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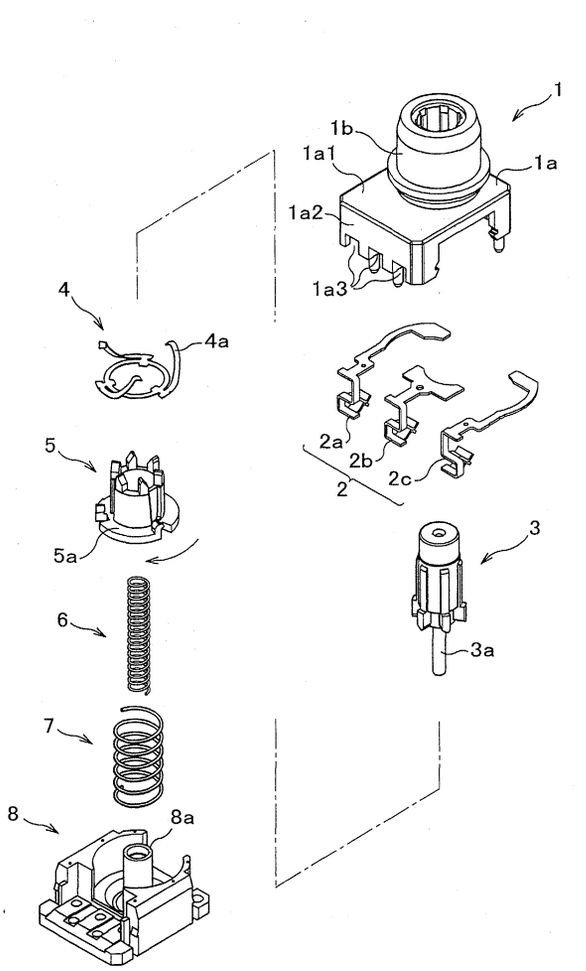
(54) Pushbutton switch

(57) A pushbutton switch, comprising an upper case (1) having a cylinder portion (1b); a button (3) which is capable of a sliding motion along the cylinder portion (1b); a rotor (5) having a flange (1a) at the bottom thereof which performs a sliding reciprocating motion while rotating in the predetermined direction responding to reciprocating motion of a button (3) by setting the axis of rotation as the long axis of the cylinder portion (1b); a contact segment (4) which is inserted in the rotor (5) and latched by the flange (5a); and stationary terminals (2a, 2b, and 2c) provided as opposed to the contact segment (4), wherein the stationary terminals have terminal portions or the cable holding ports to which lead cables are fixed and a rotor (5) carries out a predetermined angle rotation for every reciprocating motion of the button (3) to effect alternating ON/OFF switching action; arms (4a) are curving toward stationary terminals (2a,2b and 2c) in the contact segment (4); and the arms (4a) elastically buckle in accordance with the variation in distance between stationary terminals (2a,2b and 2c) and a rotor (5) caused when the rotor (5) performs a sliding reciprocating motion so as to retain the contact between stationary terminals (2a,2b and 2c) and the contact segment (4).

FIG.1



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Description

[0001] The present invention relates to a pushbutton switch, more specifically, a pushbutton switch a contact point of which is activated by an axially disposed cam.

[0002] Various forms are proposed as a pushbutton switch in which a contact point is activated by axially disposed cam.

[0003] For example, a pushbutton switch as shown in Fig. 16 to Fig. 22 is proposed in JP-A-2-72526.

[0004] Shown in an exploded perspective view of Fig. 16 is a pushbutton switch defined in JP-A-2-72526, comprising:

an actuator housing 101 having substantially cylindrical passage 101a in which a pushbutton 100 and the like as below-mentioned is contained; the pushbutton 100 having a cylindrical-shaped cylinder portion 100a (Fig. 18B) which is engaged with the passage 101a; an actuator cam follower 102 having a square shaped internal cavity portion 102a to be square columnar shape inside where a rotary contact carrier 104 as hereinafter referred is fitted loosely onto; an actuator return spring 103 which is interposed between the actuator cam follower 102 and the rotary contact carrier 104 as described below and intended to upwardly urge the actuator cam follower 102, or downwardly urge the rotary contact carrier 104; a rotary contact carrier 104 which has a stem 104a fitted into loosely onto the square shaped internal cavity portion 102a and is rotated in the flat surface portions according to a predetermined angle rotary motion of the actuator cam follower 102 to allow the rotary contact element 105 in the bottom to effect an electric connection as referred below and electrical isolation of the electric contact elements 106a, 106b, and 106c as referred below, and performs the alternating ON/OFF switching action; a stationary contact housing portion 106 wherein the electric contact elements 106a, 106b, and 106c are arranged in predetermined form; and a covering part 107 which covers the bottom of a pushbutton switch.

[0005] Subsequently, main element members of a pushbutton switch described in JP-A-2-72526 will be discussed hereinafter.

[0006] Fig. 17 is a sectional view of an actuator housing 101. A cylindrical passage way 101a with which a pushbutton 100 is engaged formed in the actuator housing 101. Pushbutton guides 101b in the profile of projection along the longitudinal direction at an equal spacing are formed in the inner surface of this passage 101a. Adjoining pushbutton guides 101b and 101b are separated by guide portions 101c which are recessed grooves. The lower ends of such pushbutton guides 101b are formed in slant surfaces, and serve as cam surfaces 101d.

[0007] Fig. 18A is a side view of a pushbutton 100, and Fig. 18B is a sectional view of a pushbutton 100. The pushbutton 100 is a hollow cylindrical member having a cylindrical-shaped cylinder portion 100a inside thereof. And four slide guides 100b (only three of them are displayed in Fig. 18A) are disposed in a lower end portions at 90-degree-intervals extending outwardly in the radial direction. This slide guides 100b are slidably engaged with the guide recess portions 101c (Fig. 17), and guide a pushbutton 100 linearly at the time of reciprocating motion of the pushbutton 100. The lower end portions of a pushbutton 100 are formed into saw teeth. Each saw tooth 100c consists of apex 100d and slant-shaped cam sides 100e which surround the apex 100d. Eight saw teeth 100c are disposed in the lower end portions of the pushbutton 100 equally spaced at 45 degree intervals.

[0008] As shown in Fig. 18B, the central axis of a slide guide 100b (Fig. 18B) is provided to pass through the apex 100d of each saw tooth 100c.

[0009] Fig. 19A is a side view of an actuator cam follower 102, and Fig. 19B is a sectional view of an actuator cam follower 102. An actuator cam follower 102 is a hollow cylindrical member which has a circular opening and a square columnar shaped internal cavity portion 102a in the square columnar shape inside thereof, as shown in Fig. 19B.

[0010] An actuator cam follower 102 is a member slidably fittingly mounted into above cylindrical cylinder portion 100a (Fig. 18B). Also, predetermined angle rotation is carried out by the cam action as hereinafter referred, while performing a vertical movement along with the reciprocating motion of a pushbutton 100, so that a translating mechanism that converts linear motion of a pushbutton to rotary motion is achieved.

[0011] The lower part of actuator cam follower 102 is adapted to a diameter expansion part 102b, diameter of which was expanded. A saw tooth 102c which has the same form as a saw tooth 100c (Fig. 18A and 18B) provided in the pushbutton 100 is provided at the upper end of this diameter expansion part 102b. Such saw tooth 102c consists of the apex 102d and slant-shaped cam sides 102e which surround the apex 102d. Further, from a diameter expansion part 102b of an actuator cam follower 102, cam follower guides 102f are extending outwardly in the radial direction spaced at a 90 degree interval.

[0012] The central axis of the slide guides 100b (Fig. 18A) of the pushbutton 100 is provided to pass through the apex 100d of each saw tooth 100c, whereas, the central axis of the cam follower guides 102f is provided to be offset from the apex 102d of the saw tooth 102c slightly.

[0013] Fig. 20 is a side view of a rotary contact carrier 104. The rotary contact carrier 104 is a member including a rotary contact element 105 which consists of a square columnar stem 104a formed in a tapered twisted end as going up, and a substantially circular metal plate

provided in the bottom of this stem 104a.

[0014] A rotary contact carrier 104 is a member wherein a stem 104a thereof is slidably engaged with a square shaped internal cavity portion 102a (Fig. 19B). Rotation of an actuator cam follower 102 accompanying reciprocal operation of a pushbutton 100 is transmitted to a stem 104a through a square shaped internal cavity portion 102a. Then, a rotary contact element 105 carries out predetermined angle (predetermined-number-step) rotation with the result that the electric connection and electrical isolation of the electric contact elements 106a, 106b, and 106c which are the electrodes provided in the stationary contact housing portion 106 (Fig. 16) are effected. Then, alternate ON/OFF switching action is effected.

[0015] Incidentally, lubricant, such as grease, is applied to the inner part of the stationary contact housing 106 to thereby allow electric contact elements 106a, 106b, and 106c to be in less friction with a rotary contact element 105 at the time of sliding rotation.

[0016] Next, operation of a pushbutton switch disclosed in a JP-A-2-72526 will be discussed.

[0017] Fig.21 is a schematic diagram, wherein cam mechanism constituted by an actuator housing 101, a pushbutton 100, and an actuator cam follower 102 is deployed in a plane view.

[0018] Fig.21A is a diagram showing the state where the pushbutton 100 is not pressed. Wherein a pushbutton 100 and an actuator cam follower 102 are urged upwardly by an actuator return spring 103 (not shown) and are fixed. Hereafter, this state is referred as top dead center. In the top dead center, slide guides 100b (Fig. 18A and Fig. 18B) and cam follower guides 102f (Fig. 19) are engaged with guide recess portions 101c-A (Fig. 17). Further, a saw tooth 100c of a pushbutton 100 and a saw tooth 102c of an actuator cam follower 102 contact with other member by mutual cam sides 100e and 102e with a state that the phase thereof being offset. This is because, as described hereinbefore, in a pushbutton 100, the central axis of slide guides 100b is provided to pass through the apex 100d (Fig. 18A), whereas in an actuator cam follower 102, the central axis of the cam follower guides 102f is provided to be offset from the apex 102d of a saw tooth 102c (Fig. 19A).

[0019] When a pushbutton 100 is pressed to descend and bottom dead center is reached, resisting the opposing force of an actuator return spring 103, an actuator cam follower 102 is guided by guide recess portions 101c-A, and moves below. When projections of a cam follower guides 102f cross over the tip part of slant cam surfaces 101d in due course, an actuator cam follower 102 is separated from the guidance of guide recess portions 101c-A to slide on cam side 100e by the opposing force of the actuator return spring 103, and moves (rotates) by distance X leftward in a diagram to enable a saw tooth 100c of a pushbutton 100 and a saw tooth 102c of an actuator cam follower 102 to be engaged with a state of the phase thereof being in agreement (Fig. 21B). When the phase of a saw tooth 100c and a saw tooth 102c is in agreement, sound by pressing (a click of a latch) occurs when cam sides 100e and cam sides 102e collide.

[0020] According to Fig. 22, when a pushbutton 100 is released after the termination of a button-pressing action of a pushbutton 100, the pushbutton 100 and an actuator cam follower 102 g'o up rapidly by an opposing force of an actuator return spring 103. By this rise, a cam follower guide 102f collides with slant cam surfaces 101d to move (rotates) by bigger distance Y than distance X leftward in a diagram, sliding on the cam surfaces 101d. At the time of the rotation of this distance Y, a rotary contact carrier 104 engaged with an actuator cam follower 102 is rotated greatly to effect the ON/OFF switching action.

[0021] A cam follower guide 102f, being engaged with guide recess portions 101c-B in due course, goes up rapidly while guided by a guide recess portions 101c-B, and results in top dead center. In the top dead center, when cam sides 100e and cam sides 102e collide, the return sound "a click of a latch" occurs.

[0022] According to Fig. 22, when a pushbutton 100 is released after the termination of a button-pressing action of a pushbutton 100, a pushbutton 100 and an actuator cam follower 102 go up rapidly by the opposing force of the actuator return spring 103. By this rise, a cam follower guide 102f collides with slant cam surfaces 101d, and moves (rotates) leftward in the drawing by bigger distance Y than distance X sliding on cam surfaces 101d. At the time of the rotation of this distance Y, the rotary contact carrier 104 engaged with the actuator cam follower 102 rotates greatly, so as to effect the ON/OFF switching action.

[0023] A cam follower guide 102f will engage with guide recess portions 101c-B in due course, goes up rapidly while guided by guide recess portions 101c-B, and results in top dead center. In the top dead center, when cam sides 100e and cam sides 102e collide, the return sound "a click of a latch" occurs.

[0024] According to an important feature of the invention disclosed in JP-A-2-72526, alternating position ON/OFF of a switch is defined when a pushbutton 100 returns to top dead center from bottom dead center. If this is checked with a user's (man's) movement, when the user presses a pushbutton 100, and the press sound "a click of a latch" can be heard first. However, in this stage, alternating ON/OFF switching position is not defined, but if a button is pressed as far as reaching the bottom dead center and a hand is lifted, the return sound "a click of a latch" can be heard after that.

[0025] Thus, a user's feeling of operation and alternating ON/OFF position of the pushbutton switch disclosed in JP-A-2-72526 do not match. Therefore the user may have a sense of incongruity.

[0026] This has posed a technical problem to be solved. This invention makes it the first problem to provide a pushbutton switch wherein alternating ON/OFF

position of a switch is defined simultaneously with a press sound of the press button. In addition, in the reciprocal motion of the press button, alternating ON/OFF position of the switch can be effected at any time at will.

[0027] Also, a pushbutton switch disclosed in JP-A-2-72526 generates a return sound, "a click of a latch" by collision of cam sides 100e and cam sides 102e in top dead center caused by the opposing force of an actuator return spring 103 when a pushbutton 100 returns to the top dead center from the bottom dead center.

[0028] Hereupon, a pushbutton switch disclosed in JP-A-2-72526 has only one actuator return spring 103 to urge two members as a pushbutton 100 and an actuator cam follower 102. This necessitates the pushbutton switch to employ a spring with large spring constant and strong opposing force. Therefore, a problem such that return sound emitted by the collision of cam sides 100e and cam sides 102e is loud arises.

[0029] These are the problems which should be solved by this invention.

[0030] This invention thus is constituted to overcome the above discussed problems in the below-mentioned manner.

[0031] The invention defined in Claim 1 provides a pushbutton switch comprising:

> a case having an substantially cylindrical-shaped cylinder portion; a substantially cylindrical button fittingly mounted into the cylinder portion so as to be capable of a sliding motion along the cylinder portion; an substantially cylindrical rotor having a flange at the bottom which performs a sliding reciprocating motion along the cylinder portion while carrying out predetermined angle rotation in the predetermined direction by setting the rotation axis as the long axis of the cylinder portion; a substantially toroidal platy contact segment which is inserted by the rotor to be latched by the rotor; and plurality of stationary terminals provided in the case as opposed to the contact segment; wherein
> the rotor carries out predetermined angle rotation for every reciprocal motion of the button, then alternating ON/OFF switching position which repeats ON state where electrical contacts was effected between the fixed terminals and the contact segment, and OFF state where electrical contacts was broken, wherein
> tabular arms which are formed into a curving shape in the direction of stationary terminals and contact with the stationary terminals spaced at predetermined intervals are provided in the outer periphery portion of the contact segment, and the arms are buckled elastically to retain the contact between the stationary terminals and the contact segment according to variation in distance from the stationary terminals to a rotor generated at the time of the reciprocal sliding of the rotor.

[0032] The invention defined in Claim 2 provides a pushbutton switch comprising:

> a case having an substantially cylindrical-shaped cylinder portion; a substantially cylindrical button fittingly mounted into the cylinder portion so as to be capable of a sliding motion along the cylinder portion; an substantially cylindrical rotor having a flange at the bottom which performs a sliding reciprocating motion along the cylinder portion while carrying out predetermined angle rotation in the predetermined direction by setting the rotation axis as the long axis of the cylinder portion; a substantially toroidal platy contact segment which is inserted in the rotor and latched by the rotor; and plurality of stationary terminals provided in the case so as to be facing the contact segment; and wherein
> the rotor carries out predetermined angle rotation for every reciprocating motion of the button, then alternating ON/OFF switching position which repeats ON state where electrical contacts was effected between the fixed terminals and the contact segment, and OFF state where electrical contacts was broken, wherein
> plurality of lead cables fixed to cable holding ports made in the stationary terminal and led out from apertures made in the case; wherein,
> tabular arms which are curving toward the stationary terminals and contact with the stationary terminals are provided at locations each on an outer periphery of the contact segment spaced at predetermined intervals, and wherein the arms retain a contact between the stationary terminals and the contact segment by elastically buckling according to a variation in distance between the stationary terminals and the rotor generated when the rotor performs the sliding reciprocating motion.

[0033] Alternating ON/OFF switching position of a pushbutton switch is defined by making a button to move reciprocately to cause a rotor carry out predetermined angle rotation by changing the contact segment provided for the rotor into the state where electrical connection is broken from the state where electrical connection is 'made between stationary terminals. A pushbutton switch according to this invention provides a pushbutton switch in which by a button-pressing action, even if the distance between a rotor (contact segment) and stationary terminals spreads, the arms provided in the contact segment are buckled so that electrical contact between stationary terminals and the contact segment may be retained. Hence, it becomes possible by changing the degree of deflection (curvature) of arms to set up the timing of contact / non-contact state between stationary terminals and the arm at any time at will in a button-pressing action.

[0034] Also, it becomes possible by changing arrangement of stationary terminals to set up the timing of

alternating ON/OFF switching position of a pushbutton switch at any time at will in return operation of the button.

[0035] The invention defined in Claim 3 is a pushbutton switch of Claim 2, including soldering the lead cables extending from the stationary terminals so that the cable can be firmly connected to the stationary terminals.

[0036] The invention defined in Claim 4 is a pushbutton switch including a first spring which urges the rotor upwardly and a second spring which urges the button upwardly.

[0037] According to the invention given in Claim 4, a pushbutton switch is urging a button and a rotor upwardly with an independent spring respectively (a first spring and a second spring). Therefore, the spring with a smaller spring constant than conventional one can be used as each spring, so that it becomes possible for the return sound emitted when the rotor urged by the first spring at the time of return operation of the button collides with other components to be smaller than a conventional pushbutton switch.

[0038] Further, even when a rotor urged by the first spring at the time of return operation of a button collides with other components, a part of this collision power is spent on making the arms of the contact segment provided for the rotor buckle between stationary terminals (arms work as a cushion so to speak). This makes it possible to weaken the collision power when a rotor collides with other components resulting in allowing the return sound to be smaller than a conventional pushbutton switch.

[0039] The invention of Claim 5 provides a pushbutton, wherein

> projections are arranged in the longitudinal direction separated mutually by the guide recess portions in inner periphery of the cylindrical portion spaced at predetermined intervals; the lower end of' each projection serves as slant cylinder portion cam sides; ribs which are fitted loosely into the guide recess portions are formed in the outer periphery of the lower ends of the button; the lower ends of the ribs constitute slant button cam sides having substantially the same inclination with the cylinder portion cam sides; projections which are fitted loosely into the guide recess portions are formed in the upper ends of the rotor; the upper ends of the projections serve as slant rotor cam sides having substantially inverse inclination with respect to the button cam sides; the cam sides perform a sliding movement to the cylinder portion cam sides by being pressed along the guide recess portions at the time of reciprocating motion of the button; and the rotor cam sides carry out sliding movement along the button cam sides so that engagement with another adjoining guide recess may be achieved.

[0040] According to the invention defined in Claim 5, ribs of the button and projections of a rotor are fitted loosely into the guide recess portions provided in inner peripheral surface of the cylinder portion. When a button-pressing action is performed, button cam sides provided in the lower end portions of the ribs are caused to press rotor cam sides provided in the upper ends of projections of the rotor. Along with this, the button and the rotor perform a sliding movement downwardly along the guide recess portions. When projections of the rotor cross over the tip portions of slant cylinder portion cam sides in due course, the rotor cam sides slidingly carry out a predetermined angle rotation to move on the cylinder portion cam sides. At this time, "a click of a latch" is emitted.

[0041] When a button returns thereafter, rotor cam sides which were moving on the cylinder portion cam sides slide on the cylinder portion cam sides to engage with guide recess portions which are adjacent to above described guide recess portions while carrying out a predetermined angle rotation. At this time, a return sound "a click of a latch" occurs.

[0042] The invention of Claim 6 provides a pushbutton switch wherein projections for a prevention of an excessive rotation which are fitted loosely into the guide recess portions are provided along the longitudinal direction of the outer peripheral surface of the button.

[0043] According to the invention defined in Claim 6, projections for a prevention of an excessive rotation which are fitted loosely into the guide recess portions of the cylinder portion are provided on the outer peripheral surface of a button. Whereby, a button always slides along guide recess portions, which obviates the disadvantage that when the button is excessively pressed, ribs of the button cross over the tip part of the cylinder portion cam sides, resulting in being rotated inadvertently to ride over cylinder portion cam sides.

[0044] The invention defined in Claim 7 is a pushbutton switch wherein a guide pole is extending along the central axis of the button from lower end portion of the button. Then, in the case facing this guide pole, a cylindrical insertion portion having opening which has substantially the same diameter with that of guide pole is provided.

[0045] According to the invention defined in Claim 7, a guide pole is extending from the lower end portion of the button, so as to be inserted in the insertion portion provided in the bottom of a case when a button-pressing action is performed. The guide pole is moved as guided by this insertion portion, so that vertically caused slight movement with respect to the central axis of the button can be suppressed.

[0046] The invention of Claim 8 is a pushbutton switch including flat surface portions which are provided within the case and keep contact with the contact segment; and terminal portions for connecting the external wiring to the pushbutton switch. Wherein the terminal portions are extending downwardly from the flat surface portions into a shape of letter "U", as well as curving in spaced

apart relation from the flat surface portions.

[0047] According to the invention defined in Claim 8, terminal portions are curving from the flat surface portions into a shape of letter "U", and also are formed into a curving shape in spaced apart relation from the flat surface portions. Whereby, reliable external wiring can be maintained, irrespective of the form of the external wiring inserted in the terminal portions.

[0048] The invention of Claim 9 is a pushbutton switch wherein the stationary terminals are connected to a printed circuit board.

[0049] According to the invention defined in Claim 9, stationary terminals are arranged upon a printed circuit board, thereby providing for alternative electrical connections to a variety of applications.

[0050] In the drawings:

Fig. 1 is an exploded perspective view of a pushbutton switch of the first embodiment of this invention.

Fig. 2 is a perspective view (Fig. 2A) of an upper case of the first embodiment and a sectional view (Fig. 2B) taken along the line A-A shown in Fig. 2A.

Fig. 3 is a side view (Fig. 3B) of stationary terminals (Fig. 2A) of the first embodiment, and a side view (Fig. 2B) of terminal portions of the stationary terminals.

Fig. 4 is a perspective view (Fig. 4A), and a side view (Fig. 4B) of a button.

Fig. 5 is a perspective view (Fig. 5A), a front view (Fig. 5B), and a side view (Fig. 5C) of the contact segment.

Fig. 6 is a perspective view (Fig. 6A), and a side view (Fig. 6B) of a rotor.

Fig. 7 is a perspective view (Fig. 7A)A of the first spring, and a perspective view (Fig. 7B) of the second spring.

Fig. 8 is a perspective view of the lower case.

Fig. 9 is a schematic diagram (Fig. 9A) deploying a cam mechanism in a plan view when a button is existing in the top dead center, and a schematic diagram (Fig. 9B) showing a disposing relationship between a contact segment shown in Fig.10 A and the first terminal.

Fig. 11 is a schematic diagram (Fig. 11A) deploying a cam mechanism in a plan view when a button is existing in the bottom dead center, and a schematic diagram (Fig. 11B) showing a disposing relationship between a contact segment shown in Fig. 12A and the first terminal.

Fig. 13 is an exploded perspective view of a pushbutton switch of the second embodiment of this invention.

Fig. 14 is a perspective view (Fig. 14A) of an upper case of the second embodiment and a sectional view (Fig. 15B) taken along the line B-B shown in Fig. 15A.

Fig. 15 is a perspective view (Fig. 15A) of stationary terminals of the second embodiment, and a side view (Fig. 15B) of the status of fixing of the stationary terminals and the lead cables.

Fig. 16 is an exploded perspective view of a conventional pushbutton switch.

Fig. 17 is a sectional view of an actuator housing 101 in the conventional pushbutton switch.

Fig. 18 is a sectional diagram (Fig. 18A) of a pushbutton in a conventional pushbutton switch, and a side view (Fig. 18B) thereof.

Fig. 19 is a side view (Fig. 19A) of an actuator cam follower 102 in a conventional pushbutton switch and a side view (Fig. 18B) thereof.

Fig. 20 is a side view of a rotary contact carrier 104 in a conventional pushbutton switch.

Fig. 21 is a schematic diagram deploying a cam mechanism in a conventional pushbutton switch in a plan view.

Fig. 22 is a schematic diagram deploying cam mechanism in a conventional pushbutton switch in a plan view.

[0051] Hereinafter, exemplary embodiments of this invention will be discussed in conjunction with the drawings as needed.

The first embodiment

[0052] A pushbutton switch of the first embodiment regarding this invention will be explained with reference to Fig.1. A pushbutton switch according to this embodiment comprises:

a substantially square housing 1a; an upper case 1 having a substantially cylindrical shaped cylinder portion 1b provided in this housing 1a; three stationary terminals 2a, 2b, and 2c made up of conductive material which contact with a contact segment 4 as referred below; a button 3 which assumes a substantially cylindrical shape and adapted to be fittingly mounted into the cylinder portion 1b so as to be capable of a sliding motion in the vertical direction along the inner surface of the cylinder portion 1b and a guide pole 3a is extending from the bottom portion thereof; a contact segment 4 which assumes a substantially toroidal platy form made up of conductive material latched by the flange 5a of the rotor 5 as referred below and has tabular arms 4a which keep contact with the stationary terminals 2a, 2b, and 2c and is formed into a curving shape on the outer periphery portion in the direction of the stationary terminals 2a, 2b, and 2c spaced at predetermined intervals; a substantially cylindrical rotor 5 having a flange 5a at the bottom thereof which performs sliding reciprocating motion along the cylinder portion 1b while carrying out predetermined angle (predetermined step) rotation in the predetermined direction by setting the axis of rotation as the

long axis of the cylinder portion 1b; the second spring 6 which passes through the cylinder portion of this rotor 5 and urges the button 3 upwardly; the first spring 7 which surrounds this second spring 6 and urges coaxially provided rotor 5 upwardly; and a lower case 8 provided with a cylindrical insertion portion 8a so that a guide pole 3a may be inserted in the bottom thereof.

[0053] Operation of a pushbutton switch according to this embodiment will be briefly explained. Incidentally, in the following explanation, "top dead center" refers to a state when the button 3 is not pressed, and "bottom dead center" refers to the state where a button 3 is pressed to the point where the button 3 is not allowed to move below any longer.

[0054] In a pushbutton switch in a manner of alternating ON and OFF positions, when a button 3 is moved downwardly from the top dead center, the rotor 5 will also move downwardly along with a button 3. At this time, opposing force of the second spring 6 and opposing force of the first spring 7 which urges the rotor 5 is applied to the button 3.

[0055] 'When' a rotor 5 moves downwardly, distance between a contact segment 4 latched by the rotor 5 and stationary terminals 2a, 2b, and 2c spreads. However, the contact segment 4 includes arms 4a which are formed into a curving shape in the direction of stationary terminals 2a, 2b, and 2c. Therefore, by buckling, the arms 4a absorb this expansion to permit the contact segment 4 and stationary 2a, 2b, and 2c to be contacted and retained as such state. Accordingly, alternating ON/OFF state of a switch is maintained as such state also.

[0056] When a button 3 moves downwardly further, cam mechanism provided in a cylinder portion 1b, a button 3 and a rotor 5 work to effect the rotor 5 to carry out predetermined angle rotation simultaneously with a press sound "a click of a latch" as indicated by the arrow in Fig. 1. At this time, a contact segment 4 is also caused to be rotated along with the rotor 5, leading to change the state of the contact between stationary terminals 2a, 2b, and 2c and the contact segment 4. Thereby alternating ON/OFF switching motion is effected. Incidentally, cam mechanism will be described fully hereinbelow.

[0057] Further, at this time a guide pole 3a is under the state of being inserted in the insertion portion 8a provided in the lower case 8. Then, a guide pole 3a, that is, a button 3 performs a sliding motion in vertical direction while guided by the insertion portion 8a to allow the slight movement of the button 3 in the horizontal direction to be suppressed.

[0058] When a button 3 reaches bottom dead center and pressing force is removed (if a finger is lifted from a button 3), the button 3, receiving an opposing force from the second spring 6 for urging the button 3 and the first spring 7 for urging a rotor 5, starts a returning operation and moves upwardly. The rotor 5, receiving the opposing force of the first spring 7, presses the button 3 and a contact segment 4 upwardly. Along with this, the rotor 5 per se is also rises. When the rotor 5 rises to some extent, the cam mechanism works and the rotor 5 is further rotated as indicated by the arrow in the drawing and fixed with a return sound "a click of a latch" emitted simultaneously. After the rotor 5 is fixed, the button 3 is moved upwardly by the opposing force of the second spring 6 only, then returns to the original position (top dead center) before a button 3 is pressed

[0059] Subsequently, each component which constitutes a pushbutton switch of this embodiment will be described more fully hereinbelow.

[0060] Fig.2 A is a perspective view of an upper case 1, and Fig.2 B is a sectional view of Fig.2 A taken along the line A-A.

[0061] An upper case 1 consists of a rectangular parallelepiped-shaped housing 1a and a cylindrical-shaped cylinder portion 1b. The housing 1a consists of a horizontally flat upper end surface 1a1 and side walls 1a2 extending downwardly perpendicular to the horizontally flat upper end surface 1a1. In the inner peripheral surface of the cylinder portion 1b, six projections 1d which are mutually separated by the guide recess portions 1c and disposed spaced at 60 degree intervals in the longitudinal direction 'of the cylinder portion 1b are formed. Here, lower end portions of the respective projections 1d constitute cylindrical slant cam sides 1e. The side wall 1a2 has three recutangular apertures 1a3 which are made in a predetermined separation distance thereon and to which terminal portions 2a2, 2b2 and 2c2 described hereinbelow are alingned.

[0062] A cylinder portion 1b serves as a guide to lead a vertical reciprocating motion of a button 3 (Fig.4) as will be described hereinbelow. Also, cylinder portion cam sides 1e provided in the lower end portions of the projections 1d serve so as to cause the rotor 5 (Fig.6) as will be described below to be rotated in the circumferential direction.

[0063] Fig.3 A is a perspective view of terminal portions 2a2, 2b2, and 2c2, and Fig.3 B is a side view of the stationary terminals 2a, 2b, and 2c.

[0064] Stationary terminals 2a, 2b, and 2c are equipped in the back side of the upper end surface 1a1 (Fig.2 A), and consist of flat surface portions 2a1, 2b1, and 2c1 and terminal portions 2a2, 2b2, and 2c2 having an external wiring interposed therebetween by cooperation of a lower case 8 as referred hereinafter.

[0065] Stationary terminals 2a, 2b, and 2c are constituted of three terminals, that is, the first terminal 2a, the central terminal 2b, and the second terminal 2c. When a pushbutton switch is activated, two external wiring are adapted to be arranged such that one of them is connected to the central terminal 2b, and the remaining one is connected to either terminal of the first terminal 2a or the second terminal 2c. Incidentally, stationary terminals 2a, 2b, and 2c are made up of conductive components, such as copper.

[0066] Flat surface portions 2a1, 2b1, and 2c1 are

molded into a peculiar shape respectively. Flat surface 2b1 of the central terminal 2b is adapted to be formed into a shape making up the situation such as to retain a contact state between the arms 4a and the contact segment 4 all the time irrespective of the alternating ON/OFF positions of the switch. Also, flat surface portions 2a1 and 2c1 of the first terminal 2a and the second terminal 2c are formed into a shape making up the situation such as to repeat the alternating switching position of ON/OFF for every predetermined angle rotation of arms 4a of the contact segment 4. More specifically, ON is a state where electrical contact with arms 4a is effected and OFF is a state where electrical contact is broken.

[0067] Also, terminal portions 2a2, 2b2, and 2c2 are extending downwardly into a shape of letter "S" from the side portions of flat surface portions 2a1, 2b1, and 2c1, and a terminal portion consisting of a pair of upper and lower elastically pinching pieces that are formed into the right-hand direction in Fig. 3B. The upper elastically pinching pieces as 2a3, 2b3 and 2c3 and the lower ones as 2a4, 2b4 and 2c4 are formed into a shape of "V" in the side views and therefore the upper piece and lower one face each other so that the foreign metal rod 10 is held by being pinched. Since the terminal portions 2a2, 2b2 and 2c2 are formed into this formation, it is possible to firmly pinch 'the foreign metal rod by keeping a high pressure force at the contact surface between the rod and the pinching metal pieces. Incidentally, by way of example, a central terminal 2b is adapted to serve as a COM terminal, and either one of the second terminal 2c is adapted to serve as a dummy terminal.

[0068] Fig.4 A is a perspective view of a button 3, and Fig.4 B is a side view of a button 3.

[0069] A button 3 is a substantially cylindrical member and an upper end surface 3b is intended to be press surface suitable for a pressing-button action. Also, a guide pole 3a as described hereinbefore is extending downwardly from the center of the lower end surface 3c. Further, six ribs 3d which are fitted loosely into the guide recess portions 1c of the cylinder portion 1b and overhanging outwardly in the radial direction is provided spaced at 60 degree intervals on the outer periphery surface of the lower end surface 3c. Lower end portions of the ribs 3d are intended to be slant button cam sides 3e which are inclined substantially in the same direction with above-described cylinder portion cam sides 1e (Fig. 2B). Also, projections 3f for a prevention of an excess rotary motion are provided on the outer periphery of the button 3, following the upper end of the ribs 3d. The projections 3f for a prevention of an excess rotary motion are shorter than the ribs 3d, and are fitted loosely into the guide recess portions 1c (Fig. 2B) along with the ribs 3d.

[0070] A button 3 is a member adapted to be fittingly mounted into above-described cylinder portion 1b (Fig. 2B). Ribs 3d and projections 3f for a prevention of an excess rotary motion are fitted loosely into guide recess portions 1c disposed spaced at 60 degree intervals in the cylinder portion 1b (Fig. 2B). The button 3 performs a linear reciprocating motion along the guide recess portions 1c (Fig.2 B).

[0071] Projections 3f for a prevention of an excess rotary motion are intended to serve as guides to lead a button 3 up and down. Namely, under the circumstances that the button 3 is pressed to excess and the ribs 3d are separated from the guide recess portions 1c (Fig. 2B), the projections 3f for a prevention of an excess rotary motion are engaged with the guide recess portions 1c, so that the movement of the button 3 is limited to up and down only. Thus, mal-function such that in case the ribs 3d separate from the guide recess portions 1c (Fig. 2B), the button 3 is circumferentially rotated to ride over the projections 1d (Fig. 2B) of the cylindrical portion 1b is obviated.

[0072] Fig. 5A is a perspective view of a contact segment 4, Fig. 5 B is a front view of the contact segment 4, and Fig.5 C is a side view of the contact segment 4.

[0073] A contact segment is a substantially toroidal platy member which consists of conductive components such as copper, and three arms 4a provided on the toroidal base 4b and outer periphery of the toroidal base 4b spaced at 120 degree intervals. The arms 4b are obliquely upwardly (in the direction of stationary terminals 2a, 2b, and 2c) extending (Fig.5 C) in such a manner as going along the 'outer periphery of the base 4b viewed from the front, and assume a curving form viewed from the side at the connection part with the base 4b. The arms 4a consist of the material having flexibility, which contributes to its buckling property like a leaf spring which are free to buckle when a force is applied from upward and return to the original form when this force is removed.

[0074] In this manner, a contact segment 4 of the first embodiment has arms 4a which are free to buckle like a leaf spring. In the process that a button 3 which is pressed to the bottom dead center (Fig. 4) returns to the top dead center, a rotor 5 (Fig. 6) collides with other member by the opposing force and a return sound "a click of a latch" is emitted. However, in a pushbutton switch according to this embodiment, the arms 4a of the contact segment 4 buckle and serve as a cushion. This enables the return sound to be smaller compared to a conventional pushbutton switch.

[0075] Also, in an inner periphery of a base 4b, latching portions 4c are extending for a engagement with recesses 5e of a rotor 5 (Fig. 6) as explained below in a manner as to cause the contact segment 4 to be latched by the rotor 5 (Fig. 6A and Fib. 6B).

[0076] The contact segment 4 is a member which is latched by a rotor 5 (Fig. 6A and Fig. 6B) so as to be rotated as the rotor 5 (Fig. 6) rotates. Alternating ON/OFF switching action is thus effected. The operation of this contact segment 4 will be explained along with the rotor 5 (Fig. 6) as described hereinbelow.

[0077] Fig. 6A is a perspective view of a rotor 5, and Fig. 6B is a side view of the rotor 5.

[0078] A rotor 5 is a substantially cylindrical member which has a cylindrical main part 5b and a flange 5a latched by the contact segment 4 (Fig. 5A, Fig. 5B, and Fig. 5C) in the bottom portion of the main part 5b. A diameter of the main part 5b is one size larger than the diameter of the button 3 (Fig. 4A and Fig. 4B) and is equal to the circle accomplished by the outer periphery of six ribs 3d.

[0079] On an upper end surface of the main part 5b which is fitted loosely into the guide recess portions 1c, projections 5c are set up spaced at 60 degree intervals. Upper end of the projections are applied to be rotor cam sides 5d having an opposite inclination to the button cam sides 3e. Also, recesses 5e are formed on the side of a main part spaced at 120 degree intervals in the longitudinal direction. The latching portion 4c (Fig. 5B) of the contact segment 4 (Fig. 5) as described hereinbefore is mated with the recesses 5e, to thereby fix the contact segment 4 (Fig. 5A, Fig. 5B and Fig. 5C) to the flange 5a. Also, projecting portions 5f are provided on the upper surface of the flange 5a. The projecting portions 5f are pressingly fixed to the backside of the upper end surface 1a1 (Fig. 2A) while a button 3 (Fig. 4A and Fig. 4B) is existing at the top dead center, thereby serving as members to enable a moderate space to be maintained between the contact segment 4 (Fig. 5A, Fig. 5B and Fig. 5C) and stationary terminals 2a, 2b, and 2c.

[0080] A rotor 5 is a member having a translating mechanism that converts linear motion of a button 3 (Fig. 4A and Fig. 4B) to rotary motion. And also, it is a member for effecting a ON/OFF switching action by cooperation of a contact segment 4 (Fig. 5A, Fig. 5B and Fig. 5C). When the button 3 (Fig. 4A and Fig. 4B) is present in the top dead center, the rotor 5 is under the state of pressingly fixed at the backside of the upper end surface 1a1 (Fig. 2A) by an opposing force of the first spring 7. At this time, the upper end surface of the flange 5a and the backside of the upper end surface 1a1 (Fig. 2A) are not closely brought into contact because the projecting portions 5f provided in the flange 5a are existing there, but face each other with a certain space vacated. The contact segment 4 latched by the flange 5a in the top dead center is kept in the space vacated by the flange 5a and the backside of the upper end surface 1a1 (Fig.2 A) in the state of the arms 4a buckled. Along with this, successive ON/OFF electrical contact is effected between the stationary terminals 2a, 2b, and 2c provided at the backside of the upper surface 1a1 (Fig. 2A)

[0081] When a button 3 (Fig. 4) is pressed, button cam sides 3e descend along guide recess portions 1c while pressing rotor cam sides 5d, that is, a rotor 5. At this time, the space between a flange 5a and the upper end surface 1a1 (Fig. 2A) spreads gradually. However, arms 4a which suited the state of buckling retained the state of an electrical contact between stationary terminals 2a, 2b, and 2c by extending gradually corresponding to expansion of the interval therebetween. Accordingly switching position of ON/OFF is retained as it is.

[0082] Further, when a button 3 (Fig. 4A and Fig. 4B) is pressed and rotor cam sides 5d descend downwardly of the lower end portions of the guide recess portions 1c, the rotor cam sides 5d separate from the guide of the guide recess portions 1c to circumferencially slide the slant cylinder portion cam sides 1e which separate the guide recess portions 1c with each other. Namely, predetermined angle rotation of the rotor 5 is caused to be carried out. At this time, a contact segment 4 (Fig. 5A, 5B and 5C) which is fixed to the rotor 5 is also rotated along with the rotor 5. This renders the circumstance that the electrical contact between the arms 4a and the stationary terminals 2a, 2b, and 2c is changed and the alternating ON/OFF switching action is effected.

[0083] In this manner, alternating ON/OFF switching action in the first embodiment of this invention is effected in the state where arms 4a have gone slack. This permits the friction generated between the arms 4a and the stationary terminals 2a, 2b, and 2c at the time of rotation of the arms 4a to be smaller than the conventional pushbutton switch. Hence, it became unnecessary to enclose grease etc., between the arms 4a and the stationary terminals 2a, 2b, and 2c.

[0084] Fig. 7A is a perspective view of the first spring 7, and Fig. 7B is a perspective view of the second spring 6.

[0085] The first spring 7 is a member fittingly mounted between a lower case 8 and a rotor 5 (Fig. 6A and Fig. 6B) to urge the rotor 5 (Fig. 6A and Fig. 6B) upwardly all the time. Also, the second spring 6 is a member fittingly mounted between the lower case 8 and a button 3 (Fig. 4A and Fig. 4B) to urge the button 3 (Fig. 4A and Fig. 4B) upwardly all the time. The second spring 6 is a coil spring having a smaller diameter than the first spring 7. Also, the first spring 7 and the second spring 6 are provided in a coaxial manner.

[0086] With this arrangement, according to the first embodiment, a button 3 (Fig. 4A and Fig. 4B) and a rotor 5 (Fig. 6A and Fig. 6B) are urged by the separate spring. In the process of the button 3 wherein the button 3 pressed as far as the bottom dead center returns to the top dead center, a return sound "a click of a latch" is emitted. This return sound is emitted by an opposing force of the first spring 7 when the rotor 5 (Fig.6A and Fig.6B) collides with other member.

[0087] Generally, only one spring is used in a conventional pushbutton switch. A returning action of the member corresponding to a button and a rotor has been covered by this one spring. Therefore, it was needed that, as a spring, a strong spring with a bigger spring constant than the first spring 7 of the first embodiment was used. Hence, a bigger return sound was emitted by a mutual collision of the members with a strong force when the button returns by an opposing force of the spring.

[0088] However, according to the first embodiment, the spring which urges a button 3 (Fig.4) and the spring which urges a rotor 5 (Fig.6) is arranged separately. Hence, it becomes possible to use the spring with a

smaller spring constant to enable the return sound emitted by the mutual collision of the rotor (Fig.6) and other members when the button 3 (Fig.4) returns to be smaller than a conventional spring.

[0089] Fig. 8 is a perspective view of a lower case 8.

[0090] The lower case 8, engaged with an upper case 1 constitutes a bottom part of a pushbutton switch. The lower case 8 includes a cylindrical insertion portion 8a disposed corresponding to a guide pole 3a of the button 3 (Fig. 4). The insertion portion 8a has an opening portion with a little expanded diameter. In this expanded diameter portion, the second spring for urging above described button 3 (Fig. 4) is inserted. Also, a rotor 5 (Fig. 6) as described hereinbefore is fitted loosely into this cylindrical insertion portion 8a outside. The first spring which urges the rotor 5 (Fig. 6) is provided to be coaxial with the second spring in a manner as to surround the second spring 6 to be supported at the bottom portion 8d of the lower case 8.

[0091] Also, the lower case 8, set up from the bottom, includes side walls 8b and 8c forming the side surfaces of a pushbutton switch. The upper end surfaces 8b1 and 8c1 of these side walls 8b and 8c are closely brought into contact with a backside of the upper end surface 1a1 (Fig. 2A) when engaged with the upper case 1 to interpose a flat portion 2a1, 2b1, and 2c1 of stationary terminals 2a, 2b and 2c therebetween, to thereby serve as to fix the stationary terminals 2a, 2b, and 2c.

[0092] Subsequently, the operation of cam mechanism of a pushbutton switch and alternating ON/OFF switching action will be explained in conjunction with Fig. 9 to Fig. 12.

[0093] Fig. 9A, Fig. 10A, Fig. 11A, and Fig. 12A are schematic diagrams of cam mechanism constituted by a cylinder portion 1b, a button 3 (Fig. 4), and a rotor 5 (Fig. 6) deployed in a plan view. Fig. 9B, Fig. 10B, Fig. 11B, and Fig. 12B, are schematic diagrams of disposing relationship between a contact segment 4 (Fig.5) corresponding to Fig. 9 A, Fig. 10 A, Fig. 11 A, and Fig. 12 A respectively and a first terminal 2a.

[0094] Fig. 9A is a diagram of a state of cam mechanism when a button 3 (Fig. 4) is not pressed but existing in the top dead center. In this state, ribs 3d of the button 3 (Fig. 4) and projections 5c of a rotor 5 (Fig. 6) are urged upwardly by the second spring 6 (not shown) and the first spring 7 (not shown) to be disposed at the upper end of the guide recess portions 1c of the cylinder portion 1b. At this time, button cam sides 3e of the ribs 3d are in the state where electrical contact with the projections 5c of the rotor 5 (Fig. 6) is effected.

[0095] Fig. 9B is a schematic diagram of a disposing relationship between a contact segment 4 (Fig. 5) when a button 3 (Fig. 4) is in the state shown in Fig. 9A and the first terminal 2a. In the state shown in Fig. 9A, a rotor 5 (Fig. 6) is urged by the first spring 7 (not shown) to be approaching the backside of the upper end surface 1a1 (Fig. 2A) most. Contact of projecting portions 5f provided in a flange 5a of the rotor 5 (Fig. 6) with the backside of the upper end surface 1a1 (Fig. 2A) allows a moderate space to be vacated between the rotor 5 (Fig. 6) and the upper case 1. In this state, the arms 4a of the contact segment 4 (Fig. 5) provided in a flange 5a contact with the first terminal 2a while buckling to define ON position of a pushbutton switch.

[0096] Fig. 10A is a diagram of a state of cam mechanism in the outset of a button-pressing action of a button 3 (Fig. 4). In this state, ribs 3d descend gradually along the guide recess portions 1c while pressing the projections 5c of a rotor 5 (Fig. 6) by button cam sides 3e. Force to go rightward (rotate) in the diagram has arisen in the projections 5c by the action of the button cam sides 3e and the rotor cam sides 5d. However, in this stage rotation is prevented by side walls of projections 1d.

[0097] Fig. 10B is a schematic diagram of a disposing relationship between a contact segment 4 (Fig. 5) when a button 3 (Fig. 4) is in the state shown in Fig. 10A and the first terminal 2a. Since a rotor 5 (Fig. 6) descends by being pressed by ribs 3d, space between the rotor 5 (Fig. 6) and the upper case 1 spreads compared to the space shown in Fig. 9B. However, arms 4a of the contact segment 4 (Fig. 5) deform following the expanded space to keep the contact state between the arms 4a and the first terminal 2a. Then, ON position of the pushbutton switch is retained.

[0098] Fig. 11A is a diagram of a state of cam mechanism when a button 3 (Fig. 4) is pressed as far as the bottom dead center. In this state, ribs 3d descend as far as the lower end portions of the guide recess portions 1c. Then, the projections 5c of a rotor 5 (Fig. 6) are separated from the guide of the guide recess portions 1c. By the way, since upward force is always applied to the rotor 5 (Fig. 6) by the first spring 7, the projections 5c carry out a obliquely upward sliding (rotating) on the button cam sides as shown by the arrow in the diagram to collide with adjoining ribs 3d and stop. When the projections 5c and the ribs 3d collide, the press sound "a click of a latch" occurs.

[0099] Fig. 11B is a schematic diagram of the disposing relationship between a contact segment 4 (Fig. 5) when a button 3 (Fig. 4) is in the state shown in Fig. 11A and the first terminal 2a. Since the projections 5c are moving below further than the case in Fig.10A, space between a rotor 5 (Fig.6) and the upper case 1 spreads further than the case in Fig.10B. Also, as shown in Fig. 11A, rotation of the rotor 5 (Fig.6) causes arms 4a to move (rotate) rightward in the drawing. Then, contact of the first terminal 2a and the arms 4a is broken so that position of the switch is changed to OFF state.

[0100] In this manner, a pushbutton switch of the first embodiment effects the ON/OFF switching action simultaneously with a press sound. In the conventional pushbutton switch, since the press sound and the timing of ON/OFF operation of a switch had shifted, the user using a pushbutton switch might have a sense of incongruity. However, with the pushbutton switch of the first

embodiment, since the press sound and the ON/OFF operation of a switch synchronize, the feeling of operation of the user who uses a pushbutton switch improves.

[0101] Also, by changing the degree of the deflection of arms 4a, the timing of the alternating ON/OFF switching action can be changed in a pressing process of a button 3 (Fig. 4). For example, with an employment of arms 4a which are almost not curved but assume a flat form, it becomes possible to effect an alternating ON/OFF switching action without waiting for the press sound emitted at the outset of a button-pressing action of the button 3 (Fig. 4). Further, variation in the form of the stationary terminals 2a, 2b, and 2c enables the switch to define ON/OFF position at any time at will when a button 3 (Fig. 4) returns from the bottom dead center to the top dead center. In this manner, by an easy specification change, a pushbutton switch of the first embodiment permits the timing of the alternating ON/OFF switching action to be changed at any time at will in the reciprocating motion of the button 3 (Fig. 4). Hence, a pushbutton switch having an ON/OFF switching action suitable for the purpose of use can be achieved.

[0102] Fig. 12A is a diagram of the state of cam mechanism in which a button 3 (Fig. 4) rises by an opposing force of the first spring 7 and the second spring 6 to return to the top dead center. In this state, projections 5c slide (rotate) on a cylinder portion cam sides 1e by receiving the upward urge from the first spring 7 to be engaged with guide recess portions 1c adjacent to the guide recess portions 1c disposed first. When the projections 5c are engaged with the guide recess portions 1c, the projections 5c collide with a button cam side 3e of ribs 3d to cause a return sound "a click of a latch" to be emitted.

[0103] According to a pushbutton of the first embodiment, a rotor 5 (Fig.6) is urged by the first spring 7 with a spring constant smaller than the conventional one to collide with button cam sides 3e. This enable the return sound to be smaller compared to a conventional pushbutton switch.

[0104] Fig.12B is a schematic diagram of the disposing relationship between a contact segment 4 (Fig.5) when a button 3 (Fig.4) is in the state shown in Fig.12 A and the first terminal 2a.

[0105] In the state shown in Fig.12 A, a button 3 (Fig. 4) has returned to the top dead center. Then, a state in which a rotor 5 (Fig.6) approaches the back surface of the upper end surface 1a1 (Fig.2A) most is made. Similarly to the case shown in Fig.9B, the projecting portions 5f contact with the back surface of the upper end surface 1a1 (Fig.2A) to maintain a suitable space between the rotor 5 (Fig.6) and the upper case 1. In this state, arms 4a of the contact segment 4 (Fig.5) do not contact with the first terminal 2a. Then, OFF position of a pushbutton switch is defined.

The second embodiment

[0106] A pushbutton switch of the second embodiment regarding this invention will be explained with references to Fig.13 to Fig. 15. A pushbutton switch according to this embodiment has the similar composing to the first embodiment as shown in Fig. 13, however the differences are at the stationary terminals 2a, 2b and 2c to which the lead cables 9a, 9b and 9c are fixingly connected. As shown in Fig. 14A, the stationary terminals 2a, 2b and 2c consisting of the similar flat surface portions 2a1, 2b1, arid 2c1 to the first embodiment, that contact the arm 4a of the contact segment 4 (Fig. 5A, Fig. 5B and -Fig. 5C) and cable holding ports 2a2, 2b2 and 2c2 to which the lead cables 9a, 9b and 9c are fixed. The lead cables 9a, 9b and 9c are firmly fixed in a way that the core wires 9a1, 9b1 and 9c1 extending out of the end of the insulators 9a1, 9b1 and 9c1 of the leading cables are crimped by the cable holding ports 2a2, 2b2 and 2c2 as shown in Fig. 14B and Fig. 14C and further soldered with the cable holding ports. As an additional embodiment, the lead cables 9a, 9b and 9c can be firmly fixed in a way that the core wires 9a1, 9b1 and 9c1 and the insulators 9a1, 9b1 and 9c1 of the leading cables are crimped by the cable holding ports 2a2, 2b2 and 2c2 and the other cable holding port portions that are made extendedly from the cable holding ports crimping the core wires. Furthermore, the other ends of the lead cables can be left as cut or other connectors are connected to these ends. The side walls 1a2 of the upper case 1, as shown in Fig. 15A and Fig. 15B (cut view as shown in Fig. 15A) has three substantially U-shaped apertures 1a3 in a predetermined separation length so that the lead cables 9a, 9b and 9c extend out from the case.

[0107] This invention thus arranged is remarkably effective in the below-mentioned manner.

[0108] A pushbutton of this invention is characterized in that: even if space between a rotor (contact segment) and stationary terminals spreads by a button-pressing action, a contact between the stationary terminals and the contact segment is retained by buckling capacity of arms provided in the contact segment. Hence, by changing the degree of the deflection (curving rate), the timing to make and break electrical contacts can be set at any time at will in the button-pressing action. Namely, the timing of the alternating ON/OFF switching action can be set at any time at will in the button-pressing action. Also, variation in the form of the stationary terminals permits the timing of the alternating ON/OFF switching action to be set at any time at will in the return action of the button to the top dead center.

[0109] In addition, in a pushbutton switch of this invention, alternating ON/OFF switching action is effected under the state of arms which have gone slack. Hence, the friction generated between the arms and the stationary terminals at the time of the rotation of the arms can be smaller than the conventional pushbutton switch. Accordingly, it became unnecessary to enclose grease

etc., between the arms and the stationary terminals. (Claims 1, 2, 5)

[0110] The stationary terminals of this invention have pairs of mutually facing metal pieces that elastically pinch therebetween and erminal portions aligned toward the apertures made in the case. Therefore the terminals can firmly pinch the foreign metal rod by keeping a high pressure force at the contact surface between the rod and the pinching metal pieces (Claim 1).

In addition, the pushbutton switch in this invention has lead cables fixed to cable holding ports made in the stationary terminals and led out from apertures made in said case, therefore no additional cabling to the pushbutton switch is not necessary. This results in facilitating the harness assembly in use of this pushbutton switch (Claims 2 and 3).

[0111] In a pushbutton switch of this invention, separated springs (the second spring and the first spring) are performing to urge a button and a rotor, while conventionally this function was achieved by one spring. Thus, as the first spring to urge the rotor, the spring with smaller spring constant and little opposing force can be used compared with a conventional spring, thereby allowing a return sound emitted due to the collision of the rotor urged by the first spring and other members to be smaller than conventional pushbutton switch.

[0112] Also, in a pushbutton switch of this invention, arms of a contact segment provided in a rotor buckle and serve as a cushion, to thereby allow the impact force caused by the collision of the rotor and other members to be smaller so as to make return sound smaller than conventional pushbutton switch. (Claim 4)

[0113] A pushbutton switch of this invention is provided with projections for a prevention of an excess rotary movement on the outer periphery of a button. These projections for a prevention of an excess rotary movement guide the button only in the vertical direction. Hence, rotation of the button in the circumferential direction is obviated even when the button is pressed excessively and ribs of the button are separated from the guide recess portions. Thus, disadvantage that the ribs' ride over cylinder portion cam sides can be prevented. (Claim 6).

[0114] A pushbutton switch of this invention is arranged in a manner that a guide pole is extending from the lower end portion of a button and this guide pole is guided by an insertion portion of the lower case when a button-pressing action is performed. Thus, a slight movement of the button in the horizontal direction is suppressed when the button has been pressed. (Claim 7).

[0115] A pushbutton switch of this invention is arranged in a manner that terminal portions of the stationary terminals connecting an external wiring are extending downwardly forming into a letter of "U" from flat surface portions of the stationary terminals. Further, the terminal portions are formed into a curving shape in spaced apart relation from the flat surface portions, to thereby fix the external wiring reliably irrespective of the form of the external wiring inserted therein. (Claim 8).

[0116] In a pushbutton switch of this invention, by connecting stationary terminals directly to a printed circuit board, it is possible to provide alternative electrical connections to a variety of popular applications. (Claim 9).

Claims

1. A pushbutton switch, comprising:

a case including a substantially cylindrical-shaped cylinder portion;
a substantially cylindrical button which is fitted into said cylinder portion slidably;
a substantially cylindrical rotor having a flange at the bottom thereof which performs a sliding reciprocating motion along the cylinder portion responding to the reciprocating motion of said button, while carrying out predetermined angle rotation in the predetermined direction by setting the axis of rotation as the long axis of the cylinder portion;
a substantially toroidal platy contact segment which is inserted in said rotor and latched by said rotor;
plurality of stationary terminals provided in said case so as to be facing said contact segment;
characterised in that:

said rotor performs a predetermined angle rotation for every reciprocating motion of said button to effect a successive ON position where said contact segment makes electrical contact between said stationary terminals and OFF position where said contact segment breaks electrical contact alternately;
said stationary terminals have pairs of mutually facing metal pieces that elastically pinch therebetween and terminal portions aligned toward the apertures made in said case; and
tabular arms which are curving toward the stationary terminals and contact with said stationary terminals are provided at locations each on an outer periphery of said contact segment spaced at predetermined intervals, and wherein said arms retain a contact between said stationary terminals and said contact segment by elastically buckling according to a variation in distance between said stationary terminals and the rotor generated when said rotor performs said sliding reciprocating motion.

2. A pushbutton switch, comprising:

a case including a substantially cylindrical-shaped cylinder portion;
a substantially cylindrical button which is fitted into said cylinder portion slidably;
a substantially cylindrical rotor having a flange at the bottom thereof which performs a sliding reciprocating motion along the cylinder portion responding to the reciprocating motion of said button, while carrying out predetermined angle rotation in the predetermined direction by setting the axis of rotation as the long axis of the cylinder portion;
a substantially toroidal platy contact segment which is inserted in said rotor and latched by said rotor;
plurality of stationary terminals provided in said case so as to be facing said contact segment; **characterised in that**:

said rotor performs a predetermined angle rotation for every reciprocating motion of said button to effect a successive ON position where said contact segment makes electrical contact between said stationary terminals and OFF position where said contact segment breaks electrical contact alternately,
plurality of lead cables fixed to cable holding ports made in said stationary terminals and led out from apertures made in said case; and
tabular arms which are curving toward the stationary terminals and contact with said stationary terminals are provided at locations each on an outer periphery of said contact segment spaced at predetermined intervals, and wherein said arms retain a contact between said stationary terminals and said contact segment by elastically buckling according to a variation in distance between said stationary terminals and the rotor generated when said rotor performs said sliding reciprocating motion.

3. A pushbutton switch defined in Claim 2, wherein said lead cables are soldered to said cable holding ports

4. A pushbutton switch defined in any one of Claims 1 to 3, further comprising a first spring which urges said rotary contact element upwardly and a second spring which urges said button upwardly.

5. A pushbutton switch defined in any one of claims 1 to 4, wherein projections are formed on the inner surface of said cylinder portion along the longitudinal direction separated mutually with guide recess portions spaced at predetermined intervals;

lower end portions of respective projections constitute slant cylinder portion cam sides;

ribs which are fitted loosely into said guide recess portions are formed on the outer periphery of the lower end portions of said button;

lower end portions of the ribs constitute slant button cam sides having substantially the same inclination with said cylinder portion cam sides;

projections which are fitted loosely into said guide recess portions are formed on the upper end portions of said rotor;

the upper end portions of the projections include slant rotor cam sides having inclination substantially contrary to said button cam sides;

said rotor cam sides perform a sliding movement along said cylinder portion cam sides by being pressed by said button cam sides along said guide recess portions; and

said rotor cam sides perform a sliding movement along said button cam sides when reciprocating motion is performed to thereby engage with another guide recess adjacent to said guide recess.

6. A pushbutton switch defined in any one of claims 1 to 5, further comprising:

projections for a prevention of an excess rotation in said guide recess portions along the longitudinal direction of the outer periphery of said button.

7. A pushbutton switch defined in any one of claims 1 to 6, wherein
a guide pole is extending along the central axis of the button, and a cylindrical insertion portion in which an end portion of said guide pole is inserted is provided in said case facing this guide pole.

8. A pushbutton switch defined in any one of claims 1 to 7, wherein
said stationary terminals are provided in said case including, flat surface portions which contact with said contact segment and terminal portions for connecting the external wiring to said pushbutton switch, wherein said terminal portions are extending downwardly forming into a letter of "U" from said flat surface portions and also formed into a curving shape in spaced apart relation from said flat surface portions.

9. A pushbutton switch defined in any one of claims 1 to 8, wherein
said stationary terminals are connected directly to a printed circuit board.

FIG.1

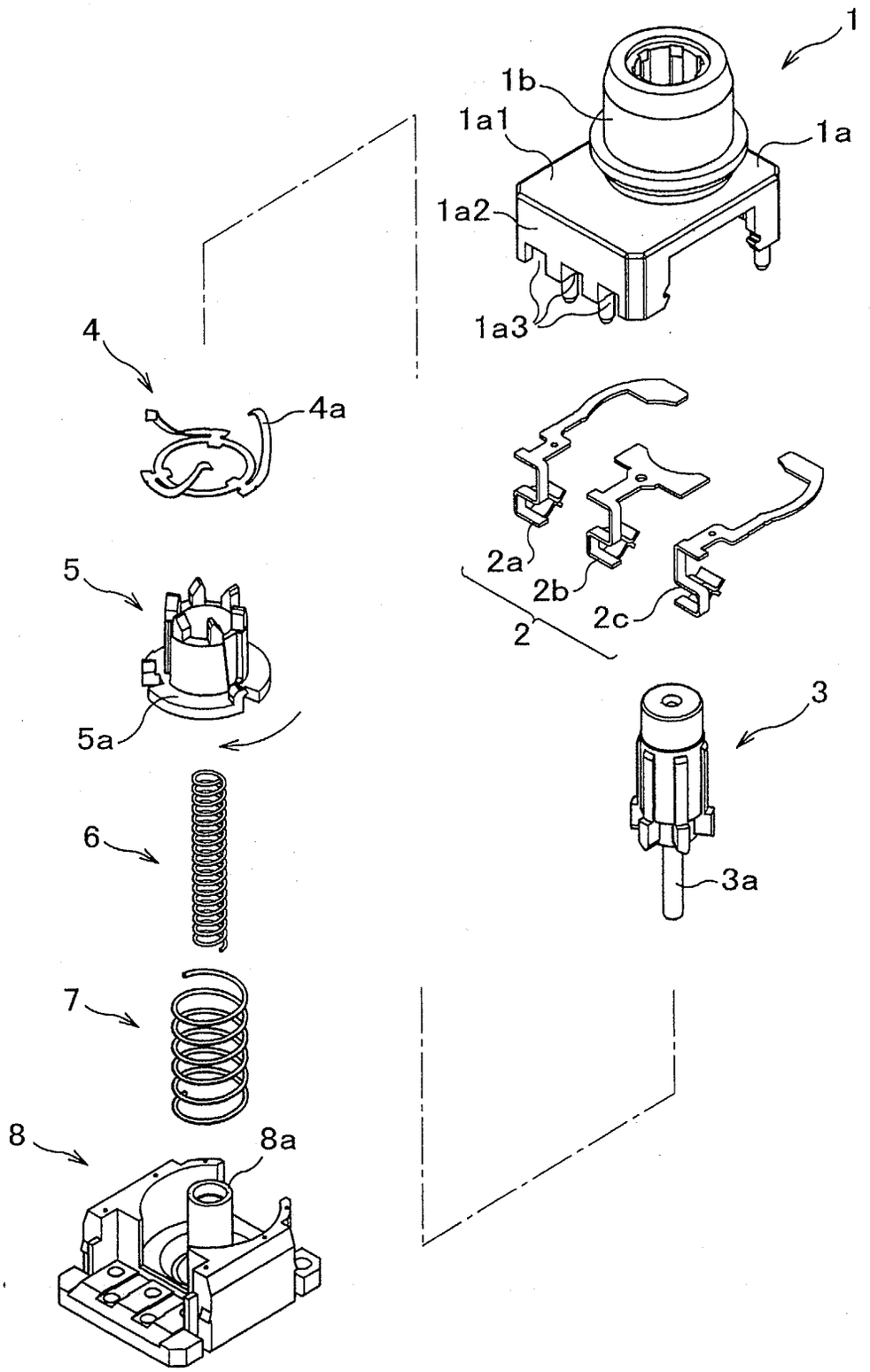


FIG.2A

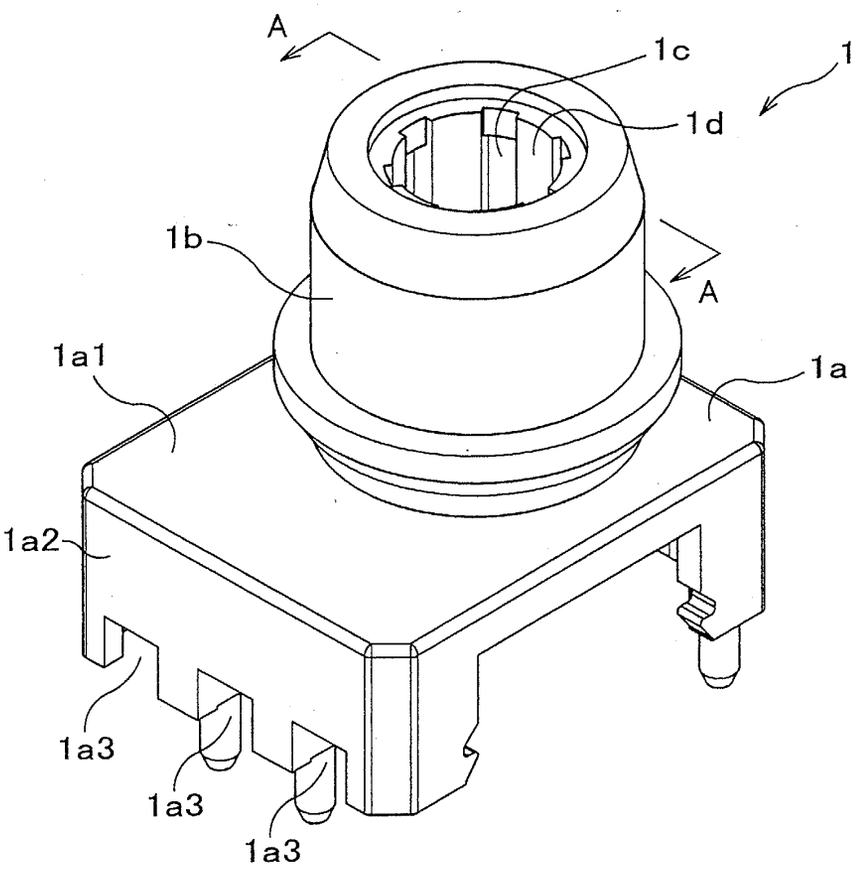


FIG.2B

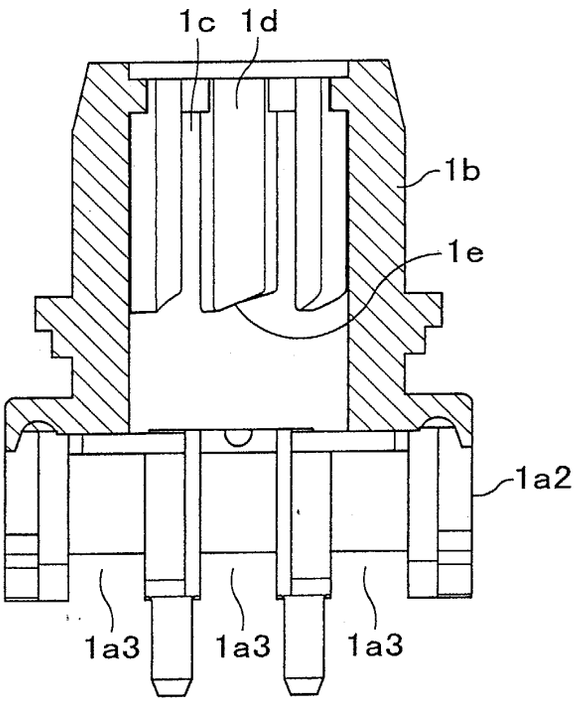
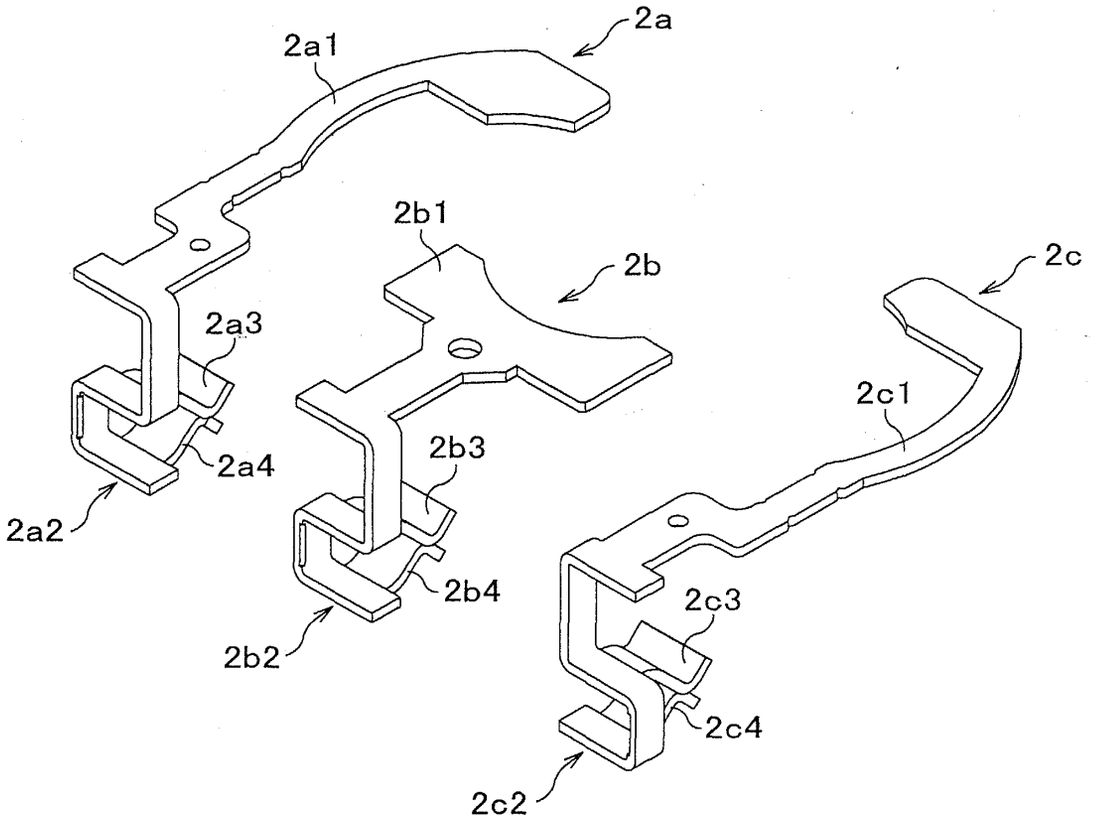


FIG.3A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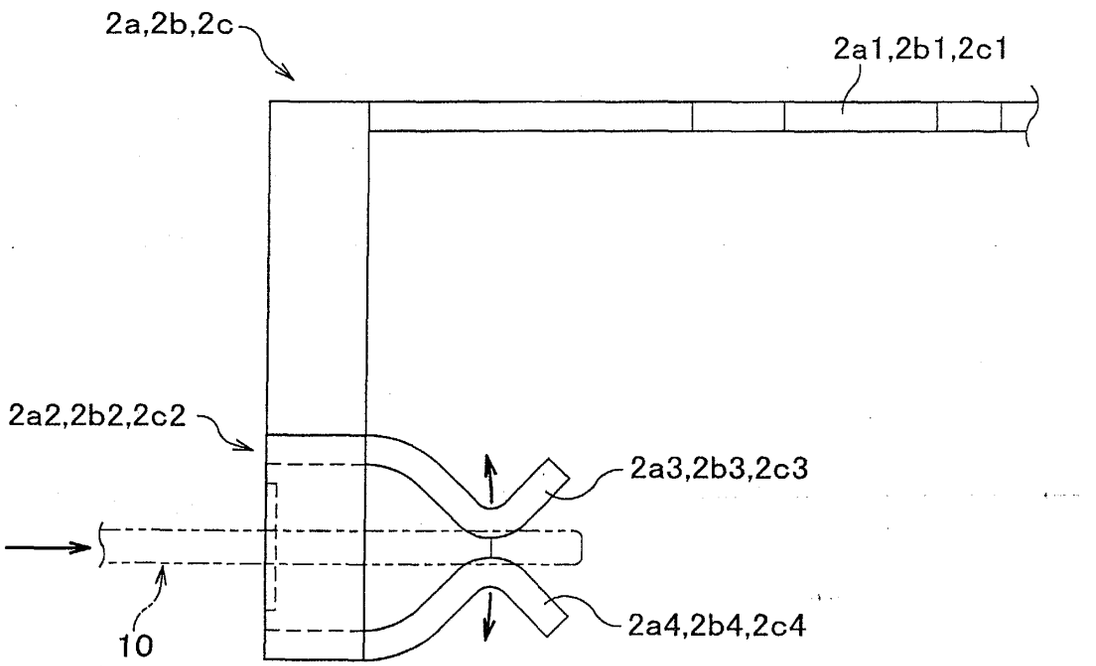
2a1
2b1
2b
2c
2a3
2c1
2a4
2b3
2a2
2b4
2c3
2b2
2c4
2c2

FIG.3B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2a1,2b1,2c1
2a2,2b2,2c2
2a3,2b3,2c3
10
2a4,2b4,2c4

FIG.4A

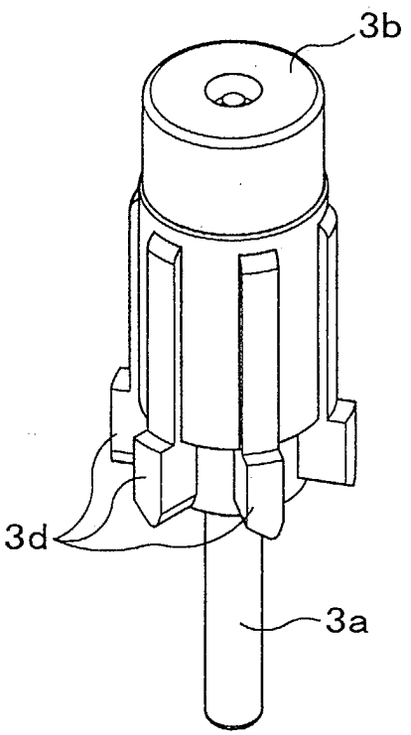


FIG.4B

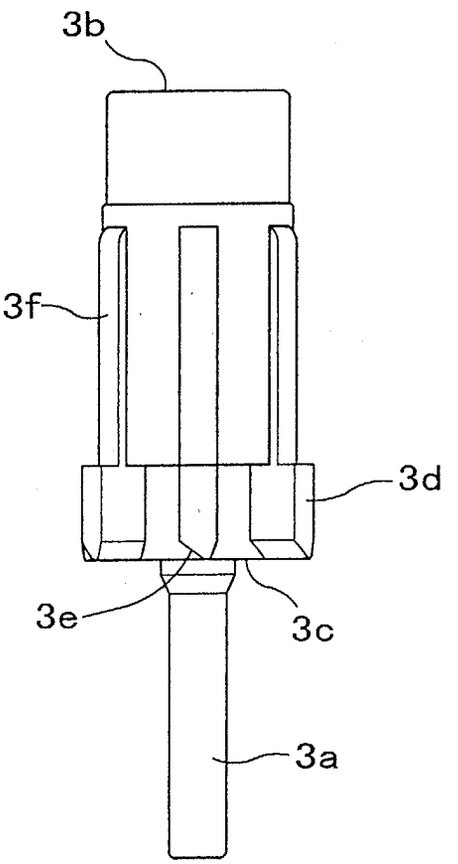


FIG.5A

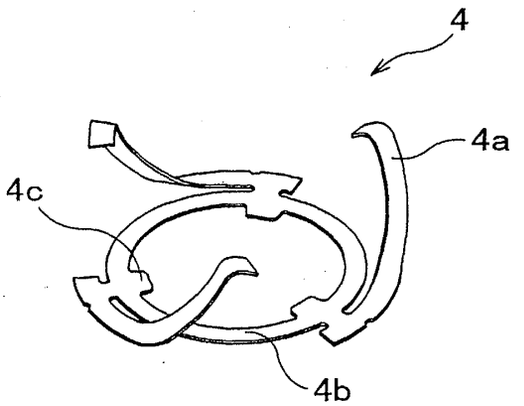


FIG.5B

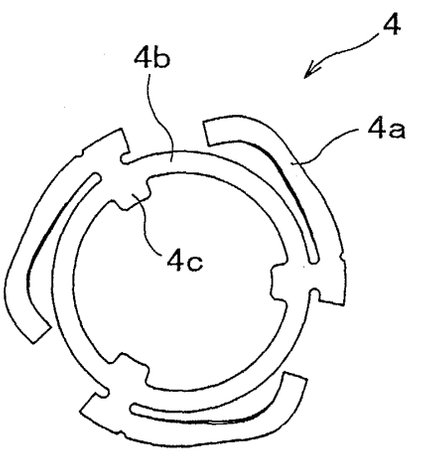


FIG.5C

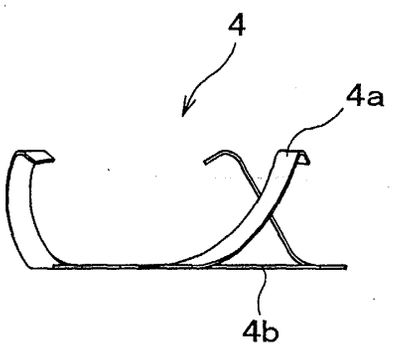


FIG.6A

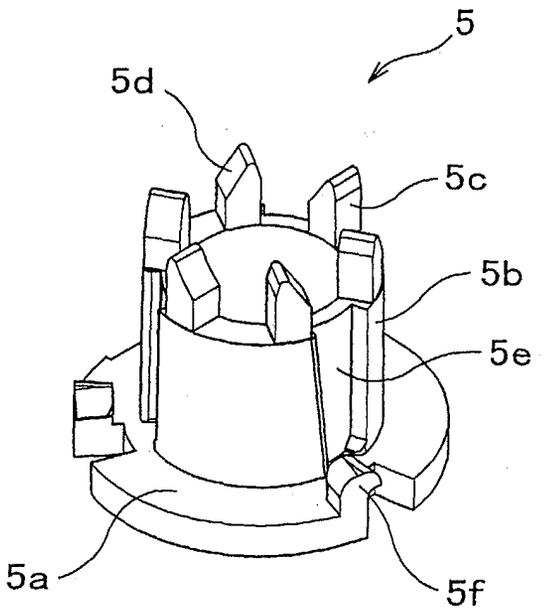


FIG.6B

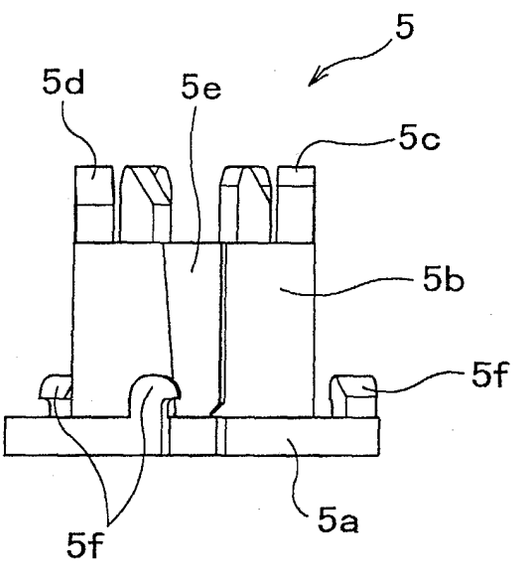


FIG.7A

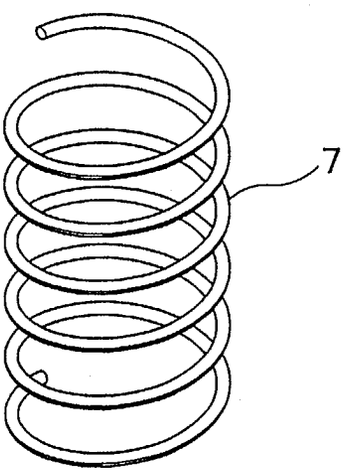


FIG.7B

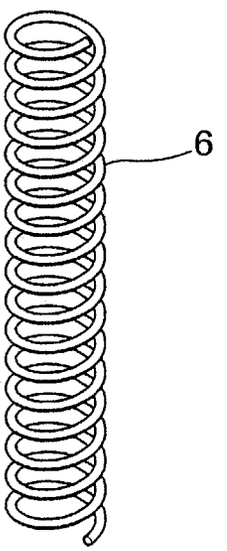


FIG.8

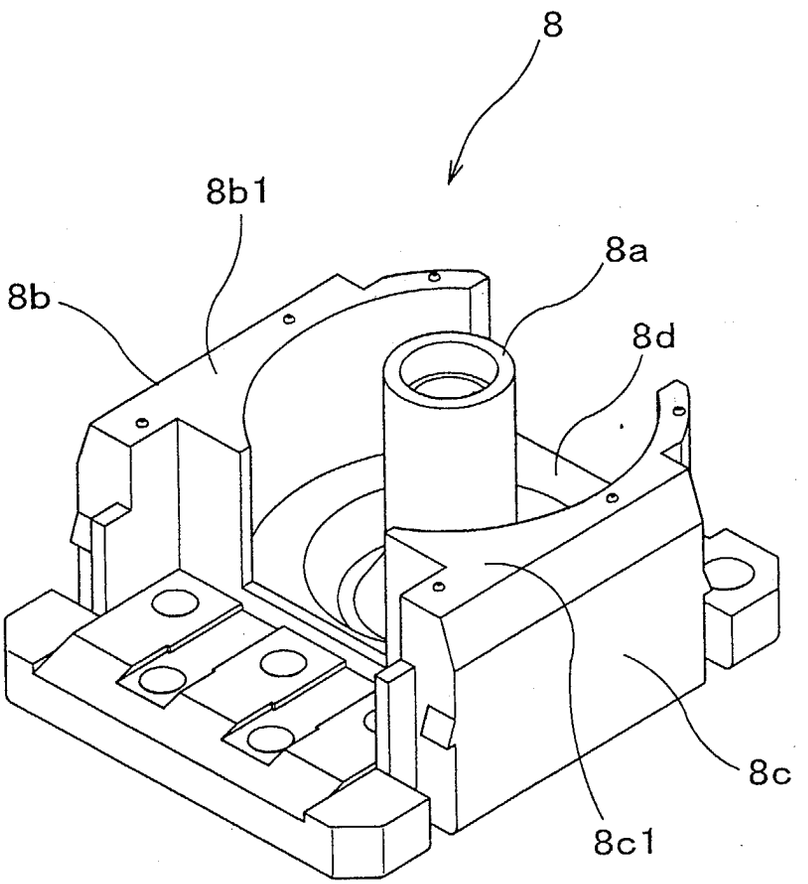


FIG.9A

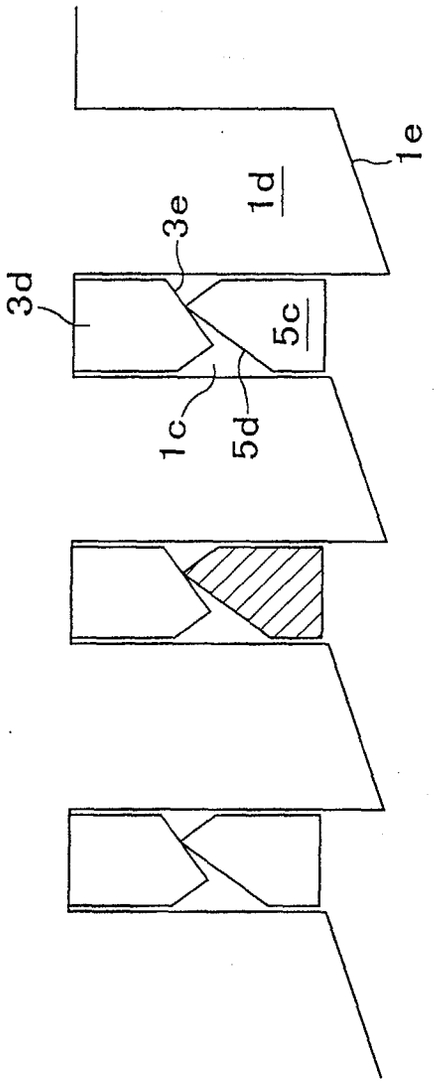


FIG.9B

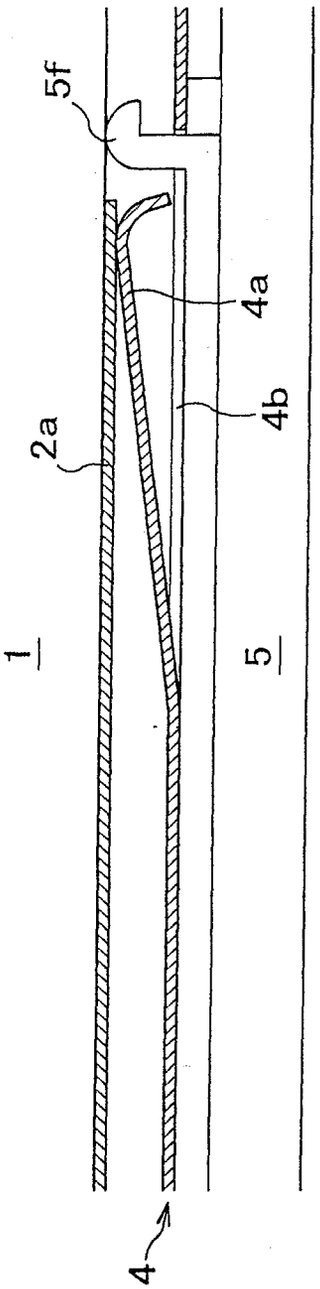


FIG.10A

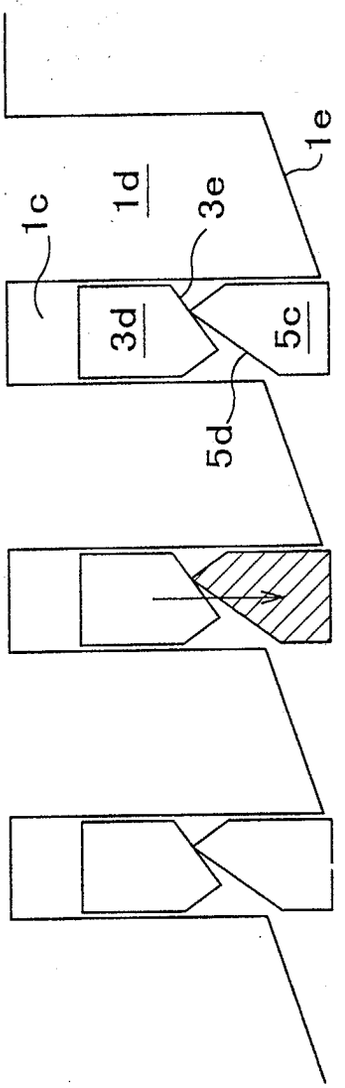


FIG.10B

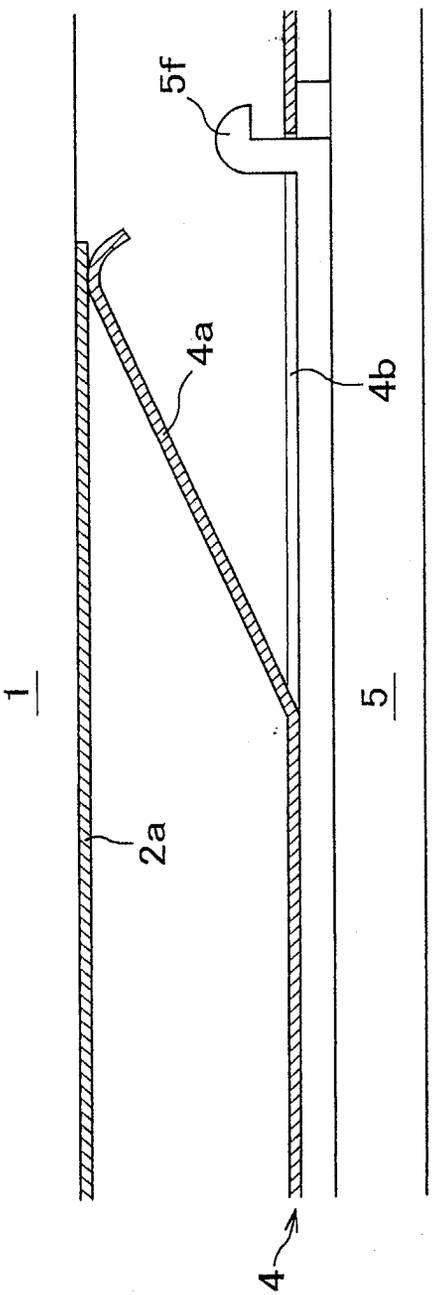


FIG.11A

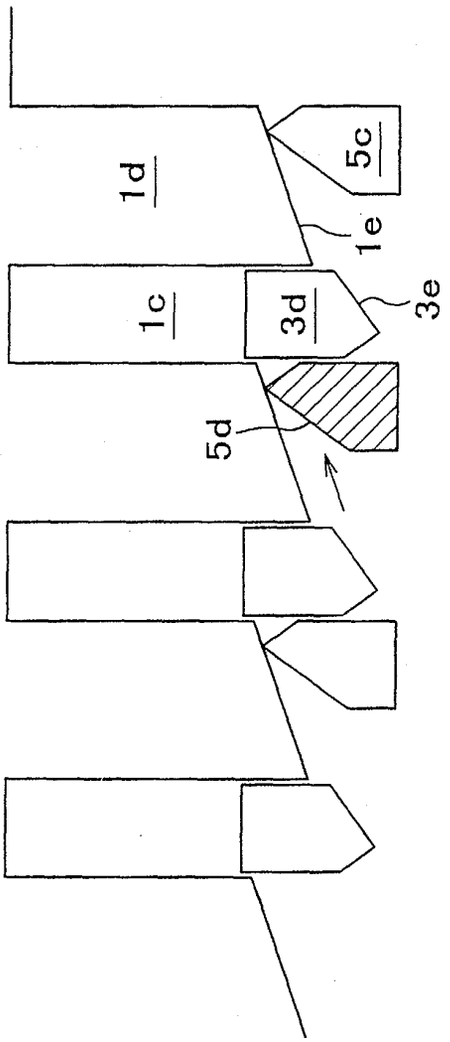


FIG.11B

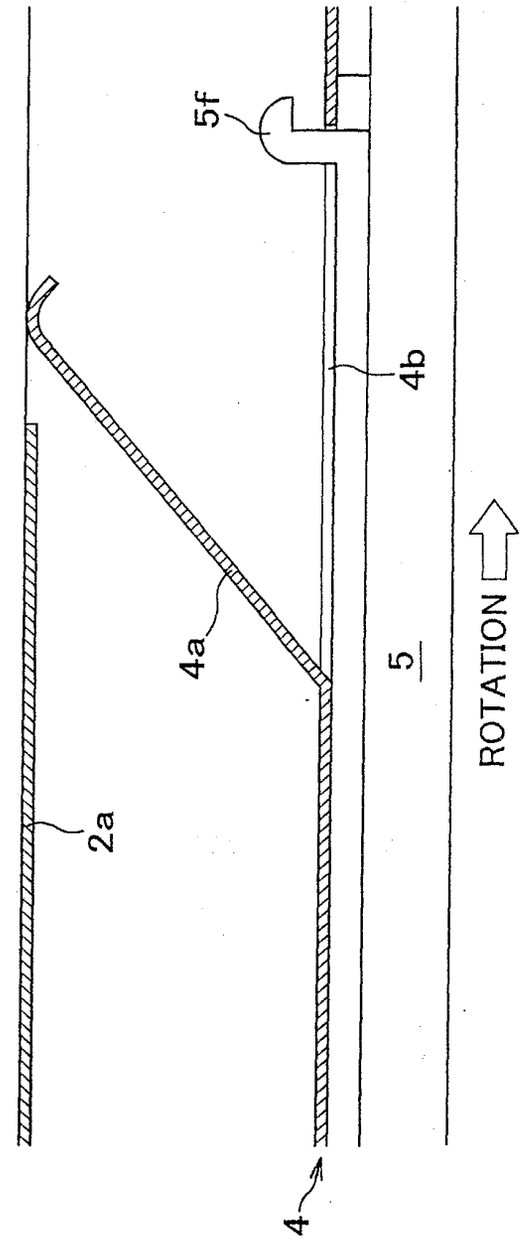


FIG.12A

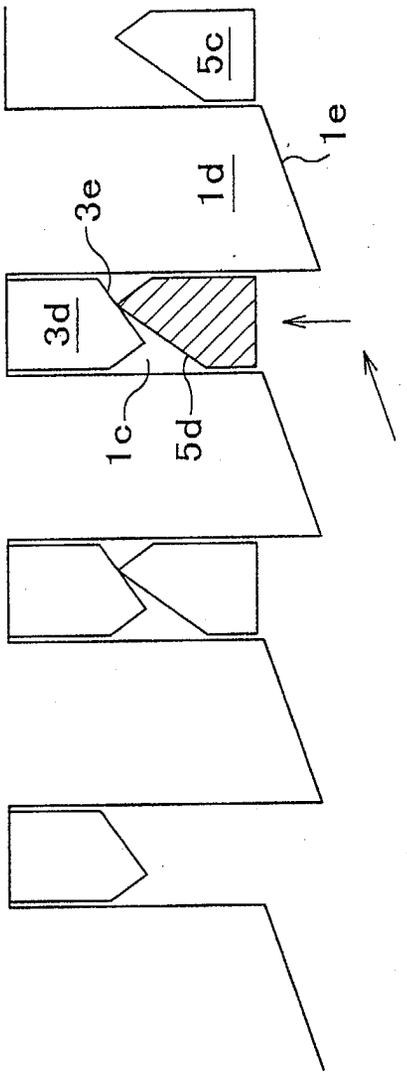
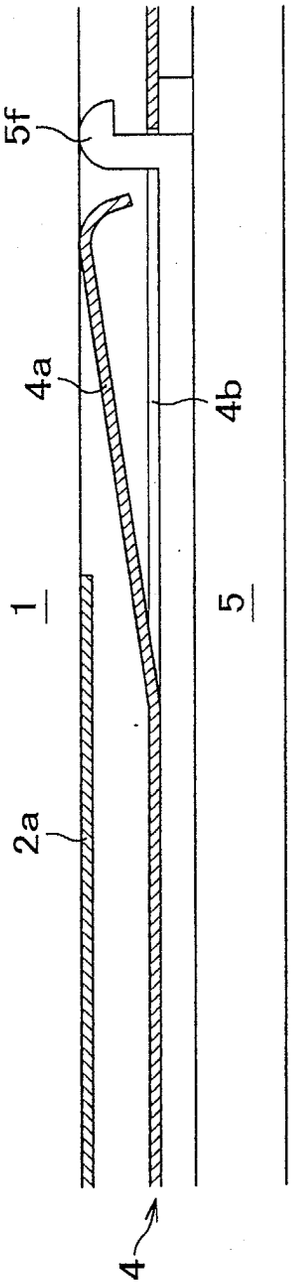
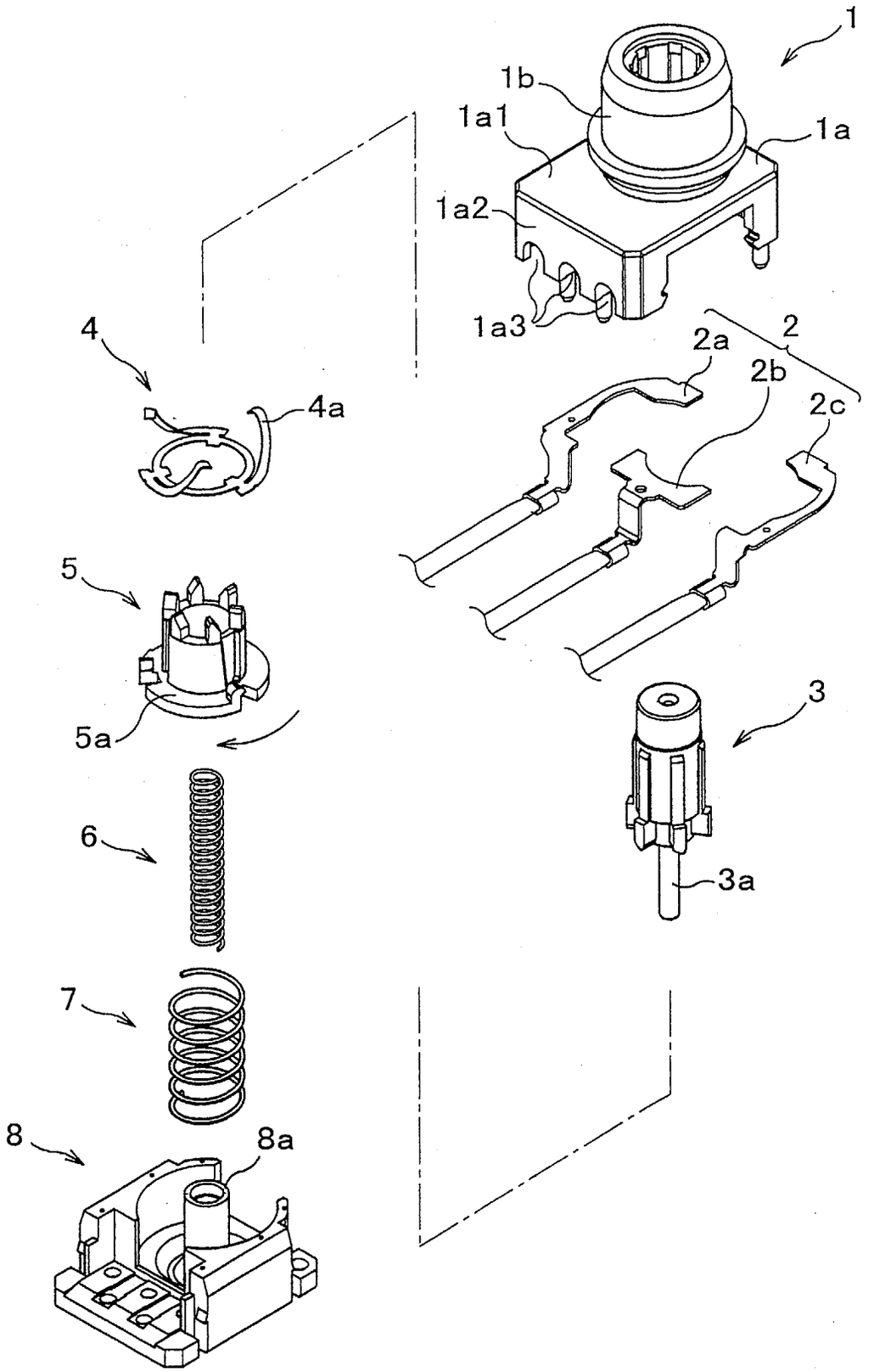


FIG.12B




1
1b
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1a
1a2
1a3
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2b
2c
4
4a
5
5a
6
7
8
8a
3
3a

FIG.14A

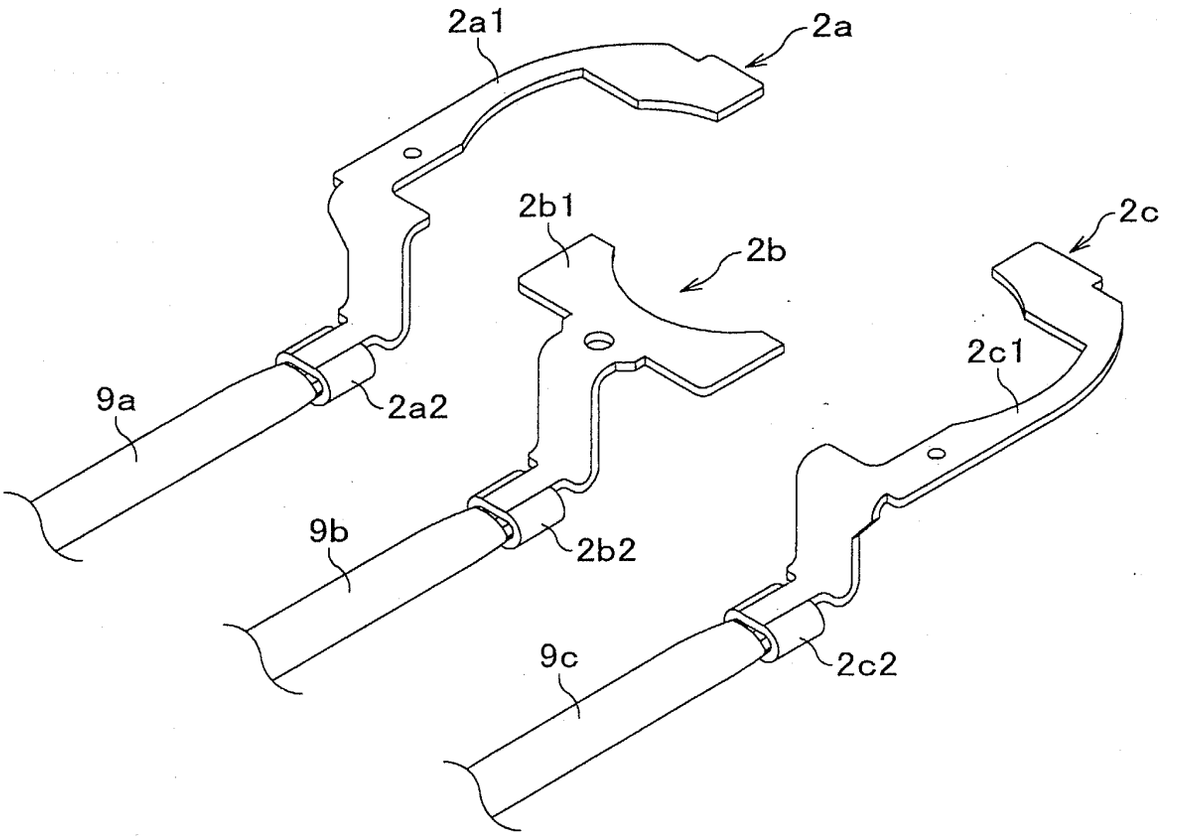


FIG.14B

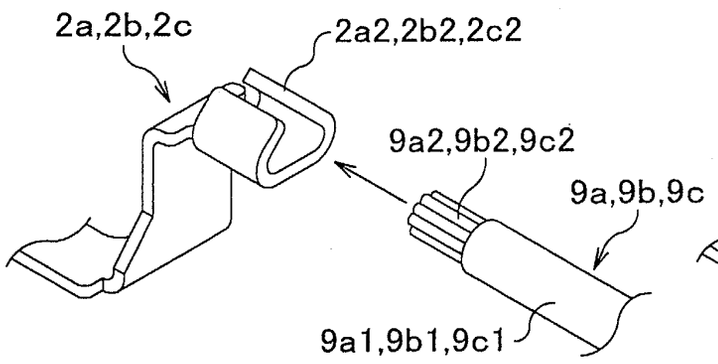


FIG.14C

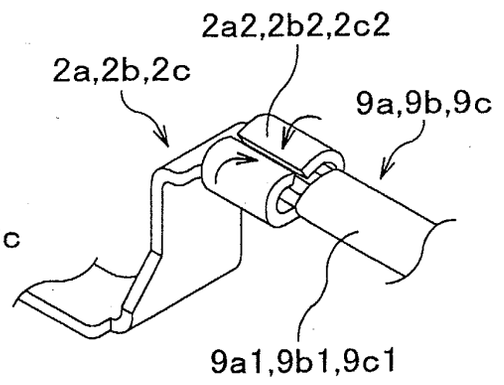


FIG.15A

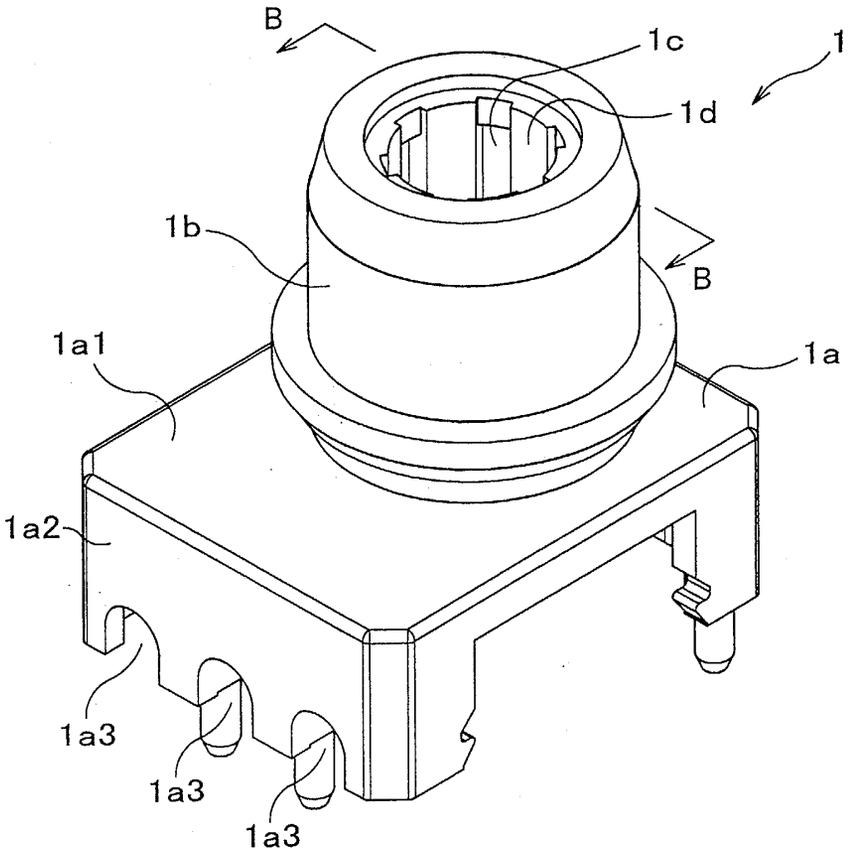


FIG.15B

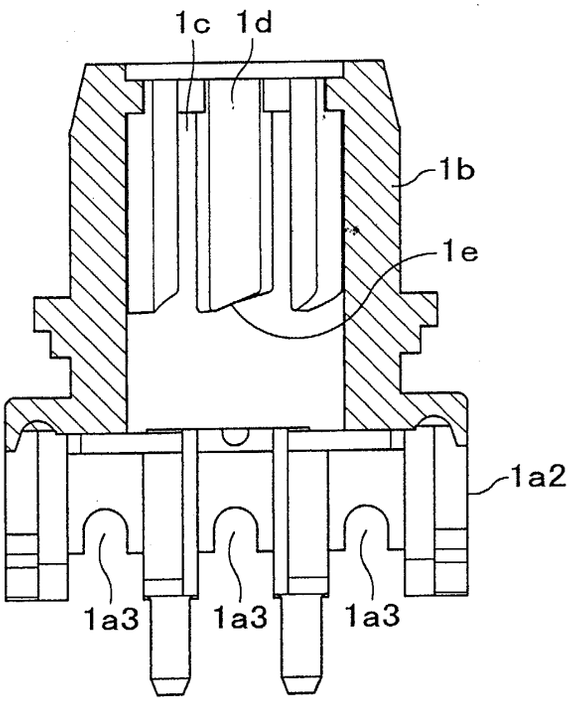


FIG.16

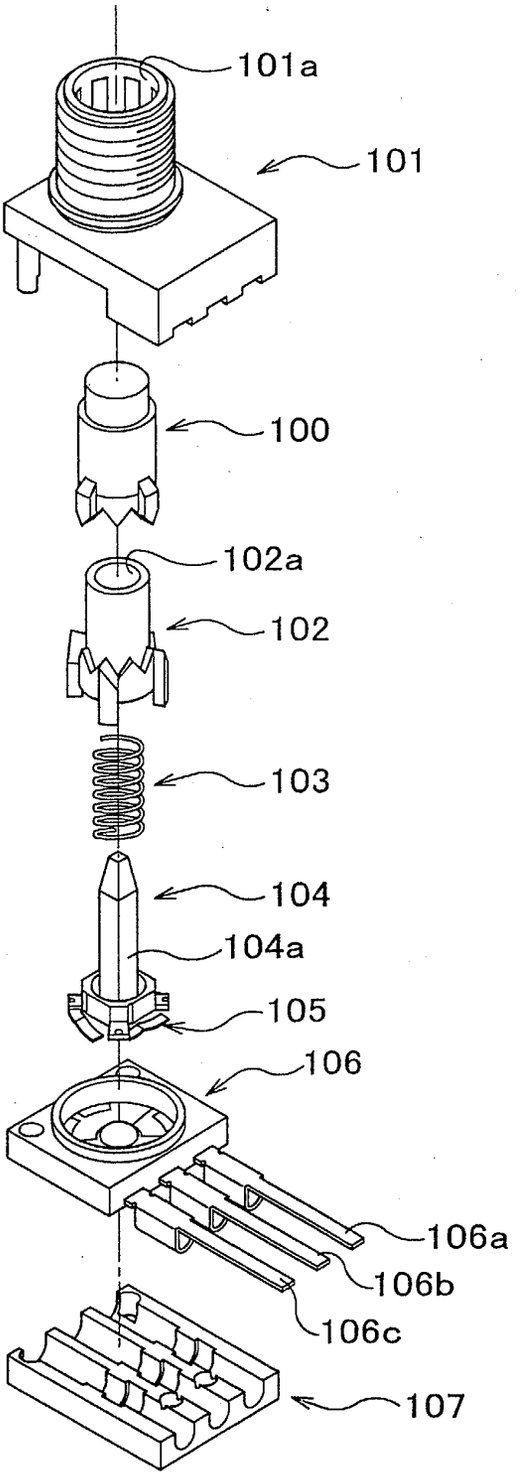


FIG.17

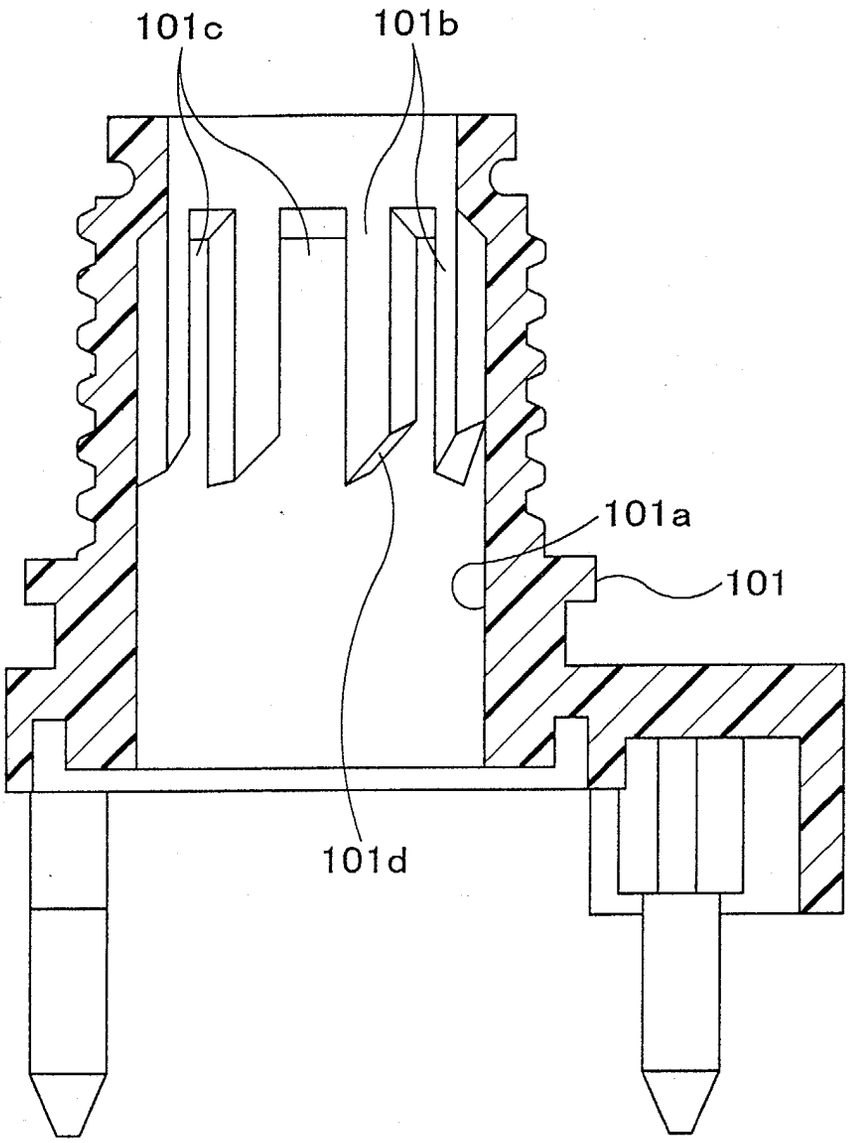


FIG.18B

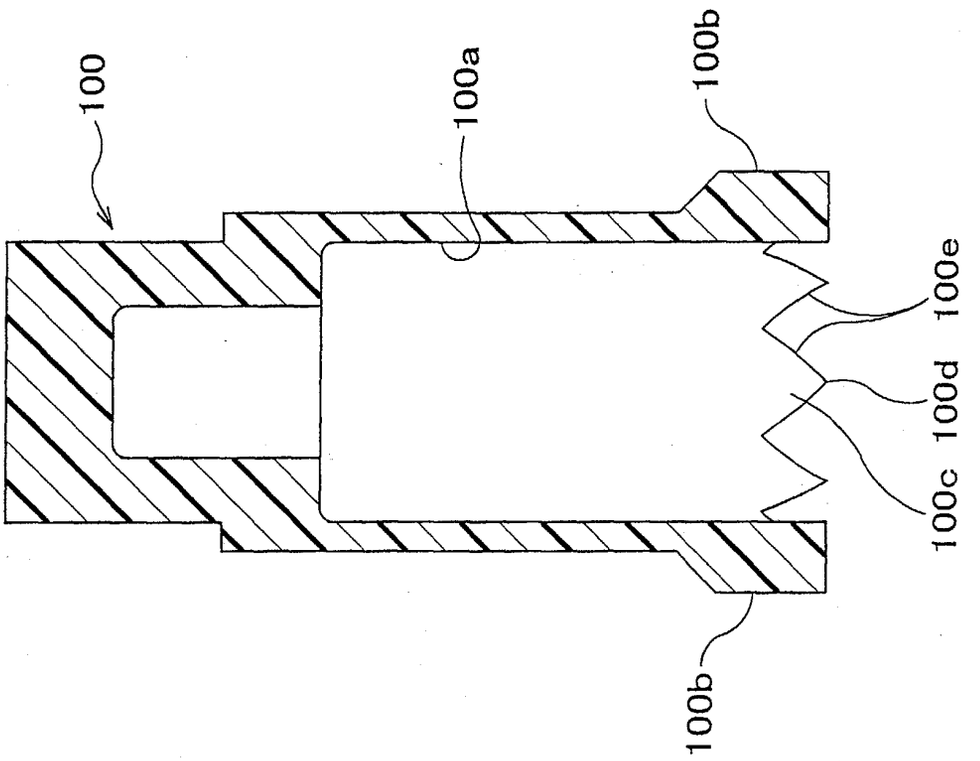


FIG.18A

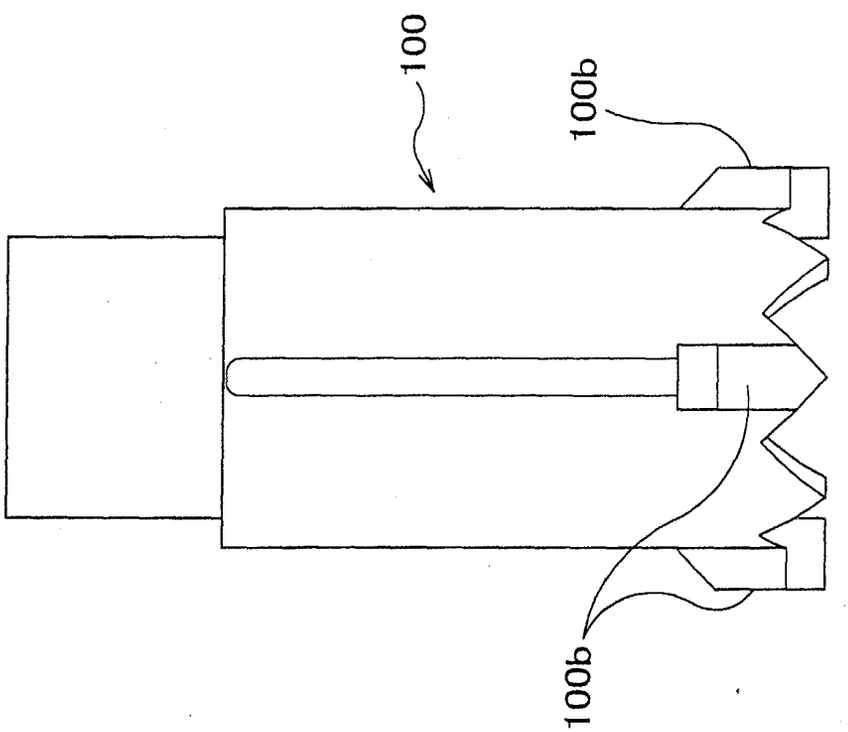


FIG.19B

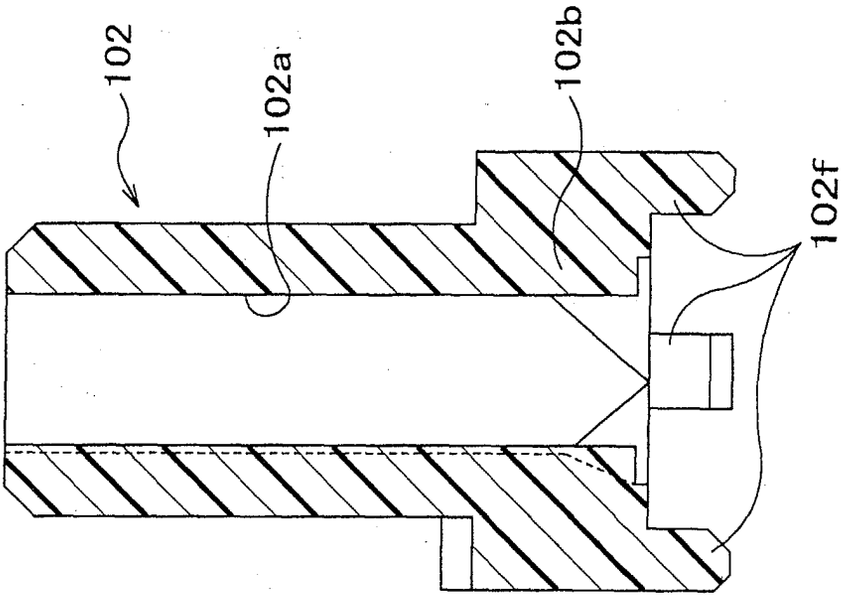


FIG.19A

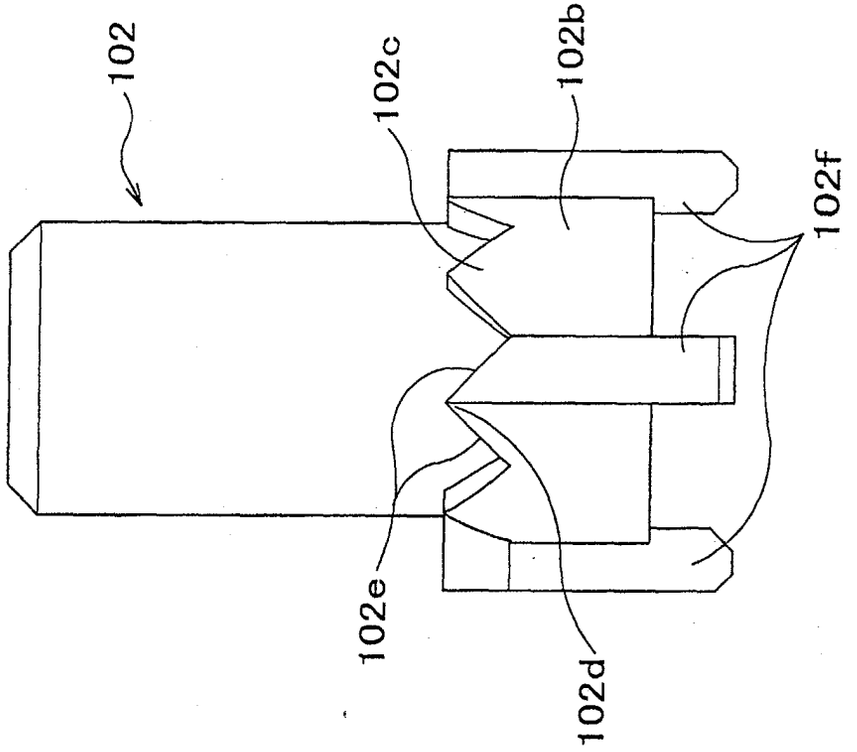


FIG.20

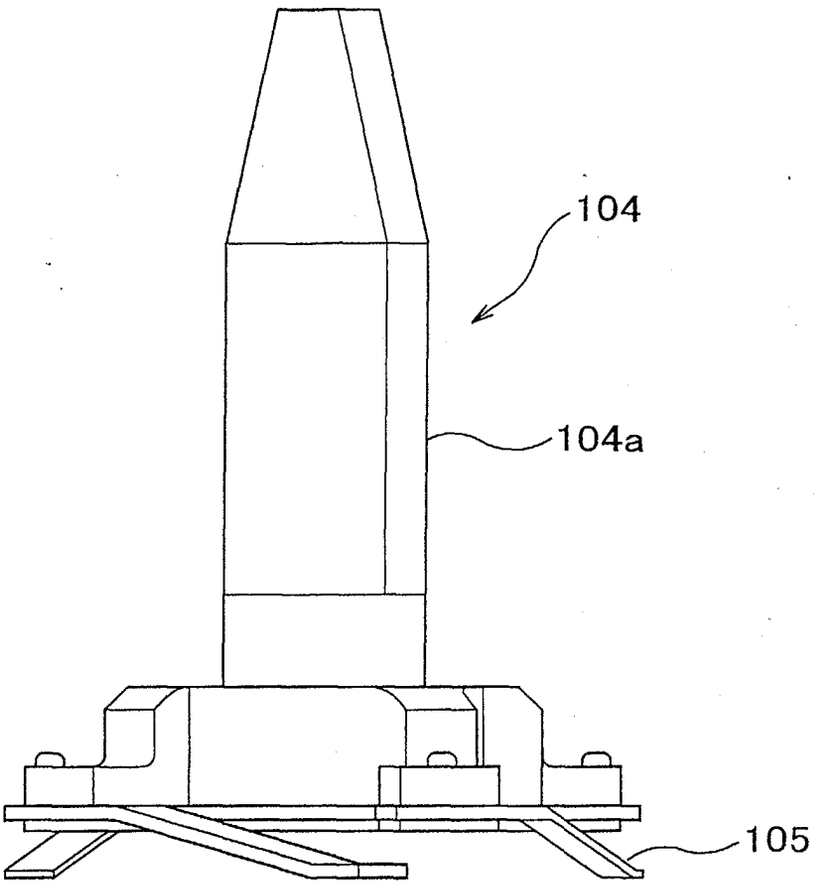


FIG.21A

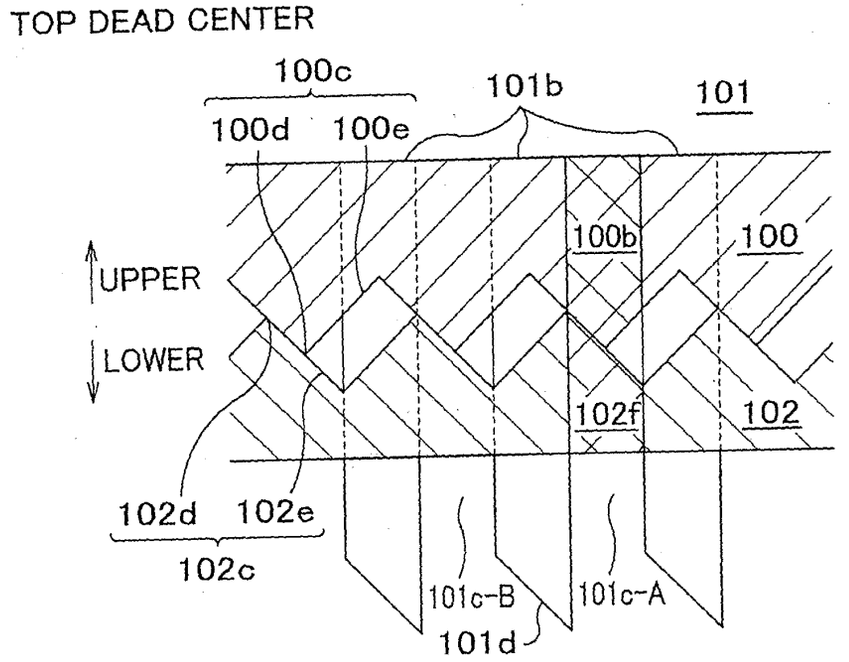


FIG.21B

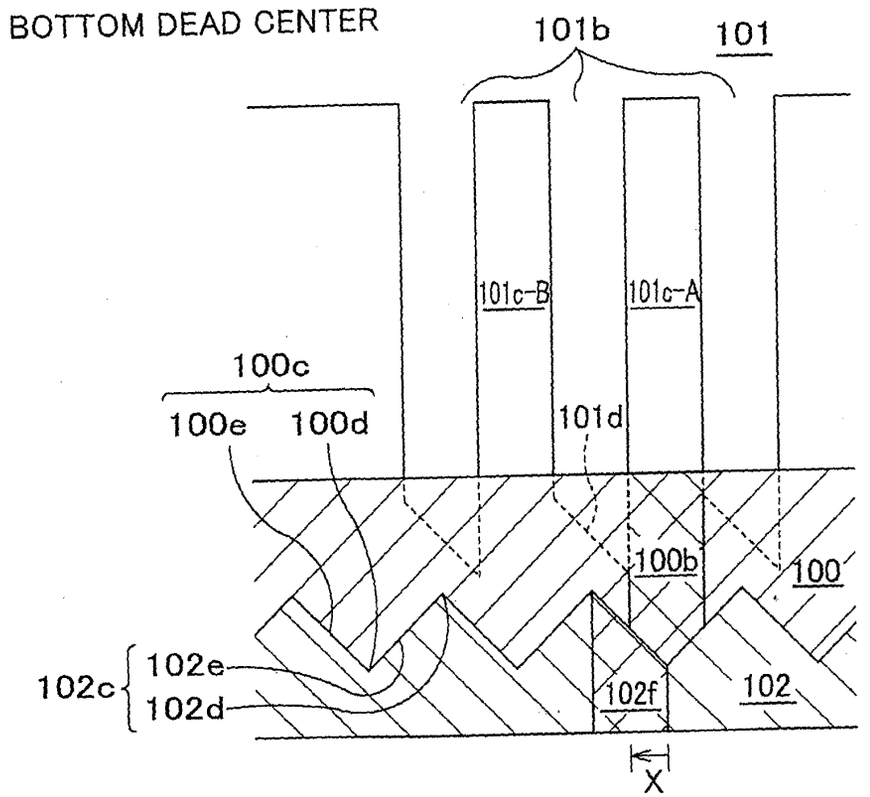
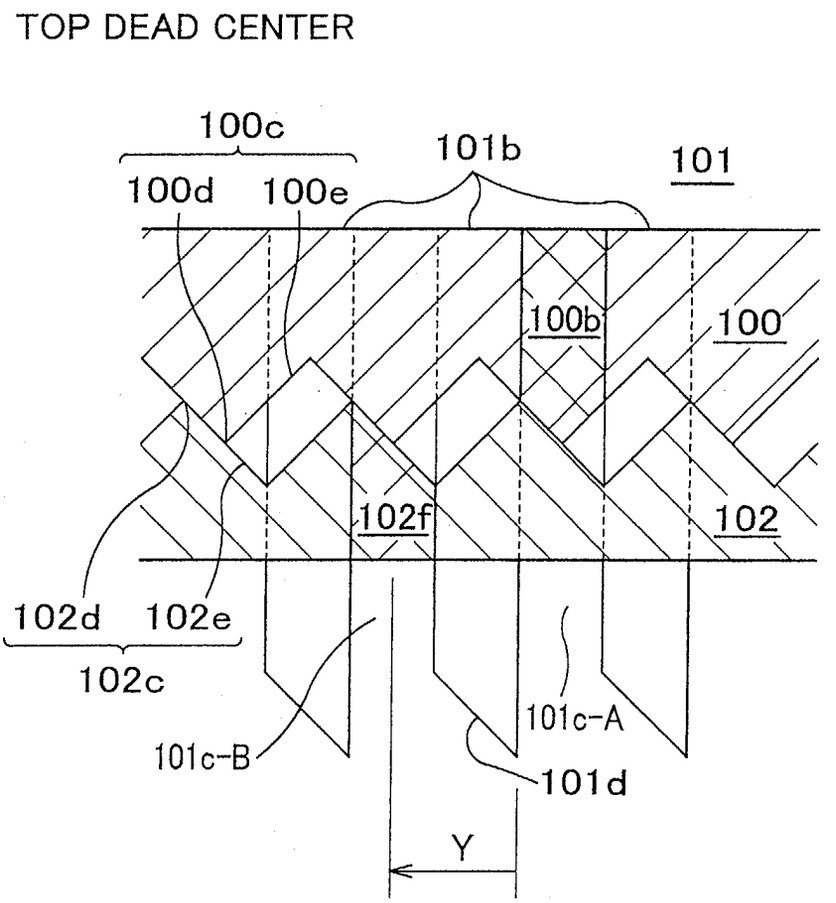


FIG.22


TOP DEAD CENTER
100c
100d
100e
101b
101
100b
100
102f
102
102d
102e
102c
101c-B
101c-A
101d
Y

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 4898

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 5 847 345 A (HARRISON CHARLES V) 8 December 1998 (1998-12-08) * the whole document *	1-9	H01H13/58
X	US 5 994 654 A (BENSON RAYMOND) 30 November 1999 (1999-11-30) * the whole document *	1-9	
X	US 4 997 999 A (VALENZONA JOSEPH) 5 March 1991 (1991-03-05) * the whole document *	1-9	
X	US 4 939 328 A (SMITH ROBERT J) 3 July 1990 (1990-07-03) * the whole document *	2,4	
A	US 5 049 709 A (PRICKETT TOMM ET AL) 17 September 1991 (1991-09-17) * the whole document *	2	
X	US 6 396 015 B1 (KO KENT) 28 May 2002 (2002-05-28) * the whole document *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01H
X	US 6 191 376 B1 (BARTOK STEPHEN) 20 February 2001 (2001-02-20) * the whole document *	2	
X	US 5 132 499 A (SMITH ROBERT J ET AL) 21 July 1992 (1992-07-21) * the whole document *	2,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 December 2003	Ruppert, H

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12-12-2003

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