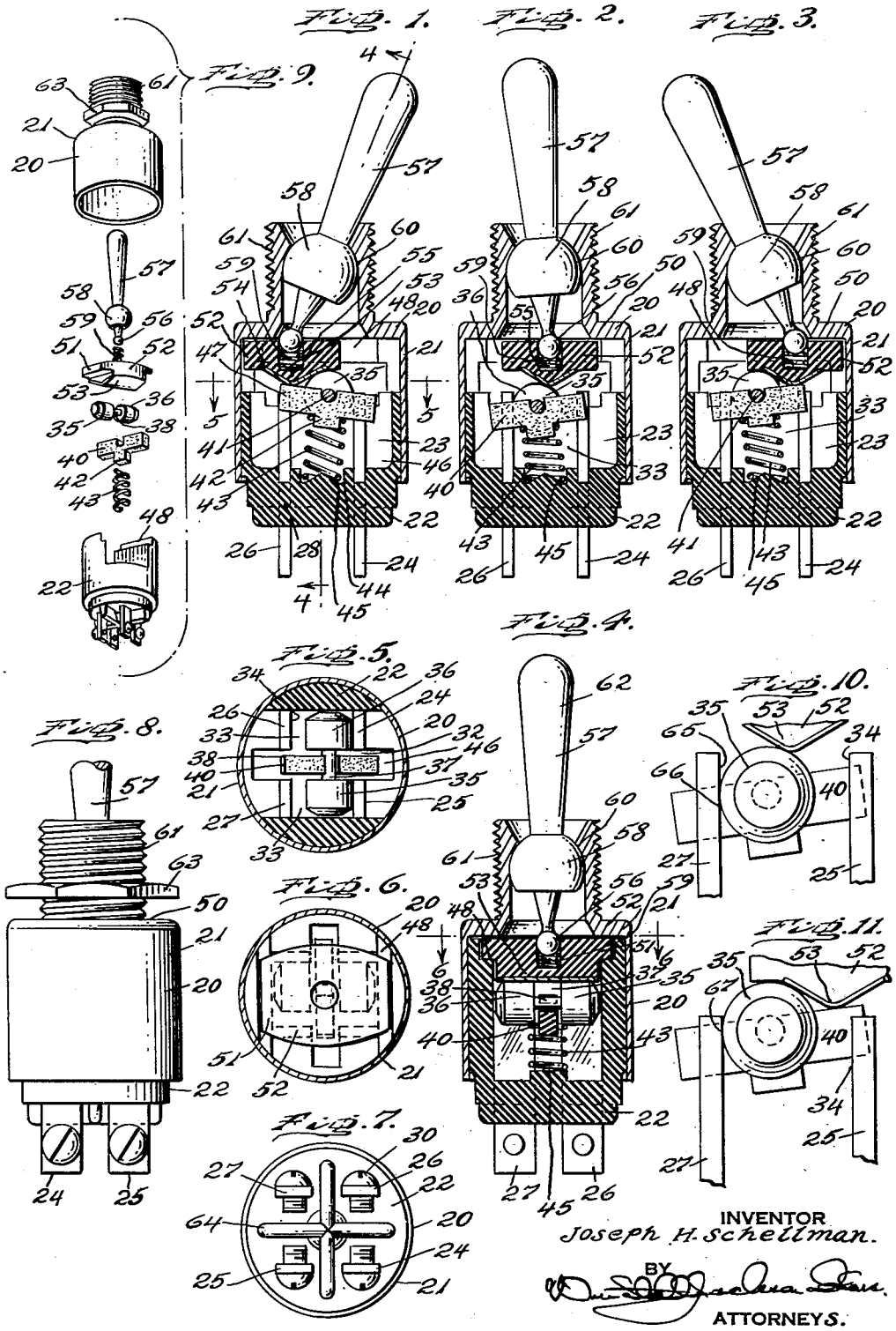
March 31, 1953 J. H. SCHELLMAN 2,633,510

ELECTRIC SWITCH

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Fig. 12.

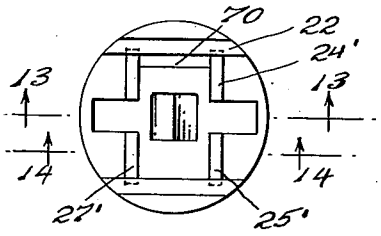


Fig. 13.

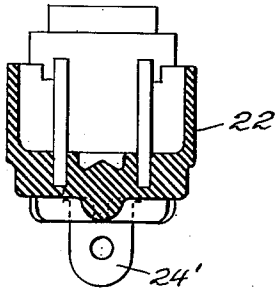


Fig. 14.

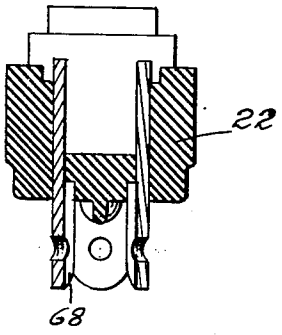


Fig. 15.

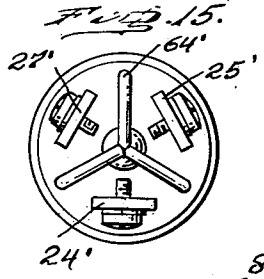


Fig. 18.

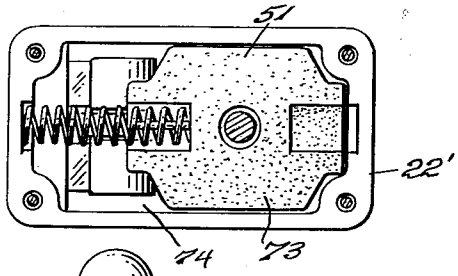


Fig. 17.

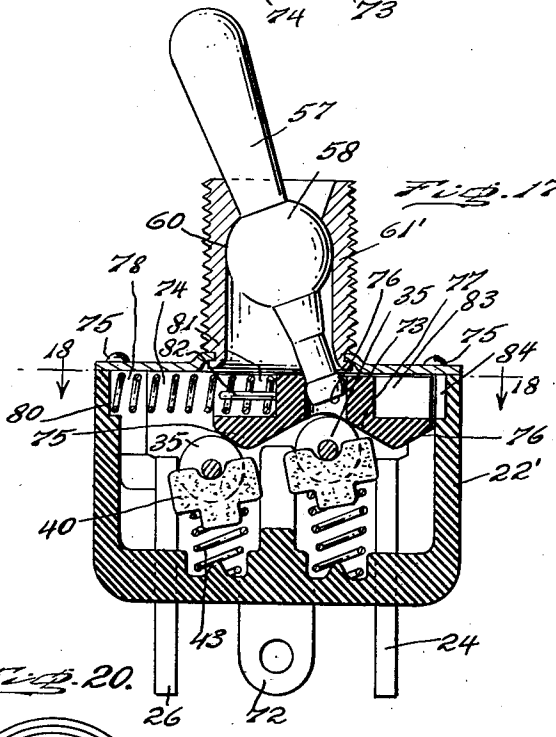


Fig. 20.

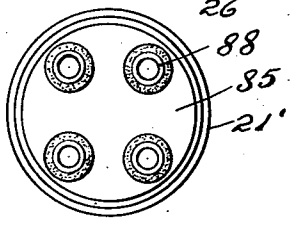


Fig. 21.

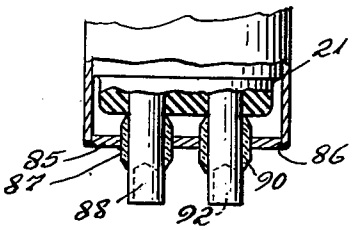
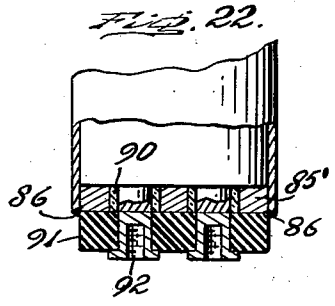


Fig. 22.



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Fig. 16.

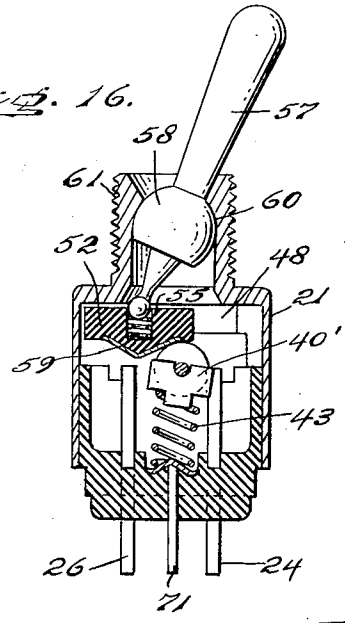


Fig. 27.

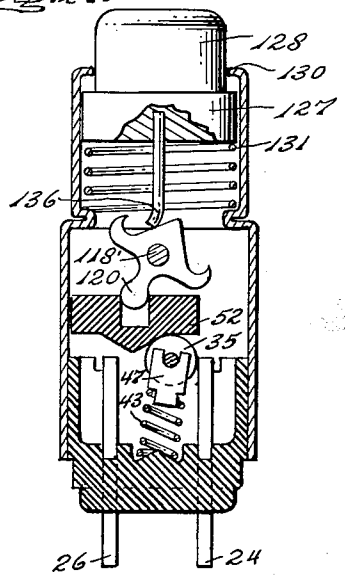


Fig. 28.

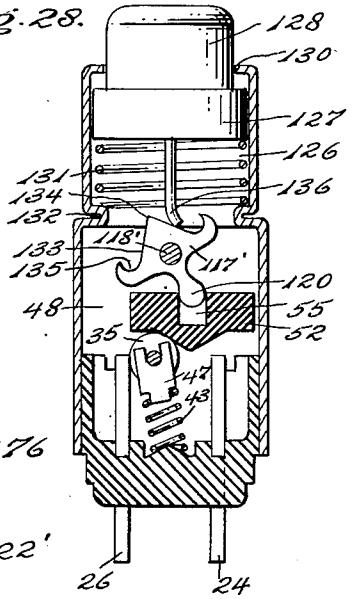
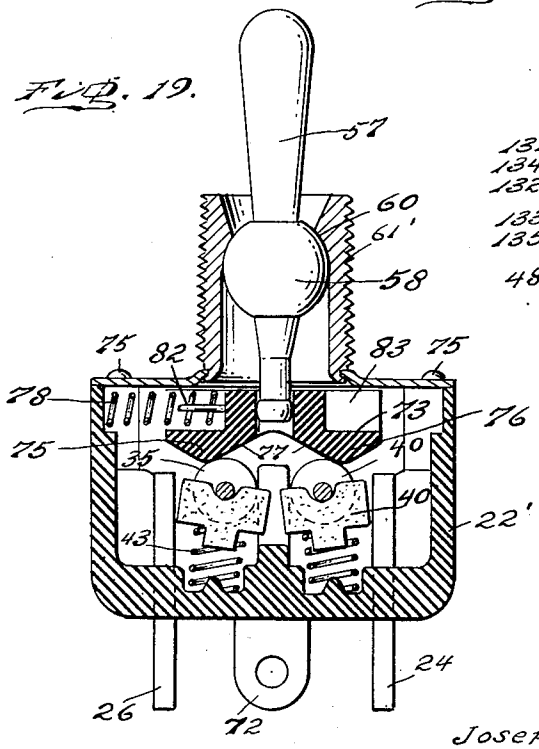


Fig. 19.



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Fig. 23.

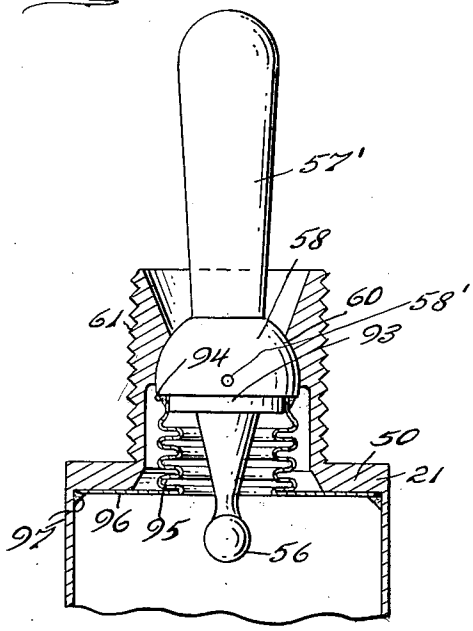


Fig. 26.

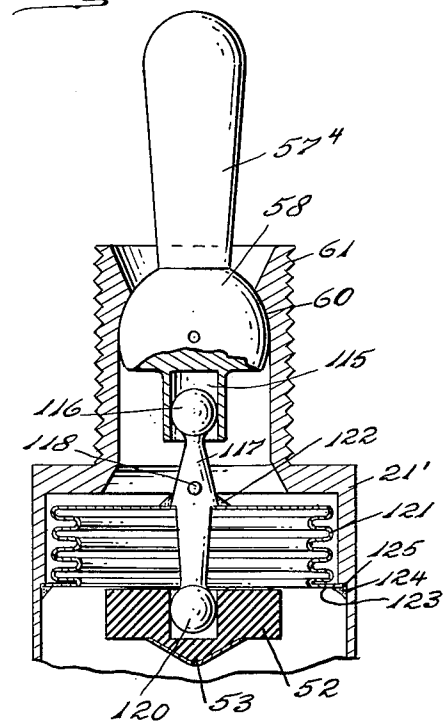


Fig. 24.

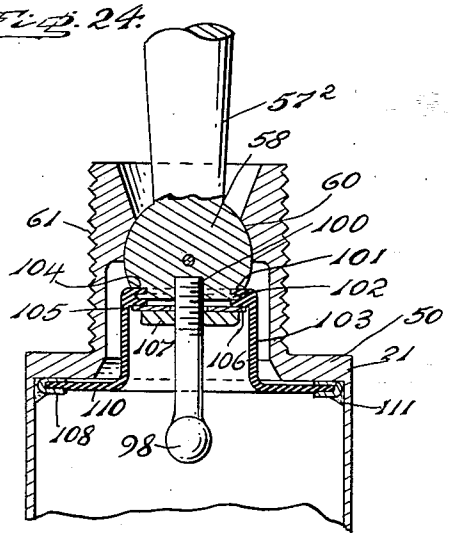
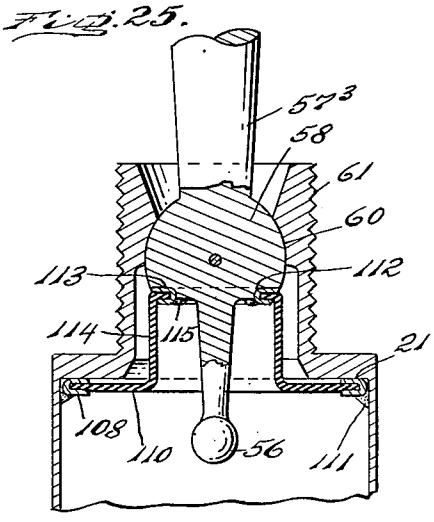


Fig. 25.



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UNITED STATES PATENT OFFICE

2,633,510

ELECTRIC SWITCH

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Application September 13, 1951, Serial No. 246,367

20 Claims. (Cl. 200—68)

1

The present invention relates to electric switches, particularly of the character which are useful in exacting applications, such air aircraft instrument switches, but also suitable for any other applications in which high grade switches are required.

The subject matter relating to the sealing means divided herefrom has been embodied in U. S. application Serial No. 339,561, filed February 26, 1953, for Sealed Electric Switch.

A purpose of the invention is to provide a contacting surface of a switch which is different from the make and break surface so that any arcing will not impair the contacting surfaces.

A further purpose is to break any welding in a switch by a cam which exerts a combination of rotation and push which may be described as a peeling action on the movable contact.

A further purpose is to complete the electric circuit between fixed contacts by moving a contact roller in one position extending across between the contacts under the action of a hill-and-valley projection moving generally transverse to the contacts and desirably controlled by guideways and manipulated by a toggle lever.

A further purpose is to urge a toggle lever into its pivot socket by a spring, acting between the end of the toggle lever and a slider, suitably a hill-and-valley projection.

A further purpose is to mount a contact roller riding a hill-and-valley projection in a cradle which is spring urged toward the hill-and-valley projection by a rocking spring, suitably of spiral compression type.

A further purpose is to make the cradle of insulating material and to extend the ends of the cradle between opposed contacts to prevent flashing across.

A further purpose is to journal the contact roller in the cradle by cutting an annular groove in the roller between the two ends.

A further purpose is to reduce the space requirments of aircraft switches so that they can be mounted closer on an instrument board.

A further purpose is to employ a plurality of contact rollers riding a plurality of hills spaced by a single valley, and desirably in one position to hold both contact rollers against a center abutment in the single valley. The abutment may suitably be either conducting or insulating.

A further purpose is to urge the double hill type of hill-and-valley projection toward one set of contacts by a spring.

A further purpose is to hermetically seal at

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the back of the switch housing by glass beads fused in place.

A further purpose is to hermetically seal to a switch operating lever such as a toggle lever by a resilient bellows engaging the housing at the outside of the bellows and engaging the operating lever inside the pivot on the inside of the housing. The bellows may be metallic or of elastomer.

A further purpose is to secure the inside of the bellows to the lever by a clamp.

A further purpose is to employ rims of metal around the outside and inside of an elastomer bellows and unite them to the housing and to the operating lever as by soldering.

A further purpose is to employ a toggle lever to manipulate an operating lever in prolongation of the toggle lever and make the bellows seal to the manipulating lever at or adjacent the pivot thereof.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

Figure 1 is an axial section of the preferred embodiment of switch operating mechanism, shown in position with the contact roller engaging the pair of contacts at the right and the toggle thrown clear to the right.

Figure 2 is a view corresponding to Figure 1 showing the toggle lever partly thrown to the left and illustrating the contact roller at the time that it first makes contact with the left hand pair of contacts.

Figure 3 is a view corresponding to Figure 1 with the contact lever fully thrown to the left and the contact roller in final contact position against the left hand pair of contacts, having rolled longitudinally along the contacts from the position of Figure 2 to the position of Figure 3.

Figure 4 is a section of Figure 1 on the line 4—4.

Figure 5 is a view of Figure 1 on the line 5—5.

Figure 6 is a section of Figure 4 on the line 6—6.

Figure 7 is a bottom plan view of Figure 1.

Figure 8 is a fragmentary side elevation of the completed switch of Figures 1 to 7, breaking away a portion of the toggle lever.

Figure 9 is an exploded perspective of the switch of Figures 1 to 8.

Figures 10 and 11 are fragmentary diagrammatic elevations showing the motion of the contact roller as contact is made or broken.

Figure 12 is a top plan view of a variant form of switch similar to that of Figures 1 to 11, omitting the toggle lever, hill-and-valley projection and top of the housing.

Figure 13 is a section on the line 13—13 of Figure 12.

Figure 14 is a section on the line 14—14 of Figure 12.

In both Figure 13 and Figure 14 the hill-and-valley projection, toggle lever and outer casing are omitted.

Figure 15 is a bottom plan view of Figure 12.

Figure 16 is a view corresponding to Figure 1, showing an electrically conducting cradle and a terminal to the spring.

Figure 17 is a view corresponding to Figure 3 of a variant form of switch mechanism.

Figure 18 is a section on the line 18—18 of Figure 17.

Figure 19 is a view corresponding to Figure 17 but with the hill-and-valley projection in central position.

Figure 20 is a bottom plan view of a variation in the switch according to the invention, with an arrangement for hermetically sealing the back.

Figure 21 is a side elevation of Figure 20 broken away to show the interior.

Figure 22 is a view corresponding to Figure 21 showing a variation.

Figures 23 to 26 inclusive are fragmentary axial sections showing various means for hermetically sealing the opening at the front of the housing in the switch of Figures 1 to 9 or any of the other forms herein.

Figures 27 and 28 are longitudinal sections in opposite positions similar to Figures 1 and 2, showing a push button type of switch, the push button being partially depressed in each view.

It will be understood that in the best embodiment, the hermetic sealing of the front and back will be applied to the switch having the operating mechanism of Figures 1 to 9 or if desired to one of the other forms.

In electric switches, particularly those used to perform operating functions on airplanes, it is highly important to be able to maintain a clean unpitted contact surface on the fixed contacts for engagement with the movable contacts. Unfortunately in most switch designs, the portion of the fixed contact surface which is engaged by the movable contact is the same as the surface from which the movable contact breaks engagement when the switch opens, and therefore any arcing is likely to cause pitting of the normal engaging surface of the fixed contact and deterioration of the surface.

In some cases in prior art switches especially where comparatively high current densities are employed, there has been a tendency of the movable contact to weld to the fixed contact, rendering the switch inoperative. In airplane work this has been disastrous, as it is very important that the pilot have immediate control over the particular function of the plane controlled by the switch, and even a short delay in operation of the switch is likely to be serious.

By the present invention the above difficulties are overcome. The surface of the fixed contacts at which the movable contact leaves and where arcing is likely to take place is different from the surface of the fixed contacts with which the movable contact makes normal contact, so that deterioration by arcing at the fixed contact surface is not likely to occur. As contact is made and also broken, the movable contact

first travels along the fixed contact parallel to the length thereof before it breaks contact.

Furthermore the same surface of the movable contact is not continuously used for contact purposes, since the movable contact rolls and changes its contacting surface.

The movable contact breaks its contact with the fixed contact under a cam action of a hill-and-valley projection, and this cam action exerts a peeling or rotation-and-push effect which is very effective in breaking any weld between the fixed contact and the movable contact.

The switch of the invention has in addition the usual toggle action produced by a hill-and-valley projection, which assures that it will where desired remain in the position set.

The possibility of arcing between the fixed contacts is further reduced by extending an insulating cradle between the fixed contacts on either or both sides of the switch.

The cradle may desirably perform the function of journalling the movable contact roller, and for this purpose the diameter of the movable contact roller is suitably reduced by an annular groove at the point where it fits in a recess in the cradle. The contact roller frees the motion of the hill-and-valley projection and is urged against the fixed contacts due to a spiral compression spring or other suitable spring which locks with the cradle.

The invention is also applicable to multiple switches having two or more movable contacts engaging sets of fixed contacts.

The switch of the invention can also if desired be continuously urged toward one direction to which it will return when the operator releases the toggle lever.

As the invention is likely to find its widest application in aircraft switches I provide improved means for horizontally sealing the housing, so that changes of internal pressure with change in altitude cannot result in "breathing" and intrusion of moisture which would render the switch inoperative.

Considering first the form of Figures 1 to 11, I illustrate a housing 20 which suitably consists of a metallic front portion 21 which receives and surrounds a suitably electrically insulating rear portion or block 22 which mounts the fixed contacts. The blocks may be of any convenient insulating material such as phenolic plastic.

The block desirably has a hollow internal portion 23 and two sets of generally parallel spaced metallic contacts 24, 25 and 26, 27 as best seen in Figure 5. The contacts are suitable strips of brass, bronze, silver alloy, beryllium copper or the like which are embedded in the molded plastic at 28, protrude out at the back carrying terminal screws 30 (the screws are omitted in Figures 1 and 4), and extend up in parallel relationship into the open space 23 at the inside of the block so as to produce contacts in pairs spaced from one another within each pair along a center opening 32 and spaced across from one another in an open space 33 (Figure 5).

While the contacts have been described as two opposed pairs, it will be understood that either of the pairs can be effectively an abutment if it is not desired to have a double throw switch.

The pairs of contacts at the opposed sides have contact faces 34 near the ends remote from the terminals, which are used in making electrical connection with a movable contact roller 35 of any suitable electrically conducting metal, desirably silver alloy, brass, bronze or beryllium

copper. The contact roller has two cylindrical ends 36 spaced far enough apart so that one can make contact with contact 24 and the other with contact 25 or one with contact 26 and the other with contact 27. Intermediate the cylindrical ends, the contact roller is desirably annularly slotted or reduced in diameter at 37 to provide an interior pivotal shaft portion 38 suitably of small diameter, which can engage a bearing.

The contact roller is journalled in a cradle 40 which in the preferred embodiment is of insulating material, extending into the annular slot of the contact roller, and has a half bearing portion 41 near the middle which acts as a journal for the pivot portion 38 of the contact roller since it rotatably mounts the center shaft portion 38.

The cradle on the side remote from the half bearing portion 41 has a spring abutment 42 which receives the upper end of a rockable spiral compression spring 43, the lower end being received in a spring recess 44 at the bottom of the hollow interior portion 23 of the block, and suitably including a dome-like spring abutment 45 which provides a rockable anchorage for the spring as it moves back and forth.

The spaces 32 between contacts of each adjoining pair are in line in the opposed pairs and recesses 46 in line with the spaces are provided in the block at opposite sides. Extensions 47 from the cradle protrude between each pair of fixed contacts and are suitably long enough so that they will space the fixed contacts of each pair by insulating material whether the switch is in one position or the other. This will serve to prevent flash-over.

At the front end, the housing block is provided with guideways 48 which extend transversely of the fixed contacts immediately behind the shoulder portion 50 of the metallic housing front 21. These guideways receive opposed guides 51 of a hill-and-valley projection 52 which extends across between the guideways and moves toward one set of contacts and away from the other set transversely to the contact faces.

The hill-and-valley projection has a hill 53 on the face directed toward the contacts and the contact roller, the hill being suitably rendered more wear resistant if desired by applying a metallic sheet 54 on the surface of the plastic or other suitable insulating material making up the hill-and-valley projection. The hill-and-valley projection is desirably symmetrical so that the hill will be central when the projection is central, although it can be differently located if desired. In the forward end of the hill-and-valley projection, a socket 55 is provided which receives an operating projection 56, suitably a ball, on the end of a toggle lever 57 which has an intermediate pivoting ball portion 58 which suitably pivotally engages in spherical socket surfaces 60 of the forward threaded shank 61 of the switch. In order to hold the ball portion 58 firmly in the spherical socket 60 and minimize entrance of moisture into the switch, a spiral compression spring 59 in socket 55 pushes longitudinally of the toggle lever. An operating handle end is provided on the lever at 62. As well known, the shank receives one or more mounting nuts 63 for securing it in a panel.

In the forms shown in Figures 1 to 9 inclusive, the metallic housing is desirably located with respect to the plastic block portion by a key and keyway (not shown), and the housing is crimped to hold it around the block, although it can be anchored with set screws if desired. The rear of the insulating block portion of the housing suitably is provided with separating ribs 64 (Figure 7).

In operation of the form of Figures 1 to 11 inclusive, when the toggle lever is thrown from the right hand position of Figure 1 to the left hand position of Figure 2, the hill-and-valley projection moves toward the right, first forcing the contact roller down while it continues to engage the right hand pair of contacts 24 and 25. The contact roller rolls on the pivotal mounting in the cradle and moves against the pressure of the rocker spring. Thus the contact roller moves away from the position at which normal contact has been made before it begins to leave the fixed contact. This is well illustrated in Figures 10 and 11, which show left-hand contacts engaged. Figure 10 shows the contact roller in a depressed position about to move over the hill-and-valley projection, having moved down along the portion 65 of the contacts which are being engaged.

When the apex of the hill-and-valley projection passes to the right over the contact roller, the contact roller jumps to the other side as shown in Figure 2 engaging the left hand pair of contacts at a point approximately 66 (Figure 10) which is substantially the point at which it will leave contact when the circuit is broken and where any arcing will occur. As the lever moves further to the left to the position of Figure 3, the contact roller rolls up along contacts 26 and 27 to a point 67 of final rest (Figure 11). When the contact lever is reversed from the posiiton of Figure 3 back through the position of Figure 2 to that of Figure 1, the reverse procedure takes place, the contact roller moving first down along the space 65 to a position somewhat beyond that of Figure 10 and then jumping to engage the contacts at the other side.

The speed with which the contact is broken due to the jump aids in avoiding arcing and any arcing which takes place does not occur at the point at which the fixed contact will subsequently maintain contact.

The cam action of the hill-and-valley projection is very desirable as tending to break any weld by virtue of the peeling or rotating and pushing action on the roller contact.

In either position it will be seen that the cradle extends out between the contacts of the adjoining pair to prevent flash-over.

The switch of the present invention has been found to be extremely compact. Actual experience indicates that it occupies only about three-fourths of the space of prior art switches intended for aircraft instrument boards.

In some cases it is desirable to cross connect the contacts. This is illustrated in Figures 12 to 15 inclusive. In this case contacts 25' and 27' are identical with contacts 25 and 27 inside the switch, although outside the switch they are deformed angularly at 68 to permit equal spacing of the three contacts at the back.

Contacts 24 and 26 of Figures 1 to 11 are cross connected and integral to form a contact 24', which is identical with contacts 24 and 26 inside the switch except for an integral cross connection 70 at the side, out of the way of the moving parts.

A single terminal is carried out at the back from double contact 24'. The ribs 64' are divided into

three portions at the back of the insulation in this form.

In some cases it is desirable to make an independent contact to the contact roller instead of insulating the contact roller cradle and spring. Figure 16 has a terminal 71 which extends to and electrically contacts the base of the spring, and has an electrically conducting metallic cradle 40' which in this case does not extend between the fixed contacts. Thus a further connection can be made to the contact roller if desired.

In some cases it is desirable to build a plurality of switches in accordance with the invention into a single housing as shown in Figures 17, 18 and 19. In this form the insulating block 22' supports pairs of contacts 24, 25, (25 is not shown) 26, 27 (27 is not shown) disposed as in the form of Figures 1 to 11 except more widely spaced, with an intermediate spaced pair of contacts 72 (only one of which is shown) having the same lateral spacing as the contacts 24, 25 and 26, 27. While in the preferred embodiment the intermediate contacts are metallic and function as contacts, they may be dummies and function as an abutment if desired.

In this form the hill-and-valley projection 73 which moves in guides 74 similar to the guides 48 has two hills 75 and 76 separated by a valley 77 disposed toward the contact rollers. The metallic housing portion including the shank 61' in this case does not surround the block but is secured to it as by screws 75. Suitably the shank and flange portions of the metallic housing portion are separate pieces, joined as by deforming a rib as shown.

In this instance two contact rollers 35 are provided, one on each side of the pair of contacts 72 and the cradles 40 and springs 43 are arranged in the spaces between the respective pairs of contacts, each of which forms a separate switch.

The toggle lever 57 is essentially the same as that already shown, extending into a socket of the hill-and-valley projection, except that the opening 76 in this case extends clear through the hill-and-valley projection, there being adequate clearance so that the contact will not engage the toggle lever. The hill-and-valley projection is of insulating material and in this case the metallic wear plate has been removed.

As shown in Figure 19 the intermediate valley 77 of the hill-and-valley projection is desirably wide enough so that both contact rollers can in the center valley remain on adjoining sides of the apexes of the hills. Thus in this form both contact rollers in this mid-position make contact with the center pair of contacts 72. Thus when the toggle lever is moved from the left hand position of Figure 17 to the right hand position, starting with the arrangement of contact rollers shown in Figure 17, the left hand contact roller is first thrown into engagement with the central fixed contacts 72, where the right hand contact roller remains, since the left hand contact roller is nearer to the left hand hill-and-valley apex than the right hand contact roller is to the right hand hill-and-valley apex. As the hill-and-valley projections move still further to the left the right hand contact roller snaps to the right and engages fixed contacts 24 and 25, while the left hand contact roller remains in engagement with middle fixed contacts 72.

In some cases it is desirable to provide spring bias of the hill-and-valley projection toward one side. With this purpose in view a spring 78 extends from a spring recess 80 at the left in the block to a spring recess 81 in the hill-and-valley projection. A pin is desirably provided at 82 to prevent the spring from jumping out of position. An alternate spring recess 83 in the hill-and-valley projection and a cooperating alternate spring recess 84 in the block are provided at the right so that the hill-and-valley projection can be biased the other way if desired by merely moving the spring 78 and moving the pin from the recess in which it is placed to a similar recess on the opposite side.

In many cases it is desirable to seal the switch housing hermetically and Figures 20 to 26 show how this may be done in the switch of the present invention. The hermetic sealing is of course applicable to other switch operating mechanisms if desired.

Figures 20 and 21 show a preferred manner of sealing the back of the housing. In this case the metallic front portion 21' is extended to the rear and a metallic closure plate 85 is secured at the back around the outside of the block as by soldering or welding at 86 around the joining edge. The closure plate has openings 87 through which the terminals 88 pass, the terminals in this case being preferably of round form rather than strip as previously shown. Fused glass beads 90 are melted in place in the openings 87, making hermetic seals to the terminals and to the plate 85.

In some cases it is desirable to set the metallic plate 85' into the back of the housing, and to cover the beads 90 and the plate by molding insulation 91 around the back of the housing and around the terminals. The terminals may have any suitable form, for example they will desirably have threaded sockets 92.

The sealing around the toggle lever is a difficult problem and I offer several solutions for the same in Figures 23 to 26. In Figure 23 the toggle lever 57' has an annular shoulder 93 around the inner end of the ball pivot surface and this is sealed by soldering or welding at 94 to a resilient metallic bellows 95 which is outwardly flanged at 96 at the inner end and soldered or welded at 97 into the inside of the shoulder portion 50 of the front of the housing portion 21. A pivot pin 58' extends through the toggle lever at the center of the pivot, and is supported in the housing.

In some cases it is preferable to use an elastomer such as rubber or synthetic rubber (silicone rubber, chloroprene, Buna S, Buna N or the like). In Figure 24 the toggle lever 57^2 has a separate operating projection 98 threaded at 100 into its inner end and immediately adjoining the inside of the ball pivot. An annular recess 101 is machined on the inner end of the ball pivot and an external annular flange 102 is formed at the outside of the recess. A resilient elastomer diaphragm 103 has inner flanges 104 and 105 which engage respectively inside and outside the flange 102 and are clamped in place by a washer 106 and nut 107 on the threads at 100. At the outside a suitable metallic annular rim 108 is crimped around the outer flange portion 110 of the diaphragm and the rim is suitably united as by soldering at 111 inside of the shoulder portion 50 of the housing.

In some cases it is preferable to accomplish the seals to the elastomer bellows both inside and outside by soldering or the like. In Figure 25 the toggle lever 57^3 has an annular recess 112 at the inner end of the ball portion and this re-

ceives an outwardly disposed crimped metallic rim 113 around elastomer diaphragm 114. The rim is united to the lever as by soldering at 115. At the outside in this form the seal is made as in Figure 24.

In some cases it is desirable to use a metallic diaphragm or bellows and to restrict the motion. This can be done by making the joint very close to the pivot. In Figure 26 I show a toggle lever 57^4 which has a socket 115 at the inner end of the ball portion 53 which receives a lost motion (ball) connection 116 of an operating lever 117 pivoted at 118 in the housing. The operating lever extends in prolongation of the toggle lever in mid-position. At the forward end the operating lever has a suitably ball-type operating projection 120 which engages in the recess of the hill-and-valley projection as in the other forms. A resilient diaphragm 121 in this case suitably of spring metal such as bronze, or beryllium copper or stainless steel, surrounds the operating lever, and is secured thereto as by soldering or welding at 122 adjacent the pivot so that there will be a minimum of motion at the inside. At the outside the flange 123 on the diaphragm is soldered or welded at 124 at a shoulder 125 of the metallic portion 21' of the housing.

In operation of any of the forms of Figures 20 to 26 inclusive, it will be understood that one of these forms will be applied to the front and also to the back of the housing of any of the switches of Figures 1 to 19, where a hermetic seal is desired.

In some instances it is desirable to operate the switch of the invention by a push button as shown in Figures 27 and 28, which show a switch having contacts, a contact roller 35, a cradle 40 and a hill-and-valley projection 52 like those shown in Figures 1 to 11. The housing at the front has a cylindrical chamber 126 which guides the annular shoulder portion 127 of a cylindrical push button 128 held against leaving the housing by a suitably spun rim 130 on the front of the housing. The push button is retracted by spiral compression spring 131 acting against the push button from spring abuttment 132 around the inside of the housing.

A rocker 117' is centrally pivoted at 118' near the hill-and-valley projection, and has an operating projection 120 which engages in socket 55 of the hill-and-valley projection.

The rocker has symmetrical diverging hillside cams 133 on the opposite sides of an apex 134 facing toward the push button and each hillside cam ends at the side remote from the apex in a pusher socket 135.

The push button carries a resilient cam follower finger 136 extending symmetrically from the push button into contact with one or other of the hillside cams. The finger 136 may be of spring metal or of stiff resilient rubber or synthetic rubber.

In operation, when the push button is pushed in the position of Figure 27, it moves forward, and finger 136 travels down the hillside cam it is engaging, forcing the rocker counterclockwise and throwing the hill-and-valley projection toward the right. In case the rocker has not been thrown to the opposite limiting position when finger 136 engages in the left hand pusher socket 135, the end of the finger 136 pushing in pusher socket 135 at the left completes the throw of the rocker, throwing the switch to the position shown in Figure 28.

When the push button is released, it retracts under the action of spring 131, and finger 136 under its resilience snaps across apex 134 and engages hillside cam 133 at the right as shown in Figure 28, the next time the push button is pushed, finger 136 moves down the right hand hillside cam, and engages the right hand pusher socket, throwing the switch to the position of Figure 27.

On retraction the finger 136 jumps to the left side of the apex as in Figure 27, and is ready to operate as described in referring to Figure 27.

It will further be evident that while I have shown the invention applied primarily to aircraft instrument switches, it may be used in other applications, both instantaneous contact switches and continuous contact switches, as desired.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claim.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an electric switch, a pair of contacts positioned side by side, a hill-and-valley projection movable toward and away from the contacts along a line generally transverse to the contacting surfaces of the contacts, a contact roller movable over the hill-and-valley projection and in one position bridging the contacts and engaging the contacting surfaces and spring means urging the contact roller against the hill-and-valley projection and against the contacts in one position along a line generally longitudinal of the contacting surfaces.

2. In an electric switch, a pair of opposed contacts having contacting faces and located side by side, a hill-and-valley projection movable toward and away from the contacting faces along a line generally transverse thereto, a contact roller engaging the hill-and-valley projection and in one position bridging the contacts and engaging the contacting surfaces, a cradle pivotally mounting the contacting roller and rockable with the contacting roller as it rides over the hill-and-valley projection and spring means urging the cradle and the contacting roller against the hill-and-valley projection and urging the contacting roller against the contacts in one position of the switch along a line generally parallel to the contacting surfaces.

3. In a switch, a pair of spaced contacts side by side and having contacting faces, a hill-and-valley projection electrically insulated from the contacts and movable toward and away from the contacting faces along a line generally transverse thereto, a contact roller engaging the hill-and-valley projection and in one position engaging the contacting faces of the contacts, the contact roller having a journal portion, an electrically insulating cradle having a bearing rotatably mounting the contact roller at the journal portion and rockable toward and away from the contacting faces, and a spiral compression spring supported from a rocking pivot at a position remote from the cradle, engaging the cradle on the side remote from the hill-and-valley projection and rockable with the cradle as the contact roller moves over the hill-and-valley projection.

4. In a switch, a pair of spaced contacts side

by side and having contacting faces, a hill-and-valley projection electrically insulated from the contacts and movable toward and away from the contacting faces along a line generally transverse thereto, a contact roller engaging the hill-and-valley projection and in one position engaging the contacting faces of the contacts, the contact roller having a journal portion, an electrically conducting cradle having a bearing rotatably mounting the contact roller at the journal portion and rockable toward and away from the contacting faces, a spiral compression spring supported from a rocking pivot at a position remote from the cradle, engaging the cradle on the side remote from the hill-and-valley projection and rockable with the cradle as the contact roller moves over the hill-and-valley projection, and a terminal making electrical contact with the spring.

5. In an electric switch, a pair of spaced contacts side by side and having contacting faces disposed in the same direction, a hill-and-valley projection movable toward and away from the contacting faces along a line transverse thereto, the hill-and-valley projection having guides, a switch housing supporting the contacts in insulating relation and having guideways which cooperate with the guides on the hill-and-valley projection and control the path of the hill-and-valley projection as it moves transversely back and forth, a contact roller engaging the hill-and-valley projection and in one position bridging the contacts and engaging the contact faces, a cradle pivotally mounting the contact roller on an axis extending across between the contacts, and a spring rockably pivoted at one end engaging the cradle at the other end on the side remote from the hill-and-valley projection, the spring rocking back and forth with the cradle as the hill-and-valley projection moves.

6. In a switch, two opposed pairs of spaced contacts on either side of an intermediate space and having opposed contact faces, a hill-and-valley projection movable transversely to the contact faces toward and away from each set of contacts at a position beyond the contacts, a contact roller bridging the contacts of one pair in each of the extreme positions and engaging the hill-and-valley projection, and spring means urging the contact roller against the hill-and-valley projection and against the pair of contacts with which the contact roller is in contact.

7. In a switch, two opposed pairs of spaced contacts on either side of an intermediate space and having opposed contact faces, a hill-and-valley projection movable transversely to the contact faces toward and away from each set of contacts at a position beyond the contacts, a contact roller bridging the contacts of one pair in each of the extreme positions and engaging the hill-and-valley projection, a cradle pivotally supporting the contact roller and rockable with the contact roller back and forth between the respective pairs of contacts and a spiral compression spring rockably positioned at the end remote from the cradle and engaging the cradle at the side remote from the hill-and-valley projection, urging the cradle and the contact roller toward the hill-and-valley projection and toward the adjoining pair of contacts.

8. In an electric switch, a plurality of opposed pairs of spaced contacts arranged side by side, a hill-and-valley projection movable toward and away from the respective pairs of contacts on a path generally transverse thereto, and located beyond one end of the contacts, a lever pivoted on the side of the hill-and-valley projection remote from the contacts, engaging the hill-and-valley projection and adapted to throw the same toward either one of the pairs of contacts, a contact roller engaging the hill-and-valley projection and one pair of the contacts in each limiting position, a cradle pivotally mounting the roller on an axis extending across between each pair of contacts and rockable with the contact roller from one pair of contacts to the other, and a spring engaging the cradle on the side remote from the hill-and-valley projection and urging the roller toward the hill-and-valley projection.

9. In an electric switch, two pairs of opposed spaced contacts, there being a space between the contacts in each pair which is in line with the space between the contacts of the opposite pair, a hill-and-valley projection movable toward and away from the contacts of each pair along a path generally transverse thereto and beyond the ends of the contacts, a contact roller riding the hill-and-valley projection, engaging the contacts of each pair in extreme positions and shorting the same, an electrically insulating cradle pivotally supporting the roller on the side remote from the hill-and-valley projection and having extensions into the space between each pair of contacts to reduce arcing across between the contacts of each pair and a spring engaging the cradle on the side remote from the hill-and-valley projection, urging the contact roller toward the hill-and-valley projection and rockable with the cradle, there being an annular groove intermediate the ends of the contact roller which receives the cradle and provides journal support for the roller.

10. In an electric switch, two pairs of opposed contacts, an abutment between the same and spaced from the contacts of each pair, a double hill-and-valley projection movable toward and away from each pair of contacts on a line generally transverse thereto and having two hills spaced by an intermediate valley disposed toward the contacts, two contact rollers one positioned between each of the pairs of contacts and the abutment and engaging the hill-and-valley projection and in one position engaging the contacts of a particular pair, and spring means resiliently urging each contact roller toward the hill-and-valley projection and rockable as the contact roller engages the contacts or the abutment alternatively.

11. In an electric switch, two pairs of opposed contacts, an abutment between the same and spaced from the contacts of each pair, a double hill-and-valley projection movable toward and away from each pair of contacts on a line generally transverse thereto and having two hills spaced by an intermediate valley disposed toward the contact, two contact rollers one positioned between each of the pairs of contacts and the abutment and engaging the hill-and-valley projection and in one position engaging the contacts of a particular pair, and spring means resiliently urging each contact roller toward the hill-and-valley projection and rockable as the contact roller engages the contacts or the abutment alternatively, the valley being wide enough to throw both contact rollers against the opposite sides of the abutment in one position.

12. In an electric switch, two pairs of opposed contacts, an abutment between the same and spaced from the contacts of each pair, a

double hill-and-valley projection movable toward and away from each pair of contacts on a line generally transverse thereto and having two hills spaced by an intermediate valley disposed toward the contacts, two contact rollers one positioned between each of the pairs of contacts and the abutment and engaging the hill-and-valley projection and in one position engaging the contacts of a particular pair, and spring means resiliently urging each contact roller toward the hill-and-valley projection and rockable as the contact roller engages the contacts or the abutment alternatively, and spring means urging the hill-and-valley projection toward one pair of contacts in its inactive position.

13. In an electric switch, a housing including a socket, a switch operating lever pivoting in the socket and having an operating handle beyond the socket at the outside of the housing, a slider movable transversely of the length of the lever and having a recess which engages the end of the lever remote from the operating handle, a spring in the slider recess pushing longitudinally on the lever, a hill-and-valley projection on the slider on the side opposite from the lever, a plurality of opposed pairs of spaced contacts arranged side by side and disposed adjacent the path of the slider with the slider moving transversely to the lengths of the contacts, a contact roller engaging the hill-and-valley projection and one pair of contacts in each limited position, a cradle pivotally mounting the contact roller on an axis extending across between each pair of contacts and rockable with the contact lever from one pair of contacts to another and a spring engaging the cradle on the side removed from the hill-and-valley projection and urging the contact roller toward the hill-and-valley projection.

14. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, spring means urging the contact roller against the hill-and-valley projection, a pivoted rocker having an operating projection engaging the hill-and-valley projection and having opposed cam faces on the side remote from the hill-and-valley projection which throw the hill-and-valley projection in opposite directions on engagement with the opposite cams, and means for selectively applying pressure to the respective cams.

15. In a push button switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, spring means urging the contact roller against the hill-and-valley projection a centrally pivoted rocker having an operating projection engaging the hill-and-valley projection and having opposed hillside cams on the side remote from the hill-and-valley projection with a central apex between the hillside cams, a push element movable toward and away from the midposition of the rocker and a resilient cam follower finger on the push element engaging the respective hillside cams and snapping across the apex from one cam to the other.

16. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, spring means urging the contact roller against the hill-and-valley projection, a pivoted rocker having an operating projection engaging the hill-and-valley projection, having opposed hillside cams on the side remote from the hill-and-valley projection with an apex between the hillside cams, and having a pusher socket at the end of each hillside cam remote from the apex, a push element movable toward and away from the midposition of the rocker and a resilient cam follower finger on the push element engaging the respective hillside cams and the respective pusher sockets and snapping across the apex from one cam to the other.

17. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, a cradle pivotally mounting the contact roller, a rockably mounted spring urging the cradle and the contact roller toward the hill-and-valley projection and a push element reversing mechanism throwing the hill-and-valley projection oppositely on successive actuations.

18. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, a cradle pivotally mounting the contact roller, a rockably mounted spring urging the cradle and the contact roller toward the hill-and-valley projection, a pivoted rocker having an operating projection engaging the hill-and-valley projection and having opposed cam faces on the side remote from the hill-and-valley projection which throw the hill-and-valley projection in opposite directions on engagement with the opposite cams, and means for selectively applying pressure to the respective cams.

19. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, a cradle pivotally mounting the contact roller, a rockably mounted spring urging the cradle and the contact roller toward the hill-and-valley projection, a centrally pivoted rocker having an operating projection engaging the hill-and-valley projection and having opposed hillside cams on the side remote from the hill-and-valley projection with a central apex between the hillside cams, a push element movable toward and away from the midposition of the rocker and a resilient cam follower finger on the push element engaging the

respective hillside cams and snapping across the apex from one cam to the other.

20. In a push switch, a pair of spaced contacts side by side, an abutment spaced from and facing the contacts, a hill-and-valley projection movable transversely of the contacts toward and away from the contacts and the abutment, a contact roller engaging the hill-and-valley projection and in limiting positions engaging the contacts or the abutment, a cradle pivotally mounting the contact roller, a rockably mounted spring urging the cradle and the contact roller toward the hill-and-valley projection, a pivoted rocker having an operating projection engaging the hill-and-valley projection, having opposed hillside cams on the side remote from the hill-and-valley projection with an apex between the hillside cams, and having a pusher socket at the end of each hillside cam remote from the apex a push element movable toward and away from the midposition of the rocker and a resilient cam follower finger on the push element engaging the respective hillside cams and the respective pusher sockets and snapping across the apex from one cam to the other.

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