



(11) **EP 4 227 971 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.08.2023 Bulletin 2023/33

(51) International Patent Classification (IPC):
H01H 33/12 ^(2006.01) **H01H 9/54** ^(2006.01)

(21) Application number: **22155883.6**

(52) Cooperative Patent Classification (CPC):
H01H 33/12; H01H 9/541; H01H 9/548

(22) Date of filing: **09.02.2022**

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

(71) Applicant: **Hitachi Energy Switzerland AG**
5400 Baden (CH)

(72) Inventor: **Peters, Hauke**
Hanau (DE)

(74) Representative: **Michalski Hüttermann & Partner**
Patentanwälte mbB
Kaistraße 16A
40221 Düsseldorf (DE)

(54) **HIGH VOLTAGE DISCONNECTOR SWITCH**

(57) The invention relates to a high voltage disconnecter switch comprising a fixed first main contact (1) comprising at least one first contact element (4a), a fixed second main contact (2) comprising at least one second contact element (4b) and axially extending in extension of the fixed first main contact (1), a movable main contact (3) comprising an axially extending opening, arranged movably between an open position and a closed position and axially in parallel to the fixed first main contact (1) and the second main contact (2), whereby the movable main contact (3) is electrically connected in both positions via the at least one second contact element (4b) with the fixed second main contact (2) and only in the closed position via the at least one first contact element (4a) with the fixed first main contact (1), a fixed arcing contact (5) connected with a first end to the fixed first main contact (1), extending axially parallel to the movable main contact (3) and arranged for being encompassed on a second opposite end by the opening of the movable main contact (3), a movable arcing contact (6) movably arranged within the opening of the movable main contact (3), electrically connected via at least one third contact element (4c) to the movable main contact (3) and comprising a spring (8) arranged within the opening of the movable main contact (3) and configured for pushing, in the closed position, the movable arcing contact (6) onto and thereby electrically contacting the fixed arcing contact (5), and a power diode (7) arranged between the fixed first main contact (1) and the fixed arcing contact (5) and/or between the fixed arcing contact (5) and the movable arcing contact (6).

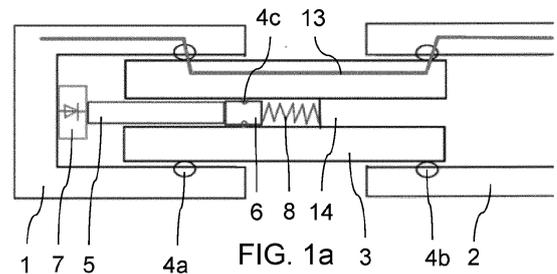


FIG. 1a

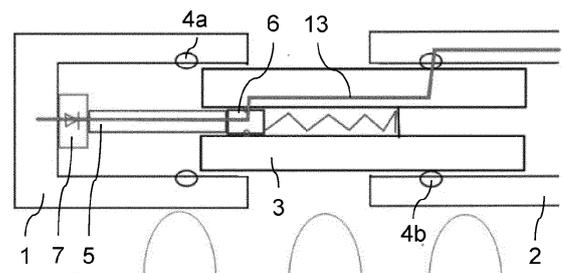


FIG. 1b

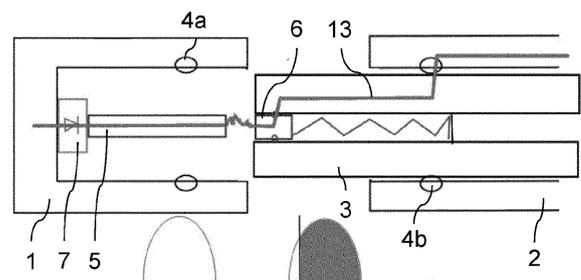


FIG. 1c

EP 4 227 971 A1

Description

Technical Field

[0001] The invention relates to a high voltage disconnect switch comprising a fixed first main contact comprising at least one first contact element, a fixed second main contact comprising at least one second contact element and axially extending in extension of the fixed first main contact and a movable main contact comprising an axially extending opening, arranged movably between an open position and a closed position and axially in parallel to the fixed first main contact and the second main contact, whereby the movable main contact is electrically connected in both positions via the at least one second contact element with the fixed second main contact and only in the closed position via the at least one first contact element with the fixed first main contact.

Background Art

[0002] Electric disconnect switches, for example isolating switches, are employed for the opening or closing of circuits by the opening or closing of electrical components. An isolating switch can thus be employed for the interruption of a circuit. In general, an isolating switch is employed for the opening and/or closing of a connection if no current, or only a very small current is flowing, for example after the switch-off of the current flow or before the switch-on of the current flow. This distinguishes an isolating switch from a power switch, which is employed for the switch-on and/or switch-off of the current flow, even at higher currents.

[0003] During the opening and closing of an electric switch, an arc can be generated, i.e. a self-sustained gas discharge which has a sufficiently high electrical potential difference for the maintenance, by impulse ionization, of the requisite high current density, between commutation contact elements or between commutation contact elements and a housing of the switch. The arc can damage, or even destroy the commutation contact elements or the housing.

[0004] Due to today's higher demand of energy bus transfer current switching requirements are increasing, as also reflected in international standards such as IEC 62271-102, where the bus transfer current, and voltage, ratings were increased in the latest revision. Discussions are ongoing if these values are sufficient or further adaptation to network requirements are necessary. As described before, during bus transfer switching an arc is drawn between the arcing contacts. The arcing time is of high importance in respect to contact erosion during operation. As most disconnectors are moving slowly, arcing times are rather long if ratings for the bus transfer current are increased. Beside that even higher ratings have to be fulfilled if a GIS, gasinsulated switchgear, disconnecter is used in air insulated applications. For such applications snapping contact systems have been devel-

oped, which allow in a certain range an increased opening speed of the arcing contacts during opening and thereby reducing the arcing time. However, improvements are required for increased ratings.

Summary of invention

[0005] It is therefore an object of the invention to provide an improved disconnect switch.

[0006] The object of the invention is solved by the features of the independent claim. Preferred implementations are detailed in the dependent claims.

[0007] Thus, the object is solved by a high voltage disconnect switch comprising

a fixed first main contact comprising at least one first contact element,
 a fixed second main contact comprising at least one second contact element and arranged in axial extension of the fixed first main contact,
 a movable main contact comprising an axially extending opening, arranged movably between an open position and a closed position and axially in parallel to the fixed first main contact and the second main contact, whereby the movable main contact is electrically connected in both positions via the at least one second contact element with the fixed second main contact and only in the closed position via the at least one first contact element with the fixed first main contact,
 a fixed arcing contact connected with a first end to the fixed first main contact, extending axially parallel to the movable main contact and arranged for being encompassed on a second opposite end by the opening of the movable main contact,
 a movable arcing contact movably arranged within the opening of the movable main contact, electrically connected via at least one third contact element to the movable main contact and comprising a spring arranged within the opening of the movable main contact and configured for pushing, in the closed position, the movable arcing contact onto and thereby electrically contacting the fixed arcing contact, and
 a power diode arranged between the fixed first main contact and the fixed arcing contact and/or between the fixed arcing contact and the movable arcing contact.

[0008] Therefore, a key point of the invention is that a power diode such as semiconductor is arranged in the arcing current pass. The power diode clips one polarity of the current flow during opening. In a current free period a dielectric strength of an insulation gas, for example SF6 or an alternative, can recover from the arc plasma and the current flow in the next upcoming half wave is prevented as the gap can already withstood recovery voltages. Thereby the arcing time is reduced to only one current loop and a contact erosion between the fixed arc-

ing contact and the movable arcing contact is reduced. Thus, the high voltage disconnecter switch can be operated with higher current and voltage ratings for the bus transfer.

[0009] The fixed first main contact and/or the fixed second main contact is preferably provided as a tube or tube-like, having the same inner and/or outer diameter and/or arranged in axial extension and distant behind each other. The fixed first main contact is preferably closed at the first axial end opposite to the fixed second main contact. Preferably the fixed first main contact and/or the fixed second main contact comprise a plurality of first contact elements and/or second contact elements, where the plurality of contact elements are preferably arranged in regular distances circumferentially around the movable main contact and/or preferably are configured for sliding on the movable main contact for thereby establishing the electrical connection.

[0010] The movable main contact is configured for establishing only in the closed position the electrical connection between the fixed first main contact and the fixed second main contact. The fixed arcing contact is configured for being at least partially encompassed by the opening of movable main contact in the closed position and/or not encompassed or at least partially not encompassed by the opening of movable main contact in the closed position. The movable arcing contact can be provided rod-like and/or having in axial extension is similar or identical shape as the fixed arcing contact. While one end of the spring is preferably firmly connected to the movable arcing contact, never opposite end of the spring is preferably firmly connected to the movable main contact.

[0011] The term high voltage relates to voltages that exceeds 1 kV. A high voltage preferably concerns nominal voltages in the range from above 72 kV to 800 kV, like 145 kV, 170 kV, 245 kV or 420 kV. The high voltage disconnecter switch may be provided as a circuit breaker and/or may include one or more components such as, a puffer-type cylinder, a self-blast chamber, a pressure collecting space, a compression space, or puffer volume, and an expansion space. The high voltage disconnecter switch preferably comprises an insulating gas which can be any suitable gas that enables to adequately extinguish an electric arc formed between the contact elements during a current interruption operation, such as, but not limited, to an inert gas as, for example, sulphur hexafluoride SF₆. Specifically, the insulating gas used can be SF₆ gas or any other dielectric insulation medium, may it be gaseous and/or liquid, and in particular can be a dielectric insulation gas or arc quenching gas.

[0012] According to a preferred implementation an anode of the power diode is connected to the fixed first main contact and/or to the fixed arcing contact. Such wise the cathode is preferably connected to the fixed arcing contact and/or to a housing of the power diode as described below. In the first case, the power unit is preferably connected in between the fixed first main contact and the

fixed arcing contact. In the second case, the power unit is preferably only connected to the fixed arcing contact, which is preferably directly connected to the fixed first main contact. The power diode can be provided as semiconductor.

[0013] In another preferred implementation a first end of the spring is connected to the movable arcing contact and an opposite second end is connected to the movable main contact. Thus, as the movable arcing contact is arranged movably in respect to the movable main contact, the spring becomes loaded by moving the movable arcing contact. The spring can be provided as a spiral spring or the like. Preferably the spring extends in axial extension. The term "axial" designates an extension, distance etc. in the direction of the axis, in particular in longitudinal extension of the high voltage disconnecter switch. An axial separation between parts means that these parts are separated from each other when seen or measured in the direction of the axis. The term "radial" designates an extension, distance etc. in a direction perpendicular to the axis. The term "cross-section" means a plane perpendicular to the axis, and the term "cross-sectional area" means an area in such a plane. The axis is presently the switching axis of the high voltage disconnecter switch.

[0014] According to a preferred implementation movement of the movable arcing contact is limited by an axial end of the movable main contact oriented away from the spring. The limitation can be achieved by a tip extending radially inwards at the axial end. Thus, when retracting the movable main contact from the fixed first main contact initially the fixed arcing contact and the movable arcing contact touch each other for providing an electrical connection loaded by the spring force, but disconnect from each other when the movable main contact moves into the fully opened position. The limitation thus may serve that the movable arcing contact remains axially within the movable main contact.

[0015] In another preferred implementation the movable arcing contact comprises a sliding contact, in particular a tulip contact and/or a snapping contact, oriented away from the spring, in particular towards the fixed first main contact, and configured for sliding on and thereby electrically connecting at least the fixed arcing contact. In case the power diode is arranged between the fixed arcing contact and the movable arcing contact, in particular on the second end of the fixed arcing contact, the sliding contact can be configured for sliding on and thereby electrically connecting with the power diode.

[0016] According to a preferred implementation the movable arcing contact comprises a tubular shape configured for encompassing the fixed arcing contact and, if the power diode is arranged between the fixed arcing contact and the movable arcing contact, the power diode. Such way as snapping contact system can be implemented, which increases switching performance.

[0017] In another preferred implementation the power diode is arranged between the fixed arcing contact and the movable arcing contact in axial extension of the fixed

arcing contact oriented towards the fixed second main contact and the sliding contact is configured for sliding, in the closed position, on and thereby electrically connecting the fixed arcing contact, and, when moving the movable main contact into the opened position, initially on and thereby electrically connecting the power diode until the spring has retracted the movable sliding contact away from the power diode. As long as the movable arcing contact electrically contacts the fixed arcing contact, current does not flow via the power diode. However, once the movable arcing contact slides over and thereby contacts the power diode, current flows over the power diode such that current clipping by the diode starts.

[0018] According to a preferred implementation the power diode comprises a conductive housing arranged in axial extension of and axially flush with the fixed arcing contact, and the housing is electrically connected to a cathode of the power diode. Thus, in case the fixed arcing contact comprises a tube-like shape having a rounded radial diameter, the housing may comprise a rounded diameter as well, in particular having the same diameter as the fixed arcing contact.

[0019] In another preferred implementation the power diode is arranged between the fixed first main contact and the fixed arcing contact, and comprising a bypass conductor arranged, via an intermediate insulation material, on a radial surface of the fixed arcing contact up to a second opposite end of fixed arcing contact, and in particular on a radial surface of the power diode, and electrically connected to the fixed first main contact. The insulation material may be provided as a coating or any of her insulating material known from prior art. Preferably, the insulating material is arranged circumferentially across the complete axial extension of the fixed arcing contact and/or of the power diode. The bypass conductor may comprise a metal foil or any other thin conducting material arranged on and thereby radially encompassing the fixed arcing contact and/or the power diode.

[0020] According to a preferred implementation the high voltage disconnecter comprises an overvoltage protection device electrically connected between the power diode and the bypass conductor. The overvoltage protection device can be provided as an arrester or any other overvoltage protection device known from prior art. The overvoltage protection device is preferably connected to the cathode of the diode. The overvoltage protection device can be arranged instead of the insulating material respectively can be axially encompassed between the power diode and the fixed arcing contact.

[0021] In another preferred implementation the second end of fixed arcing contact comprises a head having a bigger radial diameter than the bypass conductor. The head may comprise a diameter only slightly bigger than the fixed arcing contact such that the movable arcing contact can slip over the head when being retracted. The head is preferably provided free of insulating material.

[0022] According to a preferred implementation the fixed arcing contact comprises an axially extending ov-

ervoltage spark gap arranged between the bypass conductor and the second end of fixed arcing contact, in particular the head. Such gap may axially extend 1, 2, 5 or 10 mm and allows, similar or in addition to the overvoltage protection device, to limit transient overvoltages during operation.

[0023] In another preferred implementation the fixed arcing contact is provided rod-like, the movable main contact is provided tube-like and/or the movable arcing contact comprises at least one radially inward extending tip configured for establishing the electrical connection. The movable arcing contact is preferably provided as tulip contact comprising the tip.

[0024] According to a preferred implementation the first contact element, the second contact element and/or the third contact element is provided as spiral contact, lamellar contact or as a finger contact. Preferably a plurality of respective contact elements are provided, circumferentially arranged.

Brief description of drawings

[0025] These and other aspects of the invention will be apparent from and elucidated with reference to the implementations described hereinafter.

[0026] In the drawings:

Fig. 1a to 1c show a high voltage disconnecter switch in different switching positions according to a preferred implementation,

Fig. 2a to 1c show a high voltage disconnecter switch in different switching positions according to another preferred implementation, and

Fig. 3a to 3g show a high voltage disconnecter switch in different switching positions according to an even another preferred.

Description of implementations

[0027] Figs. 1a to 1c show a high voltage disconnecter switch in different switching positions according to a preferred implementation.

[0028] The high voltage disconnecter switch comprises a fixed first main contact 1, a fixed second main contact 2 and a movable main contact 3, whereby the movable main contact 3 is arranged movably in respect to the unmovably arranged fixed first main contact 1 and fixed second main contact 2 between an open position and a closed position. The fixed first main contact 1 comprises a hollow cylinder-like shape, being closed at one axial end, on the left side in Fig. 1.

[0029] The fixed second main contact 2 also comprises a hollow cylinder-like shape having the same radial diameter as the fixed first main contact 1 and is arranged in axial extension of the fixed first main contact 1. Such wise a hollow cylinder-like 'air gap' is formed between

the fixed first main contact 1 and the fixed second main contact 2. The movable main contact 3 is arranged, both in the open position and in the closed position, within the fixed second main contact 2, and in closed position additionally within the fixed first main contact 1, thereby configured for moving in parallel to the axial extension of the fixed first main contact 1 and the fixed second main contact 2.

[0030] Both the fixed first main contact 1 and the fixed second main contact 2 comprise each at least two radially inwards oriented first contact elements 4a and second contact elements 4b for establishing an electrical connection with the movable main contact 3. The first contact elements 4a and the second contact elements 4b are provided as spiral contact, lamellar contact or as finger contact. As can be seen in the Figs., the fixed first main contact 1 comprises two first contact elements 4a arranged opposite respectively facing each other and the fixed second main contact 2 also comprises two second contact elements 4b arranged opposite respectively facing each other. While not shown, the first contact elements 4a, second contact elements 4b and third contact elements 4c described below can be provided as spiral contacts in form of a ring circumferentially the movable main contact 3 respectively the movable arcing contact 6 described below. Alternatively, the respective contact elements can be provided as finger contacts. In the closed position as shown in Fig. 1a, both the first contact elements 4a and the second contact elements 4b electrically connect the movable main contact 3 such that an electrical connection respectively current flow 13 is established between fixed first main contact 1 and the fixed second main contact 2.

[0031] Fig. 1b shows the partly opened position. Compared to Fig. 1a the movable main contact 3 is moved away from the fixed first main contact 1 such that the first contact elements 4a do not connect the movable main contact 3 anymore, does leading to a different current flow 13 as in Fig. 1a. Further describing the high voltage disconnecter switch, the movable main contact 3 comprising an axially extending opening 14, which axially extends completely through the movable main contact 3.

[0032] A movable arcing contact 6 is movably arranged within the opening 14. The movable main contact 3 comprises two opposite arranged third contact elements 4c, which electrically connect to the movable arcing contact 6. The third contact elements 4c are provided as spiral contact, lamellar contact or as finger contact and are arranged radially between the movable main contact 3 and the movable arcing contact 6.

[0033] The high voltage disconnecter switch further comprises a rod-like axially extending fixed arcing contact 5 being connected with a first end to the fixed first main contact 1 via a power diode 7. Thereby the fixed arcing contact 5 is arranged within and attached to the tube-like fixed first main contact 1 for being encompassed on a second opposite end by the opening 14 of the movable main contact 3 at least in the closed position, as can

be seen in Fig. 1a.

[0034] The power diode 7 is arranged in axial extension of the fixed arcing contact 5 between the fixed arcing contact 5 and the axial end of the fixed first main contact 1, whereby an anode of the power diode 7 is connected to the fixed first main contact 1. In the switching positions shown in Figs. 1a and 1b the fixed arcing contact 5 axially touches and thus electrically connects with the movable arcing contact 6.

[0035] Fig. 1b shows an intermediate position of the movable main contact 3 moving away from the fixed first main contact 1 and having lost the electrical connection with the first contact elements 4a. Thus, as can be seen, the power diode 8 is in the current path 13 such that the power diode 8 is clipping on one half wave of the current 13. Specifically, current flows from the fixed first main contact 1 via the power diode 8, the fixed arcing contact 5 connected to the movable arcing contact 6, the third contact elements 4c, the movable main contact 3, the second contact elements 4b and the second first main contact 2.

[0036] Fig. 1c shows the movable main contact 3 moved even further away and out of the fixed first main contact 1 towards the opened position with an arc burning between the fixed arcing contact 5 and the movable arcing contact 6 not electrically connected anymore. The power diode 7 is still in the current path 13 and is clipping one half wave of the current. At one of the first current zeros with blocked current afterwards, the gap will recover and current flow 13 is stopped completely between the fixed first main contact 1 and the fixed second main contact 2. After arc extinguishing fixed first main contact 1 and the fixed second main contact 2 move into fully opened position, not shown in Fig. 1.

[0037] The high voltage disconnecter switch further comprises a spring 8, which is arranged within the opening 14 of the movable main contact 3. The spring 8 comprises a spring load configured for pushing, in the closed position, the movable arcing contact 6 onto and thereby electrically contacting the fixed arcing contact 5. Thereby a first end of the spring 8 is connected to the movable arcing contact 6 and an opposite second end is connected to the movable main contact 3. Axial movement of the movable arcing contact 6 in direction of the fixed first main contact 1 is limited by an axial end of the movable main contact 3 oriented away from the spring 8 respectively towards the fixed first main contact 1, for example by means of a radial extending edge or a rim at the axial end.

[0038] Fig. 2 shows the high voltage disconnecter switch in different switching positions according to another preferred implementation, which differs compared to the implementation shown in Fig. 1 in two aspects. First, the arcing contact system comprising the movable arcing contact 6 and the fixed arcing contact 5 is of a snapping type thanks to the spring 8, which increases switching performance. Second, the power diode 7 is arranged between the fixed arcing contact 5 and the mov-

able arcing contact 6.

[0039] Specifically, in respect to the first difference, the movable arcing contact 6 is provided as a tulip contact opened in axial direction away from the spring 8 respectively towards the fixed arcing contact 5 for at least partially encompassing the fixed arcing contact 5 at least in the closed position. Tips of the tulip contact slide on and thereby electrically connect the fixed arcing contact 5 in the closed position, as shown in Fig. 2a. Said tips radially extend towards the axis respectively towards the fixed arcing contact 5.

[0040] In respect to the second difference the power diode 7 is arranged between the fixed arcing contact 5 and the movable arcing contact 6. This means that the fixed arcing contact 5 is electrically conductive attached with one end to the fixed first main contact 1 extending axially away therefrom, and that the power diode 7 is attached on another opposite end of the fixed arcing contact 5 in axial extension thereof. Specifically, the power diode 7 comprises a conductive housing arranged in axial extension of and axially flush with the fixed arcing contact 5. Such way the housing and the fixed arcing contact 5 are provided one-piece.

[0041] The housing is electrically connected to a cathode of the power diode 7, while the anode of the power diode 7 is electrically connected to the other end of the fixed arcing contact 5. As the movable arcing contact 6 comprises a tubular shape, the movable arcing contact 6 in the closed position encompasses both at least a part of the fixed arcing contact 5 and the power diode 7 respectively the housing of the power diode.

[0042] When retracting the movable main contact 3 away from the fixed first main contact 1, as shown in Fig. 2b where the movable main contact 3 has lost the electrical connection with the first contact elements 4a, the tips of the tulip contact of the movable arcing contact 6 initially still slide on the fixed arcing contact 5, until the tips slide on the housing of the power diode 7, as shown in Fig. 2c.

[0043] Such way the current is only clipped by the power diode 7 before the movable main contact 3 and the fixed first main contact 1 i.e. the main contacts 1, 3 are or come into contact, both for opening and closing. Thereby it is prevented that the main contact touch or separation will take place during a clipped current half wave. If during a clipped current half wave the main contacts close or open, the main contacts 1, 3 would bridge the power diode 5 and the full bus transfer current would flow during first touch or separation of the main contacts 1, 3, resulting in arcing and contact erosion on the main contacts 1, 3, which could lead to failure of main contacts 1, 3, if not made from arc resistance material.

[0044] Fig. 3 shows the high voltage disconnecter switch in different switching positions according to another preferred implementation, which differs compared to the implementation shown in Fig. 2 in three aspects. First, as in the implementation shown in Fig. 1, the power diode 7 is arranged between the fixed first main contact

1 and the fixed arcing contact 5, as shown in Fig. 3a showing a partly opened position. Second, a bypass conductor 11 is arranged, via an intermediate insulation material 9, circumferentially both on a radial surface of the fixed arcing contact 5 up to a second opposite end of fixed arcing contact 5 and on a radial surface of the power diode 7.

[0045] The bypass conductor 11 is electrically connected to the fixed first main contact 1, radially covering the fixed arcing contact 5 and the power diode 7. Such way the tips of the tulip contact of the movable arcing contact 6 slide on the bypass conductor 11 in the closed position as shown in Fig. 3b. In the opened position, shown in Fig. 3c, where the main contacts 1, 3 are open, the current flow 13 goes via the bypass conductor 11 to prevent the power diode 7 to become active.

[0046] When further retracting the movable main contact 3 away from the fixed first main contact 1, as shown in Fig. 3d, the spring 8 begins to charge as the tip of the tulip contact becomes latched at a head of the fixed arcing contact 5 arranged at the second end, which comprises a bigger radial diameter than the bypass conductor 11. Current flow 13 goes still over the bypass conductor 11 such that the power diode 7 is inactive. When even further retracting the movable main contact 3 away from the fixed first main contact 1, as shown in Fig. 3e, the tip of the tulip contact slips over the head of the fixed arcing contact 5. In parallel, the movable main contact 3, due to the loaded spring 8, begins to accelerate for moving the movable main contact 3 further away from the fixed first main contact 1. The power diode 7 becomes activated and current is clipped.

[0047] In Fig. 3f the movable main contact 3 is separated from the fixed arcing contact 5 and retracts even faster away while an arc 16 is burning. Current flow 13 still goes over the power diode 7. The current flow 13 is then clipped by the power diode 7 and arcing stops so that the movable main contact 3 moves in fully open position. Fig. 3g shows that transient overvoltages during operation are limited by an axially extending overvoltage spark gap 12 or an overvoltage protection device 10. The overvoltage spark gap 12 is arranged between the bypass conductor 11 and the second end of fixed arcing contact 5 i.e. before the head, such wise leaving an axial surface of the fixed arcing contact 5 without the bypass conductor 11. The overvoltage protection device 10 is electrically connected between the power diode 7 and the bypass conductor 11.

[0048] The dashed lines 15 in Fig. 3g show the possible transfer pass of the transient wave. As bus transfer is mainly inductive as current magnetic energy is stored in a loop and during current interruption said energy is transformed in an overvoltage spike. To protect the power diode 7 from such overvoltages the overvoltage protection device 12 can be placed in parallel to the power diode 7. Such overvoltage protection can be achieved by, for example, an arrester or said gas discharge gap

[0049] While the invention has been illustrated and de-

scribed in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed implementations. Other variations to be disclosed implementations can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting scope.

Reference signs list

[0050]

- 1 fixed first main contact
- 2 fixed second main contact
- 3 movable main contact
- 4a first contact element
- 4b second contact element
- 4c third contact element
- 5 fixed arcing contact
- 6 movable arcing contact
- 7 power diode
- 8 spring
- 9 insulation material
- 10 overvoltage protection device
- 11 bypass conductor
- 12 overvoltage spark gap
- 13 current flow
- 14 opening
- 15 dashed line
- 16 arc

Claims

1. High voltage disconnecter switch comprising

a fixed first main contact (1) comprising at least one first contact element (4a), a fixed second main contact (2) comprising at least one second contact element (4b) and arranged in axial extension of the fixed first main contact (1), a movable main contact (3) comprising an axially extending opening, arranged movably between an open position and a closed position and axially in parallel to the fixed first main contact (1) and the second main contact (2), whereby the movable main contact (3) is electrically connected in both positions via the at least one second contact element (4b) with the fixed second main contact (2) and only in the closed position via

the at least one first contact element (4a) with the fixed first main contact (1), a fixed arcing contact (5) connected with a first end to the fixed first main contact (1), extending axially parallel to the movable main contact (3) and arranged for being encompassed on a second opposite end by the opening of the movable main contact (3), a movable arcing contact (6) movably arranged within the opening of the movable main contact (3), electrically connected via at least one third contact element (4c) to the movable main contact (3) and comprising a spring (8) arranged within the opening of the movable main contact (3) and configured for pushing, in the closed position, the movable arcing contact (6) onto and thereby electrically contacting the fixed arcing contact (5), and a power diode (7) arranged between the fixed first main contact (1) and the fixed arcing contact (5) and/or between the fixed arcing contact (5) and the movable arcing contact (6).

2. High voltage disconnecter switch according to the previous claim, whereby an anode of the power diode (7) is connected to the fixed first main contact (1) and/or to the fixed arcing contact (5).

3. High voltage disconnecter switch according to any of the previous claims, whereby a first end of the spring (8) is connected to the movable arcing contact (6) and an opposite second end is connected to the movable main contact (3).

4. High voltage disconnecter switch according to any of the previous claims, whereby movement of the movable arcing contact (6) is limited by an axial end of the movable main contact (3) oriented away from the spring (8).

5. High voltage disconnecter switch according to any of the previous two claims, whereby the movable arcing contact (6) comprises a sliding contact, in particular a tulip contact and/or a snapping contact, oriented away from the spring (8) and configured for sliding on and thereby electrically connecting at least the fixed arcing contact (5).

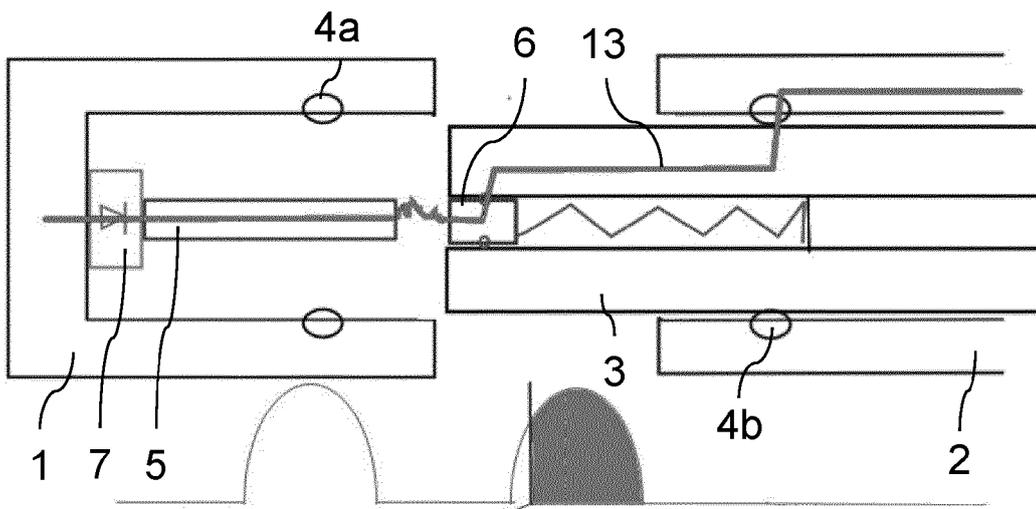
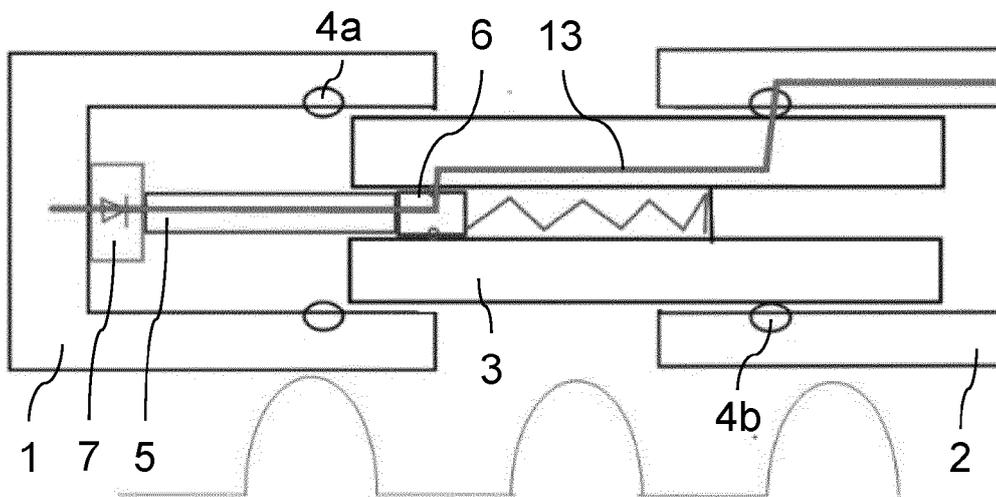
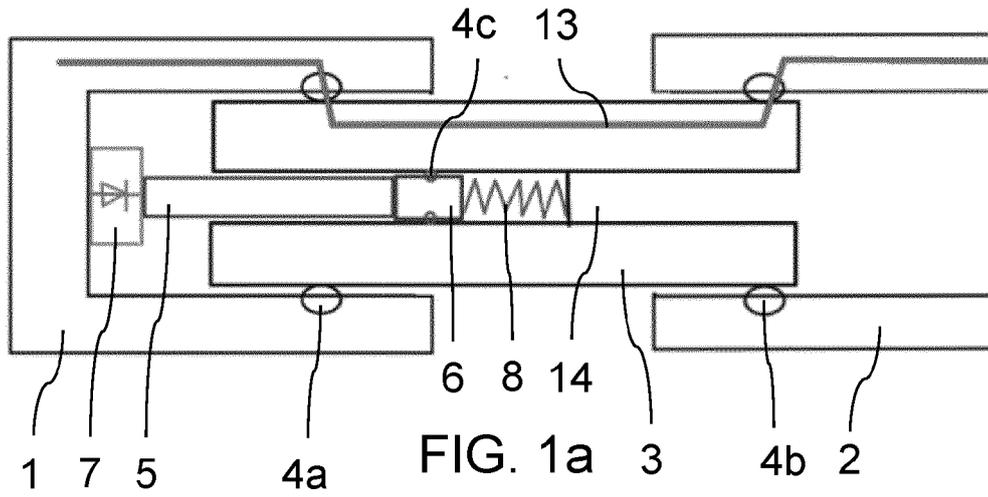
6. High voltage disconnecter switch according to the previous claim, whereby the movable arcing contact (6) comprises a tubular shape configured for encompassing the fixed arcing contact (5) and, if the power diode (7) is arranged between the fixed arcing contact (5) and the movable arcing contact (6), the power diode (7).

7. High voltage disconnecter switch according to any of the previous two claims, whereby the power diode

(7) is arranged between the fixed arcing contact (5) and the movable arcing contact (6) in axial extension of the fixed arcing contact (5) oriented towards the fixed second main contact (2) and the sliding contact is configured for sliding, in the closed position, on and thereby electrically connecting the fixed arcing contact (5), and, when moving the movable main contact (3) into the opened position, initially on and thereby electrically connecting the power diode (7) until the spring (8) has retracted the movable sliding contact away from the power diode (7).

8. High voltage disconnecter switch according to the previous claim, whereby the power diode (7) comprises a conductive housing arranged in axial extension of and axially flush with the fixed arcing contact (5), and the housing is electrically connected to a cathode of the power diode (7).
9. High voltage disconnecter switch according to any of the previous first six claims, whereby the power diode (7) is arranged between the fixed first main contact (1) and the fixed arcing contact (5), and comprising a bypass conductor (11) arranged, via an intermediate insulation material (9), on a radial surface of the fixed arcing contact (5) up to a second opposite end of fixed arcing contact (5), and in particular on a radial surface of the power diode (7), and electrically connected to the fixed first main contact (1).
10. High voltage disconnecter switch according to the previous claim, comprising an overvoltage protection device (10) electrically connected between the power diode (7) and the bypass conductor (11).
11. High voltage disconnecter switch according to any of the previous two claims, whereby the second end of fixed arcing contact (5) comprises a head having a bigger radial diameter than the bypass conductor (11).
12. High voltage disconnecter switch according to any of the previous three claims, whereby the fixed arcing contact (5) comprises an axially extending overvoltage spark gap (12) arranged between the bypass conductor (11) and the second end of fixed arcing contact (5).
13. High voltage disconnecter switch according to any of the previous claims, whereby the fixed arcing contact (5) is provided rod-like, the movable main contact (3) is provided tube-like and/or the movable arcing contact (6) comprises at least one radially inward extending tip configured for establishing the electrical connection.
14. High voltage disconnecter switch according to any of the previous claims, whereby the first contact el-

ement (4a), the second contact element (4b) and/or the third contact element (4c) is provided as spiral contact, lamellar contact or as a finger contact.



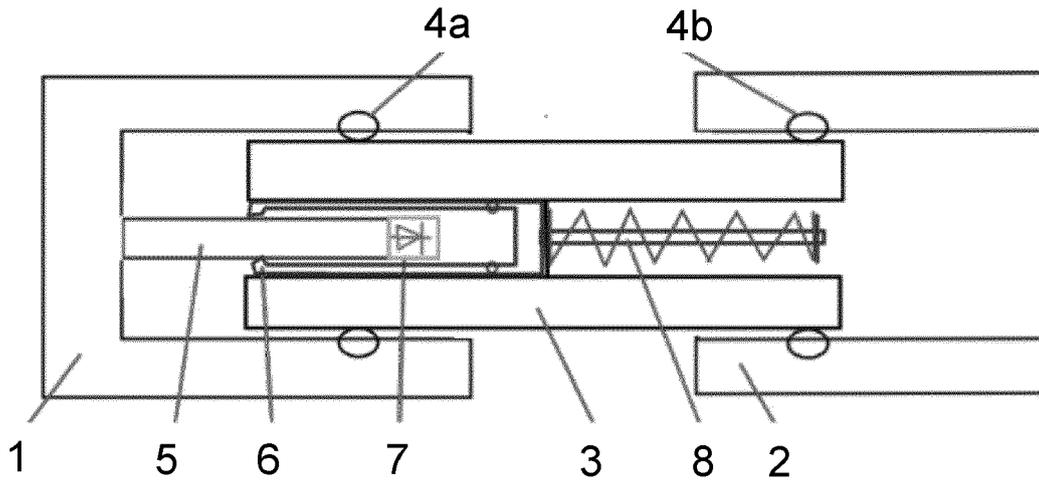


FIG. 2a

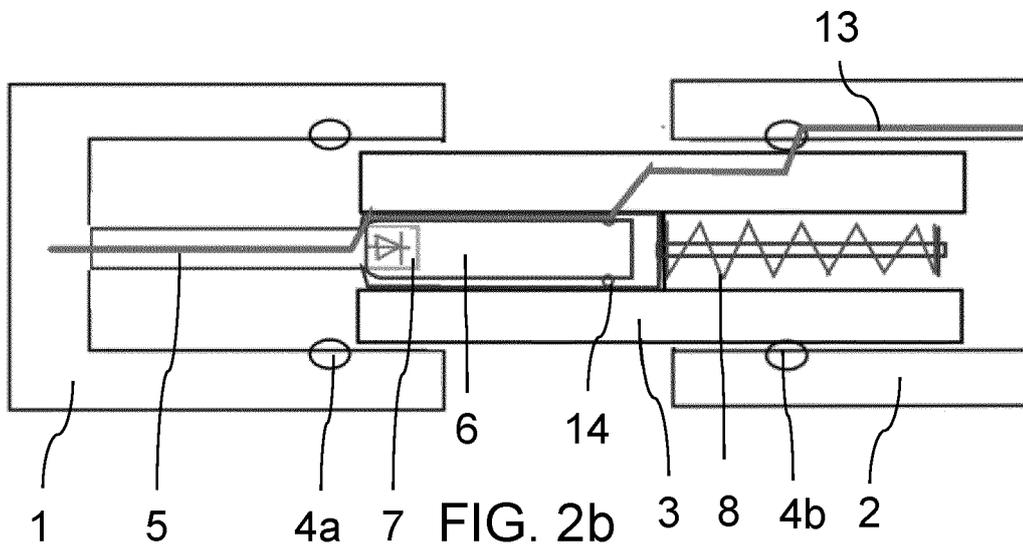


FIG. 2b

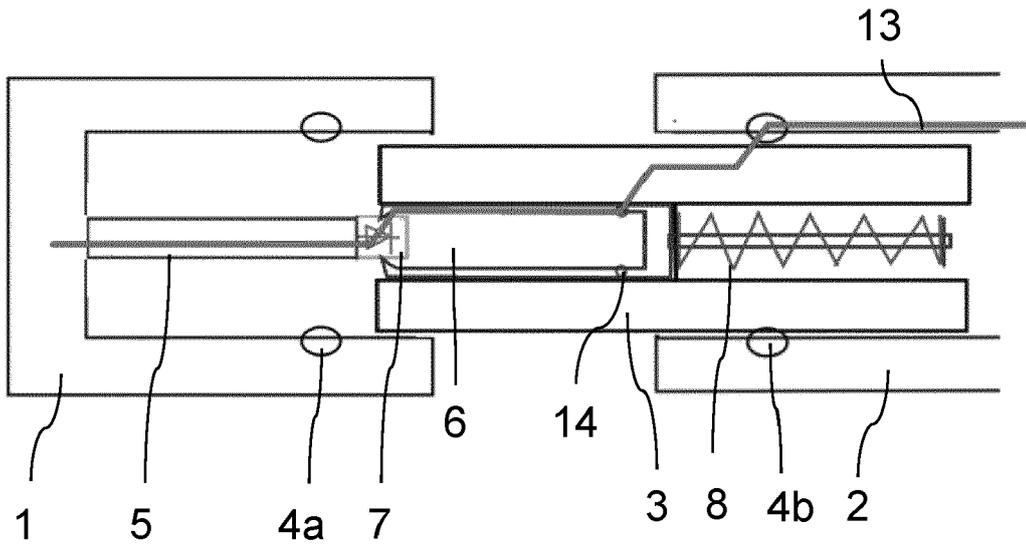


FIG. 2c

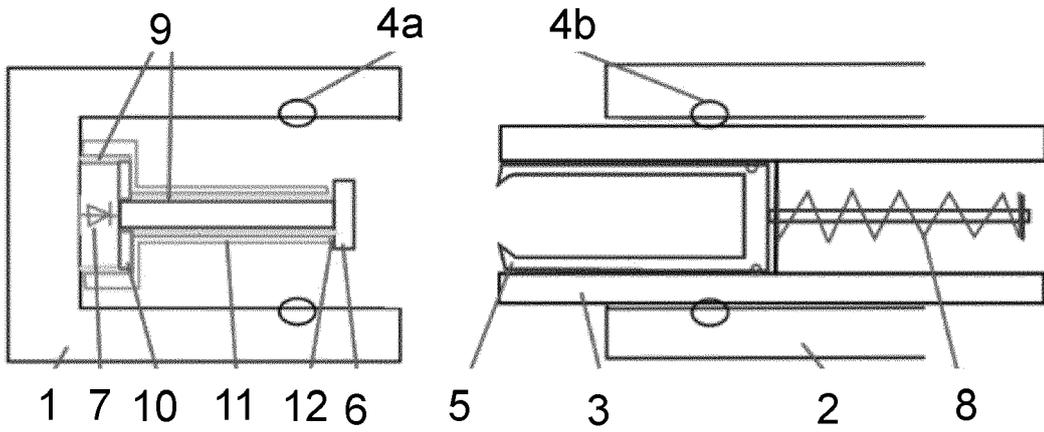


FIG. 3a

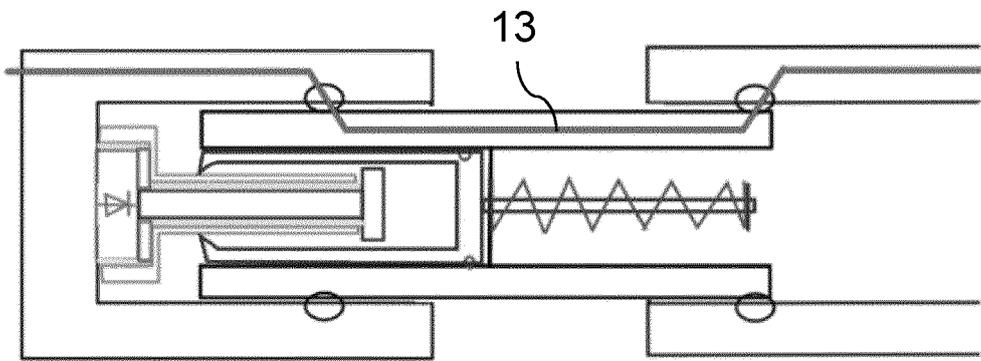


FIG. 3b

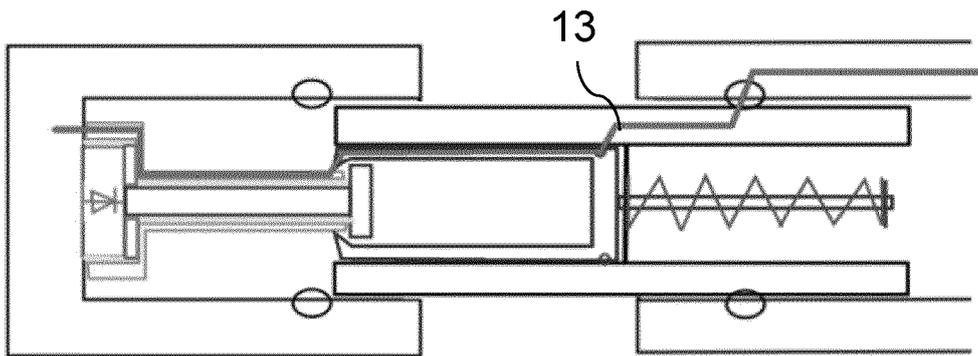


FIG. 3c

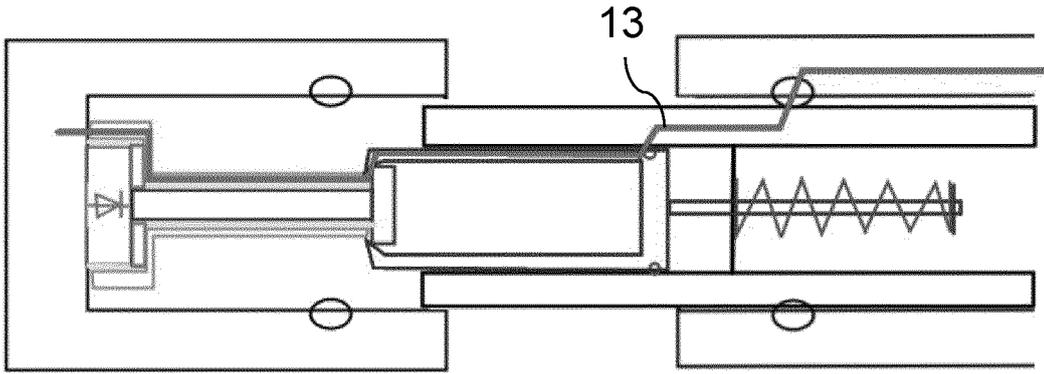


FIG. 3d

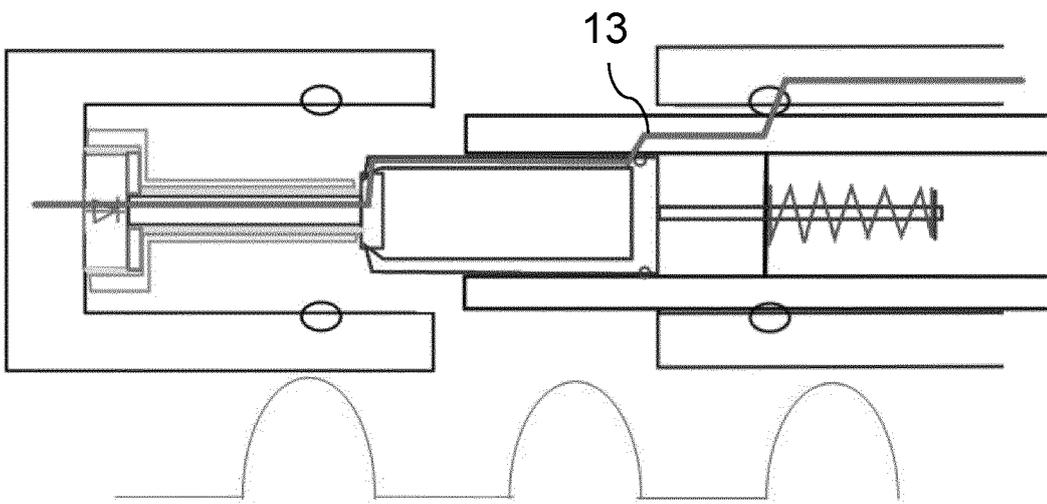


FIG. 3e

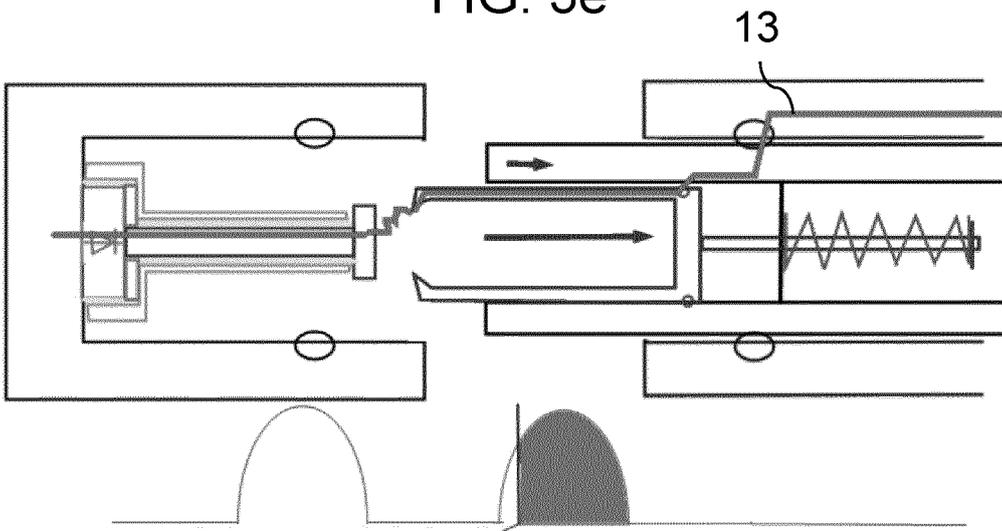


FIG. 3f

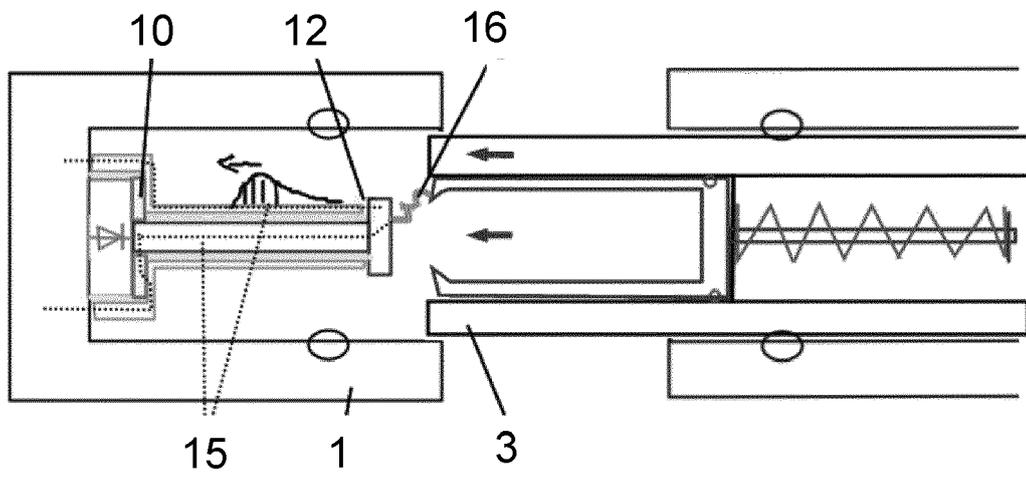


FIG. 3g



EUROPEAN SEARCH REPORT

Application Number

EP 22 15 5883

5

DOCUMENTS CONSIDERED TO BE RELEVANT

10

15

20

25

30

35

40

45

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2019/198272 A1 (PETERS HAUKE [DE] ET AL) 27 June 2019 (2019-06-27)	1-3, 5, 6, 13, 14	INV. H01H33/12
A	* paragraphs [0015] - [0025], [0034] - [0053]; figures 1-3 *	7-12	H01H9/54
Y	EP 2 523 203 A1 (ABB TECHNOLOGY AG [CH]) 14 November 2012 (2012-11-14)	1-6, 13, 14	
Y	DE 12 43 759 B (BBC BROWN BOVERI & CIE) 6 July 1967 (1967-07-06)	1-6, 13, 14	
Y	EP 3 624 160 A1 (ABB SCHWEIZ AG [CH]) 18 March 2020 (2020-03-18)	1-6, 13, 14	
Y	DE 12 66 855 B (SPINDLER DEISSLER STARKSTROM) 25 April 1968 (1968-04-25)	1-6, 13, 14	TECHNICAL FIELDS SEARCHED (IPC) H01H
Y	JP 2011 142035 A (TOSHIBA CORP; TOSHIBA HENDEN KIKI TECHNOLOGY KK) 21 July 2011 (2011-07-21)	1-5, 14	
Y	EP 2 728 602 A1 (ABB TECHNOLOGY AG [CH]) 7 May 2014 (2014-05-07)	1-5, 14	

The present search report has been drawn up for all claims

1

50

55

EPO FORM 1503 03:82 (P04C01)

Place of search The Hague	Date of completion of the search 30 June 2022	Examiner Thibaut, Arthur
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 22 15 5883

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

30-06-2022

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2019198272 A1	27-06-2019	CN 109643619 A	16-04-2019
		EP 3504726 A1	03-07-2019
		HU E052765 T2	28-05-2021
		KR 20190039308 A	10-04-2019
		US 2019198272 A1	27-06-2019
		WO 2018036904 A1	01-03-2018

EP 2523203 A1	14-11-2012	BR 102012010975 A2	19-04-2016
		CN 102779666 A	14-11-2012
		EP 2523203 A1	14-11-2012
		ES 2739471 T3	31-01-2020
		PL 2523203 T3	31-10-2019
		US 2012285806 A1	15-11-2012
		US 2016042886 A1	11-02-2016

DE 1243759 B	06-07-1967	CH 444938 A	15-10-1967
		DE 1243759 B	06-07-1967

EP 3624160 A1	18-03-2020	CN 110890241 A	17-03-2020
		EP 3624160 A1	18-03-2020
		US 2020083000 A1	12-03-2020

DE 1266855 B	25-04-1968	NONE	

JP 2011142035 A	21-07-2011	NONE	

EP 2728602 A1	07-05-2014	NONE	
