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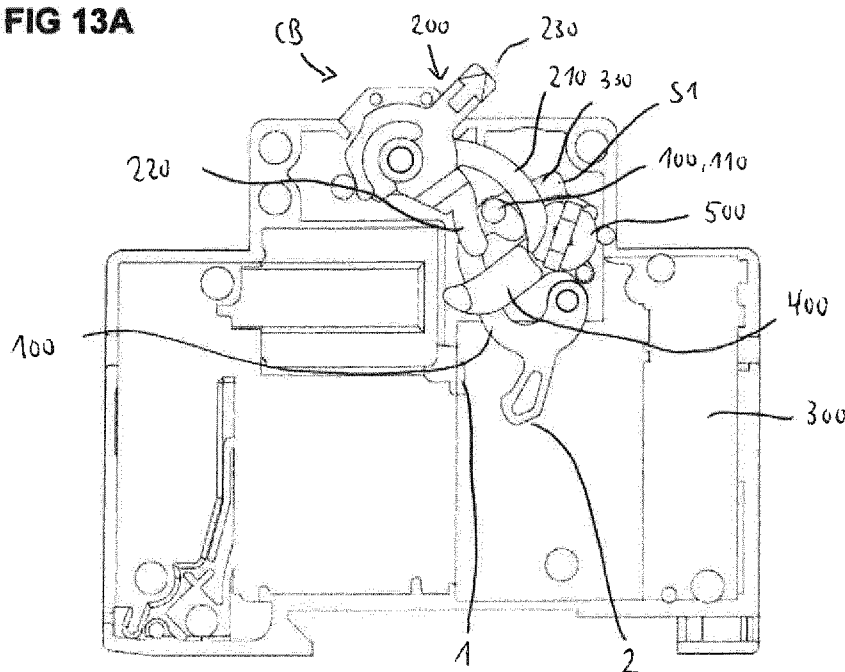
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(54) Title: CIRCUIT BREAKER WITH MULTI-PORT BISTABLE ELEMENT

FIG 13A



(57) Abstract: A circuit breaker (CB) comprises a fixed contact (1), a moving contact (2), and a bistable element (100). The moving contact (2) is disposed at the bistable element (100). The circuit breaker (CB) further comprises an actuation element (200) to manually switch the moving contact (2) between the open and closed state. The bistable element (100) is configured to be moved by the actuation element (200) such that the bistable element (100) moves to a first stable state in which the moving contact (2) is in the closed state and to a second stable state in which the moving contact (2) is in the open state. The bistable element (100) is configured as a compliant element to be elastically deformed during the movement between the first and second stable state.



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Description

CIRCUIT BREAKER WITH MULTI-PORT BISTABLE ELEMENT

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Technical Field

The invention is directed to a circuit breaker, for example a low-voltage miniature circuit breaker, wherein the function of the circuit breaker is essentially effected by a bistable element of the circuit breaker.

Background

15 A circuit breaker is an automatically operated electrical switch that is used to protect an electrical circuit from damage caused by the occurrence of a short circuit or by a large current that is lower than the current in the case of the short circuit but large enough to damage the electrical circuit. Figure 1 illustrates the functionality of a circuit breaker. The circuit breaker comprises a movable contact that may be moved in a closed and an open state. In the closed state, the movable contact is in electrical contact with a fixed/stationary contact of the circuit breaker so that the circuit breaker allows a current flow from an input terminal to an output terminal of the circuit breaker. In an open state of the circuit breaker, the movable contact is separated from the fixed contact so that the flow of current between the input and output terminals of the circuit breaker is interrupted.

The block diagram of Figure 1 shows the major input and output ports of the mechanism. The manual input port represents the force/displacement inputs from the user for the circuit breaker opening and closing operation. The

tripping input port represents the force/displacement inputs from the actuator, for example a solenoid and a bi-metallic strip, for opening the circuit breaker contacts during short circuit or overload events.

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In order to control the movement of the movable contact by means of the manual input or the tripping input, a kinematic chain inside the circuit breaker is provided to transfer the forces between the moving contact and the manual input, for example an actuation arm, and between the tripping input, for example a solenoid or a bi-metallic strip, and the moving contact. The kinematic chain is usually composed of a large number of components such as levers, joints, springs, etc..

15 It is desirable to provide a circuit breaker having a reduced number of components, particularly with reference to the kinematic chain of the circuit breaker.

Summary

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This aim and other objects that will become apparent hereinafter are achieved by a circuit breaker as specified in claim 1.

25 The circuit breaker comprises a fixed contact, a moving contact and a bistable element. The moving contact is disposed at the bistable element. The bistable element is configured to move the moving contact in an open and closed state. In the open state, the moving contact is isolated from the fixed contact, and, in the closed state, the moving contact is electrically connected to fixed contact. The circuit breaker further comprises an actuation element to manually switch the moving contact between the open and closed state. The bistable element is configured to be moved by the actuation element such that the bistable element moves

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to a first stable state in which the moving contact is in the closed state and to a second stable state in which the moving contact is in the open state. The bistable element is configured to be deformed during the movement between the first and second stable state.

The principal component of the (miniature) circuit breaker is the bistable element. The bistable element may be configured as a compliant bistable arch having a particular shape.

According to a possible embodiment, the bistable element is configured as a multi-port element in the sense that forces can be applied at more than one point to the bistable element to switch/move the bistable element from one stable state to another stable state. The multi-port design enables manual opening/closing and tripping when force is applied to the bistable element at different points in different directions.

According to an embodiment of the circuit breaker, the bistable element may be combined with a snap-fit/latching means that provides trip-free and re-latching (upon tripping) features in addition to opening/closing and tripping operations. The bistable element in combination with the latching means provides the required functionality of the (miniature) circuit breaker.

Additional features and advantages are set forth in the Detailed Description that follows, and in part will be readily apparent to those skilled in the art from the description or recognized by practicing the embodiments as described in the written description and claims hereof, as well as the appended drawings. It is to be understood that both the foregoing general description and the following Detailed Description are merely exemplary, and are intended to provide an overview or framework to understand the nature and character of the claims.

Brief Description of the Drawings

The accompanying Figures are included to provide a further
5 understanding, and are incorporated in and constitute a part
of this specification. The drawings illustrate one or more
embodiments, and together with the Detailed Description serve
to explain principles and operations of the various
embodiments. As such, the disclosure will become more fully
10 understood from the following Detailed Description, taken in
conjunction with the accompanying Figures, in which:

Figure 1 illustrates the functionality of a circuit breaker.

15 Figure 2A presents a basic block diagram of a circuit
breaker.

Figure 2B shows an embodiment of a breaker mechanism of a
circuit breaker.

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Figure 2C shows the individual components of the breaker
mechanism shown in Figure 2B.

Figure 3 shows a first embodiment of a circuit breaker
25 comprising a spring-shaped actuation element and a bistable
element formed as a compliant bistable arch.

Figure 4 shows an embodiment of the circuit breaker of Figure
3 with a moving contact in a closed configuration.

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Figure 5 shows an embodiment of the circuit breaker of Figure
3 with a moving contact in an open configuration.

Figure 6 shows an embodiment of the circuit breaker of Figure
35 3 during tripping operation.

Figure 7 shows an embodiment of the circuit breaker of Figure 3 after tripping operation.

5 Figure 8 shows an embodiment of the circuit breaker of Figure 3 during a re-latching operation.

Figure 9 shows an embodiment of the circuit breaker of Figure 3 with moving contact and tripping actuator located in
10 parallel planes.

Figure 10 shows a second embodiment of a circuit breaker comprising a bistable element.

15 Figure 11A shows the bistable element of the circuit breaker of Figure 10 in a first stable state.

Figure 11B shows the bistable element of the circuit breaker of Figure 10 in a second stable state.

20 Figure 12 shows an embodiment of the bistable element for a using by a third embodiment of a circuit breaker.

Figure 13A shows a plane view of a third embodiment of a
25 circuit breaker.

Figure 13B shows a plane view of a third embodiment of a circuit breaker.

30 Figure 14 illustrates a manual closing operation of the third embodiment of the circuit breaker.

Figure 15 illustrates a manual opening operation of the third embodiment of the circuit breaker.

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Figure 16 illustrates a first part of a tripping operation of the third embodiment of the circuit breaker.

Figure 17 illustrates a second part of a tripping operation
5 of the third embodiment of the circuit breaker.

Figure 18 illustrates a re-latching operation of the third embodiment of the circuit breaker.

10 Detailed Description

Figure 2A shows an embodiment of an automatic circuit breaker CB. The circuit breaker comprises a static/fixed contact 1 and a moving contact 2. In the open configuration of the
15 circuit breaker, the moving contact 2 is electrically isolated from the fixed contact 1. In the closed configuration, the moving contact 2 is in electrical contact with the fixed contact 1.

20 The circuit breaker comprises terminals 3a and 3b for fixing electrical wires to connect the circuit breaker to an electrical circuit. In a closed state of the circuit breaker, a current flows through the circuit breaker from one of the terminals 3a, 3b via the connection of the fixed and the
25 moving contact to the other one of the terminals 3a, 3b. In case of a short circuit in the electrical circuit to which the circuit breaker is connected to, the high current flowing through the circuit breaker is interrupted by separating the moving contact 2 from the fixed contact 1. In this case an
30 arc is generated.

In order to provide a propagation path for the arc, the circuit breaker comprising an arc runner 4 coupled to an arc chute 5. The arc chute 5 comprises a stack of mutually
35 insulated parallel metal plates which divide and cool the

arc. By splitting the arc into smaller arcs within the arc chute 5, the arc is cooled down while the arc voltage is increased and serves as an additional impedance which limits the current through the circuit breaker.

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In order to manually control the movement of the moving contact 2 between the open and the closed state of the circuit breaker, a knob 6 is provided. The knob 6 is coupled to a breaker mechanism 7. In the case of a short circuit in the electrical circuit connected to the circuit breaker, a solenoid 8 provides a magnetic field exciting a force to the moving contact 2 so that the moving contact is moved away from the fixed contact 1 and the current flow between the end terminals 3a and 3b is interrupted.

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The circuit breaker further comprises a bi-metallic strip 9 which heats up in the case of a large current flowing through the circuit breaker. This current is large enough to damage the electrical circuit coupled to the circuit breaker but is too low for opening the movable contact by means of the solenoid 8. A thermal trip actuator connects the bi-metallic strip 9 with the breaker mechanism 7. The expansion of the bi-metallic strip 9 in the case of a large current flowing through the circuit breaker enables to move the moving contact 2 in the open position so that the electrical path between the fixed contact 1 and the moving contact 2 is interrupted

Figure 2B shows the breaker mechanism 7 providing the coupling structure/kinematic chain between the knob 6 and the moving contact 2 to exert a force by the movement of the knob 6 to the moving contact 2 to control the movement of the movable contact 2. The different parts of the breaker mechanism 7 as well as the knob 6 are shown in Figure 2C as separate components. It is obvious that the large number of

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components shown in Figure 2C causes high production costs, difficulties in assembly as well as complexity of design, high sensitivity for working tolerances, and possible play and vibration.

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Figures 3 to 19 show different embodiments of a circuit breaker CB comprising a fixed contact 1, a moving contact 2 and a bistable element 100. The moving contact 2 is disposed at the bistable element 100. The bistable element 100 is configured to move the moving contact 2 in an open and closed state. In particular, in the open state, the moving contact 2 is isolated from the fixed contact 1, and, in the closed state, the moving contact 2 is electrically connected to the fixed contact 1.

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The circuit breaker CB shown in Figures 3 to 19 further comprises an actuation element 200 to manually switch the moving contact 2 between the open and closed state. The bistable element 100 is configured to be moved by the actuation element 200 to a first stable state in which the moving contact 2 is in the closed state and to a second stable state in which the moving contact 2 is in the open state. The bistable element 100 is configured to be deformed during the movement between the first and second stable state.

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The embodiments of the circuit breaker CB illustrated in Figures 3 to 19 comprise at least one elastically deformable compliant element that helps to integrate the multiple functions of a circuit breaker, such as manually opening/closing, tripping, snap opening/closing, latching and a trip-free operation, into few parts and thus simplify the mechanism while decreasing cost and increasing reliability.

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Figures 3 to 9 show a first embodiment of the circuit breaker CB that comprises a bistable element 100 being configured as an elastically deformable compliant element. The moving contact 2 is connected to the bistable element 100. The moving contact 2 may be arranged in a plane above or below the plane in which the bistable element 100 is arranged. The circuit breaker CB comprises a rigid arm 10 that is configured to be moved to a first and a second position. The bistable element 100 is mounted to the movable arm 10. In particular, the bistable element 100 may be disposed at a middle portion of the rigid arm 10 in a distance away from the rigid arm 10.

The movement of the rigid arm 10 between the first and the second position causes the bistable element 100 to be moved in a first stable state in which the moving contact 2 is in the closed configuration, and in a second stable state, in which the moving contact 2 is in the open configuration. In the closed configuration, the moving contact 2 is electrically connected to the fixed contact 1. In the open configuration, the moving contact 2 is electrically isolated from the fixed contact 1.

The bistable element 100 comprises at least one compliant arm 130 having a first end 131 and a second end 132. The first and the second end 131, 132 of the at least one compliant arm 130 are respectively fixed to a supporting element 300. The supporting element 300 may be configured as a portion of the casing of the circuit breaker CB, e.g. a wall of the casing of the circuit breaker.

As shown in Figures 3 to 9, the at least one compliant arm 130 of the bistable element 100 is coupled to the rigid arm 10 at a coupling position 133. The coupling position 133 of the at least one compliant arm 130 of the bistable element

100 is located between the first end 131 and the second 132 of the at least one compliant arm 130. The coupling position 133 is located at the middle portion of the rigid arm 10. The bistable element 100 has an enlarged portion 134 at the
5 coupling position from which a first and second section of the at least one compliant arm 130 extends.

According to the embodiment of the circuit breaker CB shown in Figures 3 to 9, the first end 131 of the at least one
10 compliant arm 130 of the bistable element 100 is fixed to at least a first fixing point 351 of the supporting element 300. The second end 132 of the at least one compliant arm 130 of the bistable element 100 is fixed to at least a second fixing point 352 of the supporting element 300. The distance between
15 the at least one first and second fixing points 351, 352 of the supporting element 300 is smaller than the length of the at least one compliant arm 130 so that the at least one compliant arm 130 is bent upwards when the rigid arm 10 is moved to the first position. Furthermore, the at least one
20 compliant arm 130 is bent downwards, when the rigid arm 10 is moved to the second position. The movement of the rigid arm 10 between the first and second position and the bending of the at least one compliant arm 130 is shown and explained below with reference to Figures 4 and 5.

25 The actuation element 200 is configured as a manually operated part. The actuation element 200 can be manually operated to change the status of the moving contact 2 from closed to open state and vice versa. Each of the bistable
30 element 100 and the actuation element 200 provide a single-piece compliant mechanism for moving the moving contact 2. Except of the fixed contact 1 and the moving contact 2, all other components of the circuit breaker are arranged in the same plane. The fixed contact 1 and the moving contact 2 are
35 arranged in a parallel plane above or below the plane in

which the bistable element 130, the rigid arm 10 and the actuation element 200 are disposed.

According to the embodiment of the circuit breaker CB shown in Figures 3 to 9, the bistable element 100 comprises two compliant arms 130 that extend from the enlarged portion 134 of the bistable element to the left and right side towards the fixing points 351 and 352. The compliant arms 130 are formed like a pair of cosine curves joined in the middle.

According to the embodiment of the circuit breaker CB shown in Figures 3 to 9, the bistable element 100 is configured as a modified double-cosine compliant bistable arch with the rigid arm 10 attached to it.

The actuation element 200 of the circuit breaker CB is configured as a manually operated part. The actuation element 200 can be manually operated to change the status of the moving contact from closed to open and vice versa. Each of the rigid arm 10 with the bistable element 100 attached to it and the actuation element 200 provide a single-piece complaint mechanism.

According to the embodiment of the circuit breaker CB, the rigid arm 10 and the actuation element 200 are configured to be in one of a latched and unlatched configuration. In the latched configuration, the actuation element 200 is coupled to the rigid arm 10 to move the rigid arm 10 between the first and the second position. In the unlatched configuration, the actuation element 200 is uncoupled from the rigid arm 10. Figures 4 and 5 show the circuit breaker CB in the latched configuration, whereas Figures 3 and 7 show the unlatched configuration of the circuit breaker.

According to the embodiment of the circuit breaker CB shown in Figures 3 to 9, the rigid arm 10 comprises at least one

latching element 13. The circuit breaker CB illustrated in Figures 3 to 9 comprises a respective latching element 13 arranged on either side (up and down) of the rigid arm 10 so that each of the latching element 13 provides half of the snap-fit/latching mechanism. The actuation element 200 comprises a latching portion 260 being arranged at a side 201 of the actuation element 200. Each of the latching elements 13 of the rigid arm 10 is configured to be engaged in the latching portion 260 of the actuation element 200, when the actuation element 200 and the rigid arm 10 are in the latched configuration, as shown in Figures 4 and 5. The at least one latching element 13 is configured as a compliant structure that is bent to be engaged in or disengaged from the latching portion 260 of the actuation element 200, as illustrated in Figures 6 and 8.

According to the embodiment of the circuit breaker CB of Figures 3 to 9, the actuation element 200 comprises at least one bearing element 250 being arranged at the first side 201 of the actuation element 200. In the latched configuration of the actuation element 200 and the rigid arm 10, the at least one bearing element 250 is in contact with a contact face 12 of a protruding portion 11 of the rigid arm 10. Figures 4 and 5 illustrate the actuation element 200 and the rigid arm 10 being in contact with each other at the bearing element 250 of the actuation element 200 and the contact face 12 of the rigid arm 10.

The actuation element 200 comprises a fixing portion 270 at a second side 202 of the actuation element 200. The actuation element 200 is fixed to the supporting element 300 at the fixing portion 270. Figure 3 shows fixing points 271 at which the actuation element 200 is fixed to the supporting element 300. The actuation element 200 further comprises a spring element 280 being arranged between the fixing portion 270 and

the bearing element 250. The spring element 280 is configured as a flexible distributed compliant translational spring.

According to the embodiment of the circuit breaker shown in Figures 3 to 9, the spring element 280 has many slits cut

5 into a planar material block.

The functioning of the circuit breaker CB during manually opening/closing, tripping and re-latching is illustrated in Figures 4 to 8. For reasons of simplification, the fixed

10 contact 1 and the moving contact 2 are not shown in Figures 4 to 8.

Figure 4 shows the circuit breaker CB in the closed configuration, in which the moving contact 2 is in contact with the fixed contact 1. In this configuration the rigid arm 10 and the actuation element 200 are latched, and the bistable element 100 is stress-free. The bistable element 100 is designed that way because the switch, i.e the moving contact and the static contact, will be in the closed configuration most of the time. When the actuation element 200 is pushed to the right, the bistable element 100 is also moved to the right, taking the moving contact 2 with it. This opens the switch, as illustrated in Figure 5 showing the moving contact 2 of the circuit breaker in the open

20 configuration. By moving the actuation element 200 to the left, the switch/moving contact can be closed again. The large segmented sheet spring element 280 is to be pushed to the right to close the moving contact and pulled to the left to open the moving contact. The operations of closing and opening can be done as many times as needed without the concern of the latch becoming unlatched.

Figures 6 to 8 show states of the circuit breaker CB during tripping (Figure 6), after tripping (Figure 7), and re-latching (Figure 8). During the tripping operation shown in

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Figure 6, the latching elements 13 are bent such that the latching elements 13 engage in the latching portion 260 of the actuation element 200. After the tripping operation, the actuation element 200 and the rigid arm 10 with the bistable element 100 are separated from each other to provide the trip-free operation of the circuit breaker. In the trip-free configuration, the moving contact 2 is always in the open configuration independent from any manual movement of the actuation element 200.

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During a latching/re-latching operation shown in Figure 8, the protruding compliant arms of the latching element 13 move towards the bistable element 100 and slide over the lateral surface of the bearing element 250 to engage in the latching portion 260 of the actuation element 200. The latch mechanism is designed such that the force required to latch the rigid arm 10 and the actuation element 200 is smaller than the force required to unlatch. Further, the force required to unlatch is larger than the restoring spring force of the distributed stretched spring element 280 of the actuation element 200. Hence, the latching condition prevails.

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Figure 9 shows an embodiment of a circuit breaker CB comprising a tripping element/actuator 400 that is configured to switch the circuit breaker in the trip-free operation state shown in Figure 7. The tripping element 400 may be coupled to a solenoid or a bi-metallic strip. The tripping element 400 may comprise a first branch 430 being coupled to the bistable element 100 to push the bistable element 100 and the rigid arm 10 to the right. The tripping element 400 may comprise a second and third branch 440, 450 that are configured to push against the latching elements 13 to bend the latching elements 13 during the tripping operation. The second and third branches 440, 450 may exert a force to a contact surface 14 of the latching elements so that the

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latching elements 13 bend towards the bistable element 100 to disengage the latching elements 13 from the latching portion 260 of the actuation element 200.

5 Unlatching of the actuation element 200 and the rigid arm 10 and opening of the moving contact 2 happen simultaneously when a solenoid or a bimetallic element/strip are activated and exert a force to the tripping element 400. The tripping
10 element 400 may have an E-shaped form with a trip-block 460 that is located in a plane above the main mechanism with a small protrusion underneath to contact and push the bistable element 100 and the latch-blocks 14 on either side, as shown in Figure 6. The pushing of the bistable element/rigid arm opens the switch. Pushing the latch-blocks 14 deforms the
15 latching elements/arms 13 towards the bistable element 100 and thus unlatching. The dynamics of tripping action is such that the latching occurs before the bistable element 100 moves to the open configuration. After tripping, the manually operated actuation element 200 has first to be pushed to the
20 right to latch it with the rigid arm 10. Only after the latching operation will pushing the actuation element 200 to the left to close a moving contact work.

Figure 10 shows a second embodiment of circuit breaker CB
25 comprising an elastically deformable compliant element that enables to provide a circuit breaker having a low number of components for realizing the functioning of the circuit breaker, such as manually opening/closing, tripping and latching operations of the circuit breaker. The circuit
30 breaker CB comprises a fixed contact 1, a moving contact 2 and a bistable element 100. The bistable element 100 is configured as the elastically deformable compliant element. The moving contact 2 is disposed at an end of the bistable element 100. The circuit breaker CB further comprises an
35 actuation element 200 to manually switch the moving contact 2

between the open and closed state. The bistable element 100 is configured to be moved by the actuation element 200 such that the bistable element 100 moves to a first stable state in which the moving contact 2 is in the closed state and to a
5 second stable state in which the moving contact 2 is in the open state.

The circuit breaker CB according to the second embodiment comprises a supporting element 300 that may be configured as
10 a casing of the circuit breaker. Furthermore, the circuit breaker comprises a first pin joint 310 and a second pin joint 320 that are mounted on the supporting element 300. The bistable element 100 is pinned at both ends and deforms elastically in a plane, as illustrated in Figures 11A and
15 11B. A first end 101 of the bistable element 100 is rotatably arranged around the first pin joint 310. A second end 102 of the bistable element 100 is rotatably arranged around the second pin joint 320. The moving contact 2 is fixed to the first end 101 of the bistable element 100 so that the moving
20 contact 2 is moved between the open and closed state by the rotation of the bistable element 100 around the first pin joint 310.

The actuation element 200 is coupled to a position, for
25 example, a mid-point, of the bistable element 100 between the first end 101 and the second end 102 of the bistable element. The bistable element 100 has two stable states that are shown in Figures 11A and 11B. The distance between the first and the second pin joint 310, 320 is smaller than the length of
30 the bistable element 100 so that, in the first stable state, for example the closed state, the bistable element 100 is bent upwards between the first pin joint 310 and the second pin joint 320, as shown in Figure 11A. In the second stable state, for example the open state, the bistable element 100

is bent downwards between the first and the second pin joint 310, 320, as shown in Figure 11B.

According to the second embodiment of the circuit breaker,
5 one of the stable states, for example the first stable state, i.e. the closed state, is stress-free in the assembled condition. A force is applied at the bistable element, for example at the mid-point of the bistable element, to switch the bistable element from the stress-free, first stable state
10 to the second stable state. This is used for manual opening and closing of the circuit breaker.

The bistable element 100 and the actuation element 200 are coupled to each other such that the bistable element 100 may
15 be pushed upwards by the actuation element 200 to move the bistable element 100 in the first stable state in which the moving contact is in the closed configuration, as shown in Figure 11A. Furthermore, the bistable element 100 may be pushed downwards by the actuation element 200 to move the
20 bistable element 100 in the second stable state in which the moving contact is in the open configuration, as shown in Figure 11B.

According to a possible embodiment of the circuit breaker CB,
25 the bistable element 100 and the actuation element 200 are coupled to each other by a latching mechanism. The latching mechanism has a snap-fit feature that enables the manual switch part, i.e. the actuation element 200, get detached from the bistable element 100 so that tripping is not
30 inhibited and trip-free functionality is satisfactorily served. The latching mechanism comprises a latching means 600 and a latching portion 240 of the actuation element 200. The latching means 600 is mounted to the bistable element 100, for example at the mid-point of the bistable element. The
35 latching means 600 can be disengaged from the latching

portion 240 of the actuation element 200 during a tripping operation. Furthermore, the latching means 600 can be engaged with the latching portion 240 of the actuation element 200 during a re-latching operation.

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The bistable element 100 that is formed like an arch between the first and second pin joint 310 and 320 can be switched back to the first stable state (Figure 11A) from the second stable state (Figure 11B) by applying a moment at the pin joints. This is used for tripping the switch. The uniqueness of the bistable element 100, as opposed to other shapes, is that the travel between the two stable states is large and the torque required at the pin joint is considerable small to be suitable for low tripping forces of solenoid and
10
15 bimetallic actuators.

Figures 13A to 18 show a third embodiment of a circuit breaker CB comprising a fixed contact 1, a moving contact 2 and a bistable element 100. The bistable element 100 is
20 configured as an elastically deformable compliant element that allows the integration of the multiple functions of the circuit breaker, i.e. manually opening/closing, tripping and re-latching into a low number of parts. Figure 12 shows a plan view in the left-hand illustration and in the right-hand
25 illustration a perspective view of the bistable element 100 used in the circuit breaker CB for moving the moving contact 2.

The moving contact 2 is disposed at the bistable element 100,
30 and the bistable element is configured to move the moving contacts 2 in the open and closed state. In the open state, the moving contact 2 is isolated from the fixed contact 1 and, in the closed state, the moving contact 2 is electrically connected to the fixed contact 1. In comparison
35 to the bistable element 100 shown for the second embodiment

of the circuit breaker according to Figures 10 to 11B, the bistable element 100 used in the third embodiment of the circuit breaker comprises the "half" of the bistable element used in the second embodiment of the circuit breaker

5 according to Figures 10 to 11B

Figure 13A shows a plan view and Figure 13B is a perspective view of the circuit breaker CB of the third embodiment. In addition to the bistable element 100, Figures 13A and 13B
10 show the further components of the circuit breaker to realize the different functions. The circuit breaker CB comprises an actuation element 200 to manually switch the moving contact 2 between the open and the closed state. Furthermore, the circuit breaker CB comprises a tripping element 400 and a
15 lifting element 500 to perform the tripping operation.

As shown in Figures 12, 13A and 13B, the circuit breaker CB comprises a supporting element 300 on which the components of the circuit breaker, such as the bistable element 100 and the
20 tripping element 400, are mounted. The supporting element 300 may be configured as the casing of the circuit breaker. The circuit breaker comprises a pin point 310 being mounted on the supporting element 300. The bistable element 100 has a first end 101 being rotatably arranged at the pin joint 310.
25 The moving contact 2 is fixed to the first end 101 of the bistable element 100 so that the moving contact 2 is moved between the open and the closed state by the rotation of the bistable element 100 around the pin joint 310.

30 The functioning of the circuit breaker CB for the manually opening/closing operation is explained below with reference to Figure 14 and 15. The bistable element 100 is configured to be moved by the actuation element 200 such that the bistable element 100 moves to a first stable state in which
35 the moving contact 2 is in the closed state and to a second

stable state in which the moving contact 2 is in the open state. The bistable element 100 is configured to be deformed during the movement between the first and second stable state.

5

In order to operate the circuit breaker in the trip-free configuration in which the moving contact 2 is in the open state independent from the switching position of the actuation element 200, the actuation element 200 and the
10 bistable element 100 are configured to be operated in unlatched configuration. In the unlatched configuration, the actuation element 200 is uncoupled from the bistable element 100. In the latched configuration, the actuation element 200 is coupled to the bistable element 100. The actuation element
15 200 comprises a manual knob 230 to manually switch the moving contact 2 between the open and closed state.

The bistable element 100 comprises a guiding pin 110 being arranged at a second end 102 of the bistable element 100. The
20 guiding pin 110 protrudes from a backside of the bistable element and is illustrated in Figure 12. The supporting element 300 comprises a slot 330. The guiding pin 110 is guided within the slot 330 when the moving contact 2 is manually switched by the actuation element 200 between the
25 open and closed state.

The mode of operation of the several components of the circuit breaker during manually opening and closing the moving contact 2 is illustrated in Figures 14 and 15. The
30 bistable element 100 is in the first stable state and the moving contact 2 is in the closed state, when the guiding pin 110 is positioned in the slot 330 at a first position S1, as shown in Figure 15. In the exemplified embodiment of the circuit breaker shown in Figure 15, the position S1 is at an
35 upper location in the slot 330. The bistable element 100 is

in the second stable state in which the moving contact 2 is in the open state, when the guiding pin 110 is positioned in the slot 330 at a second position S2. Figure 14 shows the bistable element 100 being arranged such that the guiding pin 110 is positioned in the slot 330 at the second position S2 so that the moving contact 2 is in the open state.

The bistable element 100 is configured to be deformed, when the guiding pin 110 is moved in the slot 330 from one of the first and second position S1, S2 to a third position S3 between the first and the second position S1 and S2 by the manual knob 230. In particular, the bistable element 100 is configured such that energy is stored in the bistable element 100 by the deformation of the bistable element 100, when the bistable element is moved from the first position S1 to the third position S3 or from the second position S2 to the third position S3.

The actuation element 200 comprises a first arm 210 and a second arm 220. The bistable element 100 comprises an engaging element 120 being arranged at the second end 102 of the bistable element 100. The engaging element 120 may be configured as a protruding portion/pin of the bistable element 100. The engaging element 120 protrudes from a front side of the bistable element as shown, for example, in Figure 12.

The bistable element 100 and the actuation element 200 are configured such that, in the latched configuration of the bistable element 100 and the actuation element 200, the engaging element 120 of the bistable element 100 is arranged in an area between the first arm 210 and the second arm 220 of the actuation element 200. The bistable element 100 and the actuation element 200 are configured such that, in the unlatched configuration of the bistable element 100 and the

actuation element 200, the engaging element 120 of the bistable element 100 is arranged outside an area of between the first and the second arm 210, 220 of the actuation element 200. Figure 14 shows the bistable element 100 and the actuation element 200 in the latched configuration in which the engaging element/pin 120 of the bistable element is arranged in the area between the first and second arm 210 and 220 of the actuation element. Figure 15 shows the unlatched configuration, wherein the engaging element 120 of the bistable element 100 is arranged outside the area between the first and second arm 210 and 220 of the actuation element 200.

The bistable element 100 and the actuation element 200 are configured such that, in the latched configuration of the bistable element 100 and the actuation element 200, the first arm 210 of the actuation element 200 is in contact with the engaging element/pin 120 of the bistable element to move the guiding pin 110 of the bistable element 100 in the slot 330 from the second position S2 to the third position S3 in order to move the moving contact 2 in the closed state, when manually moving the knob 230 of the actuation element 200 in a first direction. Figure 14 shows the manual closing operation of the circuit breaker. The manual knob 230 is rotated in the first direction, for example an anti-clockwise direction. The first arm 210 of the actuation element pushes the engaging element/pin 120 towards the right. The guiding pin 110 is guided upwards in the slot 330. The bistable element 100 rotates about the pin joint/pivot pin 310 making the moving contact 2 to engage with the static contact 1.

Figure 15 illustrates the moving of the moving contact 2 from the closed to the open state. The bistable element 100 and the actuation element 200 are configured such that, in the latched configuration of the bistable element and the

application, the second arm 220 of the actuation element 200 is in contact with the engaging element/pin 120 of the bistable element to move the guiding pin 110 of the bistable element in the slot 330 from the first (upper) position S1 to the third (middle) position S3 in order to move the moving contact 2 in the open state, when manually moving the knob 230 of the actuation element in the second direction.

In the configuration shown in Figure 15, the actuation element 200 and the bistable element 100 are at first in the unlatched configuration. When the manual knob 230 is rotated in the second direction, for example a clockwise direction shown by the arrow in Figure 15, the engaging element/pin 120 is engaged in the area between the first and second arm 210, 220 of the actuation element 200. When the manual knob 230 is further moved in the second direction, i.e. the clockwise direction, the second arm 220 pushes the engaging element/pin 120 towards the left, i.e. downwards. The guiding pin 110 slides downwards in the slot 330. The bistable element 100 rotates about the pin joint/pivot point 310 making the moving contact 2 to decouple from the static contact 1.

The bistable element 100 is configured such that the guiding pin 110 moves in the slot 330 by itself from the third position S3 to the first position S1, after the guiding pin 110/the engaging element 120 is moved by the actuation element 200 from the second position S2 to the third S3 of the slot 330.

The bistable element 100 is deformed, when the guiding pin 110 is moved in the slot 330 from the first position S1 to the third position S3 or from the second position S2 to the third position S3. The deformation effects that deformation energy is stored within the bistable element. The energy stored in the bistable element 100 by deformation increases

by movement of the guiding pin 110 from one of the first and second position S1, S2 in the slot 330 to the third position S3. The maximum energy is stored in the bistable element 100 at the third position S3, for example a middle position in the slot.

The bistable element 100 is in an instable state at the third position S3 so that the bistable element further deforms by itself until the guiding pin 110 reaches one of the first and second position S1 and S2 and the energy stored in the bistable element decreases, when the guiding pin slides in the slot 330 from the third position S3 to one of the first and second position S1, S2.. The energy stored in the bistable element 100 is lower in the first and second stable state of the bistable element 100, i.e. at the positions S1 and S2, than in the instable state of the bistable element 100 between the first and second stable state, i.e at the position S3.

Figures 16 and 17 illustrate the tripping operation of the circuit breaker. The circuit breaker comprises a tripping element 400 to trip a movement of the moving contact 2 from the closed to the open state independent from the state of the actuation element/manual knob 230. The tripping element 400 comprises an arm 410 to exert a force to the tripping element 400. The tripping element 400 is rotatably arranged on the supporting plate 300, for example the casing of the circuit breaker, such that the tripping element 400 performs a rotational movement, when the force is exerted to the arm 410 of the tripping element 400, as shown by the arrow in Figure 16. The tripping element 400 lifts in a direction vertical to the supporting plate 300 during the rotational movement of the tripping element 400, as illustrated by the arrow in the right-hand picture of Figure 16.

In order to lift the tripping element 400, the supporting element 300 comprises a protruding portion 340 having an inclined surface 341. The tripping element 400 has a contact surface 420 that slides over the inclined surface 341 of the protruding portion 340 of the supporting element 300 during the rotational movement of the tripping element 400.

The force exerted to the arm 410 of the tripping element 400 may be generated from a solenoid of the circuit breaker. A solenoid pin indicated in Figure 16 by the arrow pushes the tip of the arm 410 of the tripping element 400 to the right. As a result, the tripping element 400 rotates, for example in counter clockwise direction. Because of the inclined surfaces 341 and 420, the tripping element 400 gets lifted out of plane as its inclined surface 420 slides over the inclined surface 341 of the protruding portion 340 of the supporting element 300, for example a protruding portion of the casing of the circuit breaker.

The bistable element 100 is coupled to the tripping element 400 such that the bistable element 100 lifts in the (same) direction vertical to the supporting element 300 as the tripping element 400 moves. The bistable element is lifted by the tripping element 400 until the guiding pin 110 of the bistable element 100 is moved out of the slot 330. At the moment, when the guiding pin 110 is moved out of the slot 330, the bistable element abruptly releases tension and performs a rotational movement around the pin joint 310 such that the moving contact 2 snaps from the closed to the open state.

Figure 17 shows the lifting of the guiding pin 110 and thus the lifting of the bistable element 100 out of the plane in detail. The circuit breaker comprises a lifting element 500 to lift the bistable element 100 in the direction vertical to

the supporting element 300. The lifting element 500 has a contact surface 510 that abuts a protruding nose 130 of the bistable element 100. The lifting element 500 is mounted on the tripping element 400 to perform a rotational movement
5 caused due to the rotational movement of the tripping element, whereby the lifting element 500 lifts in the direction vertical to the supporting element 300. The lifting element 500 lifts the bistable element 100 by the contact surface 510 that is pressed against the protruding nose 130
10 of the bistable element so that the guiding pin 110 is moved out of the slot 330 during the rotational movement of the lifting element 500.

Figure 17 shows in the right-hand picture the lifter 500
15 moving out of the plane, when the tripping element 400 rotates. The lifting element 500 pushes the bistable element 100, particularly the guiding pin 110 of the bistable element, out of the guiding slot 330 of the supporting element 300. The instant when the guiding pin 110 is moved
20 out of the guiding slot 330, the energy stored in the bistable element pushes the bistable element back to its original position, i.e. the open state of the moving contact.

Figure 18 illustrates the re-latching operation of the
25 bistable element 100 with the actuation element 200. The first arm 210 of the actuation element 200 is configured to be flexible. When the configuration of the circuit breaker is to be changed from the unlatched to the latched state, the manual knob 230 is rotated in the clockwise direction. The
30 first arm 210 of the actuation element 200 has an inclined surface 211 that slides over an inclined surface 121 of the engaging element/pin 120 of the bistable element 100. Due to its compliant structure, the first arm 210 of the actuation element 200 is bent in a direction vertical to the supporting
35 element 300 and snaps back after slipping off the surface 121

of the engaging element/pin 120 so that the engaging element 120 is re-latched in the area between the first and the second arm 210, 220 of the actuation element 200.

List of Reference Signs

	1	fixed contact
	2	moving contact
5	3a, 3b	terminals
	4	arc runner
	5	arc shute
	6	knob
	7	breaker mechanism
10	8	solenoid
	9	bi-metallic strip
	10	rigid arm
	100	bistable element
	110	guiding pin
15	120	engaging element/pin
	130	protruding portion/nose of bistable element
	200	actuation element
	210, 220	arms of actuation element
	230	manual knob
20	300	supporting element/casing
	310	pin joint
	320	pin joint
	330	slot
	340	protruding portion of supporting element
25	400	tripping element
	410	arm of tripping element
	500	lifting element
	510	contact surface of lifting element

Claims

1. A circuit breaker, comprising:

- a fixed contact (1),
- 5 - a moving contact (2),
- a bistable element (100),
- wherein the moving contact (2) is disposed at the bistable element (100),
- wherein the bistable element (100) is configured to move
- 10 the moving contact (2) in an open and closed state, wherein, in the open state, the moving contact (2) is isolated from the fixed contact (1), and, in the closed state, the moving contact (2) is electrically connected to the fixed contact (1),
- 15 - an actuation element (200) to manually switch the moving contact (2) between the open and closed state,
- wherein the bistable element (100) is configured to be moved by the actuation element (200) such that the bistable element (100) moves to a first stable state in which the
- 20 moving contact (2) is in the closed state and to a second stable state in which the moving contact (2) is in the open state,
- wherein the bistable element (100) is configured to be deformed during the movement between the first and second
- 25 stable state.

2. The circuit breaker of claim 1,

- wherein the bistable element (100) is configured such that energy is stored in the bistable element (100) by the
- 30 deformation of the bistable element (100), wherein the stored energy is lower in the first and the second stable state of the bistable element (100) than in a state of the bistable element (100) between the the first and second stable state.

35 3. The circuit breaker of claims 1 or 2, comprising:

- a supporting element (300), wherein the bistable element (100) is mounted on the supporting element (300),
 - a pin joint (310) being mounted on the supporting element (300),
- 5 - wherein the bistable element (100) has a first end (101) being rotatably arranged at the pin joint (310),
- wherein the moving contact (2) is fixed to the first end (101) of the bistable element (100) so that the moving contact (2) is moved between the open and closed state by the
- 10 rotation of the bistable element (100) around the pin joint (310).

4. The circuit breaker of claim 3,
- wherein the bistable element (100) and the actuation
- 15 element (200) are configured to be in one of a latched and unlatched configuration,
- wherein, in the latched configuration, the actuation element (200) is coupled to the bistable element (100) and, in the unlatched configuration, the actuation element (200)
- 20 is uncoupled from the bistable element (100).

5. The circuit breaker of claim 4,
- wherein the bistable element (100) comprises a second end (102),
- 25 - wherein the supporting element (300) comprises a slot (330),
- wherein the bistable element (100) comprises a guiding pin (110) being arranged at the second end (102) of the bistable element (100),
- 30 - wherein the guiding pin (110) is guided within the slot (330) when the moving contact (2) is manually switched by the actuation element (200) between the open and closed state.

6. The circuit breaker of claim 5,

- wherein the bistable element (100) is in the first stable state and the moving contact (2) is in the closed state, when the guiding pin (110) is positioned in the slot (330) at a first position (S1),

5 - wherein the bistable element (100) is in the second stable state and the moving contact (2) is in the open state, when the guiding pin (110) is positioned in the slot (330) at a second position (S2).

10 7. The circuit breaker of claim 6,
wherein the bistable element (100) is configured to be deformed, when the guiding pin (110) is moved in the slot (330) from one of the first and second position (S1, S2) to a third position (S3) between the first and the second position
15 (S1, S2).

8. The circuit breaker of claim 7,

- wherein the bistable element (100) is configured such that the guiding pin (110) moves by itself in the slot (330) from
20 the third position (S3) to the second position (S2), after the guiding pin (110) is moved by the actuation element (200) from the first position (S1) to the third position (S3) of the slot (330),

- wherein the bistable element (100) is configured such that
25 the guiding pin (110) moves by itself in the slot (330) from the third position (S3) to the first position (S1), after the guiding pin (110) is moved by the actuation element (200) from the second position (S2) to the third position (S3) of the slot (330).

30

9. The circuit breaker of claims 5 to 8,

- wherein the actuation element (200) comprises a first and a second arm (210, 220),

- wherein the bistable element (100) comprises an engaging element (120) being arranged at the second end (102) of the bistable element (100),

- wherein the bistable element (100) and the actuation element (200) are configured such that, in the latched configuration of the bistable element and the actuation element, the engaging element (120) of the bistable element (100) is arranged in an area between the first and the second arm (210, 220) of the actuation element (200),

- wherein the bistable element (100) and the actuation element (200) are configured such that, in the unlatched configuration of the bistable element (100) and the actuation element (200), the engaging element (120) of the bistable element (100) is arranged outside the area of between the first and the second arm (210, 220) of the actuation element (200).

10. The circuit breaker of claim 9,

- wherein the actuation element (200) comprises a knob (230) to manually switch the moving contact (2) between the open and closed state,

- wherein the bistable element (100) and the actuation element (200) are configured such that, in the latched configuration of the bistable element (100) and the actuation element (200), the first arm (210) of the actuation element (200) is in contact with the engaging element (120) of the bistable element to move the guiding pin (110) of the bistable element in the slot (330) from the second position (S2) to the third position (S3) to move the moving contact (2) to the closed state, when manually moving the knob (230) in a first direction,

- wherein the bistable element (100) and the actuation element (200) are configured such that, in the latched configuration of the bistable element (100) and the actuation element (200), the second arm (220) of the actuation element

(200) is in contact with the engaging element (120) of the bistable element to move the guiding pin (110) of the bistable element in the slot (330) from the first position (S1) to the third position (S3) to move the moving contact (2) to the open state, when manually moving the knob (230) in a second direction.

11. The circuit breaker of claims 9 or 10,

- wherein the first arm (210) of the actuation element (200) is configured to be flexible,

- wherein, when the configuration of the circuit breaker is changed from the unlatched to the latched configuration, the first arm (210) of the actuation element (200) slides over a surface (121) of the engaging element (120) of the bistable element and is bent by the engaging element (120) in a direction vertical to the supporting element (300) and snaps back after slipping off the surface (121) of the engaging element (120) so that the engaging element (120) is arranged in the area between the first and second arm (210, 220) of the actuation element.

12. The circuit breaker of claims 5 to 11, comprising:

- a tripping element (400) to trip a movement of the moving contact (2) from the closed to the open state,

- wherein the tripping element (400) comprises an arm (410) to exert a force to the tripping element (400),

- wherein the tripping element (400) is rotatably arranged on the supporting element (300) such that the tripping element (400) performs a rotational movement, when exerting the force to the tripping element (400),

- wherein the tripping element (400) lifts in a direction vertical to the supporting element (300) during the rotational movement of the tripping element (400).

13. The circuit breaker of claim 12,

- wherein the bistable element (100) is coupled to the tripping element (400) such that the bistable element (100) lifts in the direction vertical to the supporting element (300) and the guiding pin (110) of the bistable element is
5 moved out of the slot (330) during the rotational movement of the tripping element (400),
- wherein the bistable element (100) performs a rotational movement around the pin joint (310) such that the moving contact (2) is moved from the closed to the open state, when
10 the guiding pin (110) of the bistable element (100) is moved out of the slot (330).

14. The circuit breaker of claims 12 or 13,

- wherein the supporting element (300) comprises a protruding
15 portion (340) having an inclined surface (341),
- wherein the tripping element (400) has a contact surface (420) that slides over the inclined surface (341) of the protruding portion (340) of the supporting element (300) during the rotational movement of the tripping element (400)
20 so that the bistable element (100) lifts in a direction vertical to the supporting element (300).

15. The circuit breaker of claims 12 to 14, comprising:

- a lifting element (500) to lift the bistable element (100)
25 in the direction vertical to the supporting element (300),
- wherein the lifting element (500) has a contact surface (511) that abuts the bistable element (100),
- wherein the lifting element (500) is mounted on the tripping element (400) to perform a rotational movement
30 caused due to the rotational movement of the tripping element, whereby the lifting element (500) lifts in the direction vertical to the supporting element (300),
- wherein the lifting element (500) lifts the bistable element (100) in the direction vertical to the supporting

element (300) so that the guiding pin (110) is moved out of the slot (330) during the rotational movement .

16. The circuit breaker of claims 1 or 2, comprising:

- 5 - a supporting element (300),
- a first and a second pin joint (310, 320) being mounted/disposed on the supporting element (300),
- wherein the bistable element (100) is flexible,
- wherein the first end (101) of the bistable element (100)
- 10 is rotatably arranged around the first pin joint (310) and the second end (102) of the bistable element (100) is rotatably arranged around the second pin joint (320),
- wherein the moving contact (2) is fixed to the first end (101) of the bistable element (100) so that the moving
- 15 contact (2) is moved between the open and closed state by the rotation of the bistable element (100) around the first pin joint (310).

17. The circuit breaker of claim 16,

- 20 wherein the distance between the first and second pin joint (310, 320) is smaller than the length of the bistable element (100) so that, in the first stable state, the bistable element (100) is bent upwards between the first and the second pin joint (310, 320) and, in the second stable state,
- 25 the bistable element (100) is bent downwards between the first and the second pin joint (310, 320).

18. The circuit breaker of claims 16 or 17,

- wherein the actuation element (200) is coupled to a position
- 30 of the bistable element (100) between the first and the second end of the bistable element (101, 102).

19. The circuit breaker of claims 16 to 18,

- wherein the bistable element (100) and the actuation element
- 35 (200) are coupled to each other such that the bistable

element (100) may be pushed upwards by the actuation element (200) to move the bistable element (100) in the first stable state and may be pushed downwards by the actuation element (200) to move the bistable element (100) in the second stable state.

20. The circuit breaker of claims 16 to 19,

- wherein the bistable element (100) and the actuation element (200) are coupled to each other by a latching mechanism,

- wherein the latching mechanism comprises a latching means (600) and a latching portion (240) of the actuation element (200),

- wherein the latching means (600) is mounted on the bistable element (100),

- wherein the latching means (600) can be engaged/disengaged from a latching portion (240) of the actuation element (200) during tripping operation.

21. The circuit breaker of claims 1 or 2, comprising:

- a rigid arm (10),

- wherein the rigid arm (10) is configured to be moved to a first and a second position,

- wherein the bistable element (100) is mounted to the rigid arm (10),

- wherein the bistable element (100) is configured to be moved in the first stable state and the second stable state by the movement of the rigid arm (10) between the first and the second position.

22. The circuit breaker of claim 21,

- wherein the bistable element (100) has at least one compliant arm (130) having a first and second end (131, 132) respectively fixed to a supporting element (300),

- wherein the at least one compliant arm (130) of the bistable element (100) is coupled to the rigid arm (10) at a coupling position of the at least one compliant arm (130) of the bistable element, wherein the coupling position is located
5 between the first and the second end (131, 132) of the at least one compliant arm (130) of the bistable element (100).

23. The circuit breaker of claim 21,

- wherein the first end (131) of the at least one compliant
10 arm (130) of the bistable element (100) is fixed to at least a first fixing point (351) of the supporting element (300),
- wherein the second end (132) of the at least one compliant arm (130) of the bistable element (100) is fixed to at least a second fixing point (352) of the supporting element,
15 - wherein the distance between the at least one first and second fixing point (351, 352) of the supporting element (300) is smaller than the length of the at least one compliant arm (130) so that the at least one compliant arm (130) is bent upwards, when the rigid arm (10) is moved to
20 the first position, and the at least one compliant arm (130) is bent downwards, when the rigid arm (10) is moved to the second position.

24. The circuit breaker of claims 21 to 23,

25 - wherein the actuation element (200) and the rigid arm (10) are configured to be in one of a latched and unlatched configuration,
- wherein, in the latched configuration, the actuation element (200) is coupled to the rigid arm (10) to move the
30 rigid arm between the first and second position,
- wherein, in the unlatched configuration, the actuation element (200) is uncoupled from the rigid arm (10).

25. The circuit breaker of claims 24

wherein the actuation element (200) comprises at least one bearing element (250) being arranged at a first side (201) of the actuation element (200), the at least one bearing element (250) is in contact with a contact face (12) of the rigid arm (10), when the actuation element (200) and the rigid arm (10) are in the latched configuration.

26. The circuit breaker of claim 25,

- wherein the rigid arm (10) comprises at least one latching element (13),

- wherein the actuation element (200) comprises a latching portion (260),

- wherein the at least one latching element (13) of the rigid arm (10) is configured to be engaged in the latching portion (260) of the actuation element (200), when the actuation element (200) and the rigid arm (10) are in the latched configuration.

27. The circuit breaker of claim 26,

wherein the at least one latching element (13) is configured as a compliant structure that is bend to be engaged in/disengaged from the latching portion (260) of the actuation element (200).

28. The circuit breaker of claims 25 to 27,

- wherein the actuation element (200) comprises a fixing portion (270) at a second side (202) of the actuation element (200), wherein the actuation element (200) is fixed to the supporting element (300) at the fixing portion (270),

- wherein the actuation element (200) comprises a spring element (280) being arranged between the fixing portion (270) and the bearing element (250).

29. The circuit breaker of claims 21 to 28, comprising:

a tripping element (400) having a first branch (430) being coupled to the bistable element (100), a second and third branch (440, 450) formed to push against the first and second latching element (13) to bend the latching element during
5 engaging with/disengaging from the latching portion (260) of the actuation element (200).

FIG 1

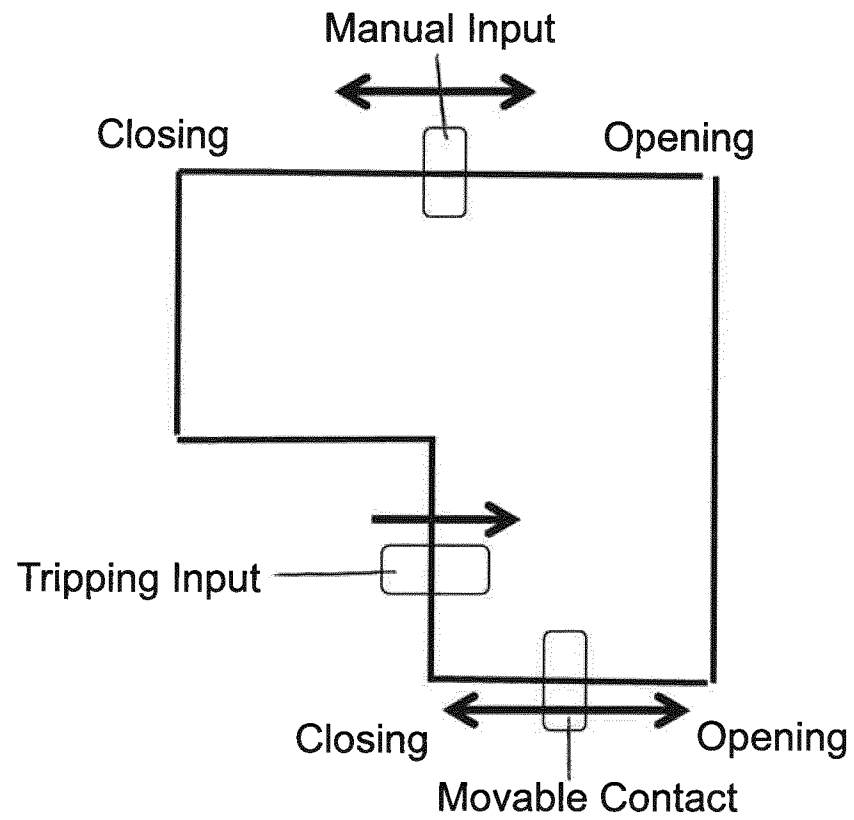


FIG 2A

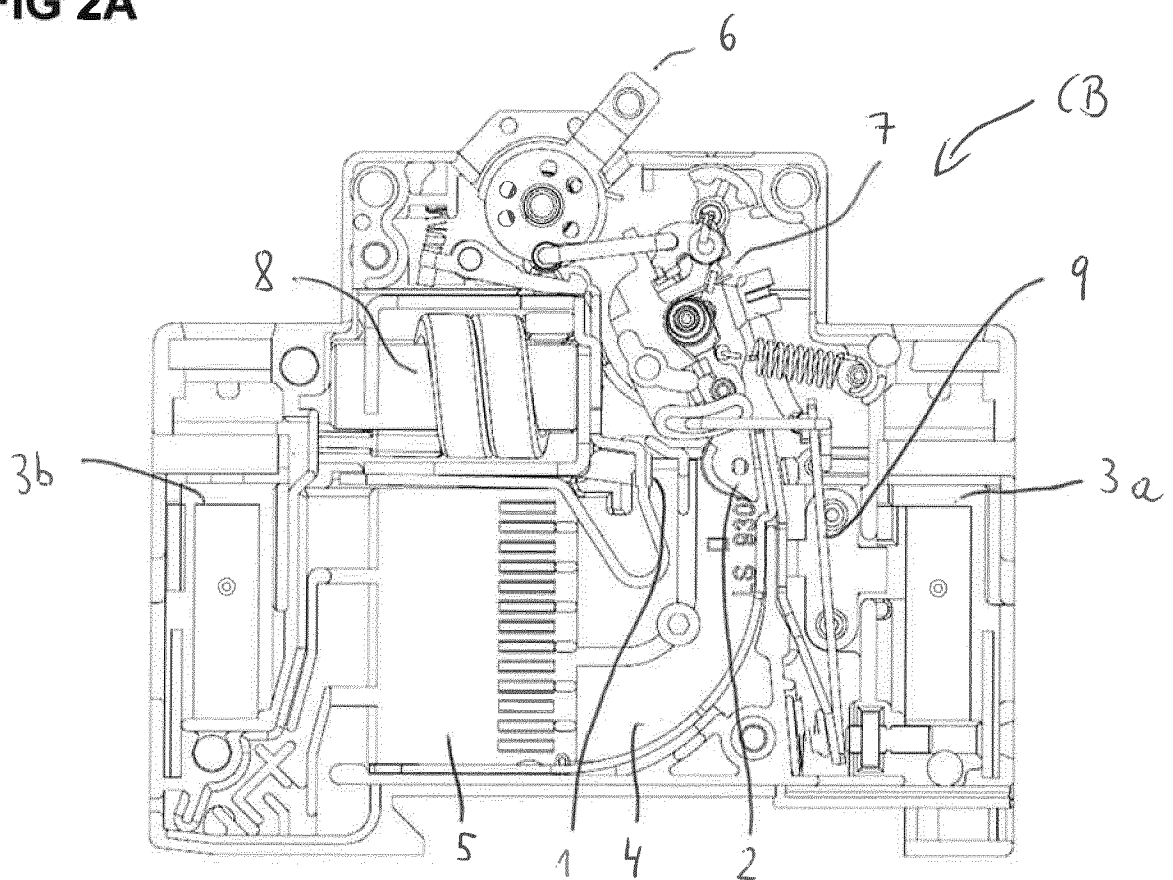


FIG 2B

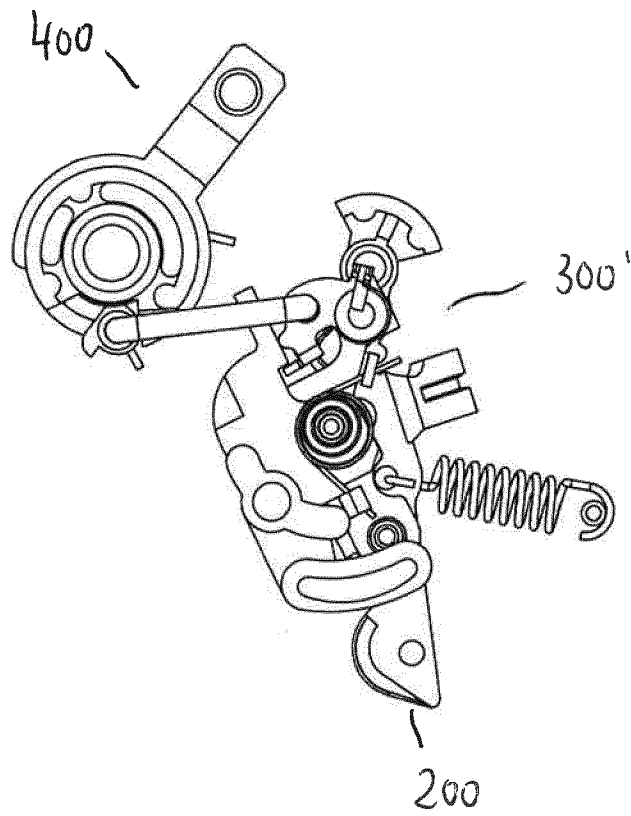


FIG 2C

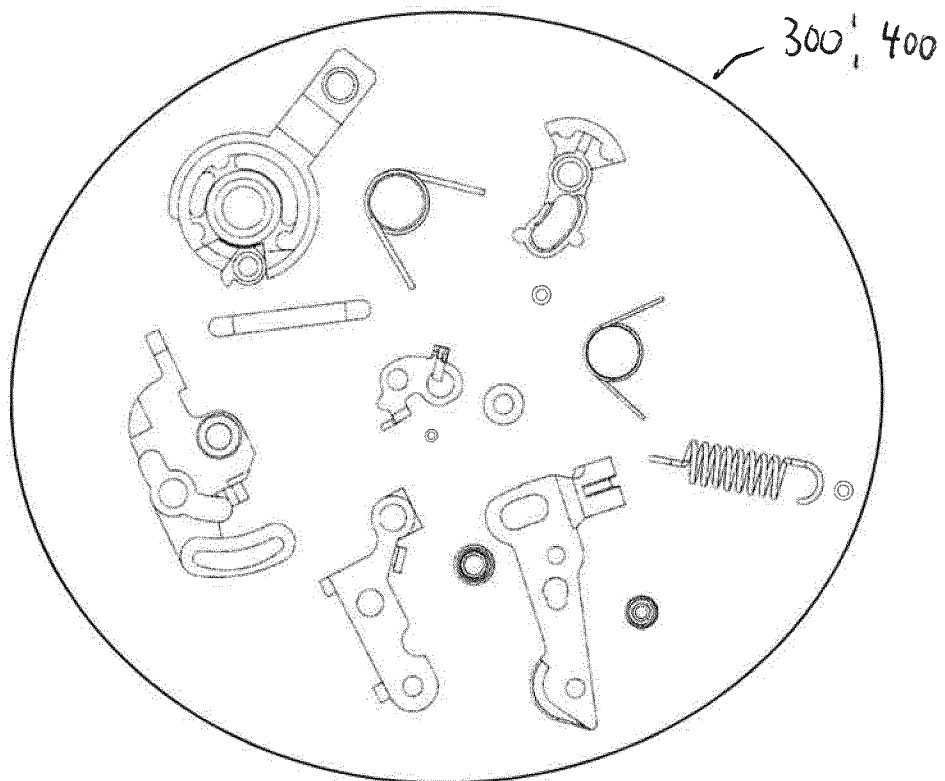


FIG 3

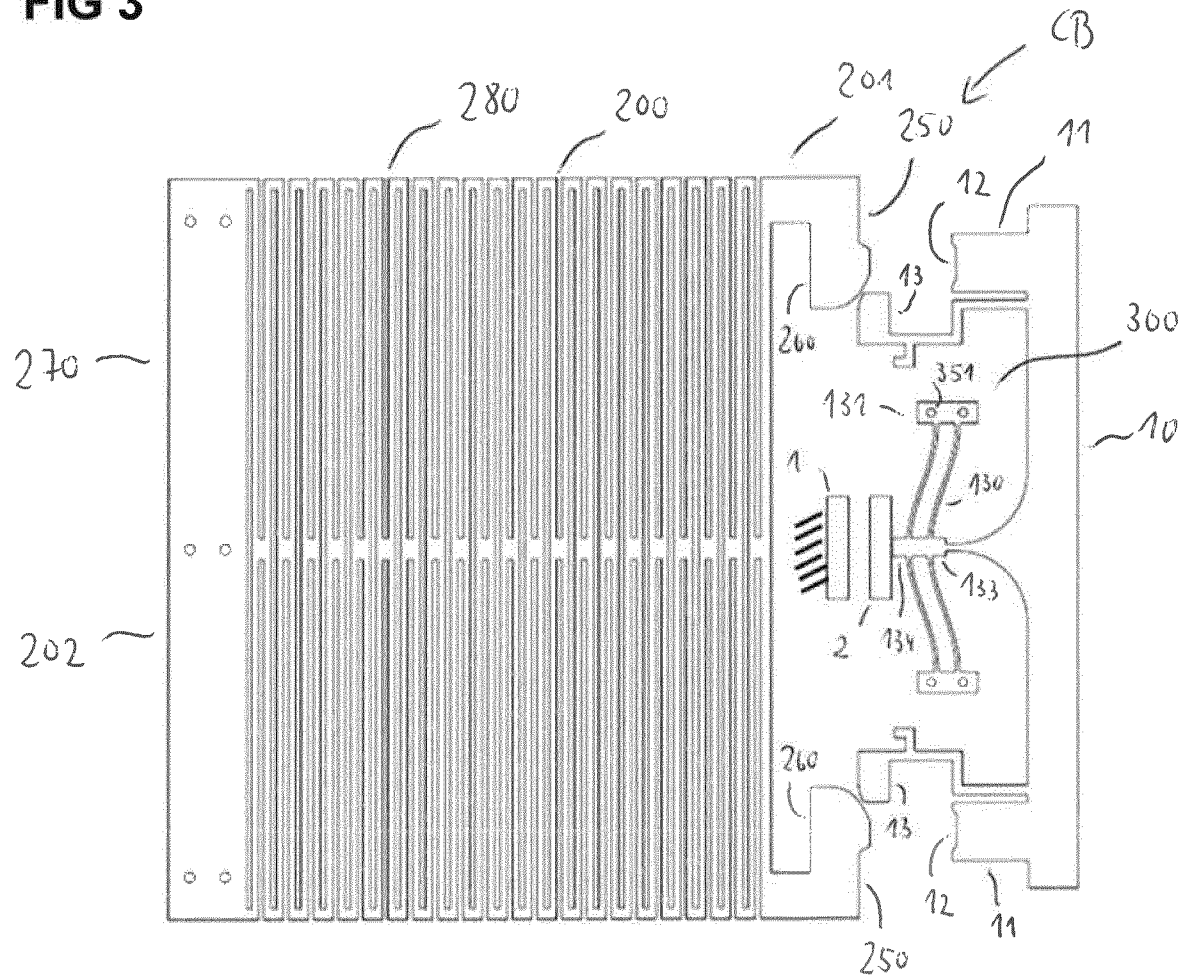


FIG 4

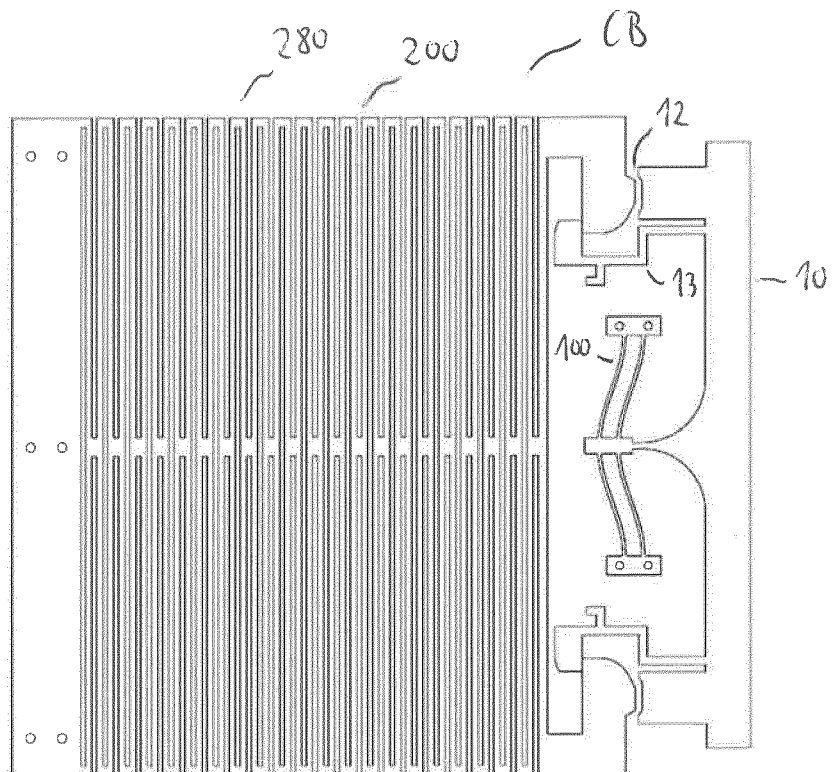


FIG 5

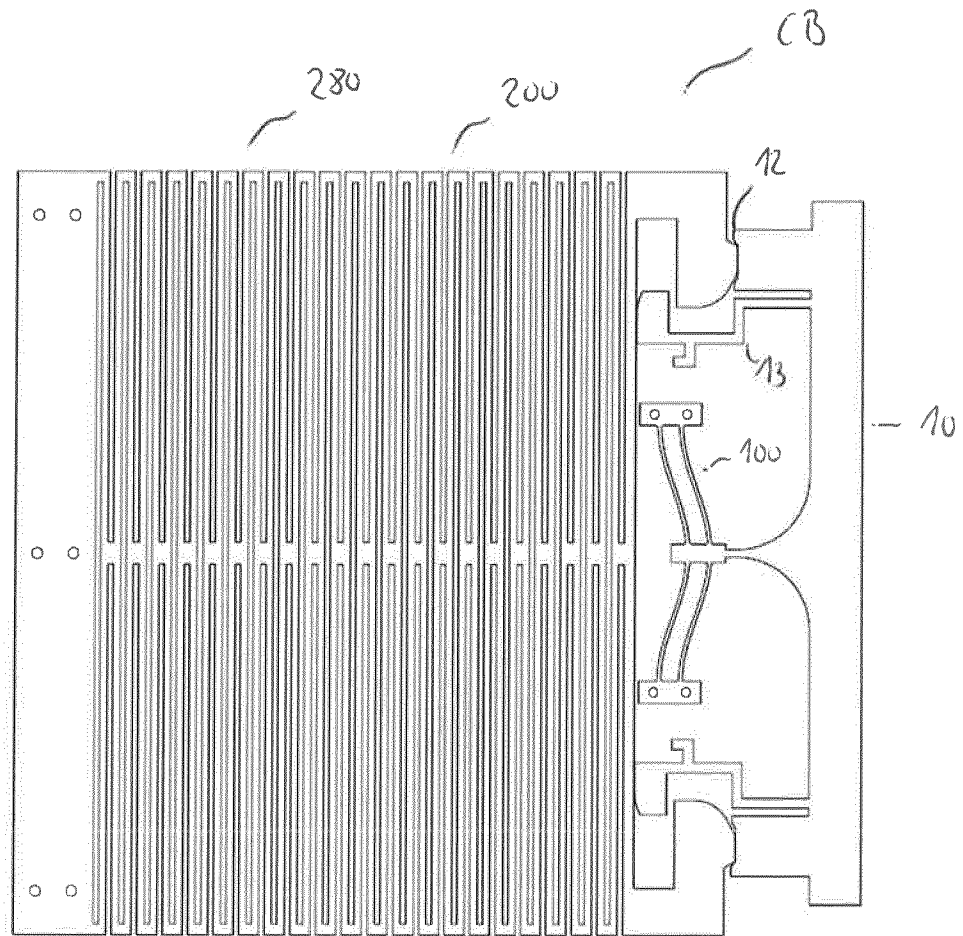


FIG 6

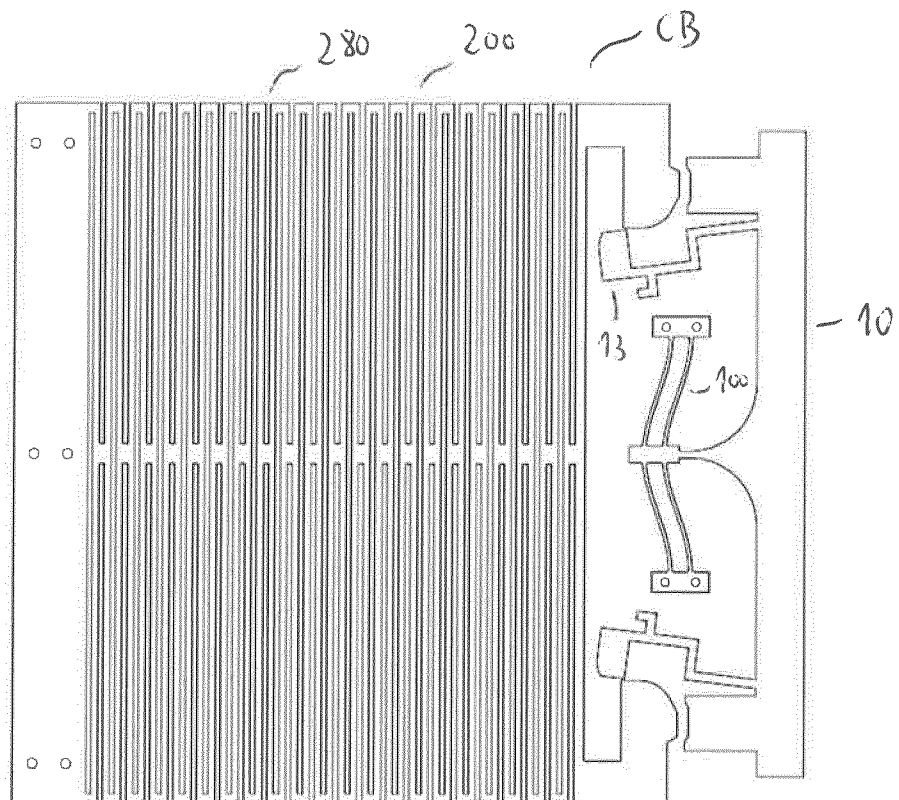


FIG 7

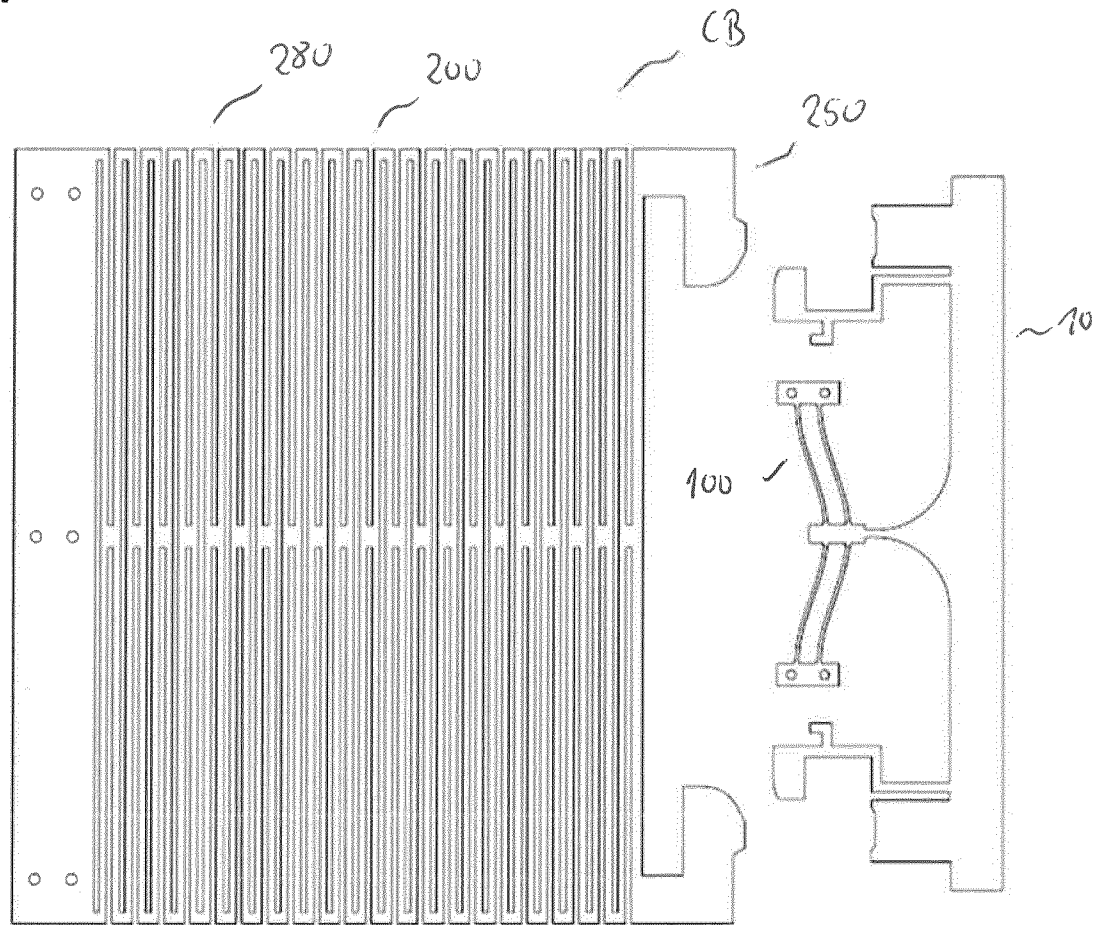


FIG 8

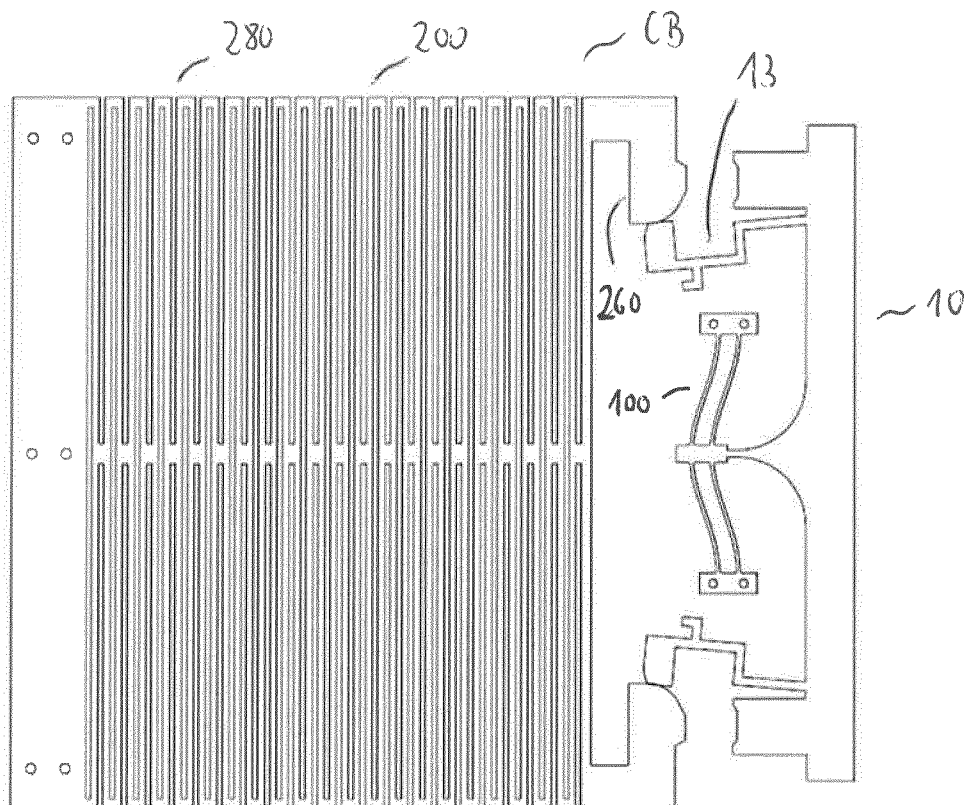


FIG 9

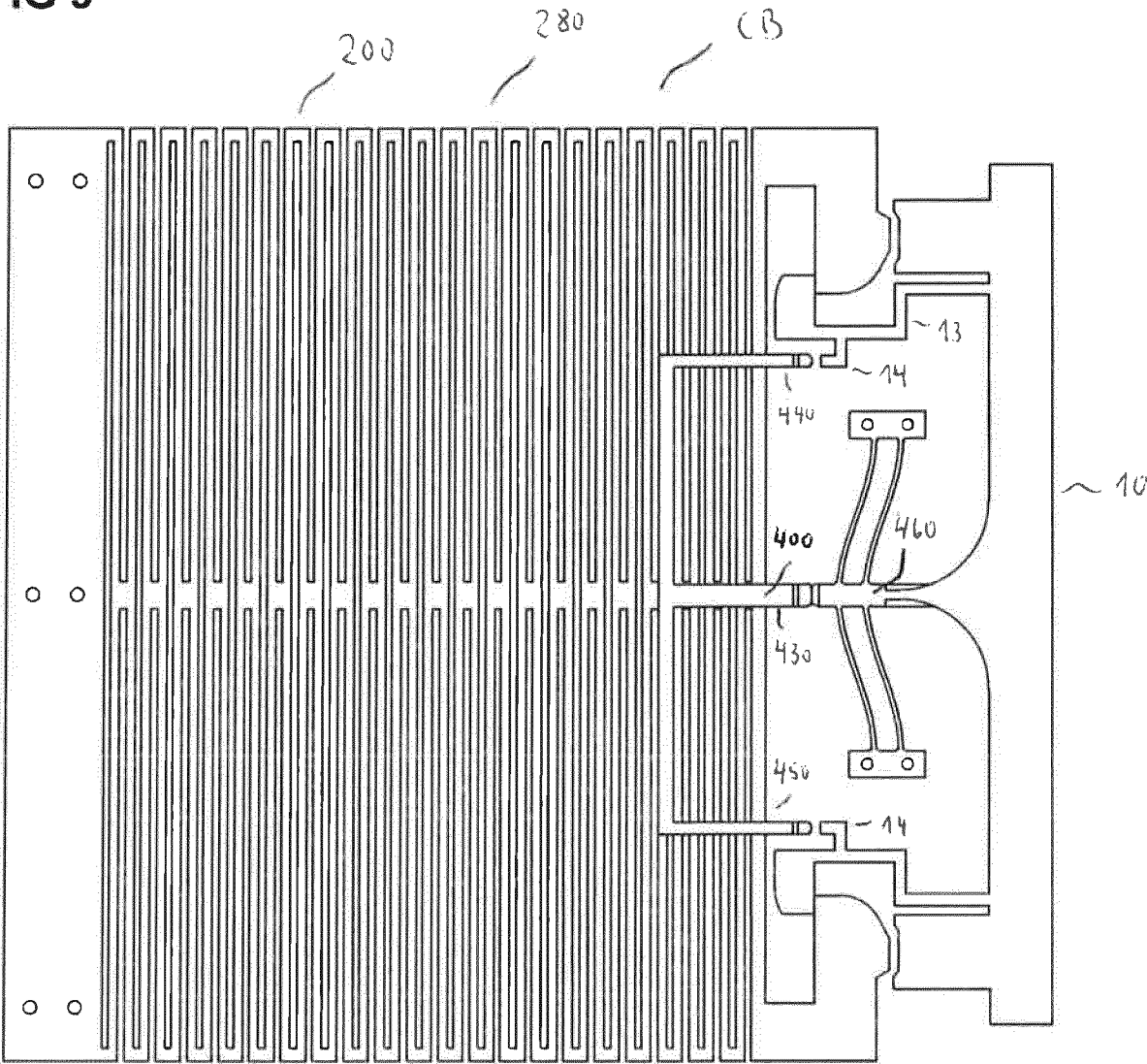


FIG 10A

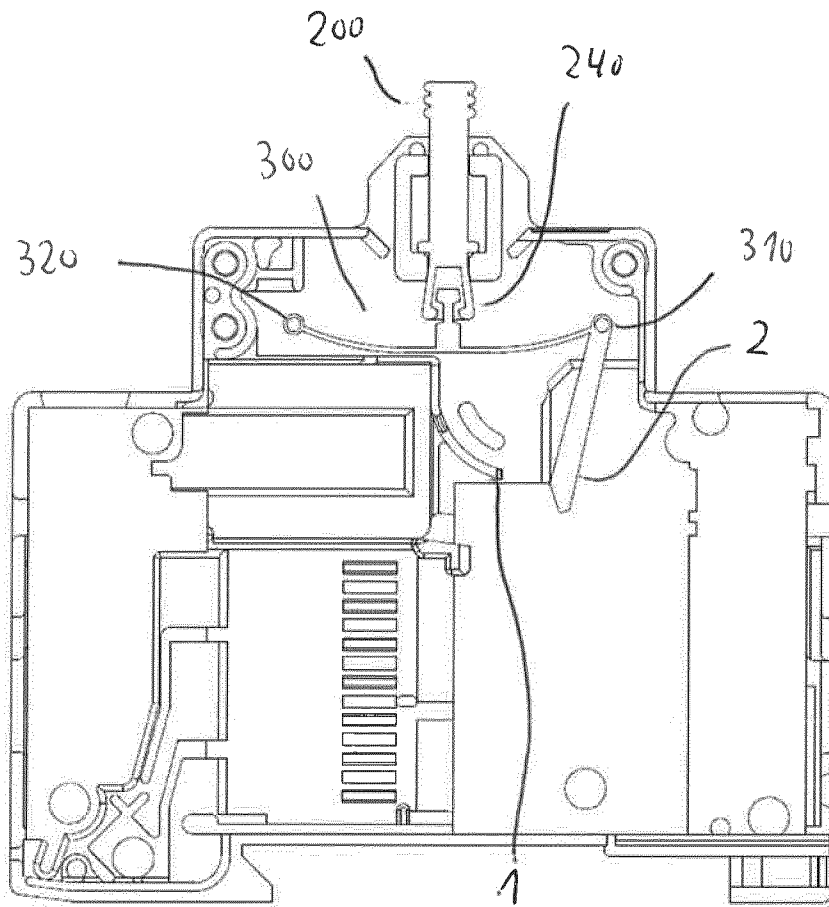


FIG 11A

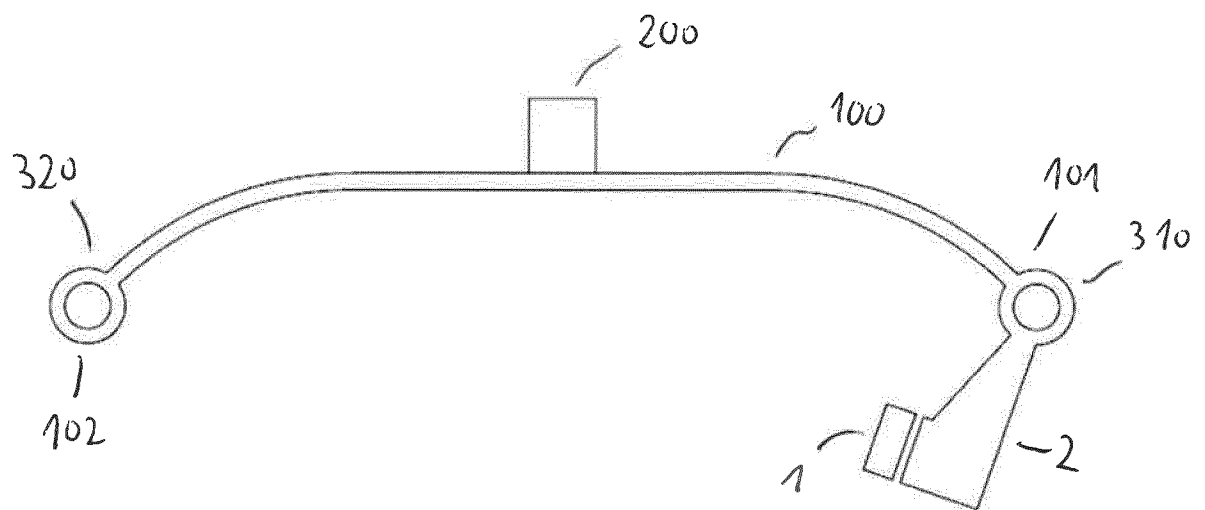


FIG 11B

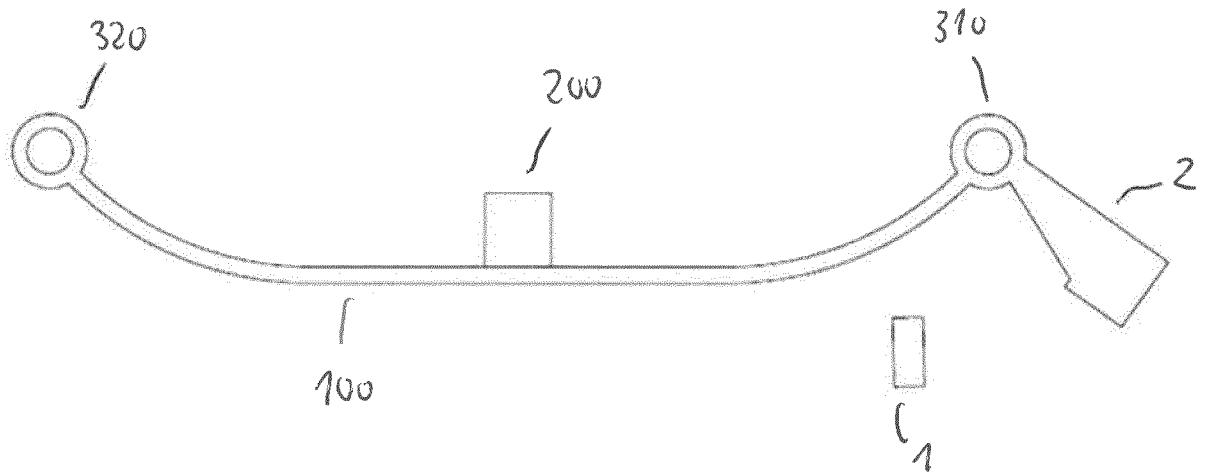


FIG 12

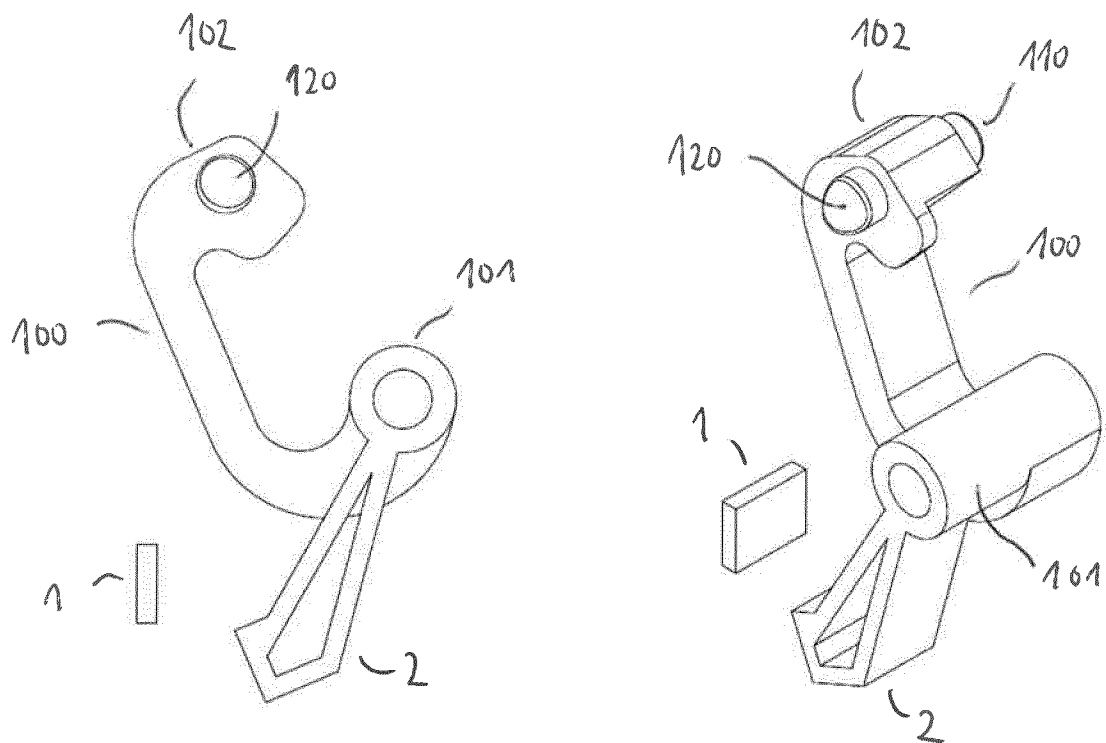


FIG 13A

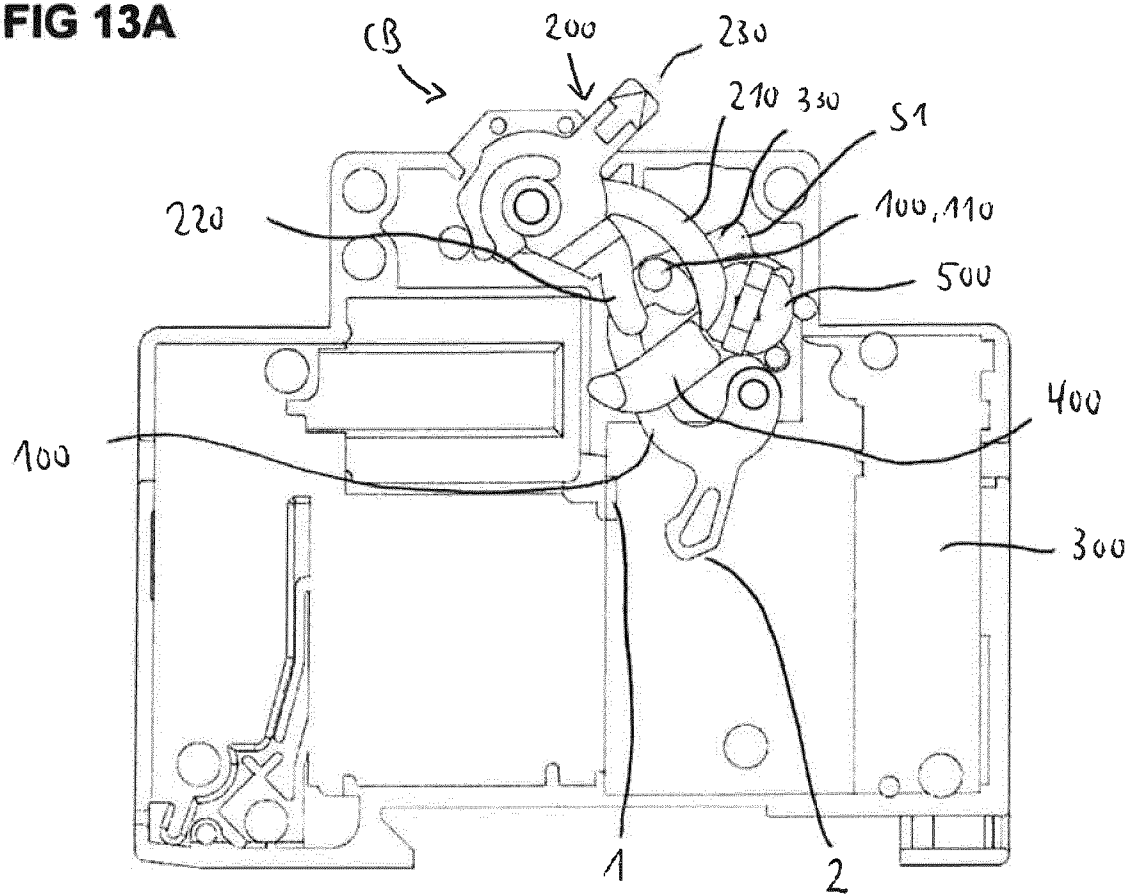


FIG 13B

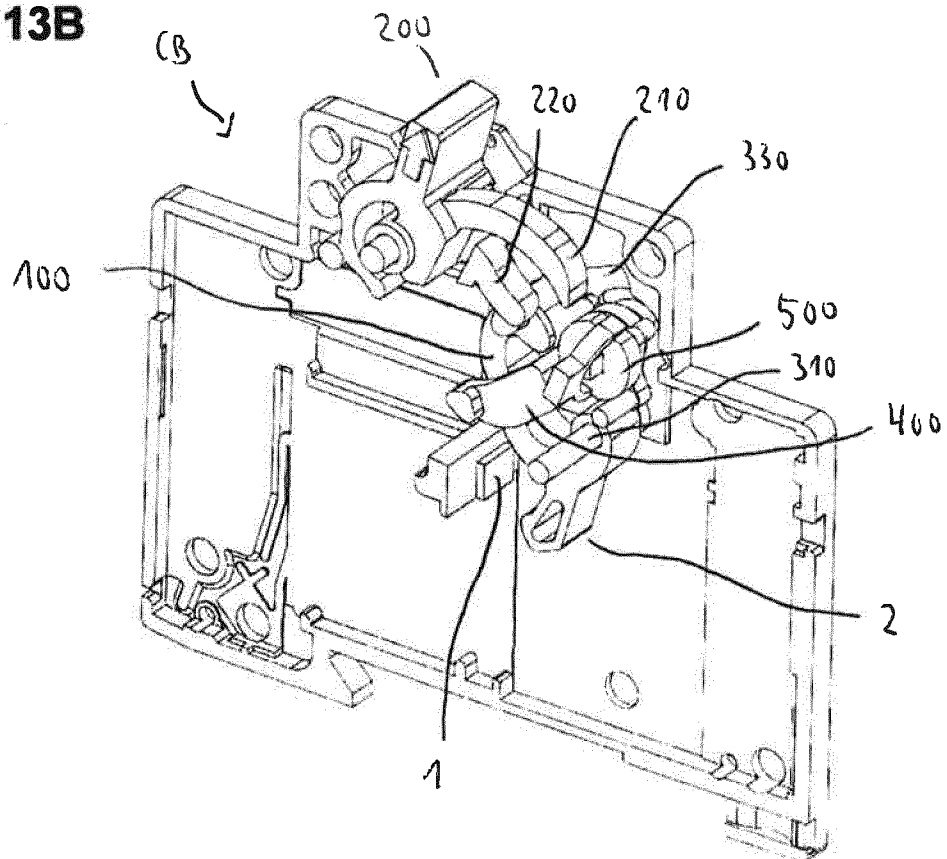


FIG 16

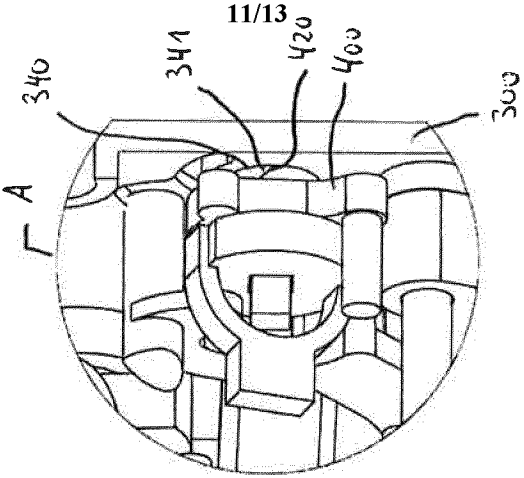
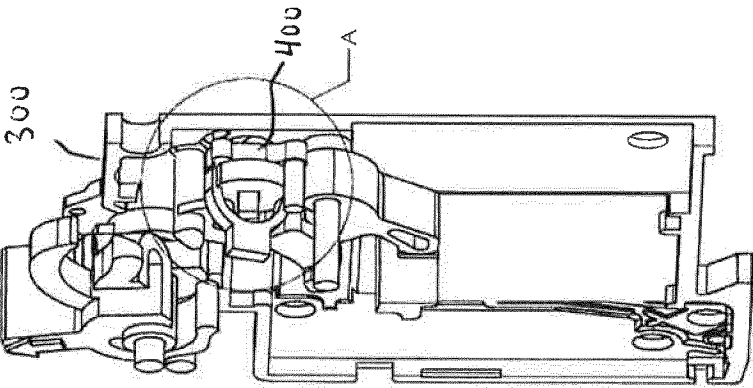
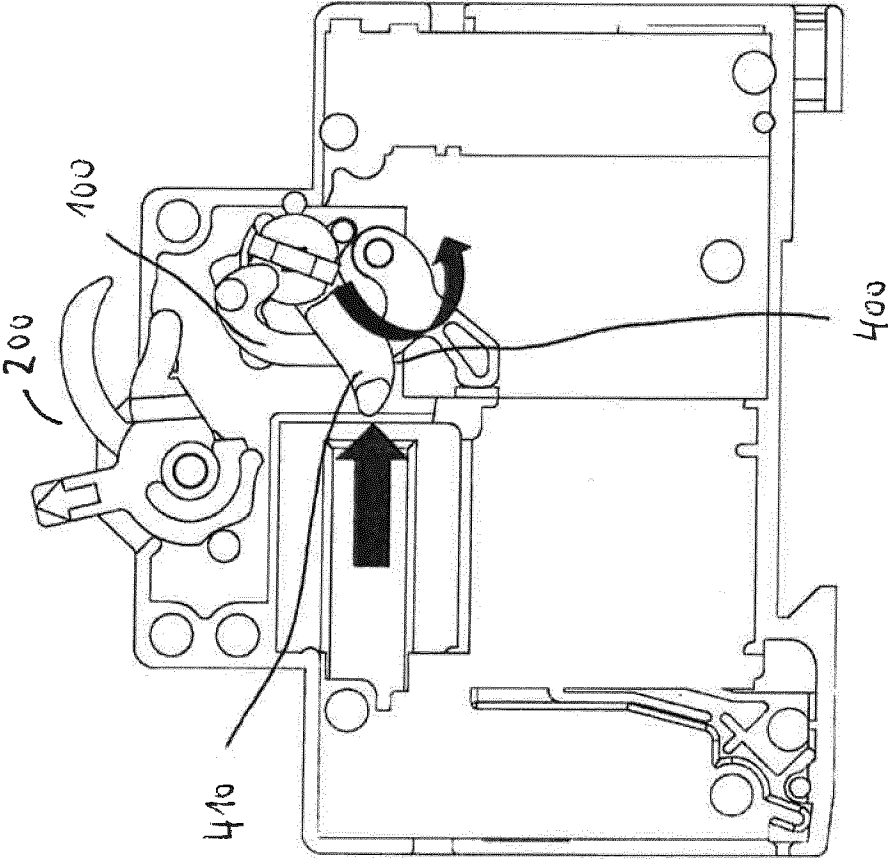


FIG 17

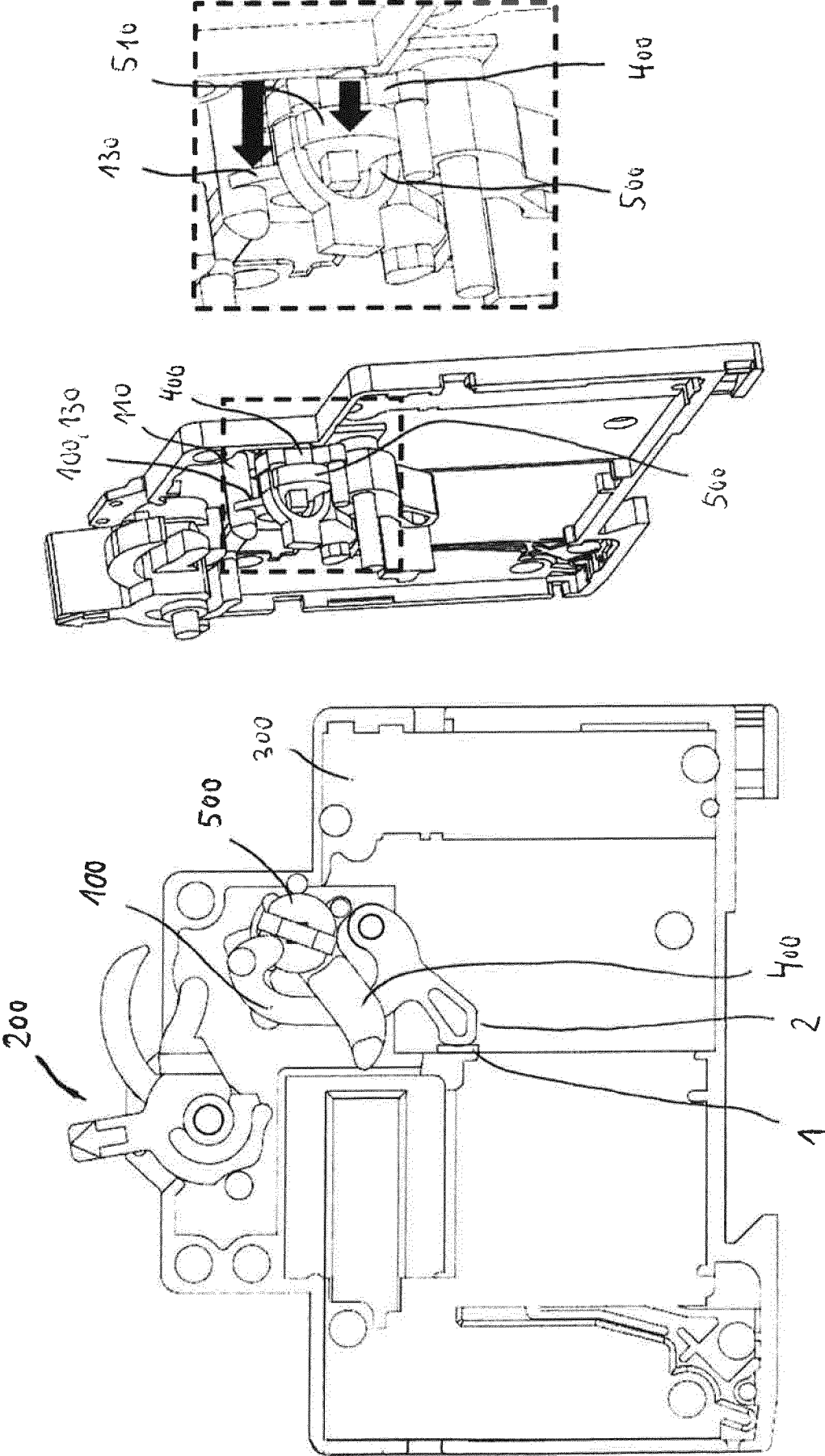
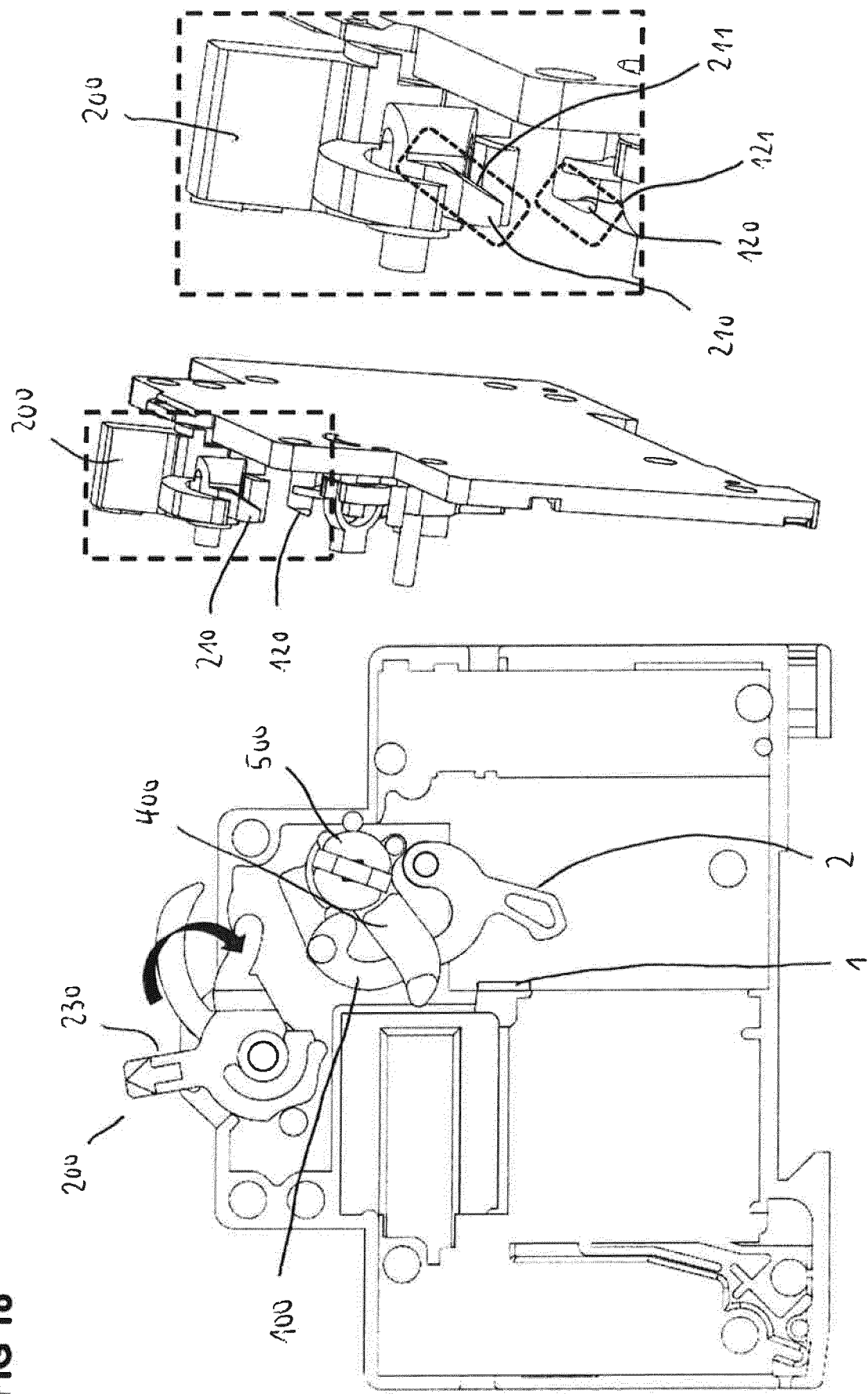


FIG 18



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/075413

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01H5/04 H01H71/52
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 2015/235794 A1 (RAKUFF STEFAN [US] ET AL) 20 August 2015 (2015-08-20) paragraph [0025] - paragraph [0052]; figures 1-12	1-5, 16-29 6-15
A	----- WO 03/012812 A1 (ABB SERVICE SRL [IT]; REDAELLI CLAUDIO [IT]) 13 February 2003 (2003-02-13) page 1 - page 14; figures 1-3	1,16,21
A	----- US 5 555 972 A (SCHWAB PIERRE P [US]) 17 September 1996 (1996-09-17) column 3, line 33 - column 5, line 4; figures 1-9	1,16,21



Further documents are listed in the continuation of Box C.



See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

19 December 2017

Date of mailing of the international search report

05/01/2018

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Fax: (+31-70) 340-3016

Authorized officer

Nieto, José Miguel

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/075413

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