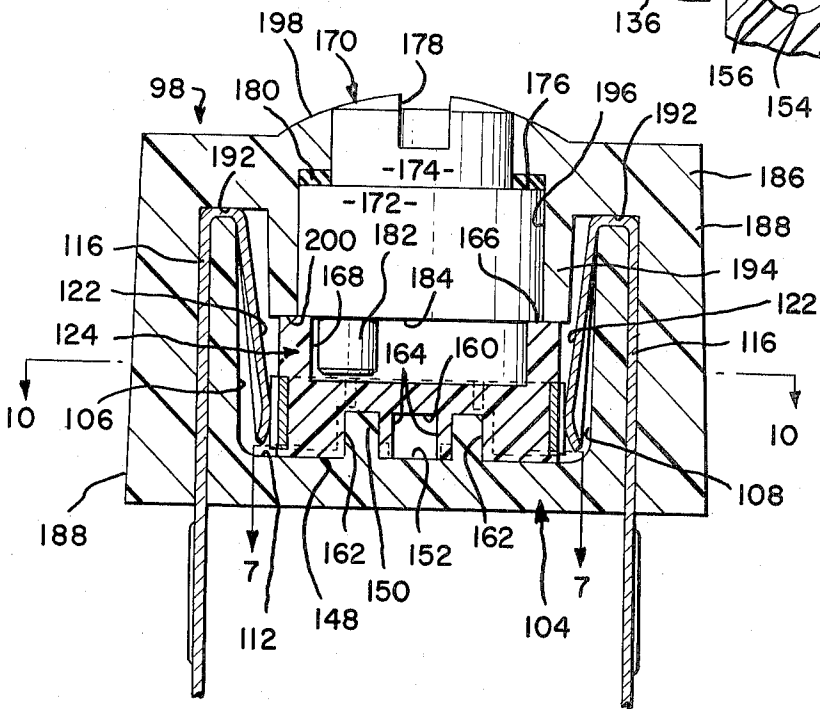
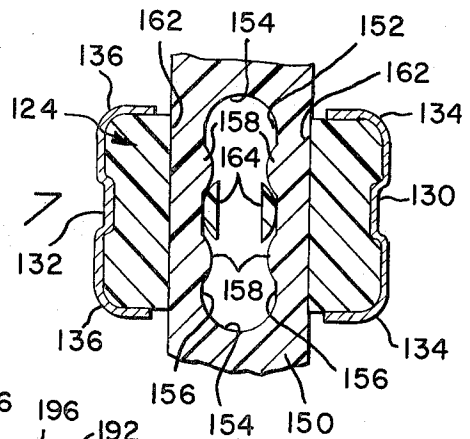


Fig. 8

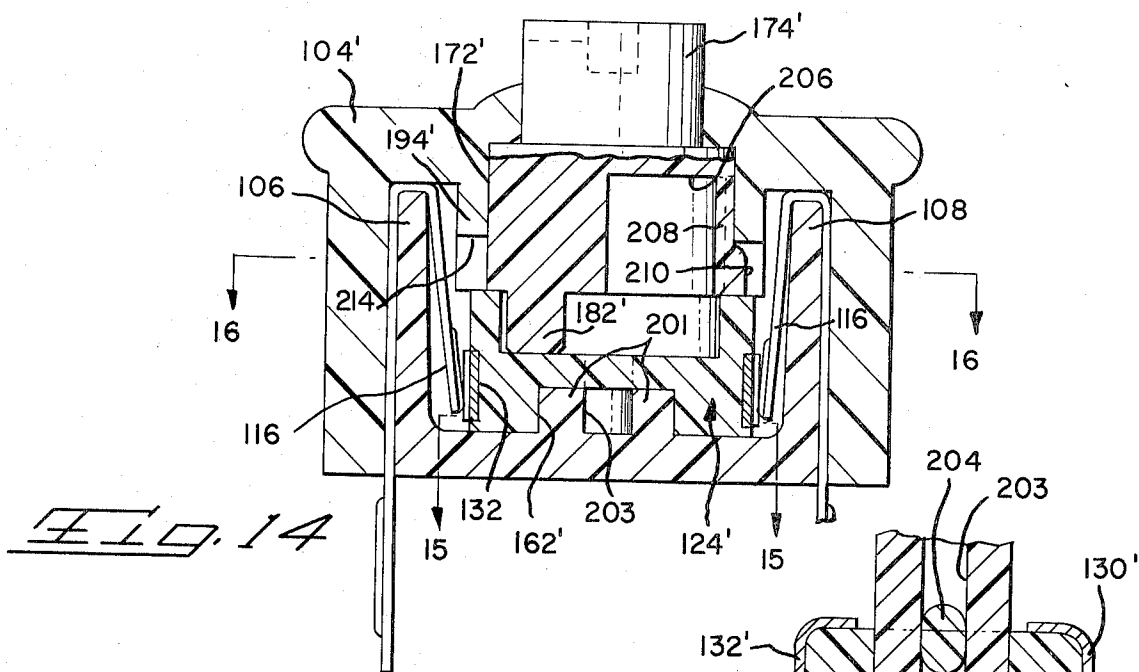
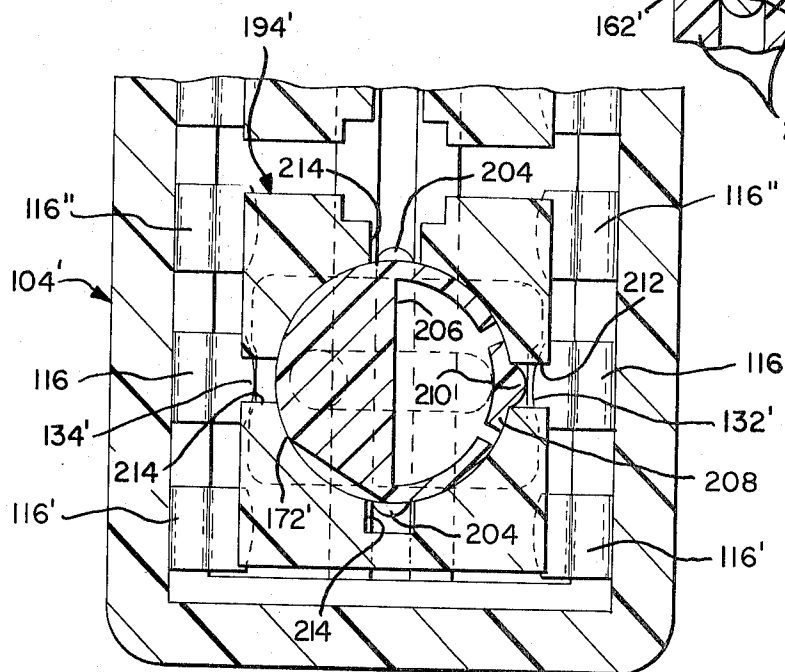
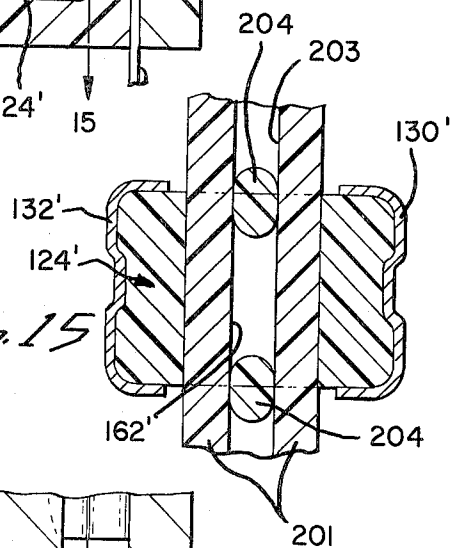


FIG. 15



OPERATING MEANS FOR HERMETICALLY SEALED DOUBLE-THROW DOUBLE-POLE SWITCH

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part application of Ser. No. 364,779, filed May 29, 1973, and now abandoned, which is a continuation-in-part of application Ser. No. 325,480, filed Jan. 22, 1973, and now abandoned. The present invention relates to a double-throw double-pole switch the design of which requires but a minimum number of parts and a minimum requirement for fasteners, adhesives and the like thereby facilitating ease in manufacture. The switch is additionally well adapted for miniaturization in the form of a microelectronic component known as a dual-in-line package (DIP). The poles of the switch are in the form of electrical contacts aligned to provide the well-known opposed pairs of electrical leads for the DIP. A lever or cam for actuating the switch is assembled without the need for conventional fasteners, such as screws or adhesives and the like, thereby permitting rapid manufacture of the switch without the time consumption and skill otherwise required for assembly using such conventional fasteners.

As a further feature of the present invention, the switch includes a carriage which is slidably displaceable internally of the switch. The carriage includes electrical contacts for bridging between selected contacts to complete corresponding electrical circuits in the familiar double-throw double-pole switch operation. The housing for the carriage and contacts which is in the form of a DIP package receives the switch actuating lever of one embodiment through an aperture provided in the housing. The housing portion which encircles the lever is utilized as a fulcrum against which the lever is pivoted in order to actuate the switch carriage and thereby either complete or interrupt the aforementioned electrical circuits. A rubber grommet is applied over the lever portion which protrudes through the housing to provide a dust cover for covering the aperture which receives the lever therethrough. In addition the housing is provided with a projection internally thereof over which the lever is forced to engage and slidably traverse. Accordingly such a projection provides some frictional resistance to pivotal motion of the lever as the lever is traversed thereover. Once the lever is pivoted to either of two fully pivoted positions which cause either completion or interruption of the double-pole double-throw circuits through the switch, the lever will become disengaged from the projection, with the projection serving therefore to latch the lever in such fully pivoted positions and prevent unwanted movement of the lever in the absence of forces applied thereto, which forces are required to operate the lever.

According to another preferred embodiment of the present invention the lever is replaced by a stepped cylindrical cam element which is rotatable about its cylindrical axis. The stepped cam element advantageously receives a sealing ring thereover to seal the interior of the switch. A short dowel or shaft depends from the cam element and is offset from the axis of rotation such that as the cam element is rotated the dowel or shaft is pivoted through a circular arc. The dowel or shaft is received in a transverse slot of the carriage, whereby the

carriage is slidably displaced as the dowel is rotated through its arc of displacement. The cam element is capable of 360° rotation and can never be overstressed or broken during actuation thereof.

In either of the embodiments, the base and cover latch together with large surface areas of abutting surfaces to provide seals preventing the flow of contaminants into the switch.

Accordingly, it is an object of the present invention to provide a double-throw double-pole switch capable of miniaturization into a DIP package, with the electrical poles of the switch arranged to provide depending electrical leads for the DIP.

Another object of the present invention is to provide a double-throw double-pole switch in the form of a DIP package with the electrical poles of the switch providing depending electrical leads for the DIP package, the switch further including a carriage which is slidably displaceable internally of the switch and a lever pivotally connected to the carriage and protruding from the housing, which lever is pivoted to first and second positions for either interrupting or completing the electrical circuits through the poles of the switch, and wherein the housing is provided with a projection over which the lever is slidably traversed in order to latch the lever in its first and second positions in the absence of forces applied to the lever.

Another object of the present invention is to provide a double-throw double-pole switch wherein the electrical poles of the switch provide externally protruding electrical leads for the switch, and wherein the electrical circuits through the poles are either interrupted or completed by pivoting a lever to either of two positions, thereby causing a carriage containing electrical bridging contacts to be slidably displaced internally of the switch, with the electrical contacts thereof either bridging between selected poles to complete the electrical circuits through the switch, the lever being pivotally connected to the carriage without the need for conventional fasteners or adhesives.

Another object of the present invention is to provide a double-throw double-pole switch containing a housing, a plurality of contacts in the housing providing the switch poles, a slidable carriage having electrical contacts bridging between selected electrical poles to complete electrical circuits through the switch, a lever pivotally connected to the carriage and pivotally displaceable to either of two positions for interrupting or completing the electrical circuits, and with the lever protruding through a housing containing the switch with a portion of the housing encircling the lever to provide a fulcrum over which the lever is pivoted to slidably displace the carriage.

Another object of the present invention is to provide a switch of miniature size adapted for mounting on a printed circuit board wherein the component parts of the switch are assembled to provide overlapping seams having relatively long barrier paths sealing the interior of the switch from solder flow and other types of contaminate flow.

Another object of the present invention is to provide a miniature switch for mounting on a printed circuit board, wherein the interior of the switch is substantially sealed to permit immersion of the switch together with the printed circuit board in cleaning solutions and to prevent all additional types of contaminants from entering the switch.

Another object of the present invention is to provide a double-throw double-pole switch containing a housing, a plurality of contacts in the housing providing the switch pole, a slidable carriage having electrical contacts bridging between selected electrical poles to complete electrical circuits to the switch, a stepped cylindrical cam element which is advantageously sealed to the cover of the housing, an offset dowel or shaft on the cam element which is displaceable through an arc upon rotation of the cam element, and the carriage being provided with a transverse slot receiving the dowel therein, such that the carriage is displaceable along a linear axis upon displacement of the dowel about a curvilinear path when the cam element is rotated about 360° of arcuate displacement.

Another object of the present invention is to provide a switch having a displaceable carriage actuated by a cam element which is capable of 360° rotation without breakage, which cam element causes back and forth displacement of the carriage during such 360° rotation.

Other objects and many attendant advantages of the present invention will become apparent upon perusal of the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an enlarged fragmentary perspective of a preferred embodiment of the present invention illustrating a plurality of double-throw double-pole switches according to the present invention arranged in a DIP package mounted on a circuit board;

FIG. 2 is an enlarged fragmentary section taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary perspective of the switch illustrated in FIG. 1 with certain of the component parts thereof illustrated in exploded configuration to illustrate the details thereof;

FIG. 4 is an enlarged fragmentary section taken along the line 4—4 of FIG. 2;

FIG. 5 is an enlarged fragmentary section taken along the line 5—5 of FIG. 2;

FIG. 6 is an enlarged fragmentary perspective of another preferred embodiment according to the present invention;

FIG. 7 is a fragmentary enlarged section taken along the line 7—7 of FIG. 8;

FIG. 8 is an enlarged section of the switch taken along the lines 8—8 of FIG. 6;

FIG. 9 is a fragmentary enlarged perspective of the preferred embodiment illustrated in FIG. 8 with the component parts thereof in exploded configuration to illustrate the details thereof;

FIG. 10 is a fragmentary enlarged section taken along the lines 10—10 of FIG. 8;

FIG. 11 is an enlarged plan of a carriage component part of the preferred embodiment illustrated in FIG. 9; and

FIG. 12 is an enlarged section taken along the lines 12—12 of FIG. 10.

FIG. 13 is an enlarged fragmentary perspective with parts broken away and with parts in section to illustrate the details thereof of a preferred embodiment according to the present invention;

FIG. 14 is an enlarged fragmentary section of an assembled switch embodiment disclosed in FIG. 13;

FIG. 15 is an enlarged section taken along the line 15—15 of FIG. 14; and

FIG. 16 is an enlarged fragmentary section taken along line 16—16 of FIG. 14.

With more particular reference to the drawings there is illustrated in FIG. 1 generally at 1 a switch according to the present invention. As shown in FIGS. 1, 2, and 5 the switch is provided with a base 2 of dielectric material having integral projecting sidewall portions 4 and 6 giving the base a generally channel shaped configuration extending in an elongated direction. The base further includes a plurality of spaced partitions generally bridging between the sidewall portions 4 and 6, with two of the partitions being illustrated at 8 and 10 in FIGS. 4 and 5. Accordingly the sidewalls and each pair of partitions of the base cooperate to provide an interior compartment, an exemplary one of which is illustrated at 12. Each of the compartments contains therein a double-throw double-pole switch according to the present invention, it being understood that either one or a plurality of switches may be fabricated according to the present invention with a corresponding one or a plurality of compartments being fabricated on the base to correspond with the number of switches desired.

As more particularly shown in FIGS. 2 and 3, the outer surfaces of sidewalls 4 and 6 are provided with a plurality of spaced generally parallel grooves, one of which is shown at 14 in FIG. 3. Each of the grooves receives therein a corresponding resilient metal spring 16, 16' or 16''. Each of the springs 16, 16' or 16'' is generally of elongated metal strip form received internally of a corresponding groove 14, as shown more particularly in FIG. 3. The grooves accordingly space the springs 16, 16' and 16'' in aligned spaced relationship along the sidewalls 4 and 6 of the base. Each of the springs has an end portion 18 protruding from the base 2 to form depending electrically conducting leads or terminals for external connection to a printed circuit board 20. The aligned springs 16, 16' and 16'' thereby form electrical contacts with depending terminals or electrical leads 18 which are also aligned along the sidewalls 4 and 6 of the base. The spacings between the aligned leads correspond with the spacings between apertures 22 of the printed circuit board 20 into which the leads 18 are inserted. In the usual manner, well-known in the prior art, the apertures 22 of the printed circuit board 20 are lined with plating, with solder filled into the plating lined apertures to form solder joints between the plating lined apertures and the electrical leads 18. The plating lined apertures then mechanically and electrically support the leads or terminals 18. Customarily the printed circuit board is provided with a plurality of circuit paths thereon, some of which are illustrated at 24, which are joined electrically to the solder joints to thereby connect the electrical leads or terminals 18 with corresponding conductor paths on the printed circuit board. As shown, each of the depending electrical leads or terminals 18 may be formed with a flute 26 which performs the functions of stiffening the leads 18, to resist bending and misalignment, and providing a channel shaped groove on one side of the lead, which allows solder to flow therealong and to be wicked therealong in the well-known wicking behavior of molten solder, and on the other side of the lead providing an outwardly bulged configuration, to render an apparent increase in thickness of the lead which substantially fills the clearance between the aperture 22

and the lead which is relatively thin in thickness except for the outwardly bulged flute portion 26 thereof.

Again with reference to FIGS. 2 and 3, taken in conjunction with FIGS. 4 and 5, the other end 28 of each spring or contact 16, 16' and 16'' is generally of inverted U-shape to provide a reversely curved portion to overlie the corresponding sidewall 4 or 6 and to project generally into the corresponding internal cavity 12 defined between the sidewalls 4 and 6. Adjacent one of the terminal ends of each spring or contact is provided a protruding arcuate button or projection 30 to provide an arcuate electrical contact surface as will be explained hereinafter. As shown in FIG. 2, the end portions 28 of the springs generally project into the cavity 12 and in diagonal diverging relationship with the corresponding sidewalls 4 and 6. This permits the spring portions 28 to be resiliently deflected in resilient spring fashion and in cantilever motion from its diverging relationship toward the corresponding sidewalls 4 and 6 as will be explained hereinafter.

With more particular reference to FIGS. 2 - 5, there is illustrated a carriage generally at 32. The carriage 32 is of dielectric material and is generally of rectangular block configuration. Each side of the block has a corresponding recess 34 or 36 on the external surface thereof. Each side further is provided thereon with an electrical conductor strip of resilient spring metal 38 or 40. The two conductor strips form spring contacts which are provided at the ends thereof with corresponding generally laterally formed U-shaped portions 38' and 40'. Each of the spring contacts 38 and 40 is assembled to a corresponding side of the block with the ends 38' and 40' partially encircling the ends of the block as shown in FIGS. 3 and 4. The U-shaped portions 38' and 40' thereby resiliently grip onto the periphery of the carriage 32 by resilient spring action. Since the contacts 38 and 40 are of resilient spring material, no additional fasteners are required, the resilient nature of the contacts thereby resiliently gripping on the outer periphery of the carriage 32 without the need for additional fasteners. As a further feature of the present invention, the carriage 32 is provided with a generally central aperture 42 generally of rectangular configuration. Two of the opposed inner sides of the carriage which define the aperture 42 are provided with generally inverted grooves 44 and 46 each of which terminates into a rounded arcuate end portion as more particularly shown in FIGS. 2 - 4. The aperture 42 receives therethrough an elongated lever generally illustrated at 48 fabricated of dielectric material and having an enlarged central portion 50 which is generally rectangular in cross section, with one end of the portion 50 being generally rounded at 52. Adjacent to the rounded end 52 are provided a pair of outwardly projecting arcuate dowel portions 54. For example, the dowel portions 54 may be molded integrally with the portion 50 of the lever, or, in the alternative, a single hole may be drilled through the lever and provided with a single dowel which projects on either side of the lever 50 to provide the protruding dowel portions 54. The other end of the lever 48 is provided with a generally cylindrical knob 56 having a groove 58 in the circular or cylindrical periphery thereof.

As shown in the figures, the lever 48 is received freely through the aperture 42 of the carriage 32, with the dowel portions 54 in registration within corresponding rounded ends of the grooves 44 and 46. The

lever 50 is thereby pivotally mounted to the carriage 32 without the need for additional fasteners or adhesives. The dowel portions 54 are aligned with respect to each other and are captured for rotation in the rounded ends of the grooves 44 and 46 to provide a pivotal connection between the carriage and lever. So long as the dowel portions 54 remain in the corresponding grooves 44 and 46, the lever will be properly assembled to the carriage.

As more particularly shown in FIGS. 2 and 4, the carriage together with the lever assembled thereto as described is placed into a corresponding cavity 12. As shown, each desired cavity 12 is provided therein with three aligned contacts 16, 16' and 16'' along each of the sidewalls 4 and 6. In the position shown in FIG. 4 the carriage 32 is disposed so that its conductor strip or contact 38 bridges between two selected contacts 16 and 16' on the wall 6, and the conductor strip or contact 40 bridges between two selected contacts 16 and 16' on the sidewall 4. As shown in FIG. 2, the carriage 32 is wedged between the contacts 16 and 16', on the sidewall 6, and the contacts 16 and 16', on the sidewall 4, thereby resiliently deflecting the spring end portions 28 of the contacts by cantilever deflection generally toward the corresponding uprights 4 and 6. Such resilient deflection assures a pressure engagement of the button portions 30 of the contacts against a corresponding terminal strip or conductor strip 38 or 40 of the carriage. To complete the assembly, a generally inverted box-like cover generally illustrated at 60 is received over the base 2. The cover has sidewalls 62 and 64 which are received over the corresponding sidewalls 4 and 6 with the springs or contacts 16 being received between the cover and base thereby to retain the contacts in place. The cover is generally made from a dielectric material which has some inherent spring resiliency so that the cover may be force-fitted over the base. The base and cover may therefore be attached without the need for separate fasteners or adhesives or the like. As shown, the lever 48 is received through an aperture 66 provided in the cover. As shown more particularly in FIGS. 2 and 5, the lever 48 is generally freely received through the aperture 66. As shown in FIG. 2 the aperture 66 has a pair of opposed sidewalls 68 and 70 which are outwardly flared at each of their open ends in a slight hourglass configuration forming opposed projecting portions 72 and 74 defining a slightly narrowed neck receiving the portion 50 of the lever therethrough. By providing the reduced necked portion, the possibility of frictional abrasion of the lever against the sidewalls 68 and 70 is reduced to abrasion only in the narrowed necked portion 72 and 74. As shown in FIG. 5, the aperture 66 has a pair of opposed sidewalls 76 and 78 which are outwardly flared at both the open ends of the aperture 66 to provide a generally hourglass shape to the aperture. With the carriage 32 in the position shown in FIGS. 4 and 5, the lever 48 projects through the aperture 66 at an incline. For example, the sidewall 78, being outwardly flared at its ends, defines a projecting corner edge 80 at the narrow neck intersection of the flared ends. The edge 80 provides a cover portion serving as a fulcrum against and over which the lever 48 is pivoted to slidably displace the carriage 32 to a first position as shown in FIGS. 4 and 5. In such a position the lever 48 will be disposed at an angle projecting through the aperture 66 as shown in FIGS. 4 and 5. The carriage 32 will have its contact

or conductor strip 38 engaged electrically on corresponding buttons 30 of a selected two of the contacts 16 and 16' which are adjacent to the sidewall 6. Additionally the conductor strip or contact 40 of the carriage will likewise electrically engage corresponding buttons 30 of a selected two of the contacts 16 and 16' which are adjacent to the sidewall 4. Accordingly, the contacts 38 and 40 electrically bridge across selected pairs of adjacent contacts 16 and 16' to complete a corresponding electrical circuit therebetween. Thus with the carriage 32 in the position shown in FIGS. 4 and 5, such a position can be considered a "throw" of the switch and since two electrical circuits are completed between selected pairs of contacts the switch is considered the "double-throw" variety, with the contacts 16 and 16' serving as the electrical "poles" of the switch. The carriage is also compressed between the opposed contacts 16 and also the opposed contacts 16'. Although not shown, the lever 48 may also be pivoted to a second position. More specifically, with reference to FIG. 5, the lever 48, shown in its first position in FIG. 5, may be pivoted against and over a projecting corner edge 81 at the intersection of the flared ends of the aperture sidewall 76 in the cover 60 so as to pivot the lever fully to a second position wherein its elongate centerline lies along the axis indicated at 82. The edge 81 of the sidewall 76 thereby provides a cover portion acting as a fulcrum over which the lever is pivoted to its second position. With the lever in its second position, the carriage 32 is slidably displaced from left to right in FIG. 5. The carriage 32 is thereby displaced internally of the corresponding cavity 12 such that it is interposed between the opposed contacts 16 and also between the opposed contacts 16', at the same time being disengaged from the opposed contacts 16'. Accordingly the respective electrical circuits formed by bridging the conductor strips 38 and 40 between the respective adjacent electrical poles 16 and 16' become interrupted, while at the same time the conductor strips 38 and 40 bridge between the corresponding adjacent pairs of electrical contacts 16 and 16' to complete additional electrical circuits between the bridged contacts 16 and 16'. Thus the carriage is in its second position has its contact or conductor strip 38 bridging between the poles 16 or 16' on the sidewall 6 to complete a first electrical circuit, with the electrical conductor strip 40 bridging between the adjacent contacts 16 and 16' on the sidewall 4 to complete a second electrical circuit. Accordingly, the carriage in its second position serves as the second "throw" for the switch according to the present invention. Since two electrical circuits are completed by the switch, the switch according to the present invention operates as a double-throw double-pole variety, with the contacts 16' serving as the electrical poles of the switch. It should be noted that the conductor strips 38 and 40 engage electrically on the arcuate buttons or projections 30 of the contacts 16, 16' and 16''. The buttons or projections are arcuate so as to reduce the sliding friction of the conductor strips 38 and 40 thereover. Since sliding contact is made between the projections 30 and the conductor strips 38 and 40, such sliding action produces a wiping action which scrub and clean the surfaces of the conductor strips 38 and 40 and the projections 30 to improve the electrical contact therebetween. Since the conductor strips 38 and 40 are continuously maintained in compression between opposed pairs of the contacts or poles

16, 16' and 16'' a pressure contact between each of the projections 30 and the corresponding conductor strips 38 and 40 is always assured. Additionally the conductor strip 38 and 40 are maintained in compression against the periphery of the carriage 32, further obviating the need for fasteners or adhesives therefor.

According to a further feature of the present invention reference will be made particularly to FIG. 5. As shown in the figure, the rounded end portion 52 of the lever 48 is pivotally displaced through an arc generally indicated at 84. The base 2 has an interior bottomwall 86 over which the end portion 52 is pivotally displaced. The bottomwall 86 has a projecting ridge 87 which accordingly is provided with an arcuate recess 88 to provide a clearance for the rounded end 52 as it is slidably displaced over the bottomwall 86 of the base. The recess 88 further is provided with an arcuate projection 90 generally centrally thereof. The ridge 87 and projection 90 as shown is molded integral with the bottomwall 86 of the base. The ridge 87 is received in an inverted rectangular recess 89 of the carriage 32, enabling the carriage to straddle the ridge 87 which serves as a sliding bearing surface to guide the carriage along the ridge in slidable traverse within the housing.

In addition, the cover 60 has a projecting inverted wall 91 which is impressed over the carriage to provide a sliding bearing surface against which the carriage slidably impinges when displaced internally of the housing. The rounded end 52 is forced to engage and slidably traverse over the arcuate projection 90 as the lever 48 is pivoted either to its first position shown in FIG. 5 or to its second position whereby it lies along the centerline 82. In order to pivot the lever 48 to either of its two positions as described, an operator must apply a pivoting force to the knob 56 of the lever, thereby forcing the lever to pivot in the manner described and to additionally forcibly traverse the rounded end 52 over the projection 90. Some resistance to pivotal motion will be felt by the operator, which will be an indication that the switch is operating properly. When the lever 48 is fully pivoted to either of its two positions, the rounded end 52 thereof will become disengaged from the projection 90, thereby giving an indication of feel to the operator that the lever has clicked or suddenly sprung free from its resistance, thereby indicating the lever is fully pivoted to a corresponding one of its two positions. When the lever is fully pivoted to either of its two positions the projection 90 thereby remains in the arcuate path of the rounded end 52 of the lever, thereby resisting pivotal motion of the lever in the absence of pivoting forces applied thereto. The projection 90 accordingly serves as a latch to prevent unwarranted pivotal motion in the absence of the applied pivoting forces, thereby further preventing the carriage 32 to slidably displace and undesirably interrupt the circuit paths in the absence of applied pivoting forces to the lever 48.

As an additional feature of the present invention the lever is provided thereover with a generally cup-shaped grommet or washer 92 having a central aperture 94 therethrough. The washer or grommet 92 registers within the groove 56 of the knob and engages continuously on a generally arcuate projection 96 on the housing 60, thereby covering the aperture 66 which receives the lever 48 therethrough, so as to prevent contaminants from entering the corresponding internal cavity 12. The switch assembly as described may be dupli-

cated to provide an array of switches of any desired number within a single housing or DIP package.

The cover may be sealed to the base, for example, by applying a band of adhesive on the outer periphery of the base, including the sidewalls 4 and 6 and the end-most partitions, such as 8. Then when the cover 60 is assembled over the base, the band of adhesive forms a seal to prevent entry of contaminants into the housing.

The cover 60 is assembled over the sidewalls and partitions 8 of the base such that the overlapping margins of the cover and base provide a substantial surface area of contact therebetween. The adjacent margins of the cover and base thereby form a relatively long sealing path to prevent the flow of contaminants and liquid solder into the switch interior, particularly when an adhesive is applied between the margins and there is pressure between the assembled cover and base margins.

With more particular reference to FIGS. 6 - 12, another preferred embodiment according to the present invention will be described in detail.

As shown in FIG. 6, there is illustrated at 98 another preferred embodiment of the switch according to the present invention. Such switch comprises an array of individual switches, the details of an individual switch being further described hereafter as a preferred embodiment.

The switch array 98 is mounted to a printed circuit board illustrated at 100, with individual conductor paths 102 provided on the printed circuit board in the usual fashion.

With reference to FIGS. 8 through 12, a preferred embodiment of an individual switch will be described in detail. More particularly in FIG. 9 there is illustrated a dielectric housing 104 generally of channel shape having a pair of opposing elongated sidewalls 106 and 108 which are integral with end walls, one of which is shown at 110. The base 104 additionally is provided with a bottomwall 112 from which the walls 106, 108 and 110 project. The sidewalls 106 and 108 are provided with a series of channels or grooves 114 similar to the grooves 14 of the preferred embodiment described in conjunction with FIGS. 1 - 5. Accordingly the grooves 114 are parallel in nature and extend over the exterior surfaces of the sidewalls 106 and 108 and receive therein corresponding resilient metal springs 116, 116' or 116''. Each of the springs has an end portion 118 protruding from the base bottomwall 112 to form depending electrically conducting leads or terminals for pluggable external connection to a printed circuit board 100. The end portions 118 thus provide electrical leads which are aligned along the sidewalls 106 and 108. The spacings between the aligned leads correspond with the spacings between apertures provided in the printed circuit board 100 into which the leads 118 are inserted. Such apertures are usually lined with plating to allow constructed solder joints between the plating lined apertures and the leads thereby mechanically and electrically supporting leads within the apertures. Thus such solder joints may connect the leads electrically to selected circuit paths 102 provided on the printed circuit board 100. As in the prior embodiment the contact ends 118 may be provided thereon with longitudinal flutes 120 for the purpose similar to the flutes 26 described in conjunction with the prior disclosed embodiment. It is to be understood

however that such flutes are optional and may be eliminated in either of the embodiments if desired.

The other end 122 of each spring or contact 116, 116' and 116'' is generally of inverted U-shape to provide a curved portion to overlie the corresponding sidewall 106 or 108 and to project generally into the corresponding internal cavity defined between the sidewalls and the end walls 110. Each of the contact ends 122 are arcuate about an axis longitudinally of the contacts to provide an arcuate electrical contact surface for a purpose to be explained hereinafter. The end portions 122 of the springs generally project into the internal cavity of the base 110 and in diagonal diverging relationship with the corresponding sidewalls 106 and 108. This permits the spring portions 122 to be resiliently deflected in resilient cantilever spring motion from its diverging relationship toward the corresponding sidewall for a purpose to be explained hereinafter.

As shown more particularly in FIGS. 9 and 11, there is illustrated a carriage generally at 124 fabricated from dielectric material and generally of rectangular block configuration. Each side of the block has a corresponding recess 126 or 128 on the external surfaces thereof. Each side is further provided thereon with an electrical conductor strip of resilient spring metal 130 or 132. The two conductor strips form spring contacts or conducting contact elements which are provided at the ends thereof with corresponding laterally formed U-shaped portions 134 and 136. Each of the spring contacts is assembled to the corresponding side of the block with the ends 134 and 136 partially encircling the block as shown in FIGS. 7, 9 and 10. Tabs 138 and 140 are provided respectively on the contact portions 134 and 136. The tabs register in a pair of recesses 142 provided in the block, thereby permitting the contacts 130 and 132 to partially encircle the block. In addition, each of the contacts 130 and 132 are mounted upon laterally projecting flanges 144 and 146 integral on the block and adjacent to the bottom surface 148 of the block. As shown in FIGS. 8 and 12, the carriage block 124 is mounted within the internal cavity of the base 104 with the bottomwall 148 of the block in slidable registration on the surface of the bottomwall 112 of the base. As shown more particularly in FIGS. 7 - 12, the base bottomwall 112 is provided thereon with an integral projecting ridge or rail 150 elongated in a direction generally extending between the end walls 110 of the base 104. As shown in FIG. 7, the projection 150 is provided with an elongated recess 152. As shown the recess 152 is also generally elongated along the length of the projection 150. The recess is provided with generally arcuate end walls 154 with opposed generally parallel sidewalls 156 connecting the end walls 154. The sidewalls 156 are provided with undulated surfaces created by spaced arcuate projections 158 which project into the recess 152. The carriage or block 124 is provided with generally inverted rectangular recess defined by planar bottomwall 160 and opposed sidewalls 162. The opposed sidewalls 162 straddle the base projection 150 to provide a sliding bearing surface for the carriage 124 along the projection 150. In addition the bottomwall 160 of the block 124 slidably engages against the surface of the block 150 also to provide a sliding bearing surface for slidable actuation of the carriage along the projection 150. Centrally of the block 124 is provided a resilient expansion element which is bifurcated to form a pair of depending fingers 162

which project into the recess 162 of the block. The fingers 162 are advantageously molded integrally with the block 124 and are provided with arcuate surfaces illustrated in FIG. 7 for registration against the sidewalls 156 provided in the projection 150. The fingers 162 are resiliently deflectable toward and away from each other, such that they are partially deflected toward each other when in registration against the sidewalls 156. Upon slidable displacement of the carriage 124 along the projection 150, the resilient fingers 162 will resiliently spread apart and register in the relatively wide spaces between the projections 158 so as to latch or detent the carriage 124 in place at a desired position. When it is desired to displace the carriage to another position, the carriage is displaced along the projection 150 with the spring fingers 162 being forced to resiliently deflect toward each other as they are forcibly traversed and squeezed between opposed projections 158 of the sidewalls 156. The arcuate surfaces of the projections 158 and of the fingers 162 permit relative ease in slidably displacing the fingers over the surfaces of the projections without excessive friction or binding.

The block 124 is provided with a planar top surface 166 which provides a sliding bearing surface for a purpose to be described. The transverse slot 168 is provided in the surface 166 for a purpose to be described hereinafter.

As shown with reference to FIGS. 8, 9 and 12, the switch further includes a cam element in the form of a stepped cylindrical shaft illustrated generally at 170. The cam element includes a central enlarged cylindrical portion 172 coaxial with a reduced cylindrical portion 174 with a stepped shoulder 176 provided at the intersection of the coaxial cylindrical portions 172 and 174. The cylindrical portion 174 is domed and provided with a transverse groove 178, a resilient sealing ring 180 is received over the cylindrical portion 174 in registration against the shoulder 176. A short cylindrical stem or shaft 182 depends from a substantially planar inverted bottom surface 184 of the cylindrical portion 172. The bottom surface is rotatable over the top surface 166 of the block 124, the surfaces 166 and 124 thus being bearing surfaces for low frictional resistance to rotation of the cam element and translation of the block 124. The shaft 182 is substantially offset from the common cylindrical axis of the coaxial cylindrical portions 172 and 174. The cam element 170 is assembled over the block 124 with the shaft 182 being received internally of the transverse groove 168. In addition the surface 184 of the cam element is a bearing surface in registration on the planar surface 166 of the carriage 124, also a bearing surface, such that the cam element may be slidably displaced over the surface 166 in a manner to be described.

To complete the switch, a cover portion 186 of dielectric material is in the form of an inverted container having sidewalls 188 and endwalls 190 which are received over the base member 104. More particularly, the sidewalls 188 are received overlapped against the corresponding sidewalls 106 and 108 of the base 104. Each of the end walls 190 of the cover are received overlapped against at least one of the endwalls 110 of the base 104. As shown in FIG. 8, the contacts 116, 116' and 116'' are received in compression between the sidewalls 188 of the cover and the corresponding sidewalls 106 and 108, thereby rigidly retaining the contacts in desired parallel alignment. In addition, the

cover 186 has a bottomwall 192 which impinges against the top surfaces of the sidewalls 106 and 108, the top surfaces of the end walls 110 and against the inverted U-shaped portions of the contacts 116, 116' and 116''. Accordingly, the cover and base with their abutting margins overlap over relatively large surface areas which, when tightly compressed together prevent the passage of contaminants and flow of molten solder into the interior of the base 104. If desired an adhesive may be coated between the abutting surfaces of the cover and base further serving to seal the margins thereof against the flow of contaminants. In addition, the relatively large surface areas of contact between the base and cover serve also to prevent the flow of adhesive into the interior of the switch merely by limiting the application of adhesives to but a small area portion of the abutting surfaces.

As shown in FIGS. 8 and 12, the cover is provided with a thickened portion 194 which projects from the surface 192. The thickened portion 194 is provided with a stepped interior bore 196 which provides cylindrical bearing surfaces rotatably receiving the cam element 170. The seal 180 is retained in compression between the cam element and the cover 186 to prevent contaminants from entering the switch through the stepped bore 196. The housing further is provided with a domed lip 198 which overlaps and encircles the periphery of the reduced cylindrical portion 174 to enclose the surfaces of the cam element 170 further, and thus provide a relatively long path further sealing the flow of contaminants into the switch. The thickened portion 194 has an inverted planar bearing surface 200 which slidably abuts against the bearing surface 166 of the carriage.

In operation, a suitable tool such as a screw driver is inserted into the groove 178 of the cam element 170 to rotate the stepped cylindrical cam element either clockwise or counter-clockwise. The offset shaft 182 will then be displaced through an arc illustrated in FIG. 10 at 202. Since the shaft 182 is received in the slot 168, the arcuate displacement of the shaft 182 will force the carriage to translate back and forth by slidable displacement along the elongated projection 150, with the bearing surfaces 184 and 166 allowing such displacement without undue frictional resistance. The shaft 182 will freely translate back and forth in the slot 168, whereas the carriage will be restricted from translation in a direction transverse to the elongated projection 150, since the carriage straddles the projection. An advantage resides in the cam element being fully capable of 360° rotation without providing positive stops which might be broken or defeated by excessive force actuating the switch cam. The cam element can never be broken during actuation thereof. Accordingly, the slidable traverse of the carriage as described will connect the conducting elements 130 and 132 with desired contacts 116, 116' or 116'' to provide a double-throw, double-pole switch, with such contacts operating as the poles of such a switch. When the carriage is received between opposed contacts, the contacts will be resiliently deflected toward the corresponding sidewalls 106 and 108 to insure pressure applied between the contacts and the contact elements 130 and 132 provided on the carriage 124. The arcuate shape of the contacts 116, 116', and 116'' provide dome shapes over which the corresponding contact elements 130

and 132 slidably impinge without undue frictional resistance.

Thus the carriage is slidably traversed, yet retained in desired position by the abutting bearing surfaces on the component parts of the switch. By selecting the component parts from a dielectric material having low surface friction properties, the component parts may be assembled and retained with their surfaces in opposed abutment with one another while their abutting surfaces provide sliding bearing surfaces enabling the carriage to slidably traverse over the abutting surfaces thereof without producing frictional resistance. In addition, a need for separate fasteners or adhesives is eliminated to assure ease in manufacture and assembly of the component parts. The dielectric parts can be readily molded such that all the appendages, bearing surfaces and recesses on the various parts may be provided quickly in molding operations without a need for separate machining or fabrication by assembly.

FIGS. 13-16 illustrate a modification of the preferred embodiment illustrated in FIGS. 6-12. With reference to FIG. 13, the modified embodiment includes a dielectric base or housing 104' similar to the housing 104. The housing 104' includes side walls 106 and 108 and end walls 110. As shown in FIG. 14, grooves 114 are provided in the end walls 106 and 108 to receive contact 116, 116' and 116'' in similar fashion as the previously disclosed embodiment.

As shown in FIGS. 13 and 15, the base or housing 104' includes a bottom wall 112' similar to the previous housing 104. However, the bottom wall 112' differs in that it includes a pair of elongated projecting rails 201 which define therebetween a groove or track 203. For example the rails 201 may be molded integral with the bottom wall 112. The modification further includes a carriage 124' which is similar to the carriage 124 in that it includes the elongated slot 168' similar to the slot 168 of the previous embodiment. Certain portions of the carriage 124' are illustrated in phantom outline for clarity. The carriage 124' includes a pair of projecting and depending feet portions 204 which project outwardly of the carriage 124 in an outrigger arrangement. As shown more particularly in FIG. 15, the carriage 124' carries a pair of contacts 132' and 130' which are similar to the contacts 130 and 132. The projecting feet 204 are in sliding registration within the track 203. The rails 201 defining the track are received within an inverted recess 162' of the carriage 124'. The carriage 124' is thus slidably received along the track 203. The outrigger configuration of the feet portions 204 and the relatively arcuate peripheries thereof provide relative ease in sliding between the rails.

As shown more particularly in FIGS. 13, 14, and 16, the modified embodiment of FIGS. 13-16 further includes a cam element 170' similar to the cam element 170. A central cylindrical enlarged portion 172' of the cam element is similar to the central enlarged portion 172 except that it is partially hollowed out at 206 to provide the cylindrical periphery of the central enlarged portion 172' with a relatively thin web segment 208. As shown in the figures the web portion 208 is defined between a pair of kerfs which make the web portion resiliently deflectable in and out of the cylindrical periphery. The web portion 208 is further provided with an integral arcuate surfaced projection 210 for a purpose to be described. The cam element further includes a depending offset shaft 182' similar to the shaft

182 for registration within the slot 168'. As in the embodiment before, when the cam element 170 is turned, the shaft 182' is forcibly disposed through an arc which creates the desired reciprocation of the carriage 124' along the rails 201, switching the contact elements 130' and 132' between the contacts 116, 116' and 116'' which are mounted in the grooves 114'. Rotation of the cam element is accomplished for example by insertion of a coin or screwdriver into the transverse slot 178' provided in the reduced cylindrical portion 174'. In addition, the reduced cylindrical portion 174' is provided with a recess 212 which is pointer shaped to indicate the position of the offset shaft 182'.

As shown more particularly in FIGS. 14 and 16, the cover portion 104' is provided with a relatively thickened portion 194' similar to the corresponding thickened portion 194. The thickened portion 194' is provided with a cylindrical recess therein for receiving the enlarged cylindrical portion 172' of the cam element. In addition the thickened portion 194 is provided with a plurality of recesses or detents 214 spaced about the cylindrical recessed portion which receives the cam element. When the cam element is rotated, the projecting portion 210 is rotated into registration in turn within each of the detents 214. Since the flap 208 is resilient, the projection 210 will provide a snap action when brought into registration within a detent to provide a tactile feel for indicating to an operator of the cam element the position of the carriage during a switching function.

What has been described is a preferred embodiment of the present invention. It is to be understood that other embodiments and modifications of the present invention will become apparent to one having ordinary skill in the art as defined within the spirit and scope of the appended claims wherein:

What is claimed is:

1. A switch comprising: a base of dielectric material, a cover of dielectric material overlying said base, said base and said cover together comprising a housing, at least two adjacent electrically conducting springs on each opposed side of said base, said springs having first portions projecting in depending relationship from said base to provide electrical terminals protruding externally of said base for making electrical connections externally of said housing, said springs having second portions in opposed spaced relationship in said housing, a carriage slidably received for sliding displacement in said housing, said carriage being received between each opposed pair of second portions of said springs and having a first and a second conductor strip on opposed sides of said carriage, said carriage being displaceable to a first position and having a first conductor strip electrically engaging two adjacent springs to complete a first electrical circuit therebetween, said carriage being displaceable to said first position and having said second conductor strip electrically engaging two adjacent springs to complete a second electrical circuit therebetween, said carriage being displaceable in said housing to a second position to disengage said first conductor strip from one of said springs and thereby interrupt said first electrical circuit, and to disengage said second conductor strip from another of said springs and thereby interrupt said second circuit, and a lever on said carriage protruding externally of said housing for receiving applied forces thereto for

pivoting said lever and for displacing said carriage to either of said first or said second positions.

2. The structure as recited in claim 1, wherein said lever includes a pivotal connection to said carriage, said housing having an aperture receiving said lever therethrough, and said housing having at least a portion adjacent said aperture to provide a fulcrum over which said lever is pivoted, said lever being pivotally displaceable in one direction to slidably displace said carriage to said first position, said lever being pivotally displaceable in a second direction to slidably displace the carriage to said second position.

3. The structure as recited in claim 2, wherein said pivotal connection comprises projecting dowel portions on said lever, said carriage having a pair of inverted grooves respectively receiving said dowel portions, and further including: an opening in said carriage freely receiving said lever therethrough.

4. The structure as recited in claim 2, wherein said base includes a projection thereon, said lever having an end slidably engageable over said projection upon pivotal displacement of said lever in either of said first direction or said second direction, said projection providing a latch to prevent pivotal motion of said lever in the absence of forces applied to said lever.

5. The structure as recited in claim 2, wherein each of said springs interfits with a groove on said base, said cover overlies said base, and said cover retains said springs between said base and said cover.

6. A sealed switch, comprising:

a housing,

a plurality of electrical contacts having first portions protruding from said base providing electrical terminals externally of said base,

said electrical contacts having second portions internally of said housing in spaced relationship,

a carriage having an electrical conductor element and being displaceable in said housing for engagement of said conductor element sequentially with selected contact second portions,

a cylindrical cam element protruding from an aperture provided in said housing,

a sealing ring encircling said cam element and in sealing compression between said cam element and said housing to seal said housing aperture from leakage of contaminants into said housing,

said cam element being rotatable about fixed axis of rotation, and

means connecting said cam element and said carriage for transmitting rotation of said cam element into linear displacement of said carriage, whereby rotation of said cam element causes translation of said carriage to engage said conductor element against selected contact second portions.

7. A structure as recited in claim 6, wherein said means includes:

a cylindrical projection depending from said cam element and being offset from the axis of rotation of said cam element, whereby rotation of said cam element causes a curvilinear displacement of said projection about the cam element axis of rotation,

an elongated slot in said carriage extending transversely of the direction of linear displacement of said carriage; and

said slot receiving the projection therein, said projection upon curvilinear displacement thereof causing linear translation of said carriage and simultaneous translation of said projection along said slot.

8. The structure as recited in claim 6, and further including:

said housing being provided with a plurality of detents,

a resilient projection depending from said carriage for registration in said detents, said projection being resiliently deflected by said housing and resiliently deflecting into registration with each detent in turn to position and locate said carriage in desired positions within said housing.

9. The structure as recited in claim 8, wherein said projection means comprises a pair of resilient fingers integral with said carriage, said detent means comprises a slot having relatively wide and relatively narrow width portions,

said fingers being forcibly resiliently deflected toward each other upon passage of said fingers along said relatively narrow portions of said slot, and said fingers being permitted to resiliently deflect away from each other for registration within said relatively wide portions of said slot and thereby detent said carriage in desired positions, with said fingers being in registration in said slot between relatively narrow portions of said slot to provide a resilient latch against displacement of said carriage from said desired positions.

10. The structure as recited in claim 6, wherein, said carriage slidably abuts said base portion and said cover portion, and said cam element slidably abuts said carriage.

11. The structure as recited in claim 6, wherein said base portion and said cover portion overlap each other to provide relatively large surface areas abutting to resist flow of contaminants.

12. The structure as recited in claim 6, and further including:

said housing being provided with a plurality of detents,

a resilient portion on said cam element for registration in turn within each of said detents, said projection being resiliently deflected into and out of registration within said detents to position and locate said carriage in desired positions within said housing.

13. The structure as recited in claim 12, wherein said cam element is provided with a substantially hollow portion defining a resilient flap portion to which said projection is mounted, said housing having said detents spaced opposite the periphery of said cam element, and said projection adapted for registration in turn with each of said detents as said cam element is rotated.

14. The structure as recited in claim 6, wherein the housing includes a bottom wall provided with a track, said carriage being provided with a pair projecting feet slidably received in said track.

15. The structure as recited in claim 14, wherein said feet project outwardly in outrigger relationship from said carriage to assist said carriage in slidable displacement within said housing.