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(54) **SHUNT BREAKING SYSTEM**

(57) The present invention provides for a shunt breaking system for a medium voltage switching apparatus such that the system is designed to generate a parallel or secondary circuit within the said apparatus where the linkage mechanism included in the said system allows the vacuum interrupter to be placed at any desirable position based on the available space within the said switching device.

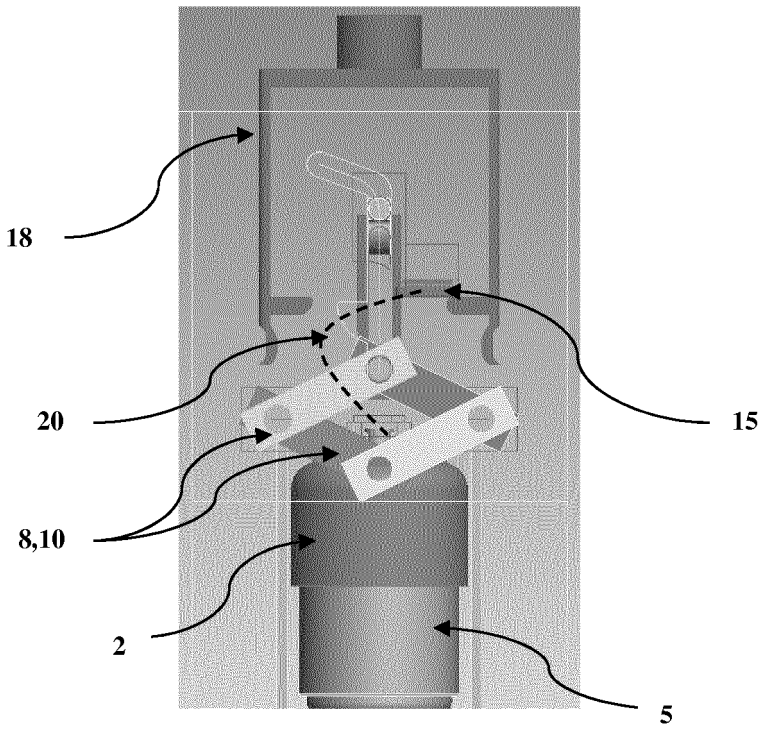

FIGURE 14

EP 3 046 129 A1

Description

[0001] Technical field: The present invention relates to a shunt breaking device designed to break an electrical circuit in a medium voltage switch disconnector, incorporating such a device.

[0002] Background and prior art: Generally an electrical switch disconnector is designed to provide a making or breaking of specified currents. As already known it mainly comprises a sealed enclosure filled with a high dielectric strength gas, in which a pair of main contacts are arranged, one stationary contact and the other movable, connected to an operating drive. A pair of arcing contact are sometimes electrically connected in parallel to the main contacts, such as to open the arcing contacts after the main contacts during breaking, and to close the arcing contacts before the main contacts during making.

[0003] There are various methods to achieve the required breaking capacity in a switch disconnector. To handle the arcing during breaking operation, some designs use arc splitters as that in FBX Ring Main Unit, some use the puffer systems as that in RM6 Ring Main Units. Prior arts such as EP2182536 and EP2479769 disclose parallel switching which has a primary circuit and a secondary circuit containing a vacuum interrupter. The primary circuit is used during the normal working of the switch disconnector. During the opening operation of the switch disconnector, current is transferred from primary circuit to secondary circuit by the moving contact and the current breaking is made to happen in a vacuum environment.

[0004] EP2182536 describes an application for a switch disconnector with rotary motion of the contacts. The linkage operating the vacuum interrupter (Figure 1) has a sliding joint 10 between the lever 7 and the moving contact 5 of the vacuum interrupter. The end positions and movement (velocity) of moving contact of vacuum interrupter depends on the length of ratios of lever 7 i.e. distance between the pivot 11 and its free end 9 to the distance between the pivot 11 to the sliding joint 10.

[0005] EP2479769 discloses an application for a switch disconnector having moving contacts with rotary and sliding or linear motion. As seen in figure 2, the lever 18, interacting with the main moving contact, is pivoted at two positions 11 and 21. This lever articulates/rotates about different pivots during opening and closing of the switch disconnector. During opening, the lever 18 rotates about pivot 21. This lever has an oblong slot which allows it to rotate about pivot 11 during closing of switch disconnector. The linkage operating the vacuum interrupter has a lever 18 which is pivoted about the pin 21. This lever is connected to the moving contact of vacuum interrupter by a hinge 11. The end positions and movement (velocity) of moving contact of vacuum interrupter depends upon the length ratios of the lever 18 i.e. distance between the pivot 11 and its free end to the distance between pivot 11 to the pivot pin 21.

[0006] On applying the above teachings to the existing switch disconnector (Figure 3); it was found that the linkage designs of the above mentioned prior arts require the vacuum interrupter to be placed close to the moving contact of the switch disconnector. Therefore the placement of vacuum interrupter, linkage pivot and linkage length provide very little flexibility. Further, adopting these designs in the existing switch disconnector require more space and shall demand increase in the size of the enclosure. Moreover, the placement of vacuum interrupter and its operating mechanism will leave very little space in terms of dielectric withstand between the live vacuum interrupter 21 and the earthed tank 20, considering the application at medium voltage levels (Rated voltage 24kV and impulse level of 125 kV of the product being designed). Figure 4 shows the dielectric criticality of such arrangement of vacuum interrupter when simulated in the Flux 2D analysis. It is known that stroke and velocity of the moving contact of a switch disconnector is dependent on its operating drive. As the secondary circuit is mechanically driven by the moving contact of the switch disconnector, any changes in its movement shall require most of the linkages to be modified to get the desired contact movement of the vacuum interrupter.

[0007] Prior art DE10047032 relates to an application for a switch disconnector having moving contacts with rotary motion (figure 5). Secondary circuit (vacuum interrupter and linkage mechanism) are mounted on the moving contact of the switch disconnector. Cam 12 operates a pin 11 which is rigidly connected to the moving contact of the vacuum interrupter. However, here, the secondary circuit along with the vacuum interrupter is mounted on the moving contact which increases the mass of the moving contact and shall demand more energy to move the contacts of switch disconnector.

[0008] Hence there was felt a pressing requirement for an alternate position of vacuum interrupter and a suitable linkage which can be accommodated in available space.

[0009] Summary of the Invention: The present invention provides for a Shunt Breaking System for a medium voltage switching apparatus such that the system is designed to generate a parallel or secondary circuit within the said apparatus where the linkage mechanism included in the said system allows the vacuum interrupter to be placed at any desirable position based on the available space within the said switching device.

[0010] Brief Description of the Drawings: A full understanding of the invention can be gained from the following description of the preferred embodiments when read in conjunction with the accompanying drawings in which:

Figure 1 describes the parallel switching mechanism existing in prior art EP2182536

Figure 2 describes the parallel switching mechanism existing in prior art EP2479769

Figure 3 illustrates the impractical positioning of vacuum interrupter of prior art solutions in present switch

disconnector

Figure 4 shows dielectric criticality of arrangement of figure 3 in Flux2D analysis

Figure 5 describes the parallel switching mechanism in prior art DE10047032 where secondary circuit are mounted on the moving contact of the switch disconnector

Figure 6 depict the vacuum interrupter device placed within the medium voltage switch disconnector of the present invention

Figure 7 illustrates the linkage mechanism of the present invention.

Figures 7a, 7b and 7c show exploded views of linkage support, pulling lever and guiding pin respectively.

Figure 8 shows the assembly of linkage mechanism with respect to vacuum interrupter device.

Figure 9 shows the interaction of the linkage mechanism with the moving contact

Figure 10 and 12 illustrate the cross sectional view of the initial position (A0) of switch disconnector while indicating upward motion of the moving contact towards outgoing busbar. The cross-sectional view of figure 10 shows the regions "D", "E" and "F".

Figure 11 represent the fixed support in which the linkage mechanism of the present invention is fixed.

Figure 13 depict the opening position (A1) of the switch.

Figure 14 show the separating position (A2) of the switch.

Figure 15 shows disconnecting position (A3) of the switch.

Figure 16 shows the closing position (A4) of vacuum interrupter switch.

Figure 17 shows the final closing of the switch disconnector after one stroke is completed.

Figure 18 shows the front view of the guiding slot of the fixed support having 3 regions "A", "B" and "C".

[0011] Detailed Description of the Invention: The present invention is intended to function as a parallel or secondary circuit for an existing switch disconnector. Considering the size of existing enclosures, vacuum interrupter has to be positioned in location such that the new linkage mechanism is rendered suitable to transfer the motion to the vacuum interrupter in less space or rather available space.

[0012] The detailed description provided hereinafter is for an embodiment where the stationary contact (1) is connected to the incoming busbar and the moving contact (18) is connected to the outgoing busbar. An embodiment where the stationary contact is connected to the outgoing busbar and moving contact is connected to incoming bus bar is also envisaged by the present invention. Referring to figures 6 - 8, there is depicted a shunt breaking system (30) of the present invention and comprising a primary circuit consisting of stationary contact (1) and moving contact (18); a secondary circuit consisting of a vacuum interrupter (5) electrically connected to the stationary contact (1) on terminal (12) with a suitable connection means (4) such as a screw and a linkage mechanism comprising multiple linkage means supported on a linkage support (6) having top linkage means (8) connected to pulling pin (7) at its first end and bottom linkage means (10) at its second end by means of sliding pins (9) slidable into slits provided in the linkage support (6). Whereas the second end of bottom linkage means (10) is connected by stationary pin (11) fixedly placed in recess provided in fixed support (19). In the present embodiment, there are eight linkage means in shape of scissors.

[0013] A collar (3), configured of passing through recess in a fixed support (19) is connected to bottom linkage means (10) with stationary pin (11) at collar first end and the moving contact (13) of vacuum interrupter (5) at collar second end. As seen in figure 11 and 18, the linkage support (6) comprising an inverse 'F' slot guiding a guiding pin (17), pulling pin (7) and pallet base (14) in it, is enabled to support linkage mechanism and insulate live parts from nearest earth/tank and other phase conductors. The fixed support (19) comprising the pallet base (14) with pallet contact (15) rigidly fixed thereto. The fixed support (6) comprises of regions "A", "B" and "C" which together comprise a guiding slot.

[0014] The moving contact end (13) is electrically connected to pallet contact (15) by means of a flexible wire (20), said pallet contact interacting with a protrusion (22) protruding out of an arm of the moving contact. An insulating cover (2) is sleeved over the vacuum interrupter (5) to provide necessary insulation during TRV. The pallet contact (15) is rigidly fixed to the pallet base (14). The guiding pin (17) configured to pass through the pulling lever (16) is connected to pallet base (14) at both ends.

[0015] The shunt breaking system of the present invention is of medium voltage type suitable for placement in a medium voltage switching apparatus such as a switch disconnector. In one embodiment, the operating drive is a linear operating drive whereas in another embodiment, the operating mechanism is a rotary operating mechanism.

[0016] The system (30) of the present invention is de-

signed to generate a parallel or secondary circuit in the said switch apparatus. The operating drive of the present invention is designed to actuate the moving contact (18) takes four positions of opening position (A1), disconnecting position (A2), separating position (A3) and closing position (A4). Before positions A1-A4 are achieved, the system of the present invention remains in an initial position (A0). Figure 10 and 12 shows the initial (A0) position of the system in which the current flows from the stationary contact (1) to the moving contact (18) through the primary circuit. The secondary circuit is inactive and vacuum interrupter (5) is in close position. The figure shows regions "D" i.e. profiled region on pallet contact (15); region "E" i.e. profiled region on moving contact (18) and region "F" i.e. profiled region of pulling lever (16).

[0017] Referring to figure 13, the opening position (A1) is a position for connection between the protrusion (22) and the pallet contact (15) when the moving contact (18) is electrically connected to the pallet contact (15) to establish a secondary circuit (1-12-13-20-15-18) besides a primary circuit (1-18). The moving contact travels vertically upwards enabling region "E" to interact with region "D". The guiding pin (17) being connected to pallet base interacts with region "F" of the pulling lever (16) transferring no movement to the vacuum interrupter (5) resulting in the vacuum interrupter being in closed position.

[0018] Referring to figure 14, separating position (A2) is a position in which the moving contact (18) leaves the stationary contact (1) causing the primary circuit (1-18) to become inactive and current to flow only through the secondary circuit. The guiding pin (17) travels in region "F" of the pulling lever (16) and region "A" of the fixed support (19) transferring no movement to the vacuum interrupter resulting in the vacuum interrupter (5) being in closed position. The guiding pin (17), on achieving a sufficient dielectric distance attaches to the pulling lever (16); the pulling pin (7) constrained with pulling lever (16) pulls the linkage support (6) for attaching to collar (3) thereto. The guiding pin (17) and pallet pivot (21) moving concurrently in region "A" of fixed support (19) along with the pallet base (14) operates the vacuum interrupter (5) resulting in breaking of current in the secondary circuit. The ratio of length of top linkage means (8) and the bottom linkage means (10) is modified based on desired rating, stroke or velocity required for opening the moving contact (18). In the present embodiment, the length of top linkage means (8) and bottom linkage means (10) is equal making the ratio of velocity of pulling pin (7) to linkage support (6) to 2:1. The linkage support (6) engages the collar (3) and vacuum interrupter moving contacts, the vacuum interrupter contact will open with half velocity in comparison to moving contact (18). The length of the linkage means to open the vacuum interrupter contacts depends on the desired velocity.

[0019] The disconnecting position (A3) is a position in which the guiding pin (17) and pallet pivot (21) interact with region "B" of the fixed support (6) while reducing speed of vacuum interrupter (5) to a desired level. The engagement between pallet contact (15) and moving contact (18) configured to keep vacuum interrupter (5) open preventing re-striking or re-igniting an arc between pallet contact (15) and moving contact (18) on separation from each other.

[0020] The closing position (A4) is a position in which release of the moving contact (18) from the pallet contact (15) renders the primary circuit and secondary circuit inactive. The linkage mechanism collapses by its weight and by the contacts closing force of vacuum interrupter (5). The pallet pivot (21) and guiding pin (17) retract to their initial position passing through regions "B" and "A" closing the vacuum interrupter (5). the moving contact (18) moves down in the linear axis from its open position, the protrusion (22) interacting with the pallet base (14), said pallet base (14) pivoting about guiding pin (17) around pallet pivot (21) in region "C" allowing the moving contact (18) to move down. The moving contact (18) electrically engages with stationary contact (1) closing primary circuit, said moving contact (18) completing its stroke resulting in pallet base (14) returning to its initial position (A0). The closing position (A4) is the intermediate position before initial position (A0) is achieved.

[0021] Advantageously, the input motion can be transferred to vacuum interrupter to allow it to act as secondary circuit even in linear motion switch disconnectors while satisfying the breaking needs for a given switch disconnector. For a given design change in stroke of the vacuum interrupter is possible by changing the slot width in pulling lever as well as by changing the slot profile in Fixed Support. For a given design, change in contact velocity of vacuum interrupter is possible by changing the length of scissor linkages. The opening of vacuum interrupter is in the same direction as the motion of moving contact which nullifies the possibility of damaging/twisting of VI moving stem.

[0022] Advantageously, the switch disconnector in RM6 Ring Main Unit has a linear contact movement and the new design for the secondary or parallel circuit is suitable considering its enclosure size. Other breaker and switch disconnectors like Flusarc also have the potential to implement the above design. The linkage mechanism can also be made suitable for a switch disconnector with rotary contacts. By changing only the length of the linkage means we can adapt to the future modification in vacuum interrupters in terms of ratings, stroke and the velocity requirement for its contact opening. With the change in specification or ratings of vacuum interrupter, we can expect the size to change, its moving contact velocity to change, or its contact displacement to be changed. All these can be achieved by using one or more features of the cam or transfer lever design parameters.

[0023] In an alternate embodiment, additional dampers could be provided to let the protrusion (22) and pallet contact be connected. To avoid the jamming and sticky movements of guiding pin at the end of opening travel, a torsion spring could be provided to have a push back force. In a further alternate embodiment, the present in-

vention may be added as a subassembly to the existing switch disconnector.

[0024] While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of the invention which is to be given the full breadth of the appended claims and any and all equivalents thereof.

Claims

1. A shunt breaking system **(30)** comprising-

(a) a primary circuit consisting of stationary contact **(1)** and moving contact **(18),** said stationary contact **(1)** being connected to incoming busbar and moving contact **(18)** is connected to outgoing busbar;
(b) a secondary circuit consisting of a vacuum interrupter **(5)** electrically connected to the stationary contact **(1)** on terminal **(12)** with suitable connection means **(4);**
(c) a linkage mechanism comprising of multiple linkage means supported on a linkage support **(6)** having top linkage means **(8)** connected to pulling pin **(7)** at its first end and bottom linkage means **(10)** at its second end with the help of sliding pins **(9)** slidable into slits provided in the linkage support **(6),** the second end of bottom linkage means **(10)** being connected by stationary pin **(11)** fixedly placed in recess provided in fixed support **(19).**

2. The shunt breaking system **(30)** as claimed in claim 1 wherein collar **(3),** configured of passing through grooves in a fixed support **(19)** is connected to bottom linkage means **(10)** with stationary pin **(11)** at collar first end and the moving contact end **(13)** of vacuum interrupter **(5)** at collar second end.

3. The shunt breaking system **(30)** as claimed in claims 1 and 2 wherein the linkage support **(6),** comprising an inverse **"F"** slot guiding a guiding pin (17), pulling pin (7) and pallet base **(14)** in it, is enabled to support linkage mechanism and insulate live parts from nearest earth/tank and other phase conductors.

4. The shunt breaking system **(30)** as claimed in any of the preceding claim wherein the moving contact end **(13)** is electrically connected to pallet contact **(15)** by means of a flexible wire **(20),** said pallet contact interacting with a protrusion **(22)** protruding out of an arm of the moving contact **(18)** and comprising a profiled region **"D"** for interacting with profiled region **"E"** of the moving contact **(18).**

5. The shunt breaking system **(30)** as claimed in any of the preceding claims wherein the fixed support **(19)** comprising a pallet base **(14)** with pallet contact **(15)** rigidly fixed thereto, said fixed support **(19)** having regions "**A**", **"B"** and **"C"** comprised in a guiding slot.

6. The shunt breaking system **(30)** as claimed in any of the preceding claims wherein the guiding pin **(17)** configured to pass through the pulling lever **(16)** is connected to pallet base **(14)** at both ends, said pulling lever comprising a profiled region **"F"** for interacting with guiding pin **(17).**

7. The shunt breaking system **(30)** as claimed in any of the preceding claims wherein the linkage mechanism designed to actuate the moving contact **(19)** takes four positions of opening position **(A1),** disconnecting position **(A2)**, separating position **(A3)** and closing position **(A4)**, said moving contact taking an initial position **(A0)** preceding to positions (**A1**-**A4**).

8. The shunt breaking system **(30)** as claimed in claim 7 wherein in initial position **(A0),** the primary circuit remains closed, the secondary circuit remains inactive and vacuum interrupter **(5)** is in closed condition.

9. The shunt breaking system **(30)** as claimed in claim 7 wherein the opening position **(A1)** being a position for connection between the protrusion **(22)** and the pallet contact when the moving contact being electrically connected to the pallet contact to establish a secondary circuit **(1-12-13-20-15-18)** besides a primary circuit **(1-18),** the moving contact **(18)** travelling vertically upwards enabling region **"E"** to interact with region **"D"** and the guiding pin **(17)** being connected to pallet base **(14)** interacts with region **"F"** of the pulling lever **(16)** transferring no movement to the vacuum interrupter **(5)** resulting in the vacuum interrupter being in closed position.

10. The shunt breaking system **(30)** as claimed in claim 7 wherein separating position **(A2)** being a position in which the moving contact **(18)** leaves the stationary contact (1) causing the primary circuit **(1-18)** to become inactive and current to flow only through the secondary circuit, the guiding pin **(17)** travels in region **"F"** of the pulling lever **(16)** and region "**A**" of the fixed support **(19)** transferring no movement to the vacuum interrupter **(5)** resulting in the vacuum interrupter being in closed position said the guiding pin **(17),** on achieving a sufficient dielectric distance attaches to the pulling lever **(16),** the pulling pin **(7)** constrained with pulling lever **(16)** pulls the linkage support **(6)** for attaching to collar thereto.

11. The shunt breaking system **(30)** as claimed in claim 10 wherein the guiding pin **(17)** and pallet pivot **(21)** moving concurrently in region "**A**" of fixed support **(19)** along with the pallet base **(14)** operates the vacuum interrupter **(5)** resulting in breaking of current in the secondary circuit, and the linkage support **(6)** engages the collar **(3)** and moving contact **(13),** said contact opening with half velocity in comparison to moving contact **(18).**

12. The shunt breaking system **(30)** as claimed in claim 11 wherein the ratio of length of top linkage means **(8)** and the bottom linkage means **(10)** being modified based on desired rating, stroke or velocity required for opening the moving contact **(18).**

13. The shunt breaking system **(30)** as claimed in claim 7 wherein the disconnecting position **(A3)** being a position in which the guiding pin **(17)** and pallet pivot interact with region **"B"** of the fixed support while reducing speed of vacuum interrupter to a desired level , the engagement between pallet contact **(2)** and moving contact **(1)** configured to keep vacuum interrupter **(5)** open preventing re-striking or re-igniting an arc between pallet contact **(2)** and moving contact **(1)** on separation from each other.

14. The shunt breaking system **(30)** as claimed in claim 7 wherein closing position **(A4)** being an intermediate position before the initial position **(A0)** is achieved, is a position in which release of the moving contact **(1)** from the pallet contact **(2)** renders the primary circuit and secondary circuit inactive , the linkage mechanism collapsing by its weight and by the contacts closing force of vacuum interrupter; the pallet pivot **(21)** and guiding pin **(17)** retracting to their initial position **(A0)** passing through regions **"B"** and "**A**" closing the vacuum interrupter **(5).**

15. The shunt breaking system **(30)** as claimed in claim 14 wherein the moving contact **(18)** moves down in the linear axis from its open position, the protrusion **(22)** interacting with the pallet base, said pallet base **(14)** pivoting about guiding pin **(17)** around pallet pivot **(21)** in region **"C"** allowing the moving contact **(18)** to move down; said moving contact **(18)** electrically engages with stationary contact **(1)** closing primary circuit, said moving contact completing its stroke resulting in pallet base **(14)** returning to its original position.

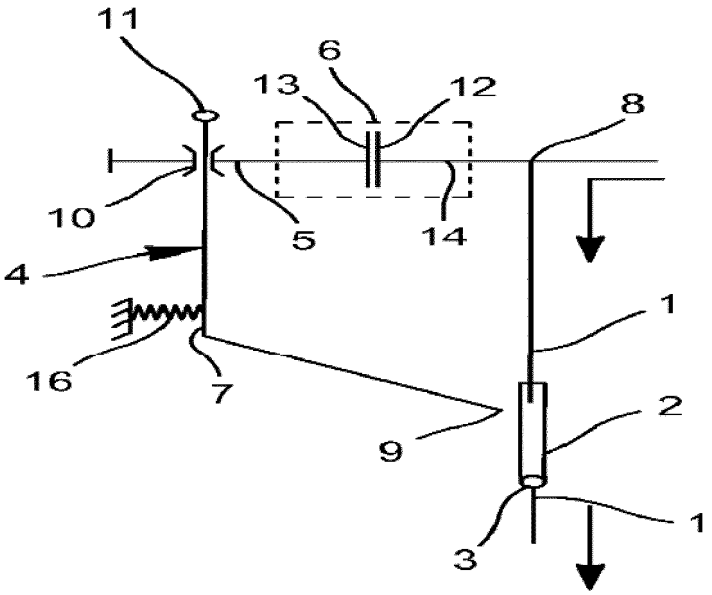

FIGURE 1 (PRIOR ART)

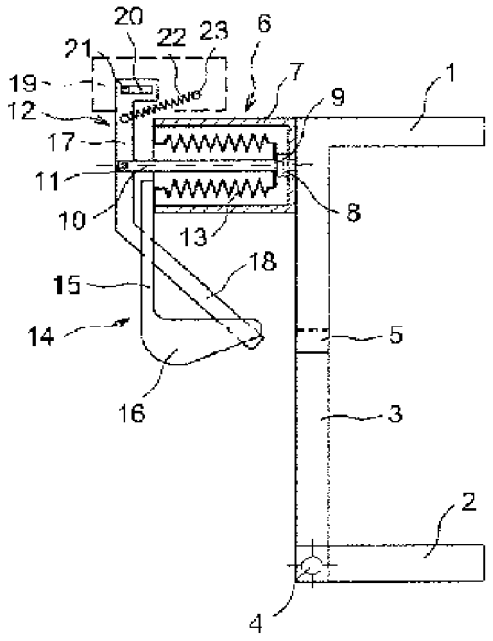

FIGURE 2 (PRIOR ART)

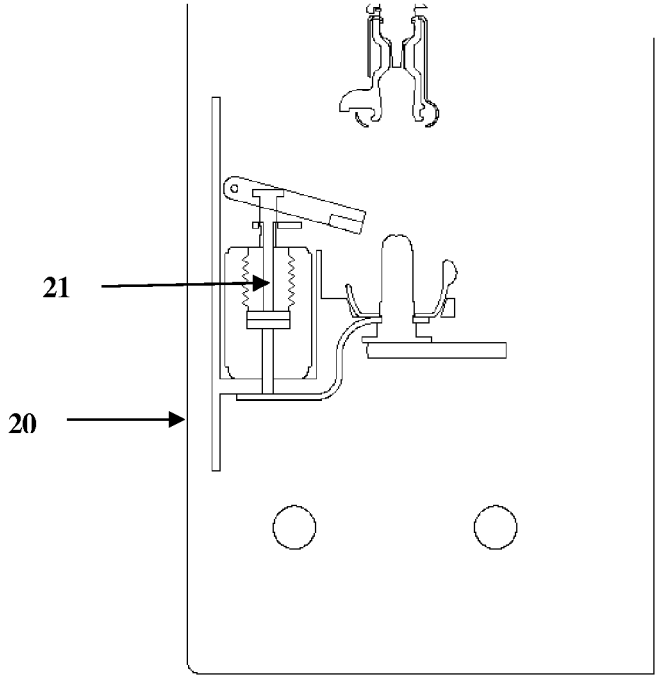

FIGURE 3

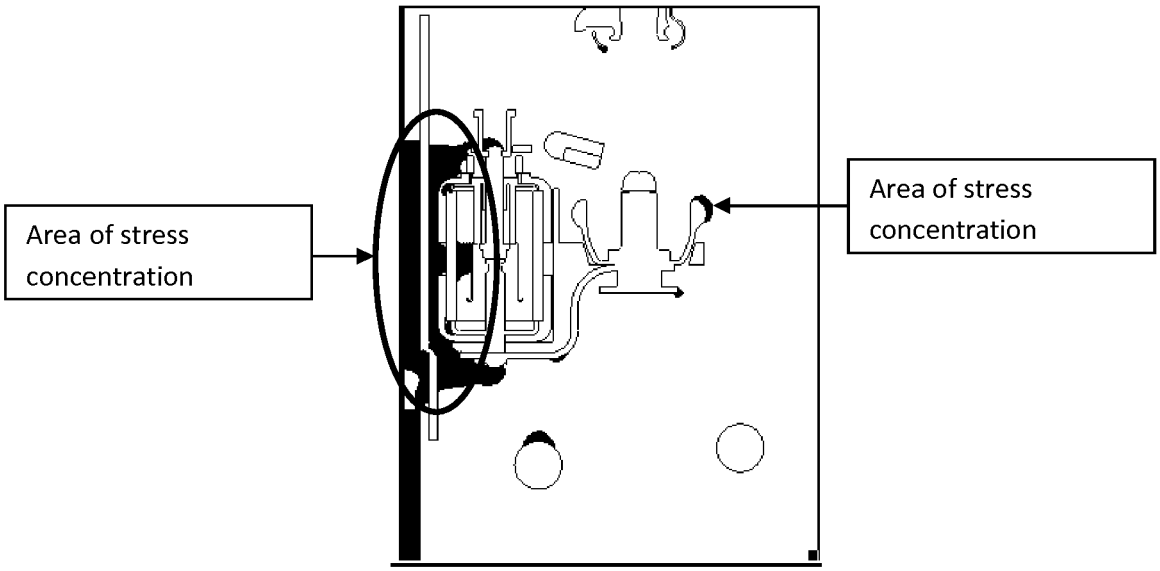

FIGURE 4

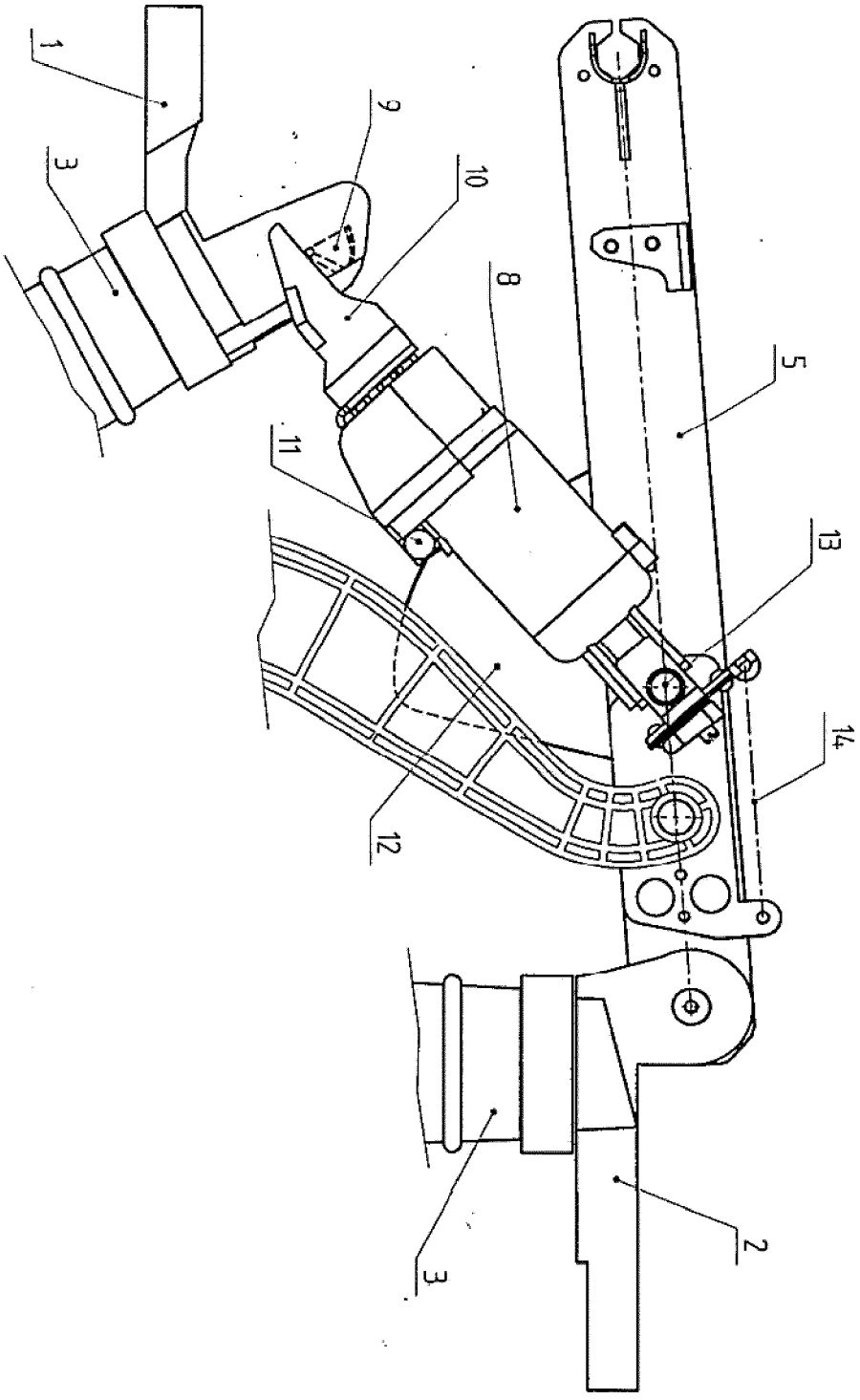

FIGURE 5

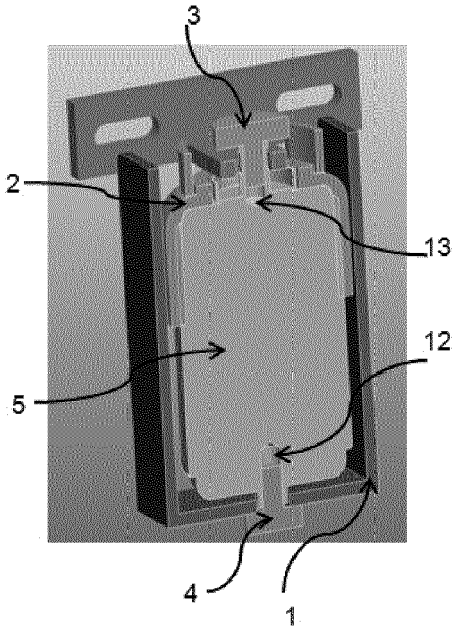

FIGURE 6

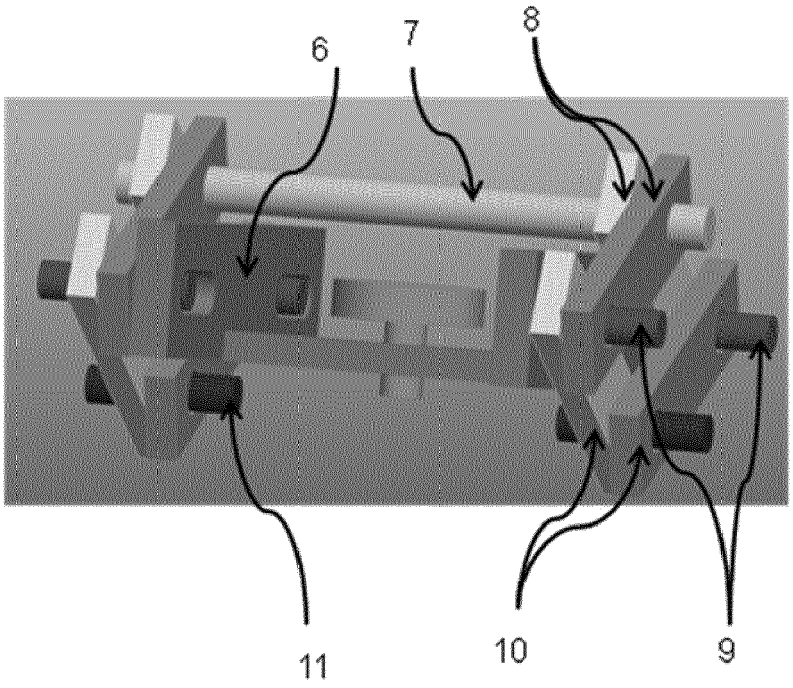

FIGURE 7

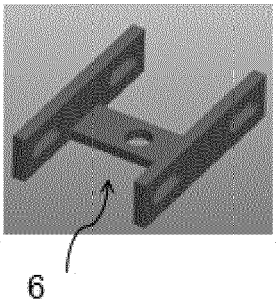

FIGURE 7a

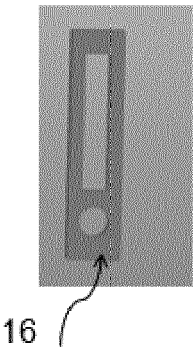

FIGURE 7b

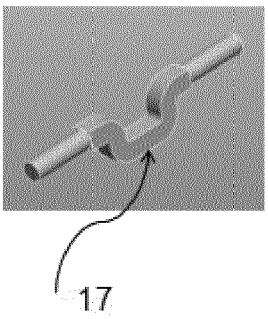

FIGURE 7c

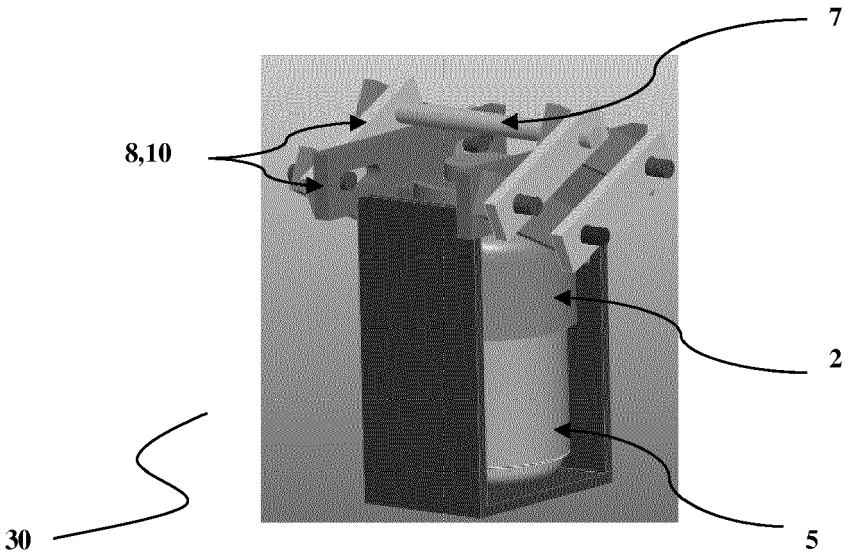

FIGURE 8

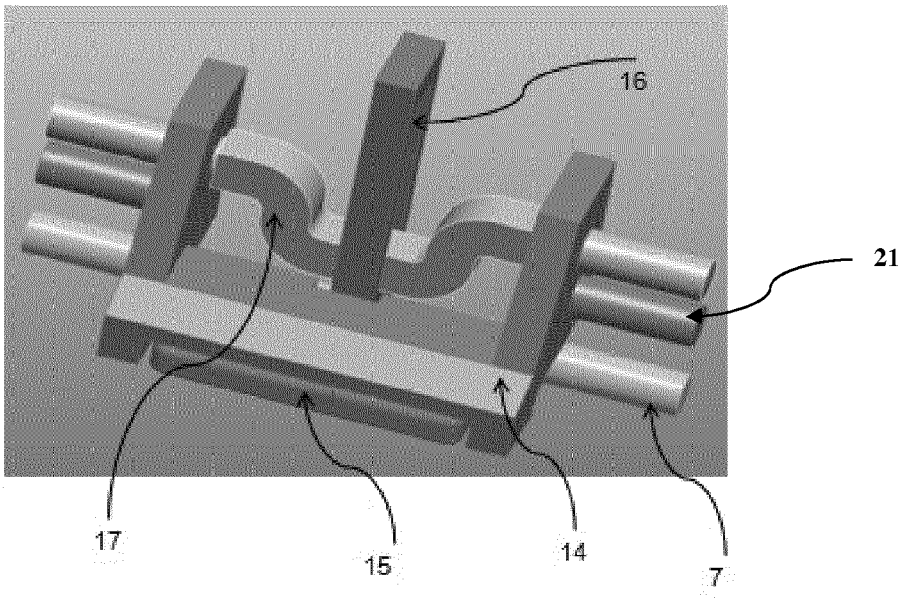

FIGURE 9

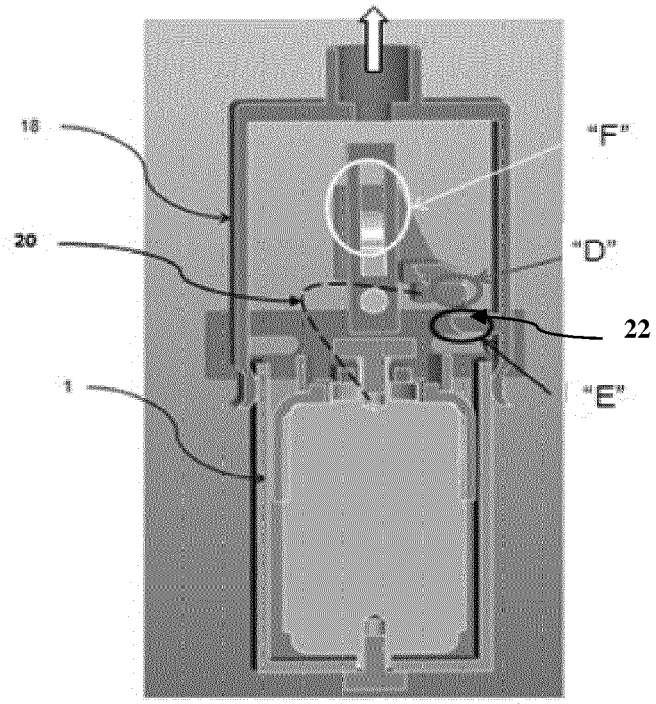

FIGURE 10

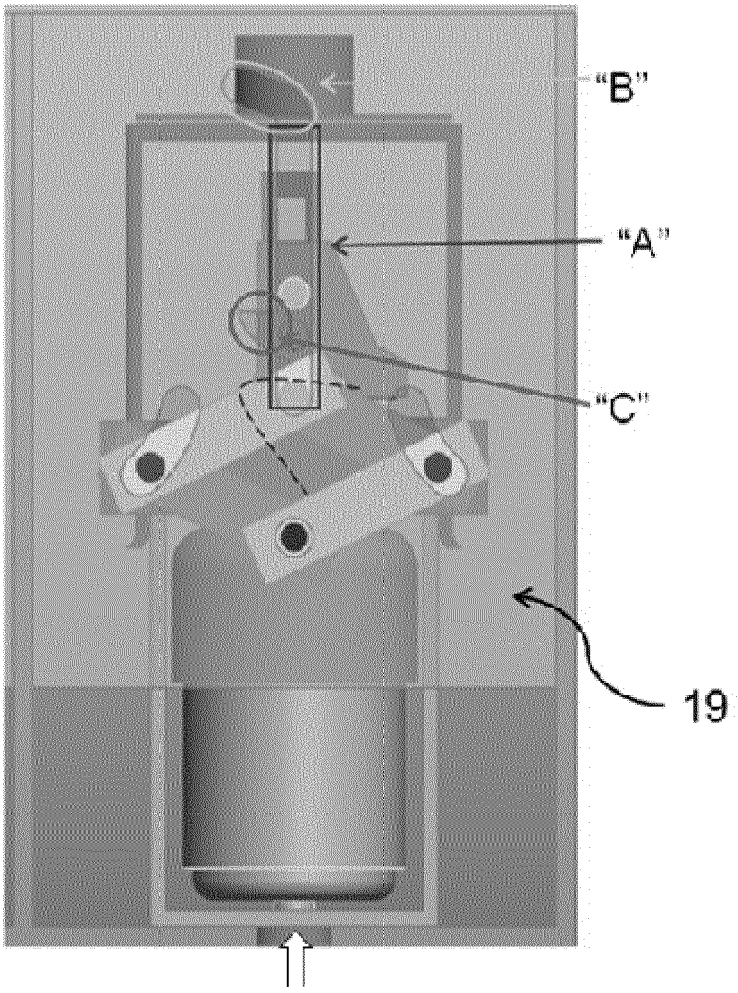

FIGURE 11

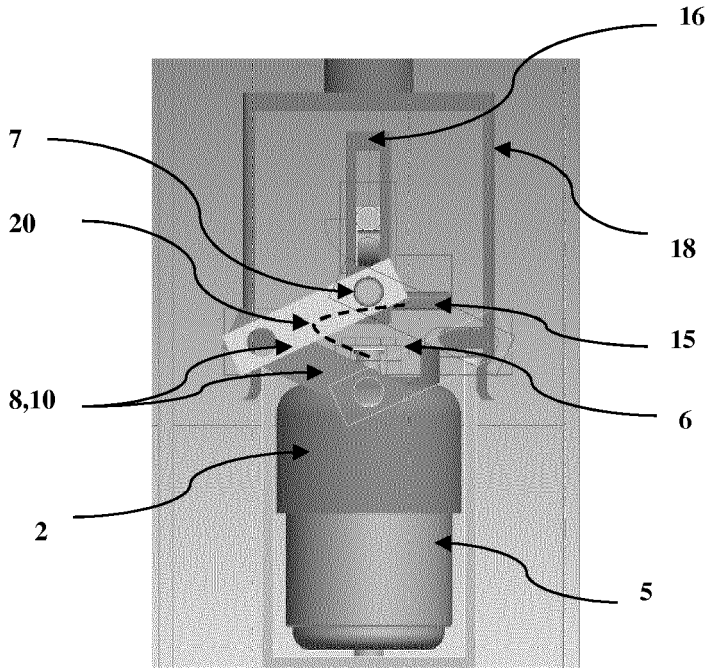

FIGURE 12

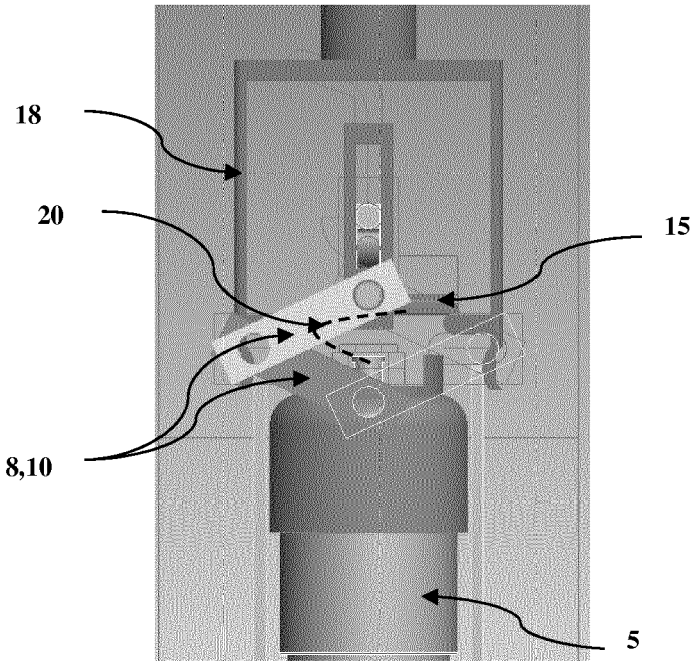

FIGURE 13

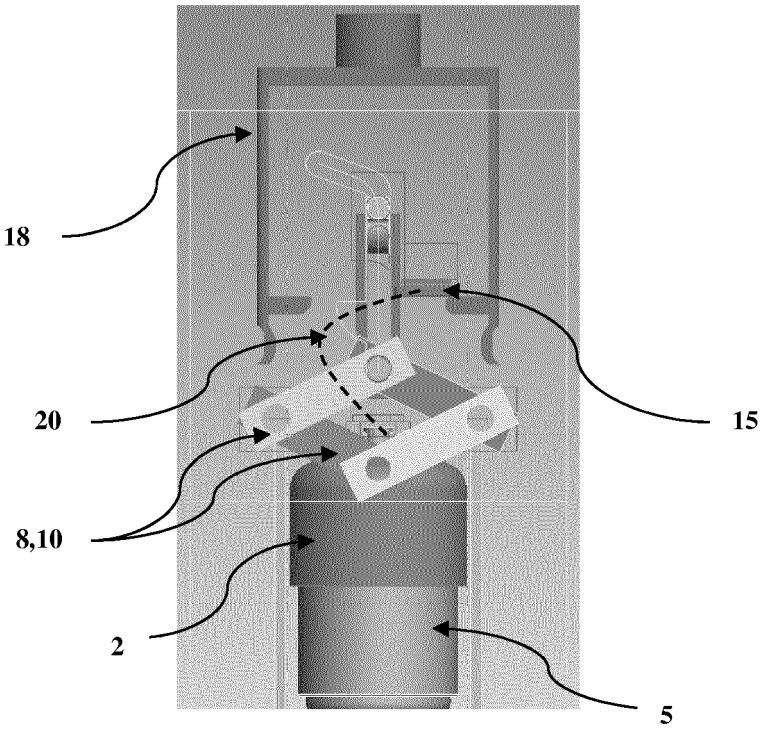

FIGURE 14

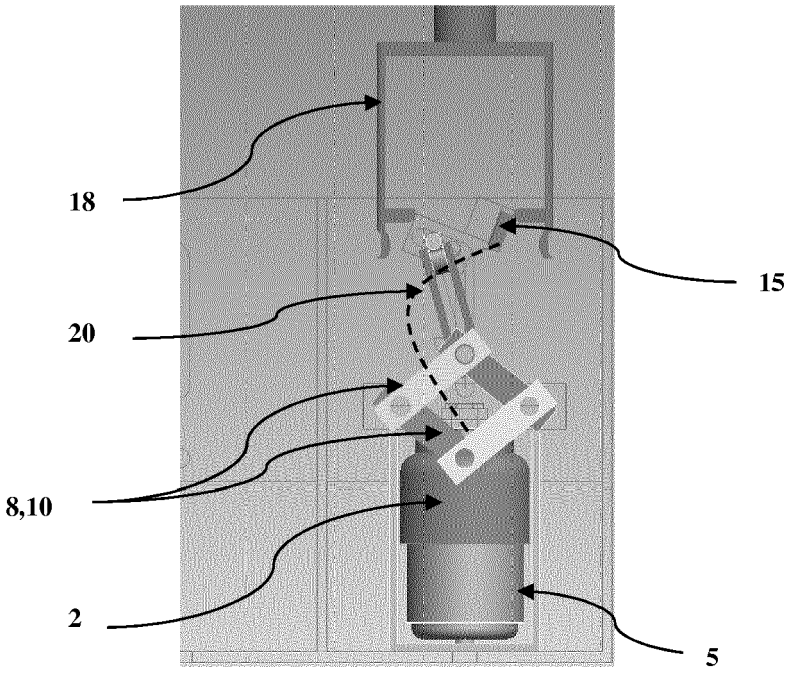

FIGURE 15

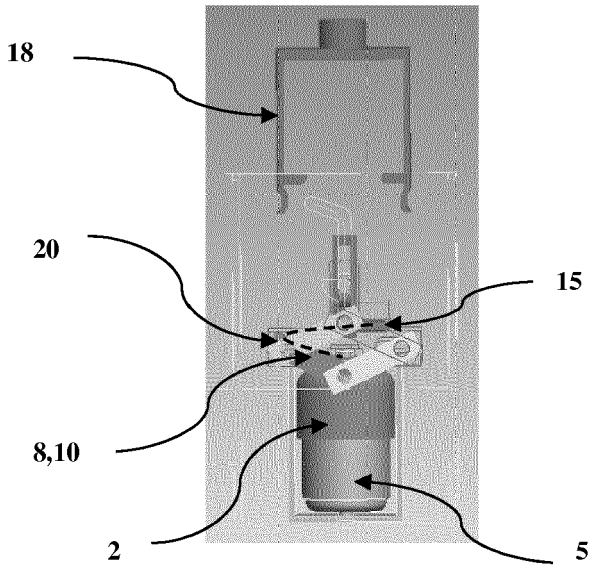

FIGURE 16

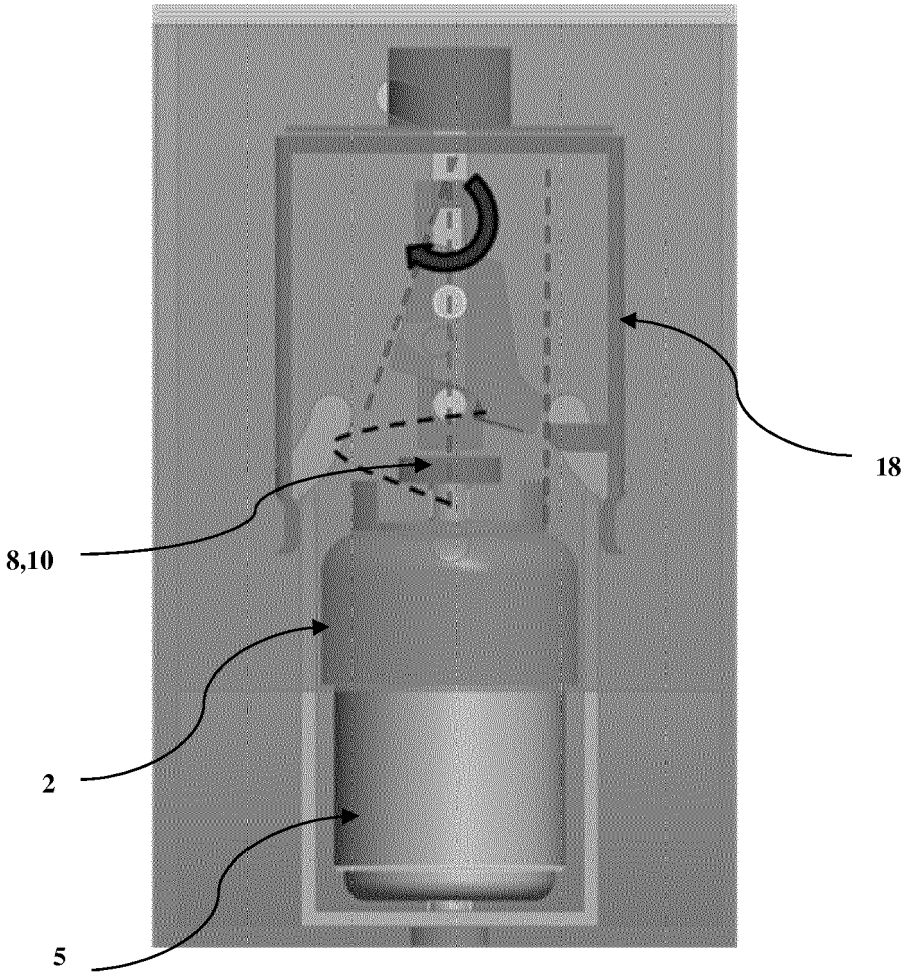

FIGURE 17

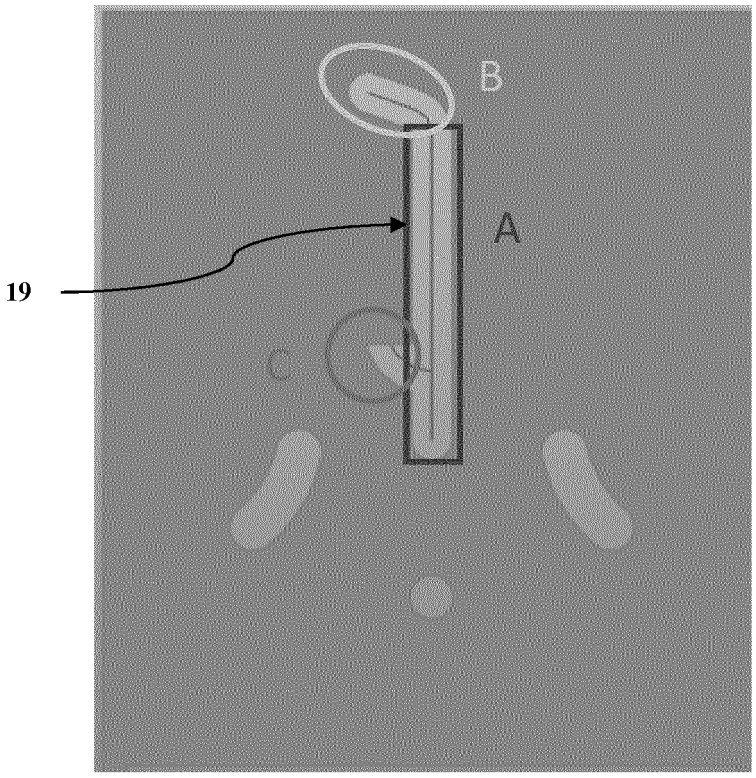

FIGURE 18

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EUROPEAN SEARCH REPORT

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	2 July 2015	Ernst, Uwe

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