(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 259 283 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
08.12.2010 Bulletin 2010/49

(51) Int Cl.:
H01H 71/52 *(2006.01)* *H01H 71/04* *(2006.01)*

(21) Application number: **09177855.5**

(22) Date of filing: **03.12.2009**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

(30) Priority: **02.06.2009 JP 2009133048**

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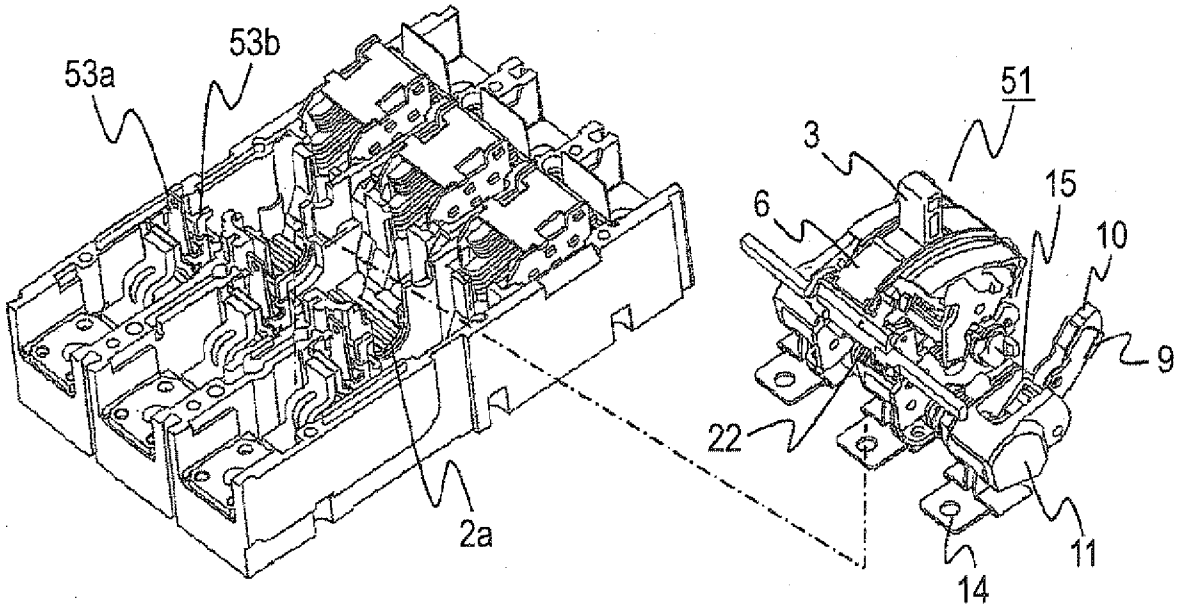
(54) Circuit breaker

(57) A circuit breaker includes: a handle fixed to a handle arm and including a grip protruding from the housing; and a slide plate having a hole through which the grip penetrates and having a circular-arc shape substantially equal to that of a flange provided on the handle. The slide plate includes: a protrusion provided on opening edges extending in a direction substantially perpendicular to a rotation direction of the slide plate, among opening edges defining the hole in the slide plate; and an engagement portion for housing the flange.

FIG. 1C



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Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority from Japanese Patent Application No. 2009-133048 filed on June 2, 2009, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a circuit breaker, such as a molded-case circuit breaker and an earth leakage breaker, and more particularly to an improvement in the shape and structure of a handle.

[0004] 2. Description of Related Art

[0005] A circuit breaker operates for breaking a current path in order to prevent burning of an electric wire and load equipment caused by flow of an excessive current, and also performs a switching function of opening and closing a current path by actuation of a handle provided in the circuit breaker. A grip of the handle is generally protrudes from a housing so as to become easy to perform opening and closing operations, i.e., OFF operation and ON operation. In general, during trip operation, the handle comes to a substantially-intermediate position between an OFF position achieved as a result of performance of OFF operation and an ON position achieved as a result of performance of ON operation, such that a determination can be made from the outside as to whether or not breakage of a current path, i.e., a trip operation, has been performed. In order to again perform ON operation of the circuit breaker having performed trip operation, it is necessary to temporarily move the handle to the OFF position (which is called reset operation). Consequently, a handle is an indispensable member even for a circuit breaker positioned at a current path where opening and closing operations are not intended (see, for example, JP-U-60-65956 (in lines 4-6 of page 4 and Figs. 1 to 3).

[0006] With consideration to the fact that a main spring is actuated by operation of a handle, more specifically a handle arm, an operation stroke of the handle is set to a larger value in order to assure a margin of operation. As is also evident from JP-U-60-65956 (especially Figs. 1 and 2), a rotation range extending from the OFF position to the ON position is inevitably wide. In JP-U-60-65956, it is understood that, for reasons of the wide rotation range, an overcurrent trip element is placed at the OFF position. That is, the overcurrent trip element is placed such that a flange of the handle does not interfere with the overcurrent trip element, as shown in Fig. 2 of JP-U-60-65956. In another document, in consideration of a case where occurrence of interruption is unavoidable for reasons of limitations on the outer shape of the circuit breaker or provision of a residual current transformer indispensable for the tripping operation at the time of electric leakage, the height of the overcurrent trip element is understood to be reduced or the height of the handle arm is understood to be increased (see, for example, WO2003/044818 (lines 46-47 of page 3 and Fig. 2)).

SUMMARY OF THE INVENTION

[0007] As mentioned above, since the rotation range of the handle is wide, there is no alternative way but to avoid occurrence of interference between the flange and the handle. Needless to say, adverse effects have already been pointed out, in which miniaturization of the length or height of the circuit breaker are hindered by the wide rotation range or it is difficult to expand a rated current or stabilize a long time-limit tripping characteristic for reasons of limitations on the volume of an overcurrent trip element. In particular, by virtue of recent technological innovation of the circuit breaker, an armature contact and an overcurrent trip element are usually connected together by means of a so-called shuntless technique. Specifically, how far a switching mechanism, which includes a shuntless technique, is miniaturized, difficulty is encountered in relocating the overcurrent trip element toward the power source (in a rightward direction on a drawing sheet of Fig. 1) for reasons of reservation of a dead space in anticipation of movement of the flange, which might be performed during the OFF operation, as is evident from Fig. 1 of JP-U-60-65956. It goes without saying that, if the left-side flange portion on the drawing sheet is cut for eliminating the dead space, clearance will arise in a handle opening area of the housing at the ON position.

[0008] The present invention has been conceived to solve the above-described circumstances, and an object thereof is to provide a circuit breaker in which an overcurrent trip element is positioned close to a power source side without involvement of a change in the volume of the overcurrent trip element.

[0009] According to an aspect of the invention, there is provided a circuit breaker comprising: a movable contact comprising a movable contact point provided at one end of the movable contact; a stationary contact comprising a stationary contact point configured to contact and to be separated from the movable contact point; a holding member that holds the movable contact; a lower link configured to drive the holding member; a lever engaged with a latch of an overcurrent trip device and configured to be rotated at a time of a trip state of the circuit breaker; an upper link supported about an axis by the lever and coupled to the lower link by way of a spring pin, thereby configuring a toggle link along with the lower link; a main spring having a drive side and a driven side, the driven side being coupled to the spring pin; a substantially U-shaped handle arm coupled to the drive side of the main spring and supported about an axis by a frame fixed to a housing of the circuit breaker such that the handle arm is freely rotatable; a handle fixed to the handle arm and comprising a grip protruding from the housing; and

a slide plate having a hole through which the grip penetrates and having a circular-arc shape substantially equal to that of a flange provided on the handle, wherein the slide plate comprises: a protrusion provided on opening edges extending in a direction substantially perpendicular to a rotation direction of the slide plate, among opening edges defining the hole in the slide plate; and an engagement portion for housing the flange.

[0010] As described above, the present invention can provide a circuit breaker capable of contributing to miniaturization.

BRIEF DESCRIPTION OF DRAWINGS

[0011] Fig. 1 is an external perspective view of a circuit breaker showing a first embodiment of the present invention;

[0012] Fig. 2 is an exploded perspective view of a switching mechanism shown in Fig. 1;

[0013] Fig. 3 is a side cross-sectional view of the circuit breaker shown in Fig. 1;

[0014] Fig. 4 is a perspective view of a circuit breaker showing a second embodiment of the present invention achieved when viewed from the back of a cover;

[0015] Fig. 5 is a perspective view of a handle and a slide plate showing a third embodiment of the present invention;

[0016] Fig. 6 is a front view and a side view including a cover shown in Fig. 5;

[0017] Fig. 7 is a perspective view of a handle and a slide plate showing a fourth embodiment of the present invention; and

[0018] Fig. 8 is a front view and a side view including a cover shown in Fig. 7.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] First Embodiment

[0020] Figs. 1 through 3 show a circuit breaker of a first embodiment of the present invention. More particularly, Fig. 1 is a perspective view of a circuit breaker in a tripped state. Fig. 1A shows external appearance of the circuit breaker; Fig. 1B is a view of the circuit breaker achieved when a cover is removed in the state shown in Fig. 1A; and Fig. 1C shows the circuit breaker in which a switching mechanism is removed in the state shown in Fig. 1B. Fig. 2 is an exploded perspective view showing only principal members of the switching mechanism shown in Fig. 1C, and Fig. 3 is a side cross-sectional view of the switching mechanism (taken along line A-A shown in Fig. 1). Fig. 3A shows the tripped state of the switching mechanism; Fig. 3B shows an ON state of the switching mechanism; and Fig. 3C shows an OFF state of the switching mechanism.

[0021] In Fig. 1, an insulating housing of a triple pole circuit breaker 101 includes a cover 1 and a base 2. A switching mechanism 51 equipped with a handle 3, arc extinguishing units 52 equal in number to poles (three arc extinguishing units in the embodiment), and an overcurrent trip device 53 are arranged in the base 2. The handle 3 protrudes from a handle window hole 1a of the cover 1, which allows the handle 3 to be actuated toward an ON position and an OFF position. As is apparent from a positional relationship between the arc extinguishing units 52 and the overcurrent trip device 53, reference numeral 4 designates a power terminal and reference numeral 5 designates a load terminal.

[0022] Fig. 1 shows the handle 3 and a slide plate 6, and remaining elements except the handle 3 and the slide plate 6, that is, the switching mechanism 51, the arc extinguishing units 52, and the overcurrent trip device 53 may be known elements. Specifically, a stationary contact 8 extends from the power terminal 4 and has a stationary contact point 7 (see Fig. 3) provided at one end of the stationary contact 8. The movable contact 10 is connected to the load terminal 5 by way of the overcurrent trip device 53. The movable contact 10 has a movable contact point 9 and is held by a crossbar 11. The crossbar 11 is one member configuring the switching mechanism 51 and is, for example, a resin molded component. Opening and closing are repeated between the stationary contact 8 and the movable contact 10. The arc extinguishing unit 52 extinguishes an arc developing between the stationary contact point 7 and the movable contact point 9 by means, particularly, of the opening action of the opening and closing actions. The crossbar 11 serves as an example of a holding member.

[0023] The structure of the switching mechanism 51 is now described. As shown in Fig. 2, the switching mechanism 51 includes a frame 12, a handle arm 13 and a handle so as to be configured as a unit. The frame 12 includes a pair of frame plates 12A and 12B which oppose each other. The handle arm 13 has a substantially U-shape and pivotally attached to the frame 12 so as to allow the handle arm 13 to freely rotate. The handle 3 is fixed to the handle arm 13. The frame 12 is fixed to the base 2 having a U-shaped groove 2a (see Fig. 1), and a lower portion (on the drawing sheet) of the frame 12 has a shape conforming to a rotation range of the crossbar 11 rotatable around the groove 2a as a rotation axis thereof. As shown in Fig. 1, the crossbar 11 accommodates the movable contact 10 that is rotated around an unillustrated axially-supported portion of a slide contact 14. Further, the movable contact 10 is urged in a clockwise direction on a drawing sheet of Fig. 3 by means of a contact pressure spring 15. As used herein, a term '"clockwise direction" and a term "counterclockwise direction" corresponds the directions determined with reference to a surface of a drawing sheet, and their repeated explanations are omitted. Therefore, in an ON state shown in Fig. 3B, an electrical contact between the stationary contact point 7 and the movable contact point 9 is maintained by means of appropriate contact resistance.

[0024] As is apparent from the descriptions provided thus far, the switching mechanism 51 operates for opening and closing the movable contact 10 by actuation of

the handle 3, and a mechanism therefor may include a known toggle link mechanism. As shown in Figs. 2 and 3, the toggle link mechanism includes: an upper link 17 and a lower link 18 that are rotatably coupled together by a spring pin 16; a handle arm 13, a lever 19, and a latch 20 which are rotatably provided on the frame 12; a trip bar 21 that hinders counterclockwise rotation of the latch 20; a latch spring 22 (see Fig. 1) for urging the trip bar 21 in a clockwise direction; and a main spring 23 (indicated by a dashed line in Fig. 3 for the sake of convenience) stretched between the spring pin 16 and the handle arm 13.

[0025] The handle arm 13 has a substantially U-shaped form as mentioned previously in such a way that both arms of the handle arm 13, specifically, ends 13a which are located in respective side surfaces of the U shape in a circular-arc geometry, are pressed against corresponding circular-arc indentations 12a made in the frame 12 by dint of force of the main spring 23; and that a locus of rotation action of the handle arm 13 becomes essentially flush with an exterior surface or an interior surface of a frame plate 12A (12B). Meanwhile, the lever 19 is also made in a substantially-U-shaped geometry in order to rotate both arms of the lever 19 between the frame plates 12A and 12B. The rotation of the lever 19 is effected by means of a first shaft 19a extending outside substantially parallel to an area corresponding to the bottom of the U shape being axially supported by shaft holes 12b made in the frame 12.

[0026] The upper link 17 is rotated in a gap generated between the frame 12 and the lever 19 as a result of a first circular-arc indentation 17a being pivotally attached to second shaft portions 19b protruding from both side surfaces of the lever 19. In relation to the gap, the shaft holes 12b are equivalent to the width of each of projections 12b1 made by so-called burring operation. In an ON state, second circular-arc indentations 17b are pressed against the respective projections 12b1 by dint of force of the main spring 23. The upper link 17 also has third circular-arc indentations 17c. The third circular-arc indentations 17c and first holes 18a of the lower link 18 are axially, pivotally attached to the respective spring pins 16, whereby the upper link 17 and the lower link 18 are joined together as a frame work of the so-called toggle link mechanism by way of the spring pins 16, as mentioned previously. Further, the second holes 18b are axially attached to a crossbar pin 24 positioned in the crossbar 11, whereby the lower link 18 and the crossbar 11 are linked together. In the embodiment, the upper link 17 is made in the substantially-U-shaped form as are the handle arm 13 and the lever 19. Further, the lower link 18 is made of a pair of mutually-opposing plates as is the frame 12. However, needless to say, these elements are not limited to the aforementioned shapes.

[0027] Subsequently, shapes of the handle 3 and the slide plate 6 will be described. The handle 3 includes a grip 3a and a flange 3b and is a resin-molded article similar to the cover 1 and the base 2. The substantially-rectangular handle window hole 1a, which matches the rotation range of the grip 3a from the ON position to the OFF position (or vice versa) of the circuit breaker 101, is provided in the cover 1 in conformance with the shapes of the grip 3a and the flange 3b. Further, a peripheral inner wall 1b of the handle window hole 1a facing the switching mechanism 51 (a ceiling of the cover 1 when viewed from the switching mechanism 51 in plain language) also assumes a circular-arc shape that is concentric with the center of rotation of the flange 3b and the handle arm 13 (more specifically, an engagement between the foregoing end 13a and the circular-arc indentation 12a). As compared with a related-art circuit breaker, a gap between the flange 3b and the peripheral inner wall 1b is made wider. The slide plate 6, which also has a concentric circular-arc shape and which is a resin-molded article, is placed in the gap. Needless to say, a material of the resin-molded components (the cover 1, the base 2, the handle 3, and the slide plate 6) does not need to be identical.

[0028] As mentioned previously, the slide plate 6 is interposed between the flange 3b and the peripheral inner wall 1b. To this end, a hole 6a for insertion of the grip 3a is provided, and engagement portions 6b for housing the respective flanges 3b are provided on the load side (the left side on the drawing sheet). Of opening edges 6a1 to 6a4 making up the hole 6a, edges (6a1 and 6a2) extending in a direction substantially perpendicular to the rotation direction of the slide plate 6 are provided with protrusions 6c1 and 6c2, respectively.

[0029] Functions of the engagement portions 6b and those of the protrusions 6c1 and 6c2 are hereinbelow described in conjunction with a series of operations of the circuit breaker 101. When the handle 3 is rotated in a clockwise direction from the OFF state shown in Fig. 3C, a drive side 23a of the main spring 23 also follows the rotation action. At this time, a line of action of the main spring 23 exceeds the upper link 17. More specifically, the spring pin 16 moves to a position shown in Fig. 3B at an instant when a line connecting the drive side 23a with a driven side 23b (the spring pin 16) has exceeded a line connecting the first circular arc indentation 17a with the third circular-arc indentation 16c (the spring pin 16). As a consequence, both links 17 and 18 positioned in the L-shaped form expand as shown in Fig. 3B, whereby the crossbar 11 rotates in a clockwise direction, whereupon the contact points 7 and 9 starts electrically contacting each other; namely, the circuit breaker shifts to an ON state, as mentioned previously. Expansion of the links is blocked by means of the second circular-arc indentation 17b colliding the projections 12b1.

[0030] When the line of action is exceeded (persons skilled in the art also say exceeding of a dead point), the rotation of the handle arm 13 induced by forcing action is blocked by the frame 12 while the handle arm 13 is being forced around the ends 13a, which serve as a center of rotation, in a clockwise direction by dint of spring force of the main spring 23 (as indicated by point B in

Fig. 3B), whereby the grip 3a comes to a standstill at a so-called ON position. Likewise, the lever 19, which is forced in a clockwise direction by way of the spring pin 16 and the upper link 17 by dint of spring force of the main spring 23, is attempted to be forced in a counterclockwise direction with reference to the latch 20 by means of forcing action. The latch 20 itself is engaged with the trip bar 21, so that the rotation of the latch 20 is blocked. Inevitably, the rotation of the lever 19 is also blocked. However, the positions of the lever 19 and the latch 20, including the position of the trip bar 21, remain unchanged between the ON state shown in Fig. 3B and the OFF state shown in Fig. 3C.

[0031] The position of the slide plate 6 achieved in the ON state; in other words, a constrained state, is as follows. First, further clockwise rotation action of the slide plate is hindered by the engagement portions 6b colliding against a load-side extremity 3b1 of the flange 3b. Further counterclockwise rotation action of the slide plate 6 is hindered by means of the protrusion 6c2 colliding against the grip 3a. Noteworthy is the fact that the circumferential length of the load-side flange 3b (on the left side of the drawing sheet) of the handle 3 along a circular arc centering on the ends 13a is shorter than the circumferential length of the power-source-side flange 3b (on the right side of the drawing sheet) of the handle 3 along the circular arc. Therefore, a gap C arise between the load-side extremity 3b1 and a load-side opening edge 1a1 of the handle window hole 1a. However, the gap C is closed by an indication surface 6d1, which is an extension of the slide plate 6 from the opening edge 6a1. For this reason, it is needless to say that intrusion of extraneous matters into the circuit breaker 101 is prevented.

[0032] There will now be described operation performed from when the overcurrent trip device 53 operates in response to flow of an overcurrent to the current path in an ON state and until when the state of the overcurrent trip device consequently shifts to a trip state. A positional change in a member making up the switching mechanism 51 involved in a shift from the ON state to the trip is well known. A shift from the OFF state to the ON state is made as a result of rotation of the lever 19 and the latch 20 that have been held in a constrained state by the trip bar 21. Specifically, in Fig. 3B, a bimetal 53a (see Fig. 1) making up the overcurrent trip device 53 is curved, or a movable iron core 53b (see Fig. 1) is rotated in a clockwise direction according to the magnitude of an overcurrent, whereby the trip bar 21 is rotated in a counterclockwise direction. Consequently, the latch 20 is brought out of engagement, whereupon the latch 20 is rotated in a counterclockwise direction. As mentioned previously, the lever 19 remaining forced in a clockwise direction is disengaged from the latch 20 that is a factor for hindering forcing of the lever 19. As a result, the lever 19 is rotated in a clockwise direction; more specifically, rotated by the main spring 23 while the first shaft 19a is taken as a rotation center until the lever collides with a frame pin 25 connecting the frame plates 12A and 12B (as indicated by point D in the drawing), as shown in Fig. 3A. Since the overcurrent trip device 53 itself is not the principal section of the present embodiment, its additional detailed explanations are omitted.

[0033] The rotation of the lever 19 equally signifies synchronous rotation of the second shaft 19b. However, as a result of movement of the line of action, a point of bending of the links 17 and 18 having remained extended thus far; namely, the spring pin 16, moves to a position shown in Fig. 3A, whereupon the links 17 and 18 are bent into the shape of the letter L. Further, the cross bar 11 is rotated in a counterclockwise direction, whereby the contact points 7 and 9 are opened. The handle arm 13 is, at this time, in the process of rotating in a counterclockwise direction by dint of spring force of the main spring 23, and a bend 13b of the handle arm 13 collides with the lever 19, whereby the grip 3a comes to a standstill at a so-called trip position.

[0034] Meanwhile, movement of the slide plate 6 is constrained in an ON state by the engagement portions 6b and the protrusion 6c2. The same also applies to a trip position. Namely, the first feature of the embodiments lies in that the slide plate 6 also follows as-is movement of the handle 3 from the ON state to the trip state.

[0035] Subsequently, a shift from the trip state to the OFF state is now described. This operation is indispensable as a preliminary step for bringing the handle again into the ON state as mentioned in connection with the background art section. When the handle 3 is rotated in the counterclockwise direction from the trip state shown in Fig. 3A, the bend 13b rotates the lever 19 in a counterclockwise direction. The lever 19 is engaged with the latch 20 while promoting engagement of the latch 20 with the trip bar 21, whereby the handle is brought into the OFF state shown in Fig. 3C. More specifically, reset operation is completed. At this time, the second shaft 19b is also rotated in association with rotation action of the lever 19, whereby the position of the spring pin 16 is downwardly moved on the drawing sheet as is evident from the difference between Figs. 3A and 3C. Since movement of the lower link 18 induced by movement of the spring pin 16 is not transmitted to the crossbar 11, the entirety of the substantially-L-shaped links is slightly moved. However, the crossbar 11 remains stationary and, by extension, the position of the movable contact 10 also remains unchanged.

[0036] Attention is paid to the movements of the handle 3 and the slide plate 6. As in the related art, the handle 3 comes to a standstill at the so-called OFF position shown in Fig. 3C that is slightly returned in the clockwise direction from a position where the handle arm 13 has collided with the frame 12 [a point E (see Fig. 2), and the position is usually referred to as a "reset position"] by dint of spring force of the main spring 23. Meanwhile, the slide plate 6 follows rotation action of the handle arm 13 part way by means of the engagement portions 6b and the protrusion 6c2. However, the other protrusion 6c1 collides against the step 1c1 situated at a point along an

imaginary line connecting the load-side opening edge 1a1 with the peripheral inner wall 1b, whereby further counterclockwise rotation of the slide plate 6 is blocked.

[0037] The handle 3 has not yet reached the OFF position at a point in time when the rotation of the slide plate 6 is hindered. However, operation for rotating the handle 3 to the OFF position is continually performed regardless of a hindrance to the rotation of the slide plate 6. The load-side extremity 3b1 then depresses the engagement portions 6b imparted with a spring feature and reaches the OFF position shown in Fig. 3C while being accommodated in the engagement portions 6b. A second feature of the embodiments lies in that the slide plate 6 does not follow the movement of the handle 3 from the trip state to the OFF state up to an arbitrary point but not further and comes to a standstill, to thus conversely enter a state of engagement with the handle 3.

[0038] A series of operations; namely, the OFF state, the ON state, the trip, and the OFF state have been described thus far. In relation to opening operation without involvement of a trip; in other words, a shift from the ON state to the OFF state, at the instant when the line of action of the main spring 23 has exceeded the upper link 17 during the course of action from Fig. 3B to Fig. 3C, the links 17 and 18 remaining extended thus far comes into the shape of the letter L as shown in Fig. 3C in reverse manner to the case of the shift from the OFF state to the ON state. The operation itself is known. The positional relationship between the handle 3 and the slide plate 6 except the trip position applies directly to the operations. The summarized second feature of the embodiments lies in that the handle 3 is engaged with the slide plate 6 during a shift to the OFF state.

[0039] In the explanations about operation pertaining to the shift from the OFF state to the ON state, action of the slide plate 6, which would be performed in response to the rotation of the handle 3 in the clockwise direction, has not been referred to. Therefore, the action of the slide plate 6 is described anew. First, the slide plate is in engagement with the handle 3 in the OFF state as mentioned previously. As is obvious from Fig. 3C, further rotation of the slide plate 6 in the clockwise direction is hindered by the load-side extremity 3b1, and further rotation of the slide plate 6 in the counterclockwise direction is hindered by the step 1c1. When the grip 3a is rotated clockwise in this state, the protrusion 6c2 comes into collision with the step 1c2 situated at a point along an imaginary line connecting the power-side opening edge 1a2 with the peripheral inner wall 1b.

[0040] However, the grip 3a has not yet reached the ON position at a point in time when collision has occurred. The load-side extremity 3b1 goes out of the engagement portions 6b by further clockwise rotation of the handle 3, whereupon both the handle 3 and the slide plate 6 come to a standstill at positions shown in Fig. 3B. A third feature of the embodiments in short lies in that the handle 3 and the slide plate 6, which are engaged with each other, are disengaged during the course of movement to the ON position.

[0041] As is apparent from the descriptions provided thus far, the slide plate 6 is not simply put on the grip 3a. A contrivance is made to the hole 6a. Specifically, there are provided the protrusions 6c1 and 6c2 that bear portions of the opening edges 1a1 and 1a2 of the handle window hole 1a in the course of the OFF and ON operations. As a result, the circumferential length of the load-side flange 3b, among a right flange and a left flange on the drawing sheet; namely, a power-side flange and a load-side flange, can be shortened. As is known from Fig. 3C, dead space arising when the handle 3 is situated at the OFF position (described in connection with the background art) does not need to be taken into account. Therefore, the overcurrent trip device 53 can be brought closer to the power side. For instance, a leakage current detection function can be readily provided at a space corresponding to the amount by which the overcurrent trip device has been moved. There can be acquired a much smaller circuit breaker equivalent to the circuit breaker 101 whose lengthwise direction (a direction parallel to rotation action of the handle 3) is shorted.

[0042] Second Embodiment

[0043] Fig. 4 shows a circuit breaker of a second embodiment of the present invention; more specifically, a perspective view of the circuit breaker with a handle and a slide plate achieved when viewed from the back of a cover. Figs. 4A, 4B, and 4C respectively show a trip state, an ON state, and an OFF state for showing displacement of the handle and the slide plate.

[0044] In connection with the first embodiment, the slide plate is engaged with the handle when the handle shifts from the ON state to the OFF state or from the trip state to the OFF state and that the handle is disengaged from the slide plate when the handle shifts from the OFF state to the ON state. In other words, the slide plate is disengaged from the handle in the ON state and the trip state, and the slide plate becomes engaged with the handle in the OFF state. Now, a shift to the trip state is made from the OFF state that is not described in detail in connection with the first embodiment as well as from the aforementioned ON state (as a result of detection of an overcurrent). The circuit breaker is generally equipped with a device capable of bringing about a trip state when actuated (pressed) from the outside; namely, a so-called trip button. The device is especially used at the time of sequence-checking of alarm contact points built in the circuit breaker. Sequence check is also presumed to be performed in an OFF state. Even when a shift is made from the OFF state to the trip state, occurrence of reliable disengagement; namely, a state identical with that achieved when a disengaged state is held in the middle of a shift from the ON state to the trip state, is expected (in plain language, it is indispensable to hold the state of Fig. 3A described in connection with the first embodiment in the trip state regardless of whether the shift is made from the ON state or the OFF state). Accordingly, performance of reliable disengagement even in the middle

of a shift from the OFF state to the trip state is described in connection with the second embodiment. The positions of the handle and those of the slide plate achieved in the respective states are the same as those described in connection with the first embodiment. Further, means for constraining the slide plate in the ON state and the OFF state; namely, the steps (1c1 and 1c2) and the protrusions (6c1 and 6c2) are also provided even in the second embodiment.

[0045] As mentioned previously, Figs. 4A to 4C show a rotation of a slide plate 36 along a peripheral inner wall 31b of a cover 31. The second embodiment is identical with the first embodiment except that the cover 31 is equipped with a convex stopper 31d assuming a triangular cross-sectional profile and that a handle 33 is equipped with a guide 33c. As in the state of Fig. 3B, the slide plate 36 is constrained from performing rotation action by a grip 33a and a protrusion 36c2 (neither of them is provided in Figs. 4A to 4C) in the trip state shown in Fig. 4A, and the slide plate 36 is constrained, in the ON state shown in Fig. 4B, from performing rotation action by a load-side extremity 33b1 and an engagement portion 36b. In other words, the stopper 31d and the guide 33c are not at all involved in rotation action in the trip state and the ON state. Namely, although the stopper 31d is situated within the rotation range of the engagement portion 36b, the engagement portion 36b has not yet reached the stopper 31d in the trip state shown in Fig. 3A. Further, the handle 33 and the slide plate 36 still remain disengaged from each other, and hence the guide 33c has not yet performed its function.

[0046] The stopper 31d and the guide 33c perform their functions at the time of a shift to the OFF state and a shift from the OFF state, which will now be described. As mentioned previously, the stopper 31d is situated at the rotation range of the engagement portions 36b. Therefore, on the occasion of a shift from the state of Fig. 4A to the state of Fig. 4C, the engagement portions 36b first go up onto the stopper 31d, and the protrusion 36c1 subsequently collides with the step 31c1 (neither of them is provided in Figs. 4A to 4C). The slide plate 36 is thereby brought into a predetermined position; namely, the OFF position. Subsequently, the load-side extremity 33b1 is housed in the engagement portion 36b, whereby the engagement portion 36b and the guide 33c become adjacent to each other as shown in Fig. 4C. Therefore, the second embodiment differs from the first embodiment in that, on the occasion of a shift to the OFF state, the engagement portion 36b goes up onto the stopper 31d and that the engagement portion 36b is adjacent to the guide 33c in the OFF state.

[0047] A shift from the OFF state is now described. Even in the case of a shift from the state of Fig. 4C to the state of Fig. 4A or a shift from the state of Fig. 4C to the state of Fig. 4B, the slide plate 36 follows rotation action of the handle 33 until the engagement portion 36b collides with the stopper 31d. After colliding with the stopper, the engagement portions attempt to go up onto the stopper as in the aforementioned case of the shift from the trip state to the OFF state (the same also applies to the shift from the ON state to the OFF state). However, the adjacent guide portion 33c temporarily hinders the engagement portions from going up onto the stopper. Namely, the handle 33 keeps rotating, whilst the slide plate 36 is hindered from performing rotation action. As a result, the handle 33 is disengaged from the slide plate 36 at this point in time. Disengagement signifies that the engagement portion 36b does not become adjacent to the guide portion 33c. During subsequent rotation action of the handle 33, the protrusion 36c2 is pressed against the grip 33a (neither of them is provided in Figs. 4A to 4C), whereby the engagement portion 36b goes up onto the stopper 31d along with the fact that the engagement portion 36b is not adjacent to the guide portion 33c.

[0048] As a result of the engagement portions going up onto the stopper, the handle 33 and the slide plate 36 remain disengaged from each other in the trip state as well as in the ON state as shown in Figs. 4A and 4C. As is obvious from the descriptions provided thus far, on the occasion of the shift from the OFF state to the ON state, the handle 3 and the slide plate 6 are engaged with each other, and the protrusion 6c2 collides with the step 1 c2 in the first embodiment, whereupon the handle and the slide plate are disengaged from each other. In contrast, in the second embodiment, by means of provision of the stopper 31d and the guide 33c, the stopper and the guide are disengaged from each other immediately after the rotation of the handle 33. As mentioned previously, the stopper and the guide reliably contribute to disengagement of the handle from the slide plate even on the occasion of the shift from the OFF state to the trip state. Accordingly, for instance, even in a case where, after the trip button 26 (see Fig. 1) is pressed while the grip 33a is pressed, the grip 33a is (manually) rotated to the trip position, the state shown in Fig. 3A can be fulfilled without involvement of a problem. Therefore, a circuit breaker with higher reliability can be provided. In the second embodiment, the engagement portion 36b is provided only on one side. However, the engagement portion may also be provided on both sides as in the case of the first embodiment (see Fig. 2). Needless to say, in this case, the stopper 31d and the guide 33c are also provided such that a pair is provided on either side.

[0049] Third Embodiment

[0050] Fig. 5 and Figs. 6A to 6C show a circuit breaker of a third embodiment of the present invention. Specifically, Fig. 5 is a perspective view (corresponding to Fig. 2) of a handle and a slide plate. Figs. 6A to 6C are portions of a front view and a side view of the circuit breaker equipped with a cover. Figs. 6A, 6B, and 6C respectively show a trip state, an ON state, and an OFF state in order to show displacement of the handle and the slide plate.

[0051] As also described in connection with the background art section, the state of the circuit breaker can be ascertained from the position of the handle as is well known. However, as can be seen from Figs. 6A to 6C, it

is rather difficult to ascertain the position of the handle (the grip) from the front rather than from sideways. Further, when the entirety of the circuit breaker is housed in a board, difficulty is encountered in ascertaining the position of the handle even from sideways. Therefore, the circuit breaker is usually provided with an ON plate and an OFF plate that are affixed to the handle (the flanges), thereby making it possible to clearly identify the state of the circuit breaker even from the front. In the third embodiment, the ON plate and the OFF plate; particularly, positions where the plates are to be affixed, will primarily be described by reference to the handle and the slide plate described in connection with the second embodiment.

[0052] As can be seen from Figs. 6B and 6C, a lower half of the handle window hole 31a on the drawing sheet is covered with a display surface 36d1 of the slide plate 36 in the ON state. Further, in the OFF state, an upper half of the handle window hole 31a on the drawing sheet is covered with a display surface 36d2 of the slide plate 36 (see also reference numeral 6d1 in Fig. 3B and reference numeral 6d2 in Fig. 3C). Therefore, as shown in Fig. 5, the display surface 36d1 is affixed with a red ON plate 27 indicating an ON state, and the display surface 36d2 is affixed with a green OFF plate 28 indicating an OFF state. As a result, as shown in Figs. 6B and 6C, the ON plate 27 can be visually ascertained in the ON state, and the OFF plate 28 can be visually ascertained in the OFF state through the handle hole 31a. Therefore, even in the case of a circuit breaker having the slide plate 36, the state of the circuit breaker can be clearly ascertained.

[0053] Fourth Embodiment

[0054] Still another embodiment is described as a fourth embodiment in connection with affixing of the ON plate and the OFF plate as in the third embodiment. Fig. 7 corresponds to Fig. 5 of the third embodiment, and Figs. 8A to 8C correspond to Figs. 6A to 6C of the third embodiment.

[0055] The third embodiment has been described primarily in connection with the ON state and the OFF state. Needless to say, the circuit breaker also has a trip state. As is obvious from Fig. 6A, the grip 33a is situated at a substantially intermediate position of the handle window hole 31a in the trip state. Therefore, both the ON plate 27 and the OFF plate 28 are visually ascertained in this state. Incidentally; for instance, in relation to the "trip state," a compact circuit breaker for home use to be operated by an infinite number of persons is not provided with a trip state. Occurrence of an overcurrent trip is known to immediately cause a shift to the OFF state (this is also called an automatic reset). As is described in connection with the background art and the first embodiment, this is said to be a countermeasure against the fact that an ordinary person is unfamiliar with performance of a temporal reset (performance of a shift to the OFF state) on the occasion of a shift from the trip state again to the ON state.

[0056] Meanwhile, the circuit breaker having a trip state described in connection with the present embodiments is originally intended to be used by an operator who is engaged in energizing operation. For this reasons, as mentioned previously, it is possible to ascertain a trip state from the fact that the grip 33a is situated at a substantially-intermediate position and that an ON display line 27a appended to the ON plate 27 is concealed in the trip state. However, it is more preferable to avoid the potential of both red and green plates being simultaneously visually ascertained in one circuit breaker on the occasion of checking of states of a plurality of circuit breakers positioned side by side. Accordingly, preventing visual ascertainment of both plates in a trip state is now described as the fourth embodiment.

[0057] In contrast with the third embodiment, the OFF plate 30 is affixed to a position close to the handle 33 in such a way that the ON plate 29 is affixed to a display surface 36d1 and that the OFF plate 30 is affixed to a flange 33b, as shown in Fig. 7. In consideration of the fact that both plates 29 and 30 are concealed by the cover 31 or the slide plate 36, outside dimensions of the plates are made small. As a result, the ON plate 29, which is visually ascertained in Fig. 8B, is concealed by the peripheral inner wall 31b (see Fig. 4B) along with a shift to the trip state. In the meantime, the OFF plate 30, which is visually ascertained in Fig. 8C, is concealed by a display surface 36d2 along with a shift to the trip state (see also Fig. 3A). Therefore, in the trip state shown in Fig. 8A, neither the plate 29 nor the plate 30 is visually ascertained. Thus, by generation of a state in which neither a red color nor a green color is visually ascertained, occurrence of a trip; namely, occurrence of an anomaly in an electric path in which the circuit breaker is placed, can be readily informed.

Claims

1. A circuit breaker comprising:

a movable contact comprising a movable contact point provided at one end of the movable contact;

a stationary contact comprising a stationary contact point configured to contact and to be separated from the movable contact point;

a holding member that holds the movable contact;

a lower link configured to drive the holding member;

a lever engaged with a latch of an overcurrent trip device and configured to be rotated at a time of a trip state of the circuit breaker;

an upper link supported about an axis by the lever and coupled to the lower link by way of a spring pin, thereby configuring a toggle link along with the lower link;

a main spring having a drive side and a driven

side, the driven side being coupled to the spring pin;
a substantially U-shaped handle arm coupled to the drive side of the main spring and supported about an axis by a frame fixed to a housing of the circuit breaker such that the handle arm is freely rotatable;
a handle fixed to the handle arm and comprising a grip protruding from the housing; and
a slide plate having a hole through which the grip penetrates and having a circular-arc shape substantially equal to that of a flange provided on the handle,
wherein the slide plate comprises:

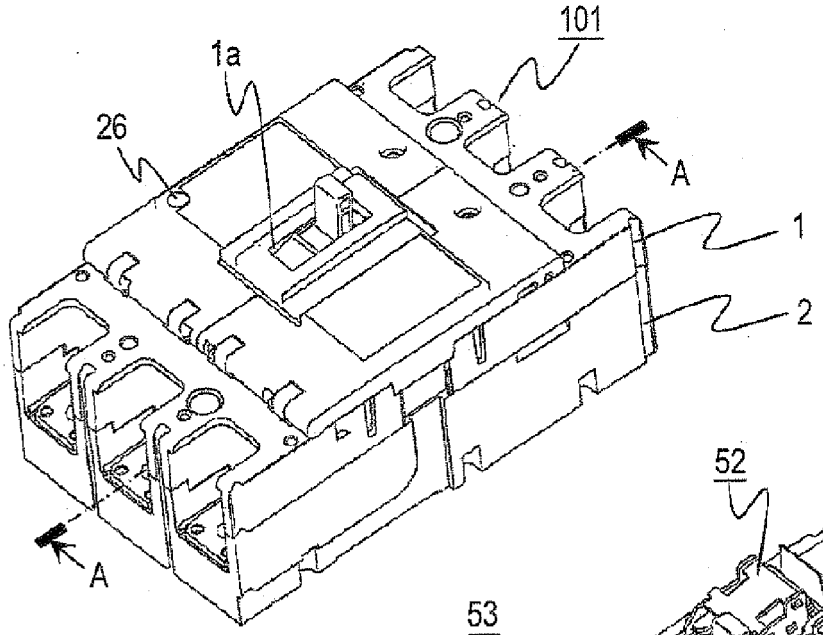
a protrusion provided on opening edges extending in a direction substantially perpendicular to a rotation direction of the slide plate, among opening edges defining the hole in the slide plate; and
an engagement portion for housing the flange.

2. The circuit breaker according to claim 1, wherein the flange is not housed in the engagement portion in an ON state and a trip state but housed in an OFF state.

3. The circuit breaker according to claim 2, wherein an indication for ascertaining a state of the circuit breaker is provided on the slide plate.

4. The circuit breaker according to claim 2, wherein an indication for ascertaining a state of the circuit breaker is provided on the handle and the slide plate.

FIG. 1A



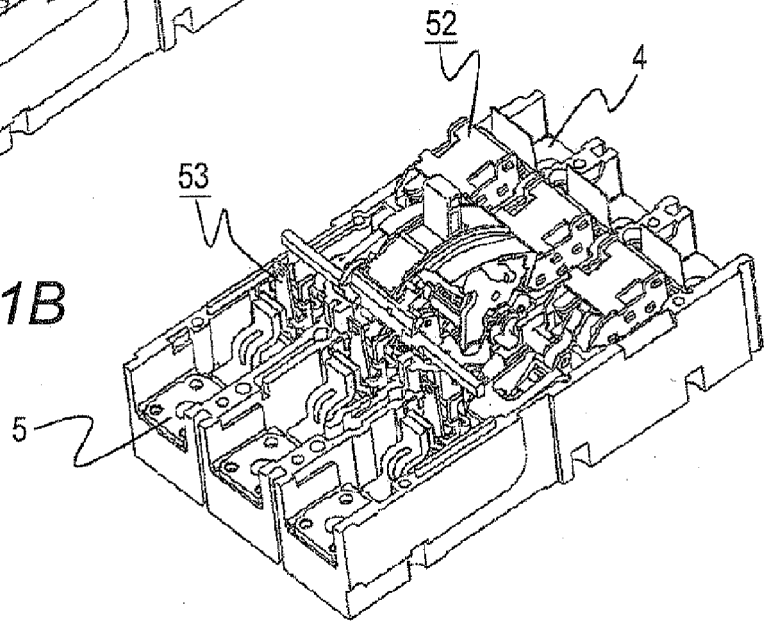


FIG. 1B

FIG. 1C

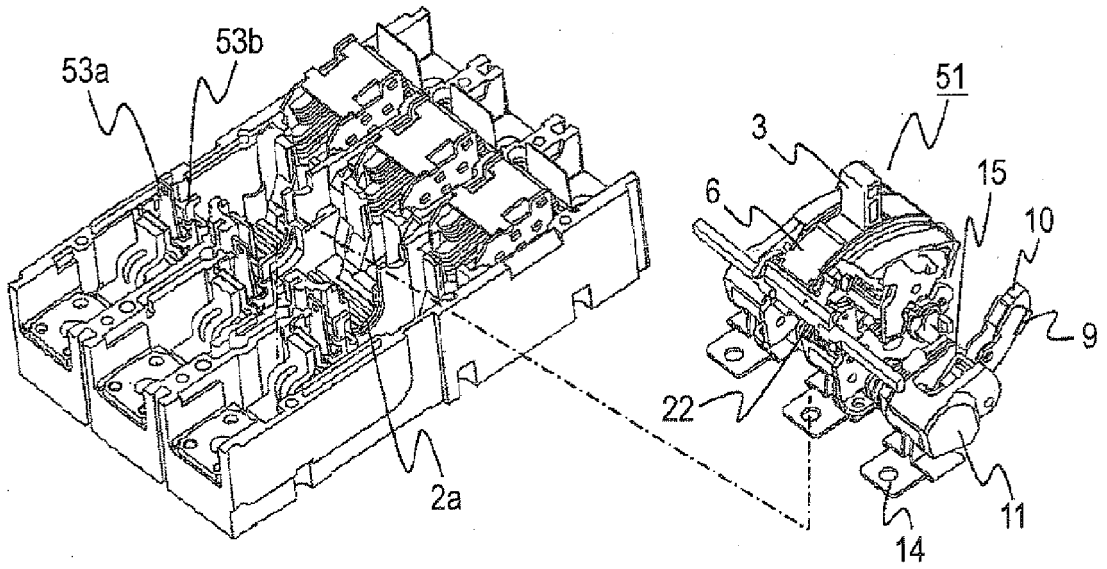
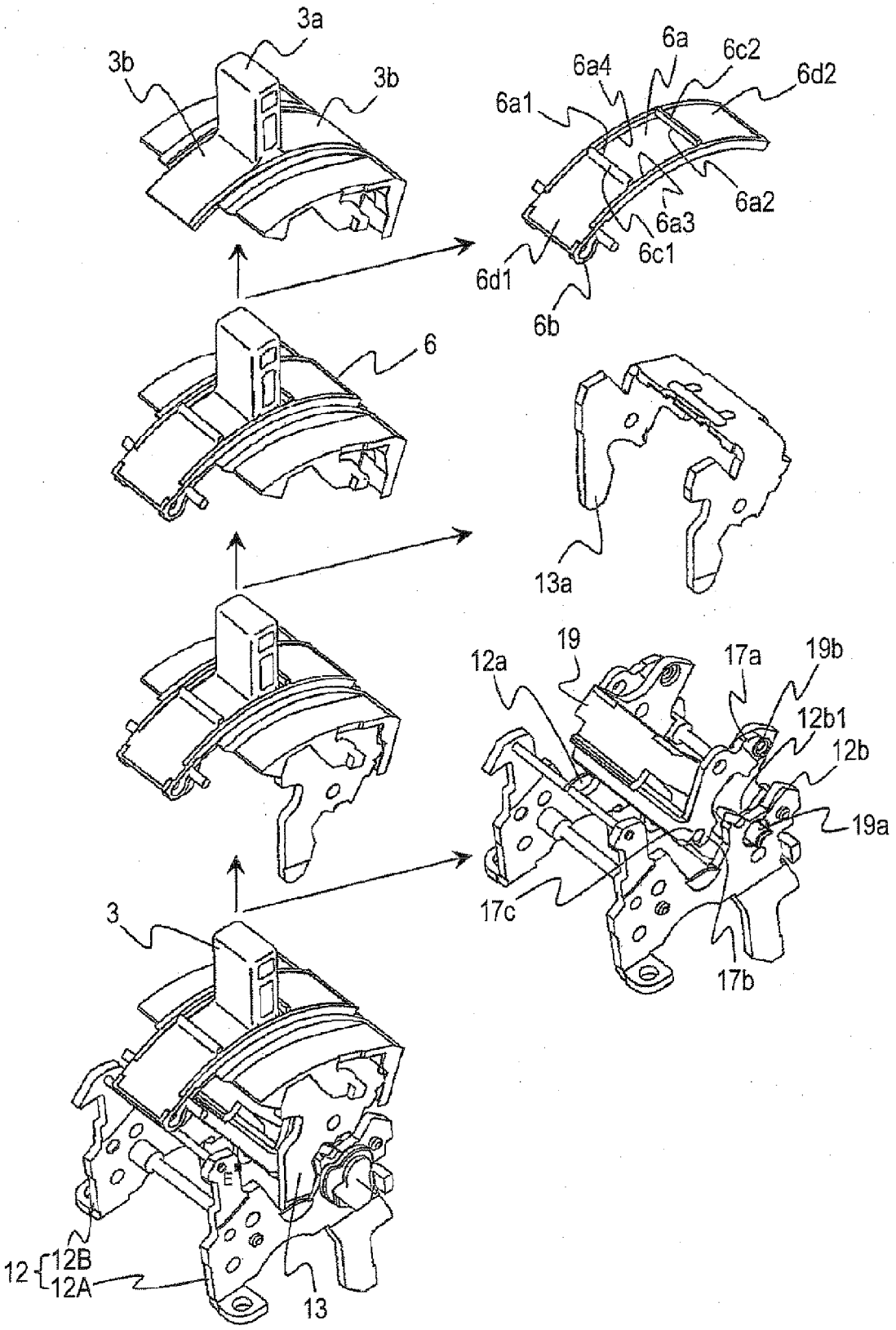


FIG. 2


3a
3b
3b
6a
6c2
6a4
6d2
6a1
6a2
6a3
6c1
6d1
6b
6
13a
19
12a
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19b
12b1
12b
19a
17c
17b
3
12
12B
12A
13

FIG. 3A

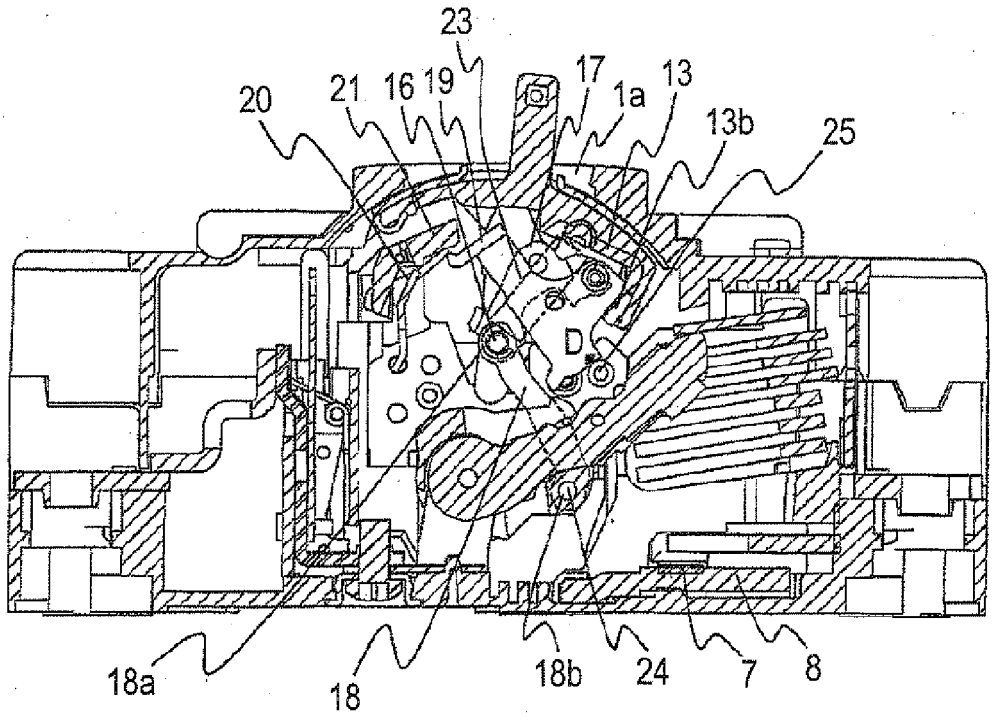


FIG. 3B

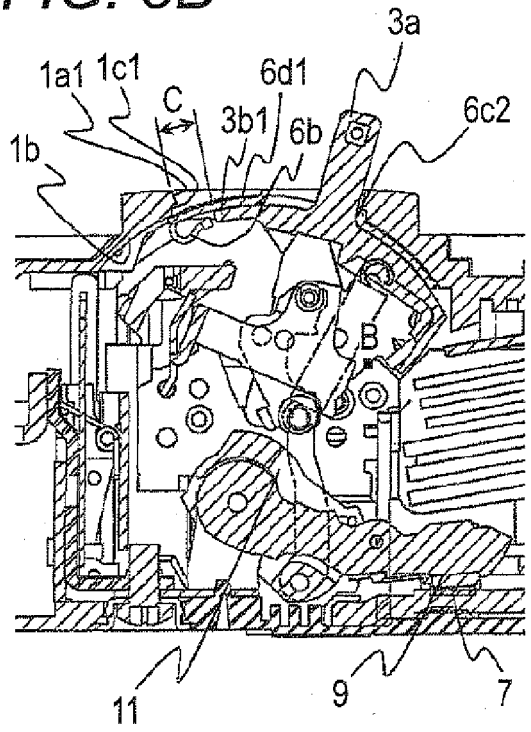


FIG. 3C

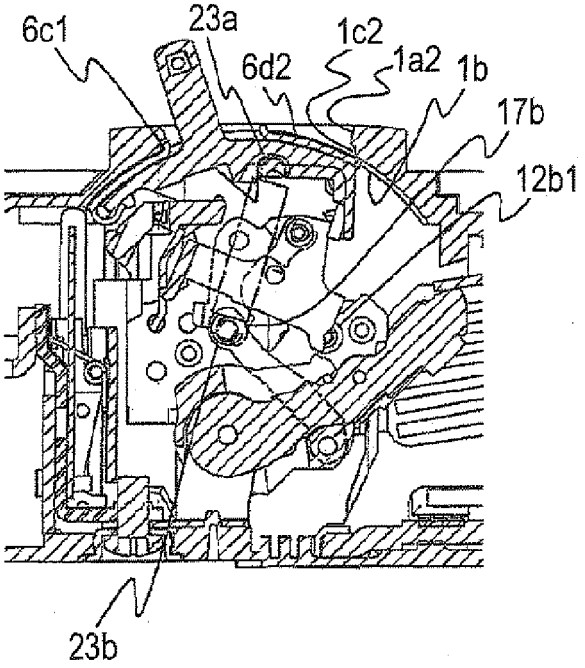


FIG. 4A

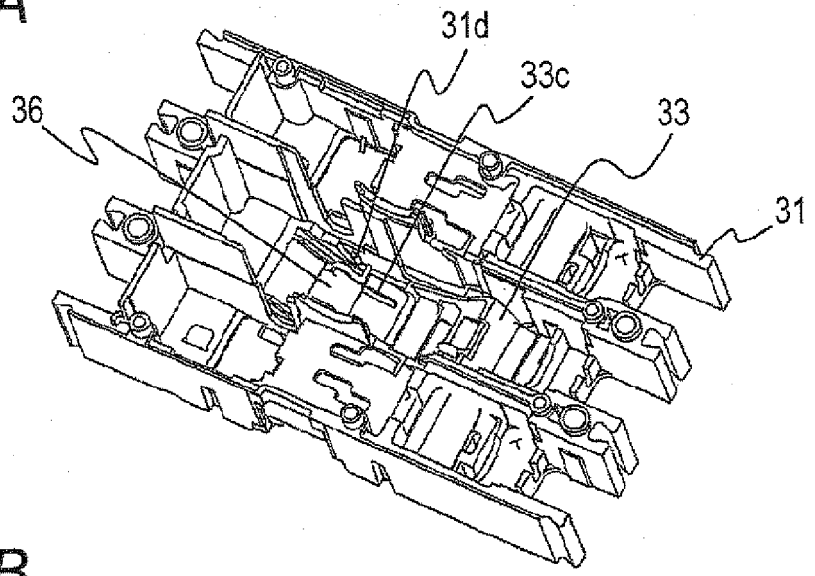


FIG. 4B

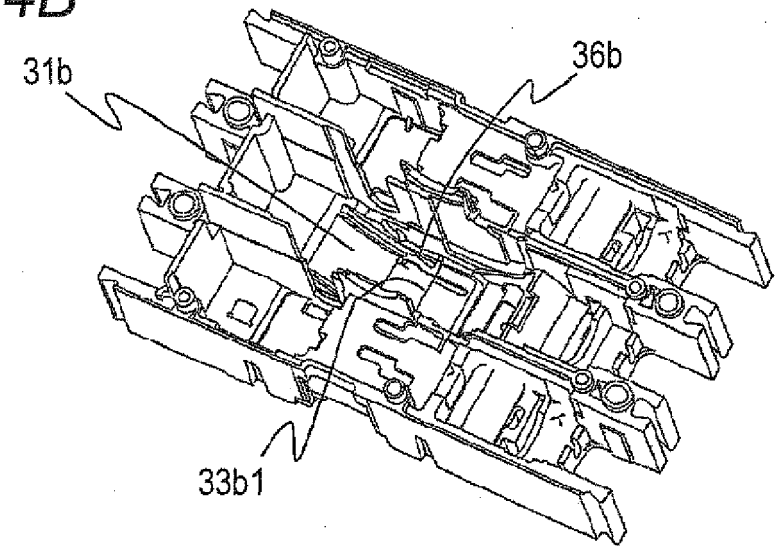


FIG. 4C

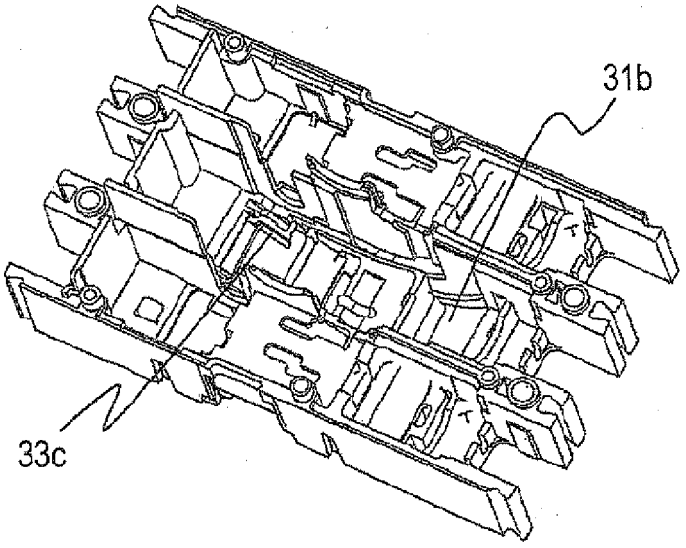


FIG. 5

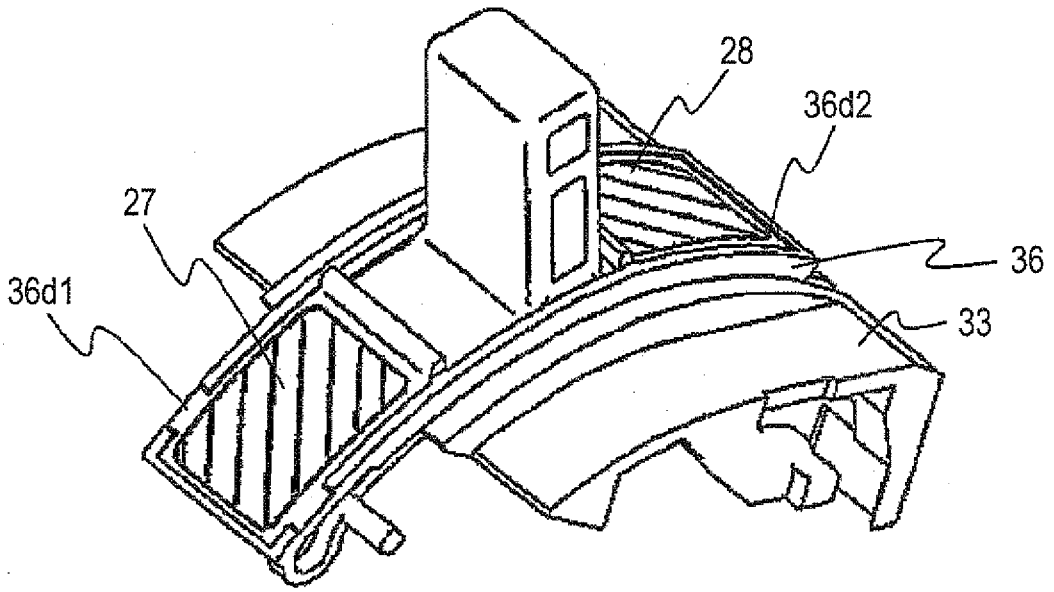


FIG. 6A

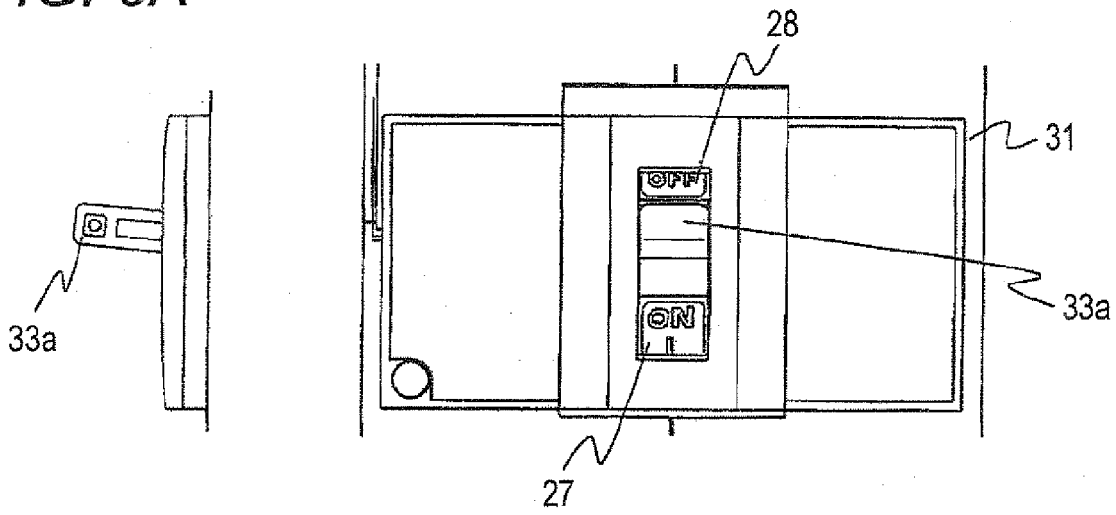


FIG. 6B

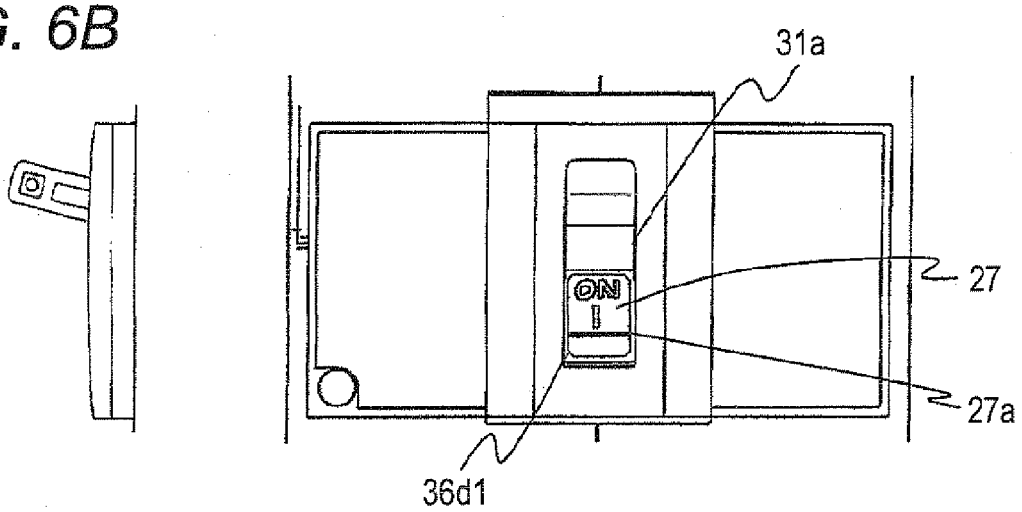


FIG. 6C

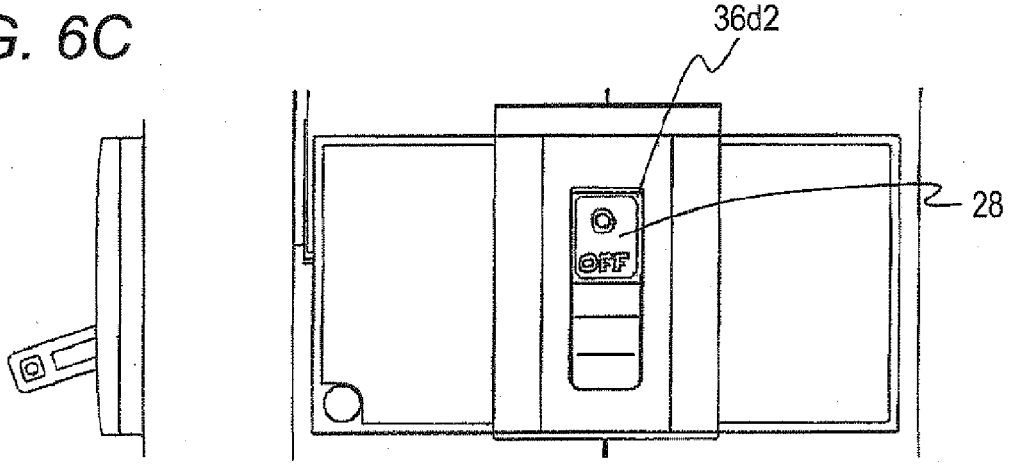


FIG. 7

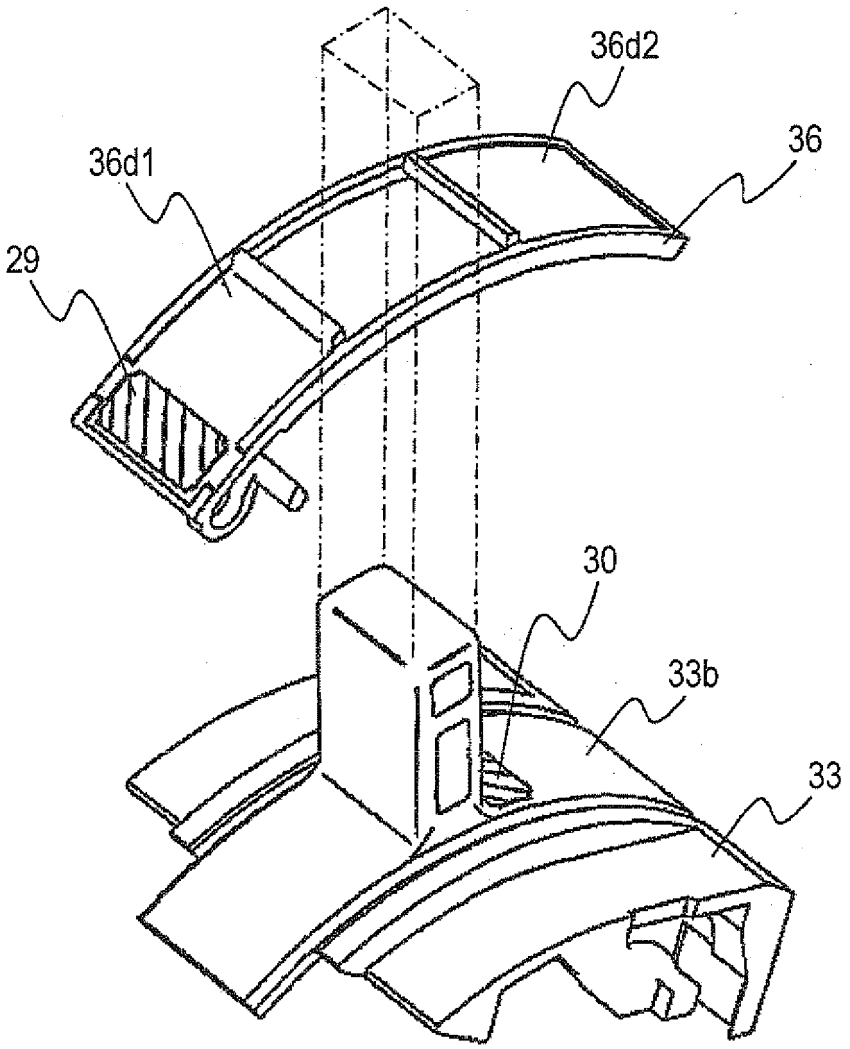


FIG. 8A

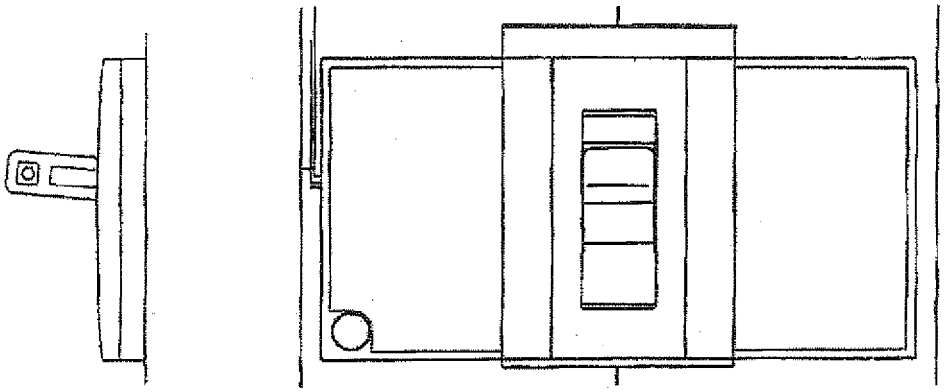


FIG. 8B

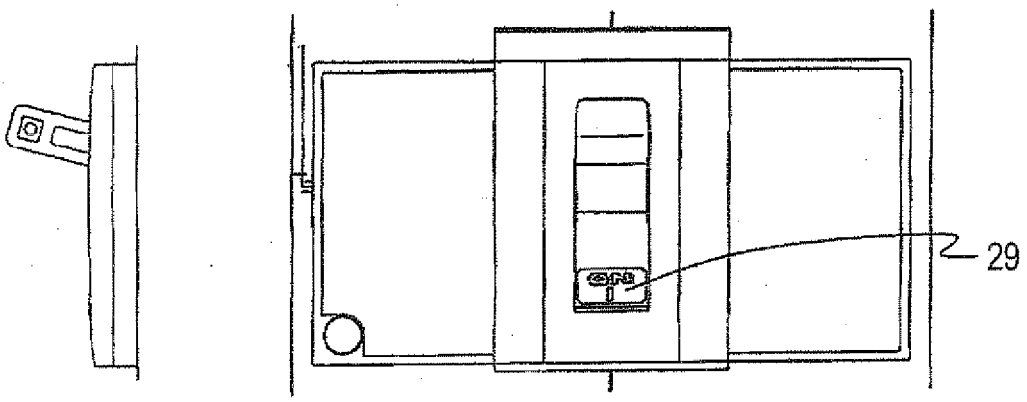
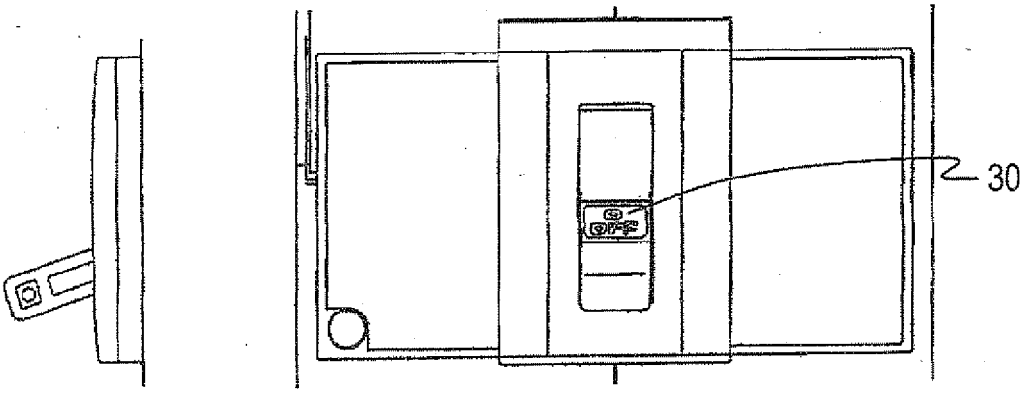


FIG. 8C



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- WO 2003044818 A **[0006]**