

Description

[0001] The present invention relates to a switching apparatus for medium voltage electric systems, more particularly to a load-break switch for medium voltage electric systems.

[0002] Load-break switches are well known in the state of the art.

[0003] These switching apparatuses, which are generally used in secondary distribution electric grids, are capable of providing circuit-breaking functionalities (namely breaking and making a current) under specified circuit conditions (typically nominal or overload conditions) as well as providing circuit-disconnecting functionalities (namely grounding a load-side section of an electric circuit).

[0004] Most traditional load-break switches of the state of the art have their electric poles immersed in a sulphur hexafluoride (SF₆) atmosphere as this insulating gas ensures excellent performances in terms of dielectric insulation between live parts and arc-quenching capabilities when currents are interrupted.

[0005] As is known, however, SF₆ is a powerful greenhouse gas and its usage is subject to severe restriction measurements for environmental preservation purposes. For this reason, over the years, there has been made a considerable effort to develop and design load-break switches not employing SF₆ as an insulating gas.

[0006] Some load-break switches have been developed, in which electric poles are immersed in pressurized dry air or other environment-friendly insulation gases, such as mixtures of oxygen, nitrogen, carbon dioxide and/or fluorinated gases. Unfortunately, the experience has shown that these switching apparatuses generally do not show fully satisfactory performances, particularly in terms of arc-quenching capabilities.

[0007] Other currently available load-break switches employ, for each electric pole, different contact arrangements electrically connected in parallel between the pole terminals.

[0008] A contact arrangement has electric contacts operating in an atmosphere filled with an environment-friendly insulating gas or air and it is designed for carrying most of the current flowing along the electric pole as well as driving possible switching manoeuvres.

[0009] Another contact arrangement, instead, has electric contacts operating in a vacuum atmosphere and it is specifically designed for quenching the electric arcs arising when the current flowing along the electric pole is interrupted.

[0010] These last switching apparatuses have proven to ensure a relatively low environmental impact while providing, at the same time, high-level performances in terms of dielectric insulation and arc-quenching capabilities. However, until now, they adopt complicated solutions to manage and coordinate the operation of the above-mentioned multiple contact arrangements. Therefore, they still offer poor performances in terms of struc-

tural compactness and reliability in operation. The main aim of the present invention is to provide a switching apparatus for MV electric systems that allows solving or mitigating the above-mentioned technical problems.

[0011] More particularly, it is an object of the present invention to provide a switching apparatus ensuring high-level performances in terms of dielectric insulation and arc-quenching capabilities during the current breaking process.

[0012] Another object of the present invention is to provide a switching apparatus showing high levels of reliability in operation.

[0013] Another object of the present invention is to provide a switching apparatus having electric poles with high compactness and structural simplicity.

[0014] Another object of the present invention is to provide a switching apparatus that can be easily manufactured at industrial level, at competitive costs with respect to the solutions of the state of the art.

[0015] In order to fulfill these aim and objects, the present invention provides a switching apparatus, according to the following claim 1 and the related dependent claims.

[0016] In a general definition, the switching apparatus of the invention comprises one or more electric poles.

[0017] For each electric pole, the switching apparatus comprises a first pole terminal, a second pole terminal and a ground terminal. In operation, the first pole terminal can be electrically coupled to a first conductor of an electric line, the second pole terminal can be electrically coupled to a second conductor of said electric line and the ground terminal can be electrically coupled to a grounding conductor.

[0018] For each electric pole, the switching apparatus comprises a plurality of fixed contacts spaced apart one from another. Such a plurality of fixed contacts comprises a first fixed contact electrically connected to the first pole terminal, a second fixed contact electrically connected to the second pole terminal, a third fixed contact electrically connected to the ground terminal and a fourth fixed contact, which, in operation, can be connected electrically to the second fixed contact.

[0019] For each electric pole, the switching apparatus further comprises a movable contact, which is reversibly movable about a corresponding rotation axis according to opposite first and second rotation directions, so that said movable contact can be mechanically and electrically coupled to or uncoupled from one or more of the above-mentioned fixed contacts.

[0020] For each electric pole, the switching apparatus further comprises a vacuum interrupter, which comprises a fixed arc contact electrically connected to the fourth fixed contact, a movable arc contact electrically connected to the first fixed contact and reversibly movable along a corresponding translation axis between a coupled position with the fixed arc contact and an uncoupled position from the fixed arc contact. The vacuum interrupter additionally comprises a vacuum chamber, in which the fixed

arc contact and the movable arc contact are enclosed and can couple or decouple.

[0021] For each electric pole, the switching apparatus further comprises a motion transmission mechanism mechanically coupled to the movable arc contact. Such a motion transmission mechanism is actuatable by said movable contact, when said movable contact moves about said rotation axis, in order to cause a movement of said movable arc contact along said translation axis.

[0022] According to the invention, said motion transmission mechanism comprises at least a lever member and at least a spring member. Each lever member is pivoted on a fixed support at a first hinge axis and on said movable arc contact at a second hinge axis. Each spring member is pivoted on a fixed support at a third hinge axis and on a corresponding lever member at a fourth hinge axis.

[0023] According to the invention, each lever member of said motion transmission mechanism comprises first and second lever arms spaced apart one from another and extending towards said movable contact. Said first and second lever arms are configured so that they are alternatively actuatable by said movable contact at different points of the motion trajectory of said movable contact.

[0024] Conveniently, the first and second lever arms of each lever member extend towards said movable contact along different directions in such a way to intersect the motion trajectory of said movable contact at different points of said motion trajectory, depending on the configuration taken by said motion transmission mechanism.

[0025] Preferably, the first lever arm of each lever member is actuated by said movable contact when said movable contact moves according to said first rotation direction while the second lever arm of each lever member is actuated by said movable contact when said movable contact moves according to said second rotation direction.

[0026] More particularly, the first lever arm of each lever member is actuated by said movable contact at a first point of the motion trajectory of said movable contact, when said movable contact moves according to said first rotation direction and it electrically connects the fourth fixed contact to the second fixed contact, while the second lever arm of each lever member is actuated by said movable contact at a second point of the motion trajectory of said movable contact, when said movable contact moves according to said second rotation direction and it electrically connects the first fixed contact to the second fixed contact.

[0027] Preferably, said movable contact comprises, at a first movable contact region, at least a coupling member configured to couple mechanically to the first and second lever arms of said at least a lever member, in such a way to actuate said at least a lever member.

[0028] Preferably, said motion transmission mechanism comprises a pair of lever members arranged in parallel one to another at opposite sides of said vacuum

interrupter and a pair of second lever members arranged in parallel one to another at said opposite sides of said vacuum chamber. Preferably, said motion transmission mechanism is configured to take alternatively a first configuration, at said movable arc contact is in said coupled position, and a second configuration, at which said movable arc contact is in said uncoupled position.

[0029] Preferably, said motion transmission mechanism is configured to maintain stably said first configuration or said second configuration, if the lever arms of each lever member are not actuated by said movable contact.

[0030] Preferably, said motion transmission mechanism is configured to change configuration, if a lever arm of each lever member is actuated by said movable contact.

[0031] More particularly, said motion transmission mechanism is configured to switch from said first configuration to said second configuration upon an actuation of the first lever arm of each lever member by said movable contact and is configured to switch from said second configuration to said first configuration upon an actuation of the second lever arm of each lever member by said movable contact.

[0032] A transition of said motion transmission mechanism from said first configuration to said second configuration causes a movement of said movable arc contact from said coupled position to said uncoupled position while a transition of said motion transmission mechanism from said second configuration to said first configuration causes a movement of said movable arc contact from said uncoupled position to said coupled position.

[0033] According to an aspect of the invention, each movable contact region of said movable contact comprises at least a contact blade, more preferably a pair of parallel contact blades.

[0034] Further characteristics and advantages of the invention will emerge from the description of preferred, but not exclusive embodiments of the switching apparatus, according to the invention, non-limiting examples of which are provided in the attached drawings, wherein:

- Figure 1 shows an outer view of the switching apparatus of the invention;
- Figures 2-13 are schematic views partially showing the structure and operation of an electric pole of the switching apparatus of the invention;
- Figures 14-15 are schematic views showing some structural details of an electric pole of the switching apparatus, according to the invention.

[0035] With reference to the figures, the present invention relates to a switching apparatus 1 for medium voltage electric systems.

[0036] For the purposes of the present invention, the term "medium voltage" (MV) relates to operating voltages at electric power distribution level, which are higher than 1 kV AC and 1.5 kV DC up to some tens of kV, e.g. up to 72 kV AC and 100 kV DC.

[0037] For the purposes of the present invention, the terms "terminal" and "contact" should be hereinafter intended, unless otherwise specified, as "electric terminal" and "electric contact", respectively, thereby referring to electrical components suitably arranged to be electrically connected or coupled to other electrical conductors.

[0038] The switching apparatus 1 is particularly adapted to operate as a load-break switch. It is therefore designed for providing circuit-breaking functionalities under specified circuit conditions (nominal or overload conditions) as well as circuit-disconnecting functionalities, in particular grounding a load-side section of an electric circuit.

[0039] In the following, the switching apparatus of the invention will be described with particular reference to this application for the sake of simplicity only and without intending to limit the scope of the invention.

[0040] The switching apparatus 1 comprises one or more electric poles 2.

[0041] Preferably, the switching apparatus 1 is of the multi-phase (e.g. three-phase) type and it comprises a plurality (e.g. three) of electric poles 2.

[0042] According to the embodiments shown in the cited figures, the switching apparatus 1 preferably comprises an insulating housing 4, which conveniently defines an internal volume where the electric poles 2 are accommodated.

[0043] Preferably, the insulating housing 4 has an elongated shape (e.g. substantially cylindrical) developing along a main longitudinal axis. The electric poles 2 are arranged side by side along corresponding transversal planes perpendicular the main longitudinal axis of the switching apparatus.

[0044] Preferably, the insulating housing 4 is formed by an upper shell 41 and a lower shell 42 that are mutually joined along suitable coupling edges.

[0045] For each electric pole, the insulating housing 4 comprises a first bushing 43 protruding from a top region of the upper shell 41 and a second bushing 44 protruding from a bottom region of the second shell 42 (reference is made to a normal operating positioning of the switching apparatus as shown in figure 1).

[0046] In the following, the switching apparatus of the invention will be described with particular reference to these embodiments for the sake of brevity only and without intending to limit the scope of the invention.

[0047] As a matter of fact, according to other embodiments of the invention (not shown), the switching apparatus of the invention may be installed in a cubicle together with other electric devices. In this case, the switching apparatus may not comprise a dedicated housing as shown in the cited figures.

[0048] Preferably, the internal volume of the switching apparatus 1 is filled with pressurized dry air or another insulating gas having a low environmental impact, such as a mixture of oxygen, nitrogen, carbon dioxide and/or a fluorinated gas.

[0049] For each electric pole 2, the switching apparatus

1 comprises a first pole terminal 11, a second pole terminal 12 and a ground terminal 13. The first pole terminal 11 is configured to be electrically coupled to a first conductor of an electric line (e.g. a phase conductor electrically connected to an equivalent electric power source), the second pole terminal 12 is configured to be electrically connected to a second conductor of an electric line (e.g. a phase conductor electrically connected to an equivalent electric load) while the ground terminal 13 is configured to be electrically connected to a grounding conductor.

[0050] According to the embodiments shown in the cited figures, the first pole terminal 11 is at least partially accommodated in the first bushing 43 while the second pole terminal 12 is at least partially accommodated in the second bushing 44.

[0051] Preferably, for each electric pole, the first and second pole terminals 11, 12 are arranged at opposite sides of the switching apparatus.

[0052] For each electric pole 2, the switching apparatus 1 comprises a plurality of fixed contacts, which are spaced apart one from another around the main longitudinal axis of the switching apparatus. In particular, the switching apparatus 1 comprises a first fixed contact 5, a second fixed contact 6, a third fixed contact 7 and a fourth fixed contact 8.

[0053] The first fixed contact 5 is electrically connected to the first pole terminal 11, the second fixed contact 6 is electrically connected to the second pole terminal 12, the third fixed contact 7 is electrically connected to the ground terminal 13 while the fourth fixed contact 8 is electrically connected to a vacuum interrupter of the switching apparatus as better explained in the following.

[0054] The switching apparatus 1 comprises, for each electric pole 2, a movable contact 10 reversibly movable (along a given plane of rotation) about a corresponding rotation axis A1, which is substantially parallel to or coinciding with the main longitudinal axis of the switching apparatus. The movable contact 10 can rotate according to a first rotation direction R1, which is conveniently oriented away from the first fixed contact 5, or according to a second rotation direction R2, which is opposite to the first rotation direction R1 and is oriented towards the first fixed contact 5 (figure 2). With reference to the observation plane of figures 2-13, the above-mentioned first rotation direction R1 is oriented counter-clockwise while the above-mentioned second rotation direction R2 is oriented clockwise.

[0055] In operation, the switching apparatus 1 is capable of switching in three different operating states, namely:

- a closed state, in which each electric pole 2 has the first and second pole terminals 11, 12 electrically connected one to another and electrically disconnected from the ground terminal 13. When the switching apparatus is in a closed state, a current can flow along each electric pole 2 between the corresponding first and second pole terminals 11, 12

(figure 2);

- an open state, in which each electric pole 2 has the first and second pole terminals 11, 12 and the ground terminal 13 electrically disconnected one from another. When the switching apparatus is in an open state, no currents can flow along the electric poles 2 (figure 8);
- a grounded state, in which each electric pole 2 has the first and second pole terminals 11, 12 electrically disconnected one from another and the second pole terminal 12 and the ground terminal 13 electrically connected one to another. When the switching apparatus is in a grounded state, no currents can flow along the electric poles 2. However, the second pole terminal 12 of each electric pole (and therefore the second line conductor connected thereto) is put at a ground voltage (figure 13).

[0056] In principle, the switching apparatus 1 may be of the "single-disconnection" type (not shown) or "double-disconnection" type (as shown in the cited figures) depending on how the current path through each electric pole is interrupted, when the switching apparatus reaches an open state.

[0057] If the switching apparatus is of the "single-disconnection" type, the movable contact 10 is electrically coupled to the second fixed contact 6 and is electrically decoupled from the remaining fixed contacts 5, 7, 8, when the switching apparatus is in an open state. The current path through each electric pole is thus interrupted only at one end of the movable contact ("single-disconnection").

[0058] If the switching apparatus is of the "double-disconnection" type, the movable contact 10 is electrically decoupled from any fixed contact 5, 6, 7, 8, when the switching apparatus is in an open state. The current path through each electric pole is thus interrupted at both ends of the movable contact ("double-disconnection").

[0059] In the following, the switching apparatus of the invention will be described with particular reference to the above-mentioned "double-disconnection" configuration, for the sake of brevity only and without intending to limit the scope of the invention.

[0060] The switching apparatus 1 is capable of carrying out different type of manoeuvres, each corresponding to a transition among the above-mentioned operating states. In particular, the switching apparatus is capable of carrying out:

- an opening manoeuvre when it switches from a closed state to an open state;
- a closing manoeuvre when it switches from an open state to a closed state;
- a disconnecting manoeuvre when it switches from an open state to a grounded state;
- a reconnecting manoeuvre when it switches from a grounded state to an open state.

[0061] The switching apparatus can switch from a closed state to a grounded state by carrying out an opening manoeuvre and subsequently a disconnecting manoeuvre while the switching apparatus can switch from a grounded state to a closed state by carrying out a reconnecting manoeuvre and subsequently a closing opening manoeuvre.

[0062] In order to carry out the above-mentioned manoeuvres, the movable contact 10 of each electric pole is suitably driven according to the above-mentioned first rotation direction R1 or second rotation direction R2.

[0063] In particular, the movable contact 10 moves according to the first rotation direction R1 during an opening manoeuvre or a disconnecting manoeuvre of the switching apparatus and it moves according to the second rotation direction R2 during a closing manoeuvre or a reconnecting manoeuvre of the switching apparatus.

[0064] In general, the movable contact 10 of each electric pole is reversibly movable between a first end-of-run position P_A , which corresponds to a closed state of the switching apparatus (figure 2), and a second end-of-run position P_C , which corresponds to a grounded state of the switching apparatus (figure 13). Conveniently, the movable contact 10 passes through an intermediate position P_B , which corresponds to an open state of the switching apparatus (figure 8), when it moves between the first and second end-of-run positions P_A , P_C .

[0065] As it is reversibly movable about the rotation axis A1, the movable contact 10 can be mechanically and electrically coupled to or uncoupled from one or more of the fixed contacts 5, 6, 7, 8 thereby being electrically connecting or electrically disconnecting these fixed contacts depending on the on-going manoeuvre.

[0066] When it is in the first end-of-run position P_A (closed state of the switching apparatus), the movable contact 10 is coupled to the first fixed contact 5 and to the second fixed contact 6 and it electrically connects these fixed contacts and, consequently, the first and second pole terminals 11, 12.

[0067] When it is in the second end-of-run position P_C (grounded state of the switching apparatus), the movable contact 10 is coupled to the second fixed contact 6 and to the third fixed contact 7 and it electrically connects these fixed contacts 6, 7 and, consequently, the second and third pole terminals 12, 13.

[0068] In the embodiment shown in the cited figures, when it is in the intermediate position P_B (open state of the switching apparatus), the movable contact 10 is coupled to no fixed contacts ("double-disconnection" type).

[0069] Preferably, in the switching apparatus of the invention, the above-mentioned fixed contacts 5, 6, 7, 8 are formed by corresponding pieces of conductive material, which are suitably shaped according to the needs.

[0070] Preferably, the first fixed contact 5 is formed by a blade-shaped conductive body having a contoured end coupled to the first pole terminal 11 and a blade-shaped free end for coupling to the movable contact 10.

[0071] Preferably, the second fixed contact 6 is formed

by an arc-shaped conductive body extending partially around the rotation axis A1 of the movable contact 10 and having contoured ends and protrusions for coupling to the movable contact 10.

[0072] Preferably, the third fixed contact 7 is formed by a blade-shaped conductive body having a contoured end coupled to the third pole terminal 13 and a blade-shaped free end and a blade-shaped free end for coupling to the movable contact 10.

[0073] Preferably, the fourth contact 8 is formed by a L-shaped conductive body having the shorter leg mechanically and electrically coupled to a vacuum interrupter of the switching apparatus and a longer arc-shaped leg slidably couplable to the movable contact 10.

[0074] In the embodiments shown in the cited figures, the movable contact 10 has a pair of movable contact regions 10A, 10B for coupling with the fixed contacts 5, 6, 7, 8 (figures 2, 8, 13). Said contact regions are located at opposite positions relative to the rotation axis A1 of the movable contact 10 and are preferably aligned one to another along a same direction.

[0075] Preferably, the movable contact 10 and the fixed contacts 5, 6, 7, 8 are arranged so that, in operation:

- the first movable contact region 10A of the movable contact 10 can be coupled mechanically and electrically to or uncoupled from the first contact 5, the fourth fixed contact 8 and the second fixed contact 6, when the movable contact 10 moves between the first and second end-of-run positions P_A , P_C ;
- the second movable contact region 10B of the movable contact 10 can be coupled mechanically and electrically to or uncoupled from the second fixed contact 6 and the third fixed contact 7, when the movable contact 10 moves between the first and second end-of-run positions P_A , P_C .

[0076] Preferably, when it is in the first end-of-run position P_A , the movable contact 10 has the first movable contact region 10A coupled to the first fixed contact 5 and the second movable contact region 10B coupled to the second fixed contact 6. As mentioned above, in this situation, the movable contact 10 electrically connects the first and second fixed contacts 5, 6 and, consequently, the first and second pole terminals 11, 12.

[0077] When it is in the intermediate position P_B , the movable contact 10 has no contact regions coupled to fixed contacts and it is therefore electrically disconnected from these latter.

[0078] Preferably, when it is in the second end-of-run position P_C , the movable contact 10 has the first movable contact region 10A coupled to the second fixed contact 6 and the second movable contact region 10B coupled to the third fixed contact 7. As mentioned above, in this situation, the movable contact 10 electrically connects the second and third fixed contacts 6, 7 and, consequently, the second pole terminal 12 and the ground terminal 13.

[0079] Preferably, when it moves between the first and second end-of-run positions P_A and P_C , the movable contact 10 slidably couples (at the first movable contact region 10A) to the fourth fixed contact 8.

[0080] Preferably, the first fixed contact 5 and the fourth fixed contact 8 are relatively positioned along the motion trajectory of the movable contact 10, so that the movable contact 10 couples to the fourth fixed contact 8 before decoupling from the first fixed contact 5, when said movable contact moves according to the first rotation direction R1, and so that the movable contact 10 couples to the first fixed contact 5 before decoupling from the fourth fixed contact 8, when said movable contact moves according to said second rotation direction R2.

[0081] Advantageously, the movable contact 10 is formed by a shaped piece of conductive material.

[0082] Preferably, the movable contact 10 is formed by an elongated conductive body centred on the rotation axis A1 and having a first contoured end forming the first movable contact region 10A and a second contoured end (opposite to the first end 10A relative to the rotation axis A1) forming the second movable contact region 10B.

[0083] Preferably, each movable contact region 10A, 10B of the movable contact 10 comprises at least a contact blade, more preferably a pair of parallel contact blades.

[0084] Preferably, the switching apparatus 1 comprises an actuation assembly providing suitable actuation forces to actuate the movable contacts 10 of the electric poles.

[0085] Preferably, such an actuation assembly comprises a motion transmission shaft 9 made of electrically insulating material, which can rotate about the rotation axis A1 and it is coupled to the movable contacts 10 of the electric poles 2.

[0086] The motion transmission shaft 9 thus provides rotational mechanical forces to actuate the movable contacts 10 during the manoeuvres of the switching apparatus.

[0087] The above-mentioned actuation assembly preferably comprises an actuator (not shown) coupled to the transmission shaft through a suitable kinematic chain. The actuator may be, for example, a mechanical actuator, an electric motor or an electromagnetic actuator.

[0088] In general, the actuation assembly of the switching apparatus may be realized according to solutions of known type. Therefore, in the following, it will be described only in relation to the aspects of interest of the invention, for the sake of brevity.

[0089] According to the invention, for each electric pole 2, the switching apparatus 1 comprises a vacuum interrupter 20.

[0090] The vacuum interrupter 20 comprises a fixed arc contact 21 electrically connected to the fourth fixed contact 8 (at the shorter leg of the conductive body forming this latter).

[0091] Preferably, the fixed arc contact 21 is formed by an elongated piece of conductive material having one

end coupled to the fourth fixed contact 8 and an opposite free end intended to be coupled to or decoupled from another arc contact.

[0092] The vacuum interrupter 20 comprises a movable arc contact 22 reversibly movable along a corresponding translation axis A, which is preferably aligned with a main longitudinal axis of the vacuum interrupter.

[0093] As it is reversibly movable about the displacement axis A, the movable arc contact 22 can be coupled to or uncoupled from the fixed arc contact 21, thereby being electrically connected to or electrically disconnected from this latter.

[0094] The movable arc contact 22 is electrically connected to the first fixed contact 5. To this aim, the movable arc contact 22 can be slidably coupled to the first fixed contact 5, as shown in the cited figures. As an alternative, the movable arc contact 22 can be electrically connected to the fixed contact 5 through a conductor (e.g. a flexible conductor) or other equivalent connection means.

[0095] Preferably, the movable arc contact 22 is formed by an elongated piece of conductive material having a first free end (e.g. having a forked shape as shown in the cited figures) slidably coupled to the first fixed contact 5 and an opposite second free end intended to be coupled with or decoupled from the fixed contact 21.

[0096] The vacuum interrupter 20 comprises a vacuum chamber 23, in which a vacuum atmosphere is present.

[0097] Conveniently, the fixed arc contact 21 and the movable arc contact 22 are at least partially enclosed in the vacuum chamber 23, so that they have respective contact regions that can be mutually coupled or decoupled inside said vacuum chamber, therefore while being permanently immersed in a vacuum atmosphere.

[0098] Preferably, the vacuum interrupter 20 comprises a fixed support structure 25 made of electrically insulating material to hold the vacuum chamber 23 in its operating position.

[0099] For each electric pole 2, the switching apparatus 1 comprises a motion transmission mechanism 30 operatively coupled to the movable arc contact 22 and actuable by the movable contact 10 to cause a movement of the movable arc contact 22, when such a movable contact moves about its rotation axis A1.

[0100] According to the invention, the motion transmission mechanism 30 comprises one or more lever members 31, each pivoted on a fixed support (preferably the fixed support 25 of the vacuum interrupter) at a first hinge axis H1 and on the movable contact 22 at a second hinge axis H2.

[0101] According to the invention, the motion transmission mechanism 30 comprises one or more spring members 32, each pivoted on a fixed support (preferably the fixed support 25 of the vacuum interrupter) at a third hinge axis H3 and on a corresponding lever member 31 at a fourth hinge axis H4.

[0102] The mechanical connections between the above-illustrated components of the motion transmission mechanism 30 may be realized according to known so-

lutions, e.g. through pins, screws, rivets, and the like.

[0103] Conveniently, the above-mentioned hinge axes H1, H2, H3, H4 of the lever members 31 and spring members 32 are parallel to the rotation axis A1 of the movable contact 10.

[0104] According to the invention, each lever member 31 comprises first and second lever arms 311, 312 spaced apart one to another and extending towards the movable contact 10.

[0105] The first and second lever arms 311, 312 of each lever member 31 are configured so that they are alternatively actuable by the movable contact 10 at different points of the motion trajectory of said movable contact. In practice, the first and second lever arms 311, 312 are configured so that they can alternatively intersect the motion trajectory of the movable contact 10 depending on the configuration taken by the motion transmission mechanism 30.

[0106] Preferably, each lever member 31 has the first and second lever arms 311, 312 configured so that the first lever arm 311 of each lever member 31 is actuated by the movable contact 10, when said movable contact moves according to the first rotation direction R1, and so that the second lever arm 312 of each lever member 31 is actuated by the movable contact 10, when said movable contact moves according to the second rotation direction R2.

[0107] More preferably, each lever member 31 has first and second lever arms 311, 312 configured so that:

- the first lever arm 311 of each lever member 31 is actuated by the movable contact 10, when said movable contact moves according to the first rotation direction R1 and it electrically connects the first fixed contact 5 to the second fixed contact 6, as it is coupled to these fixed contacts; and
- the second lever arm 312 of each lever member 31 is actuated by the movable contact 10, when said movable contact moves according to the second rotation direction R2 and it electrically connects the fourth fixed contact 8 to the second fixed contact 6, as it is coupled to these fixed contacts.

[0108] Preferably, each lever member 31 is made of electrically insulating material.

[0109] As shown in the cited figures, each lever member 31 is preferably formed by a body of electrically insulating material with a reversed-U shaped configuration, in which the first and second lever arms 311, 312 forms the legs of said insulating body.

[0110] Each lever arm 311, 312 has a suitable profile designed to synchronize the actuation of the lever arm 31 (and of the arc movable contact 22) by the movable contact 10 with the movements of the movable contact itself, as explained above.

[0111] Preferably, each spring member 32 is formed by a spring coaxially arranged along a supporting body of electrically insulating material.

[0112] According to preferred embodiments of the invention (shown in the cited figures), the motion transmission mechanism 30 comprises a pair of lever members 31 and a pair of spring members 32 arranged in parallel one to another at opposite sides of the vacuum interrupter 20. Preferably, the motion transmission mechanism 30 advantageously comprises at least a reinforcement member 33 joining the parallel lever arms 312 of the lever members 31 (figure 15).

[0113] Preferably, the movable contact 10 comprises, at the first movable contact region 10A, one or more coupling members 10C configured to couple mechanically, in an alternate manner, with the first and second lever arms 311, 312 of one or more corresponding lever members 31 in such a way to actuate these latter.

[0114] Preferably, each coupling member 10C is formed by a coupling pin protruding perpendicularly from a corresponding contact blade of the first movable contact region 10A. As an example, when the movable contact region 10A has a double blade configuration, the movable contact 10 includes a pair of contact pins 10C, which protrude perpendicularly, along opposite directions, from the contact blades of the movable contact region 10A.

[0115] According to preferred embodiments of the invention, the motion transmission mechanism 30 is configured to take alternatively a first configuration C1 and a second configuration C2.

[0116] The first configuration C1 of the motion transmission mechanism 30 corresponds to a closed condition of the vacuum interrupter 20, in the sense that, when the motion transmission mechanism takes this configuration, the movable arc contact 22 is in a coupled position P3 with the fixed arc contact 21.

[0117] The second configuration C2 of the motion transmission mechanism 30 instead corresponds to an open condition of the vacuum interrupter 20, in the sense that, when the motion transmission mechanism takes this configuration, the movable arc contact 22 is in an uncoupled position P4 from the fixed arc contact 21.

[0118] The motion transmission mechanism 30 is configured to maintain stably the first configuration C1 or the second configuration C2, if the lever arms 311, 312 of each lever member 31 are not actuated by the movable contact 10.

[0119] Instead, the motion transmission mechanism 10 is configured to switch its configuration, upon an actuation of the lever arms 311, 312 of each lever member 31 by the movable contact 10. Any transition of configuration of the motion transmission mechanism 30 causes a corresponding movement of the arc movable contact 10 and a consequent change of condition of the vacuum interrupter 20.

[0120] The motion transmission mechanism 30 is configured to switch from the first configuration C1 to the second configuration C2 upon an actuation of the first lever arm 311 of each lever member 31 by the movable contact 10 at a first point of the motion trajectory of the

movable contact 10, while this latter is moving according to the first rotation direction R1 and it electrically connects the fourth fixed contact 8 to the second fixed contact 6 (as it is coupled to said fixed contacts). The transition of the motion transmission mechanism 30 from the first configuration C1 to the second configuration C2 causes a corresponding movement of the movable arc contact 22 from the coupled position P3 to the uncoupled position P4.

[0121] The motion transmission mechanism 30 is configured to switch from the second configuration C2 to the first configuration C1 upon an actuation by the movable contact 10 at a second point of the motion trajectory of the movable contact 10, while this latter is moving according to the second rotation direction R2 and it electrically connects the first fixed contact 5 to the second fixed contact 6 (since it is coupled to said fixed contacts). The transition of the motion transmission mechanism 30 from the second configuration C2 to the first configuration C1 causes a corresponding movement of the movable arc contact 22 from the uncoupled position P4 to the coupled position P3.

[0122] The mechanical behaviour of the motion transmission mechanism 30 and its mechanical interaction with the movable arc contact 22 is briefly described in the following with reference to figures 3-7 and 9-12.

Transition from the first configuration C1 to the second configuration C2

[0123] Figures 3-5 show the motion transmission mechanism 30 in the first configuration C1.

[0124] In this case, the fourth hinge axis H4 of each spring member 32 is in a first position, at which the movable arc contact 22 is in the coupled position P3 with the fixed arc contact 21.

[0125] The first hinge axis H1 of each lever member 31 is not aligned with the hinge axes H3, H4 of each spring member 32. The lever members 31 and the spring members 32 are relatively positioned one to another, so that the motion transmission mechanism 30 does not exert any force on the movable arc contact 22.

[0126] Upon actuation of the first lever arm 311 by the movable contact 10 (more particularly by the coupling members 10C), while said movable contact is rotating according to the first rotation direction R1 (figure 6), each lever member 31 rotates about the first hinge axis H1 (according to a clockwise direction with reference to the observation plane of figures 3-7).

[0127] The fourth hinge axis H4 of each spring member 32 moves away from the above-mentioned first position and it travels towards a second position, at which the movable arc contact 22 is in the uncoupled position P4 from the fixed arc contact 21 (figures 6-7).

[0128] Each spring member 32 stores elastic energy due to such a motion of the fourth hinge axis H4 and it exerts a force on movable arc contact 22, which is directed to maintain the movable arc contact 22 coupled to the

fixed arc contact 21.

[0129] Each lever member 31, however, exerts a force on the movable arc contact 22, which is directed to decouple the movable arc contact 22 from the fixed arc contact 21.

[0130] The movable arc contact 22 thus moves away from the fixed arc contact 21 notwithstanding the vacuum attraction force generated by the vacuum atmosphere in the vacuum chamber and the force exerted by each spring member 32.

[0131] While it is travelling towards the above-mentioned second position, the fourth hinge axis H4 of each spring member 32 passes through an intermediate deadlock position, in which the first hinge axis H1 is aligned with the hinge axes H3 and H4 of each spring member 32.

[0132] In the meanwhile, the movable arc contact 22 continues to move away from the fixed arc contact 21 due to the force exerted by each lever member 31 (figure 6).

[0133] As soon as the fourth hinge axis H4 passes beyond the intermediate deadlock position, each lever member 31 stops actuating the movable arc contact 22 and each spring member 32 releases, at least partially, the stored elastic energy.

[0134] In this situation, each spring member 32 exerts a force on movable arc contact 22, which is directed to decouple the movable arc contact 22 from the fixed arc contact 21.

[0135] In the meanwhile, the movable contact 10 decouples from the first lever arm 311 and stops actuating each lever member 31.

[0136] The movable arc contact 22, however, continues to move away from the fixed arc contact 21 due to the force exerted by each spring member 32 and notwithstanding the vacuum attraction force.

[0137] At the end, the first hinge axis H1 of each lever member 31 reaches the above-mentioned second position (figure 7) and the movable arc contact 22 reaches the uncoupled position P4 from the fixed arc contact 21, which is stably maintained due to the force exerted on the movable arc contact 22 by each spring member 32, which opposes to the vacuum attraction force.

Transition from the second configuration C2 to the first configuration C1

[0138] Figures 9-11 show the motion transmission mechanism 30 in the second configuration C2.

[0139] In this case, the fourth hinge axis H4 of each spring member 32 is in a second position, at which the movable arc contact 22 is in the uncoupled position P4 with the fixed arc contact 21.

[0140] The first hinge axis H1 of each lever member 31 is not aligned with the hinge axes H3, H4 of each spring member 32. The lever members 31 and the spring members 32 are relatively positioned one to another, so that the motion transmission mechanism 30 exerts a force on the movable arc contact 22, which is directed to

maintain this latter uncoupled from the fixed arc contact 21.

[0141] Upon actuation of the second lever arm 312 by the movable contact 10 (more particularly by the coupling members 10C), while said movable contact is rotating according to the second rotation direction R2 (figure 12), each lever member 31 rotates about the first hinge axis H1 (according to a counter-clockwise direction with reference to the observation plane of figures 9-12).

[0142] The fourth hinge axis H4 of each spring member 32 moves away from the above-mentioned second position and it travels towards the above-mentioned first position.

[0143] Each spring member 32 stores elastic energy due to such a motion of the fourth hinge axis H4 and it exerts a force on movable arc contact 22, which is directed to maintain the movable arc contact 22 uncoupled from the fixed arc contact 21.

[0144] Each lever member 31, however, exerts a force on the movable arc contact 22, which is directed to couple the movable arc contact 22 to the fixed arc contact 21.

[0145] The movable arc contact 22 thus moves towards the fixed arc contact 21 notwithstanding the force exerted by each spring member 32.

[0146] While it is travelling towards the above-mentioned first position, the fourth hinge axis H4 of each spring member 32 passes through the above-mentioned intermediate deadlock position. In the meanwhile, the movable arc contact 22 continues to move towards the fixed arc contact 21 due to the force exerted by each lever member 31 (figure 12).

[0147] As soon as the fourth hinge axis H4 passes beyond the intermediate deadlock position, each lever member 31 stops actuating the movable arc contact 22 and each spring member 32 releases, at least partially, the stored elastic energy.

[0148] In this situation, each spring member 32 exerts a force on movable arc contact 22, which is directed to couple the movable arc contact 22 to the fixed arc contact 21.

[0149] In the meanwhile, the movable contact 10 decouples from the first lever arm 311 and stops actuating each lever member 31.

[0150] The movable arc contact 22, however, continues to move towards the fixed arc contact 21 due to the vacuum attraction force and the force exerted by each spring member 32.

[0151] At the end, the first hinge axis H1 of each lever member 31 reaches the above-mentioned first position (figure 3) and the movable arc contact 22 reaches the coupled position P3 with the fixed arc contact 21, which is stably maintained due to the force exerted on the movable arc contact 22 by each spring member 32 and by the vacuum attraction force.

[0152] The operation of the switching apparatus 1 (with a "double-disconnection" configuration) for each electric pole 2 is now described in more details.

Closed state of the switching apparatus

[0153] When the switching apparatus is in a closed state, each electric pole 2 is in the operating condition illustrated in figure 2.

[0154] In this situation, each electric pole 2 has:

- the movable contact 10 in the first end-of-run position P_A ;
- the movable contact 10 with the first movable contact region 10A coupled to the first fixed contact 5 and the second movable contact region 10B coupled to the second fixed contact 6;
- the first and second fixed contacts 5, 6 electrically connected one to another and electrically disconnected from the third fixed contact 7;
- the fourth fixed contact 8 electrically disconnected from the second fixed contact 6;
- the motion transmission mechanism 30 in the first configuration C1;
- the movable arc contact 22 in a coupled position P3 with the fixed arc contact 21.

[0155] The first lever arm 311 of each lever member 31 is positioned along the motion trajectory of the movable contact 10.

[0156] A current can flow through the electric pole between the first and second pole terminals 11, 12 passing through the first fixed contact 5, the movable contact 10 and the second fixed contact 6. No currents can flow through the vacuum interrupter 20 as the fourth fixed contact 8 is electrically disconnected from the second fixed contact 6.

Open state of the switching apparatus

[0157] When the switching apparatus is in an open state, each electric pole 2 is in the condition shown in figure 8.

[0158] In this situation, each electric pole 2 has:

- the movable contact 10 in the intermediate position P_B ;
- the movable contact 10 with both the first and second movable contact regions 10A, 10B decoupled from any fixed contact;
- the first, second and third fixed contacts 5, 6, 7 electrically disconnected one from another;
- the fourth fixed contact 8 electrically disconnected from the second fixed contact 6;
- the motion transmission mechanism in the second configuration C2.
- the movable arc contact 22 in an uncoupled position P4 from the fixed arc contact 21;

[0159] The second lever arm 312 of each lever member 31 is positioned along the motion trajectory of the movable contact 10.

[0160] No currents can flow between the first and second pole terminals 11, 12.

Grounded state of the switching apparatus

[0161] When the switching apparatus is in a grounded state, each electric pole 2 is in the condition illustrated in figure 13.

[0162] In this situation, each electric pole 2 has:

- the movable contact 10 in the second end-of-run position P_C ;
- the movable contact 10 with the first movable contact region 10A coupled to the third fixed contact region 6B of the second fixed contact 6 and with the second movable contact region 10B coupled to the third fixed contact region 7A of the third fixed contact 7;
- the second and third fixed contacts 6, 7 electrically connected one to another and electrically disconnected from the first fixed contact 5;
- the fourth fixed contact 8 electrically disconnected from the second fixed contact 6;
- the motion transmission mechanism in the second configuration C2.
- the movable arc contact 22 in an uncoupled position P4 from the fixed arc contact 21;

[0163] The second lever arm 312 of each lever member 31 is positioned along the motion trajectory of the movable contact 10.

[0164] No currents can flow between the first and second pole terminals 11, 12 and the second pole terminal 12 is put at a ground voltage.

Opening manoeuvre

[0165] The switching apparatus 1 carries out an opening manoeuvre, when it switches from the closed state to the open state.

[0166] During an opening manoeuvre of the switching apparatus, each movable contact 10 moves, according to the first rotation direction R1, between the first end-of-run position P_A and the intermediate position P_B . Each movable contact 10 thus moves away from the corresponding first fixed contact 5.

[0167] When the movable contact 10 starts moving according to the first rotation direction R1, the first movable contact region 10A of the movable contact 10 couples to the fourth fixed contact 8 while still being slidingly coupled to the first fixed contact 5 (figures 3-4). The second movable contact region 10B of the movable contact 10 remains slidingly coupled to the second fixed contact 6.

[0168] The movable contact 10 thus electrically connects both the first fixed contact 5 and the fourth fixed contact 8 with the second fixed contact 6. A current can flow between the first and second pole terminals 11, 12 passing through the first fixed contact 5 and the vacuum interrupter 20 in parallel. Obviously, most of the current

will flow along the first fixed contact 5 as the current path passing through this electric contact has a lower equivalent resistance with respect to the current path passing through the vacuum interrupter.

[0169] At this stage of the opening manoeuvre, the movable contact 10 does not interact with the motion transmission mechanism 30 yet.

[0170] Upon a further movement according to the first rotation direction R1, the movable contact 10 decouples from the first fixed contact 5 while remaining slidably coupled to the fourth fixed contact 8 and the second fixed contact 6 (figure 5).

[0171] The movable contact 10 thus electrically disconnects the first fixed contact 5 from the second fixed contact 6 while maintaining the fourth fixed contact 8 electrically connected with the second fixed contact 6. In this situation, a current flowing along the electric pole is fully deviated through the vacuum interrupter 20 as no current can flow through the first fixed contact 5. The formation of electric arcs at the contact region 10A of the movable contact 10 is thus prevented.

[0172] While it is slidably coupled to the fourth fixed contact 8 and to the second fixed contact 6, the movable contact 10 (namely the coupling members 10C thereof) couples to and actuates the first lever arm 311 of each lever member 31 (figure 6).

[0173] The actuation of each first lever arm 311 by the movable contact 10 causes a transition of the motion transmission mechanism from the first configuration C1 to the second configuration C2 and a consequent movement of the movable arc contact 22 from the coupled position P3 with the fixed arc contact 21 to the uncoupled position P4 from the fixed arc contact 21.

[0174] The separation of the electric contacts 21, 22 causes the rising of electric arcs between said electric contacts. However, since the electric contacts 21, 22 are immersed in a vacuum atmosphere, such electric arcs can be quenched efficiently, thereby quickly leading to the interruption of the current flowing along the electric pole.

[0175] In the meanwhile, the movable contact 10 maintains the fourth fixed contact 8 electrically connected to the second fixed contact 6, thereby preventing the formation of electric arcs at the contact regions 10A, 10B of the movable contact 10.

[0176] Upon a further movement towards the intermediate position P_B, according to the first rotation direction R1, the movable contact 10 decouples from the motion transmission mechanism 30, which remains in the second configuration C2, and from the second and fourth fixed contacts 6 and 8, which thus result electrically disconnected (figure 7).

[0177] The movable contact 10 then reaches the intermediate position P_B, which corresponds to an open state of the switching apparatus (figure 8).

Closing manoeuvre

[0178] The switching apparatus 1 carries out a closing manoeuvre, when it switches from the open state to the close state.

[0179] Before carrying out a closing manoeuvre, the switching apparatus may have carried out a reconnecting manoeuvre in order to switch in an open state.

[0180] During a closing manoeuvre of the switching apparatus, each movable contact 10 moves, according to the second rotation direction R2, between the intermediate position P_B and the first end-of-run position P_A. Each movable contact 10 thus moves towards the corresponding first fixed contact 5.

[0181] Upon an initial movement according to the second rotation direction R2, the movable contact 10 couples to the fourth fixed contact 8 (at the first movable contact region 10A) and to the second fixed contact 6 (at the second movable contact region 10B), thereby electrically connecting the fourth fixed contact 8 with the second fixed contact 6 (figure 9).

[0182] At this stage of the closing manoeuvre, the movable contact 10 does not interact with the motion transmission mechanism 30 yet.

[0183] Upon a further movement according to the second rotation direction R2, the movable contact 10 couples to the first fixed contact 5 (at the movable contact region 10A) while being still slidably coupled to the fourth fixed contact 8 and to the second fixed contact 6 (figure 10). In this transitory situation, both the first fixed contact 5 and the fourth fixed contact 8 are electrically connected with the second fixed contact 6.

[0184] Upon a further movement according to the second rotation direction R2, the movable contact 10 decouples from the fourth fixed contact 8 and it remains slidably coupled to the first fixed contact 5 and to the second fixed contact 6 (figure 11).

[0185] The movable contact 10 thus electrically disconnects the fourth fixed contact 8 from the second fixed contact 6 and it maintains the first fixed contact 5 and the second fixed contact 6 electrically connected. In this way, the vacuum interrupter 20 does not have to carry a possible short circuit current or an overload current or, more simply, a nominal current during the "making current" process. The vacuum chamber 23 can be realized with a more compact design, which allows obtaining a size and cost reduction for the overall switching apparatus. While it is slidably coupled to the first fixed contact 5 and to the second fixed contact 6, the movable contact 10 (namely the coupling members 10C thereof) couples to and actuates the second lever arm 312 of each lever member 31 (figure 12).

[0186] The actuation of the second lever arm 312 of each lever member 31 by the movable contact 10 causes a transition of the motion transmission mechanism 30 from the second configuration C2 to the first configuration C1 and a consequent movement of the movable arc contact 22 from the uncoupled position P4 from the fixed arc

contact 21 to the coupled position P3 with the fixed arc contact 21. In the meanwhile, the movable contact 10 maintains the first fixed contact 5 electrically connected to the second fixed contact 6.

[0187] The movable contact 10 then reaches the first end-of-run position P_A , which corresponds to a closed state of the switching apparatus (figures 2-3).

Disconnecting manoeuvre

[0188] The switching apparatus 1 carries out a disconnecting manoeuvre, when it switches from an open state to a grounded state.

[0189] Obviously, before carrying out a disconnecting manoeuvre, the switching apparatus has to carry out an opening manoeuvre as described above in order to switch in an open state.

[0190] During a disconnecting manoeuvre of the switching apparatus, each movable contact 10 moves, according to the first rotation direction R1, between the intermediate position P_B and the second end-of-run position P_C .

[0191] When the movable contact 10 reaches the second end-of-run position P_C , its first movable contact region 10A couples to the second fixed contact 6 while its second movable contact region 10B couples to the third fixed contact 7.

[0192] In this situation, the movable contact 10 electrically connects the second fixed contact 6 with the third fixed contact 7 and, consequently, the second pole terminal 12 with the ground terminal 13. The second pole terminal 12 results therefore put at a ground voltage.

[0193] The movable contact 10 does not interact with the motion transmission mechanism 30, which remains in the second configuration C2, when the switching apparatus carries out a disconnecting manoeuvre.

Reconnecting manoeuvre

[0194] The switching apparatus 1 carries out a reconnecting manoeuvre, when it switches from a grounded state to an open state.

[0195] During a reconnecting manoeuvre of the switching apparatus, each movable contact 10 moves, according to the second rotation direction R2, between the second end-of-run position P_C and the intermediate position P_B .

[0196] In this way, the first movable contact region 10A decouples from the second fixed contact 6 while the second movable contact region 10B decouples from the third fixed contact 7. The movable contact 10 thus electrically disconnects the third fixed contact 7 from the second fixed contact 6. As a consequence, the movable contact 10 does not electrically connect the second pole terminal 12 with the ground terminal 13 anymore. The second pole terminal 12 is therefore at a floating voltage.

[0197] The movable contact 10 does not interact with the motion transmission mechanism 30, which remains

in the second configuration C2, when the switching apparatus carries out a reconnecting manoeuvre.

[0198] As it is apparent from the above, the operation of the switching apparatus occurs according to similar operating modes, if the switching apparatus is of the "single-disconnection" type.

[0199] The switching apparatus, according to the invention, provides remarkable advantages with respect to the known apparatuses of the state of the art.

[0200] The switching apparatus of the invention includes, for each electric pole, a bistable motion transmission mechanism 30, which allows the movable contact 10 to drive the separation of the movable arc contact 22 from the fixed arc contact 21 depending on the position reached during an opening manoeuvre of the switching apparatus.

[0201] As illustrated above, the lever arms 311, 312 of each lever member 31 of the motion transmission mechanism 30 are actuatable at different points of the motion trajectory of the movable contact 10. This solution improves the synchronization between the movement of the movable arc contact 22 and the movement of the movable contact 10.

[0202] In this way, the breaking process of the current flowing along each electric pole can be easily made to occur at level of the arc contacts 21, 22 accommodated in the vacuum chamber 23. Possible electric arcs, which derive from the interruption of a current flowing along each electric pole, therefore form in a vacuum atmosphere only, which allows improving their quenching process.

[0203] The circumstance that the motion transmission mechanism 30 can stably take two different configurations further improves synchronization between the movements of the movable arc contact 22 and the movable contact 10, during the opening and closing manoeuvres of the switching apparatus.

[0204] As illustrated above, during a closing manoeuvre of the switching apparatus, the movable contact 10 reaches the first fixed contact 5 before decoupling from the fourth fixed contact 8. In this way, during a closing manoeuvre, the vacuum interrupter 20 has not to carry a possible short circuit current or an overload current or, more simply, a nominal current. This solution is quite advantageous as it allows designing a more compact vacuum chamber 23, which allows obtaining a size and cost reduction for the overall switching apparatus.

[0205] The switching apparatus of the invention has electric poles with a very compact, simple and robust structure with relevant benefits in terms of size optimization.

[0206] The switching apparatus, according to the invention, ensures high-level performances in terms of dielectric insulation and arc-quenching capabilities during the current breaking process and, at the same time, it is characterised by high levels of reliability for the intended applications. The switching apparatus, according to the invention, is of relatively easy and cheap industrial pro-

duction and installation on the field.

Claims

1. A switching apparatus (1) for medium voltage electric systems, said switching apparatus comprising one or more electric poles (2), wherein, for each electric pole, said switching apparatus comprises:

- a first pole terminal (11), a second pole terminal (12) and a ground terminal (13), said first pole terminal (11) being electrically couplable to a first conductor of an electric line, said second pole terminal (12) being electrically couplable to a second conductor of said electric line and said ground terminal (13) being electrically couplable to a grounding conductor;
- a plurality of fixed contacts spaced apart one from another, said plurality of fixed contacts comprising a first fixed contact (5) electrically connected to said first pole terminal (11), a second fixed contact (6) electrically connected to said second pole terminal (12), a third fixed contact (7) electrically connected to said ground terminal (13) and a fourth fixed contact (8);
- a movable contact (10) reversibly movable about a corresponding rotation axis (A1) according to opposite first and second rotation directions (R1, R2), so that said movable contact can be coupled to or uncoupled from said fixed contacts (5, 6, 7, 8);
- a vacuum interrupter (20) comprising a fixed arc contact (21) electrically connected to said fourth fixed contact (8), a movable arc contact (22) electrically connected to said first fixed contact (5) and reversibly movable along a corresponding translation axis (A) between a coupled position (P3) with said fixed arc contact (21) and an uncoupled position (P4) from said fixed arc contact (21), and a vacuum chamber (23), in which said fixed arc contact (21) and said movable arc contact (22) are enclosed and can be coupled or decoupled;
- a motion transmission mechanism (30) operatively coupled to said movable arc contact (22), said motion transmission mechanism being actuatable by said movable contact (10) to cause a movement of said movable arc contact (22) along said translation axis (A), when said movable contact moves about said rotation axis (A1);

characterised in that said motion transmission mechanism (30) comprises at least a lever member (31) and at least a spring member (32), wherein each lever member (31) is pivoted on a fixed support (25) at a first hinge axis (H1) and on said movable arc contact (22) at a second hinge axis (H2),

wherein each spring member (32) is pivoted on a fixed support (25) at a third hinge axis (H3) and on said a corresponding lever member (31) at a fourth hinge axis (H4), wherein each lever member (31) comprises first and second lever arms (311, 312) alternatively actuatable by said movable contact (10) at different points of the motion trajectory of said movable contact (10).

2. Switching apparatus, according to claim 1, **characterised in that** the first lever arm (311) of each lever member (31) is actuated by said movable contact (10) when said movable contact (10) moves according to said first rotation direction (R1), and **in that** the second lever arm (312) of each lever member (31) is actuated by said movable contact (10) when said movable contact (10) moves according to said second rotation direction (R2).
3. Switching apparatus, according to claim 2, **characterised in that** the first lever arm (311) of each lever member (31) is actuated by said movable contact (10), when said movable contact (10) electrically connects said fourth fixed contact (8) to said second fixed contact (6), and **in that** the second lever arm (312) of each lever member (31) is actuated by said movable contact (10), when said movable contact (10) electrically connects said first fixed contact (5) to said second fixed contact (6).
4. Switching apparatus, according to one or more of the previous claims, **characterised in that** said movable contact (10) comprises at least a coupling member (10C) configured to couple to the first and second lever arms (311, 312) of each lever member (31) in such a way to actuate said lever member.
5. Switching apparatus, according to one or more of the previous claims, **characterised in that** said motion transmission mechanism (30) comprises a pair of lever members (31) and a pair of spring members (32) arranged in parallel at said opposite sides of said vacuum chamber (23).
6. Switching apparatus, according to one of the previous claims, **characterised in that** said motion transmission mechanism (30) is configured to take a first configuration (C1), at said movable arc contact (22) is in said coupled position (P3), and a second configuration (C2), at which said movable arc contact (22) is in said uncoupled position (P4), wherein said motion transmission mechanism (30) is configured to maintain stably said first configuration (C1) or said second configuration (C2), if the lever arms (311, 312) of each lever member (31) are not actuated by said movable contact (10), wherein said motion transmission mechanism (30) is configured to change configuration, if a lever arm

(311, 312) of each lever member (31) is actuated by said movable contact (10).

7. Switching apparatus, according to claim 6, **characterised in that** said motion transmission mechanism (30) is configured to switch from said first configuration (C1) to said second configuration (C2) upon an actuation of the first lever arm (311) of each lever member (31) by said movable contact (10), a transition of said motion transmission mechanism from said first configuration (C1) to said second configuration (C2) causing a movement of said movable arc contact (22) from said coupled position (P3) to said uncoupled position (P4).
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8. Switching apparatus, according to one of the claims from 6 to 7, **characterised in that** said motion transmission mechanism (30) is configured to switch from said second configuration (C2) to said first configuration (C1) upon an actuation of the second lever arm (312) of each lever member (31) by said movable contact (10), a transition of said motion transmission mechanism from said second configuration (C2) to said first configuration (C1) causing a movement of said movable arc contact (22) from said uncoupled position (P4) to said coupled position (P3).
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9. Switching apparatus, according to one of the previous claims, **characterised in that** said movable contact (10) comprises at least a contact blade.
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10. Switching apparatus, according to one of the previous claims, **characterised in that** it is a load-break switch for medium voltage electric systems.
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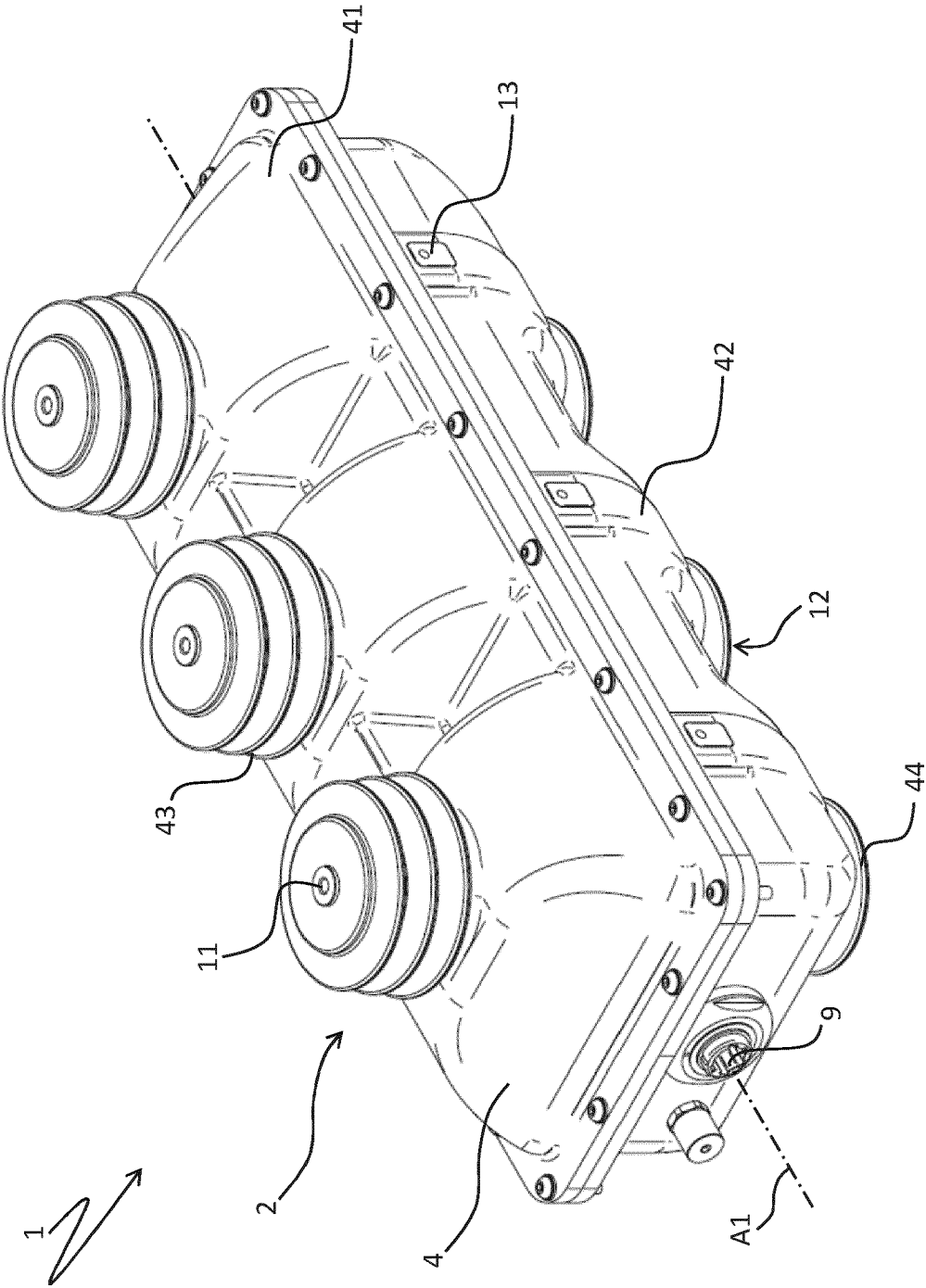
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FIG. 1



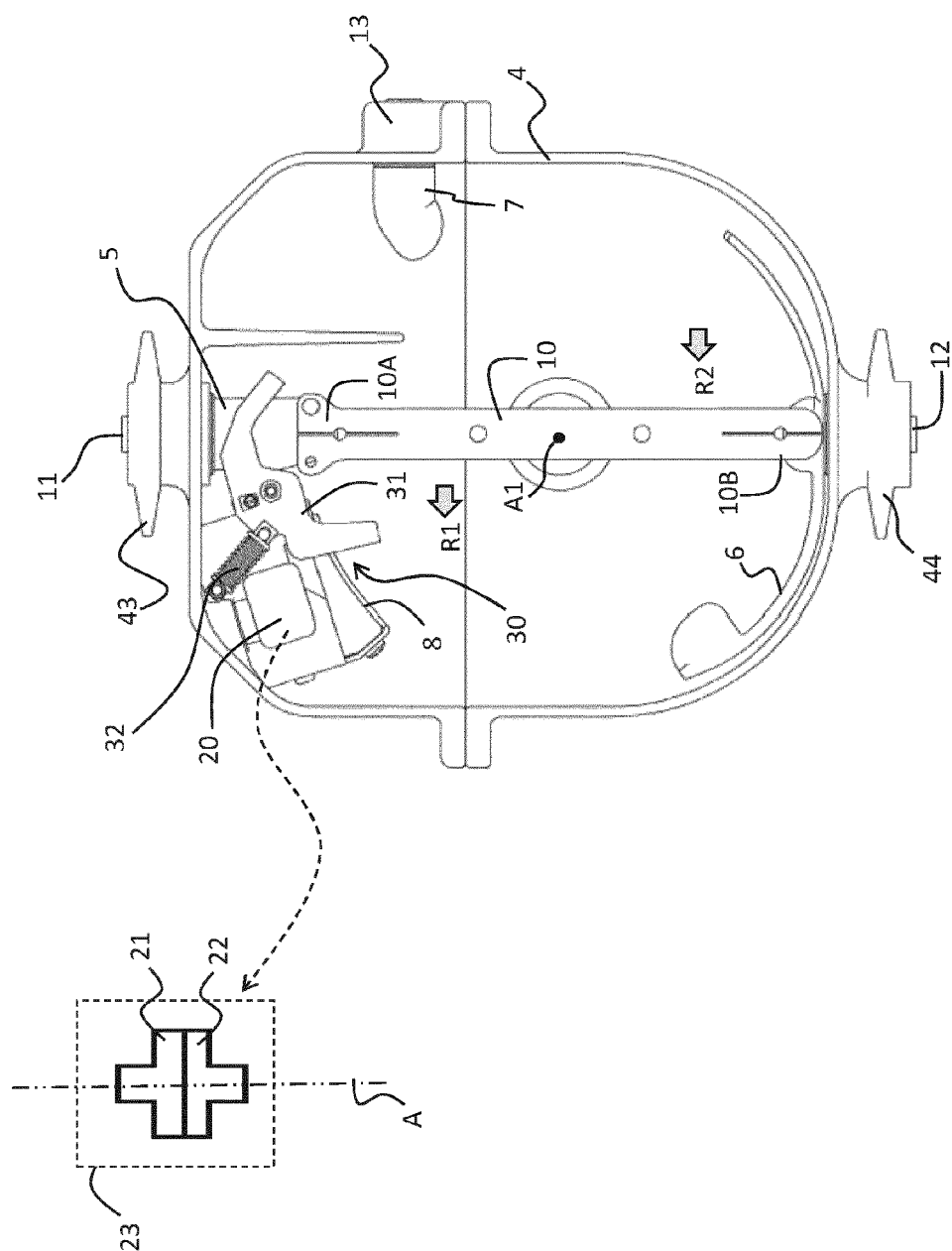


Fig. 2

 P_A, C_1, P_3 , closed state

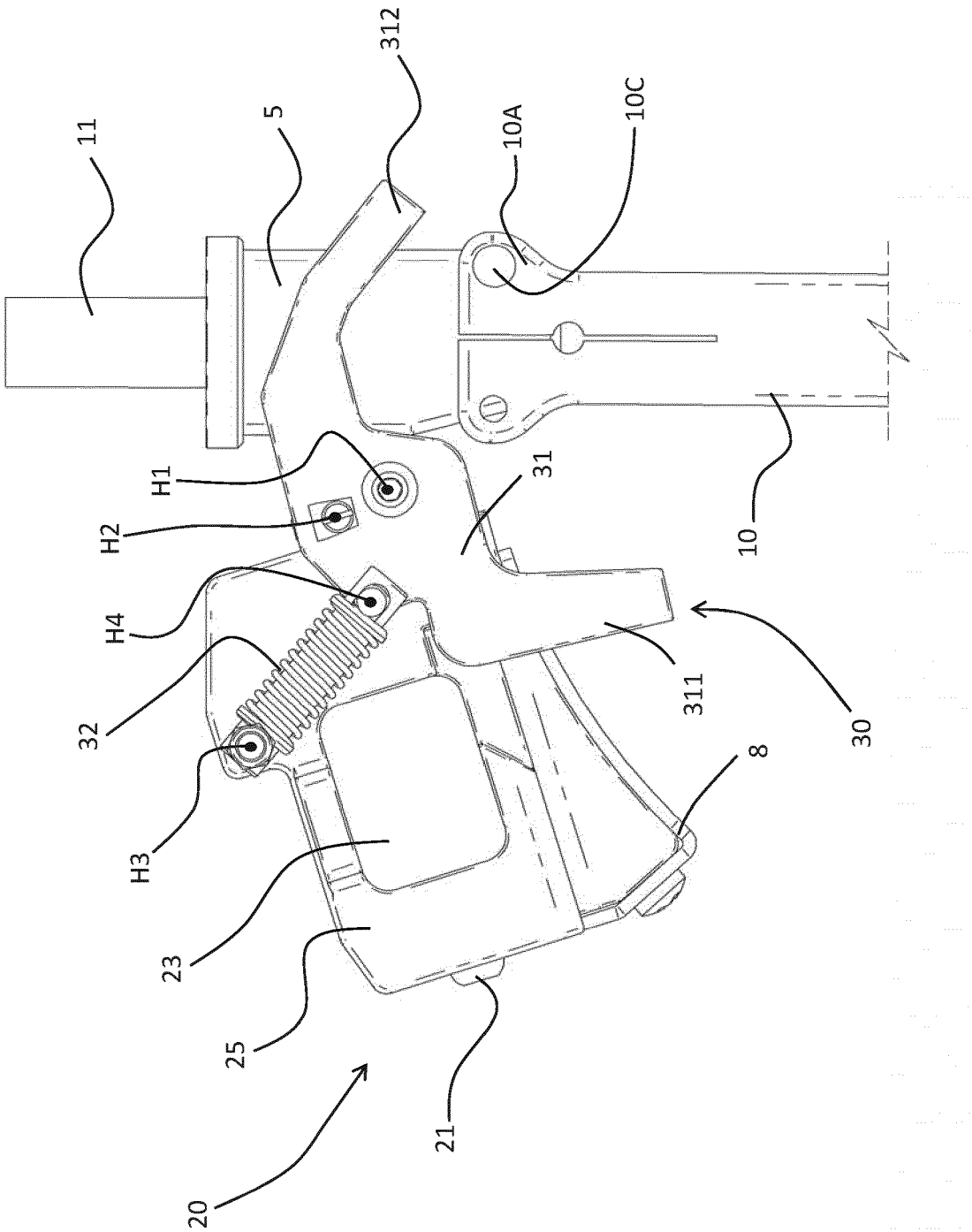


FIG. 3

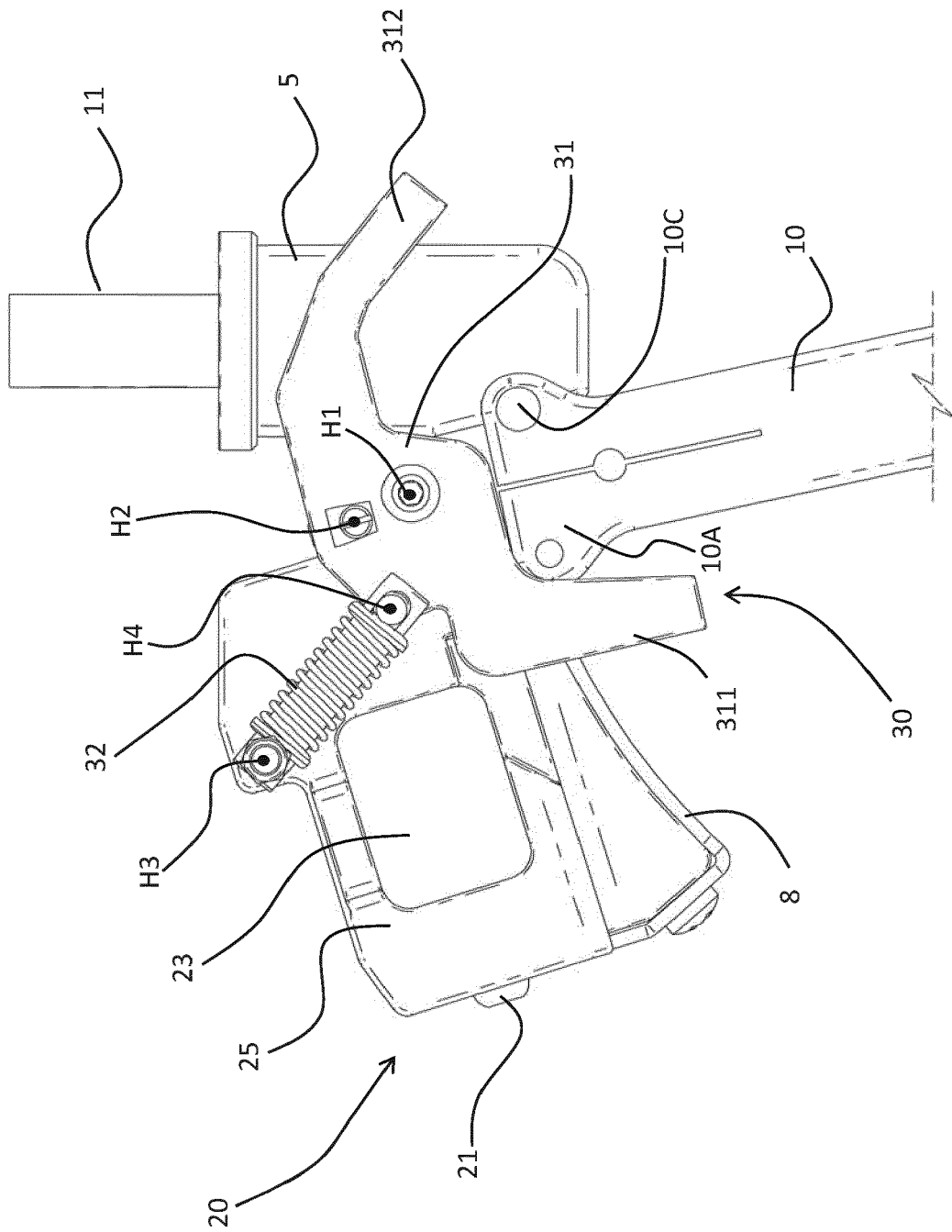
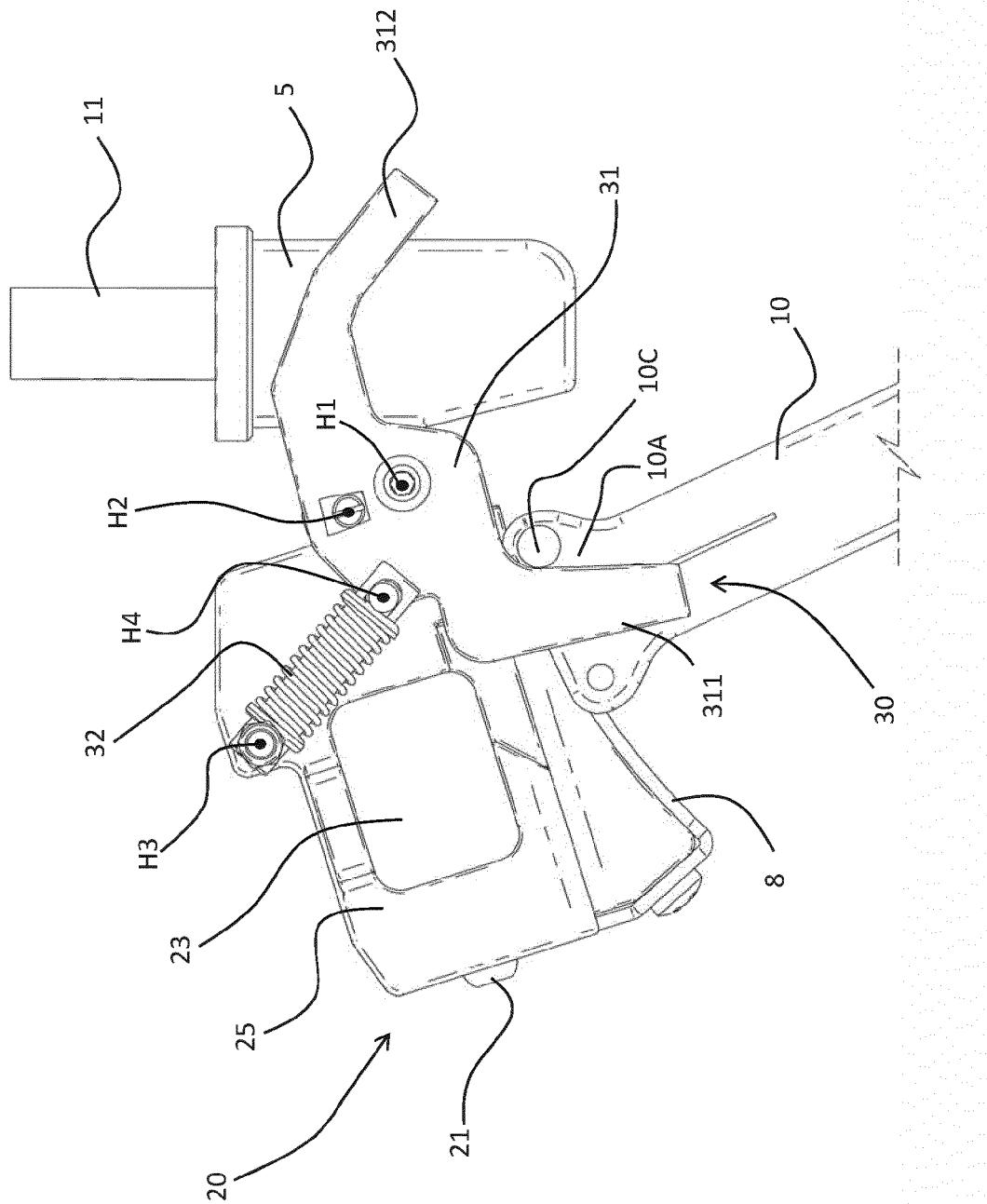
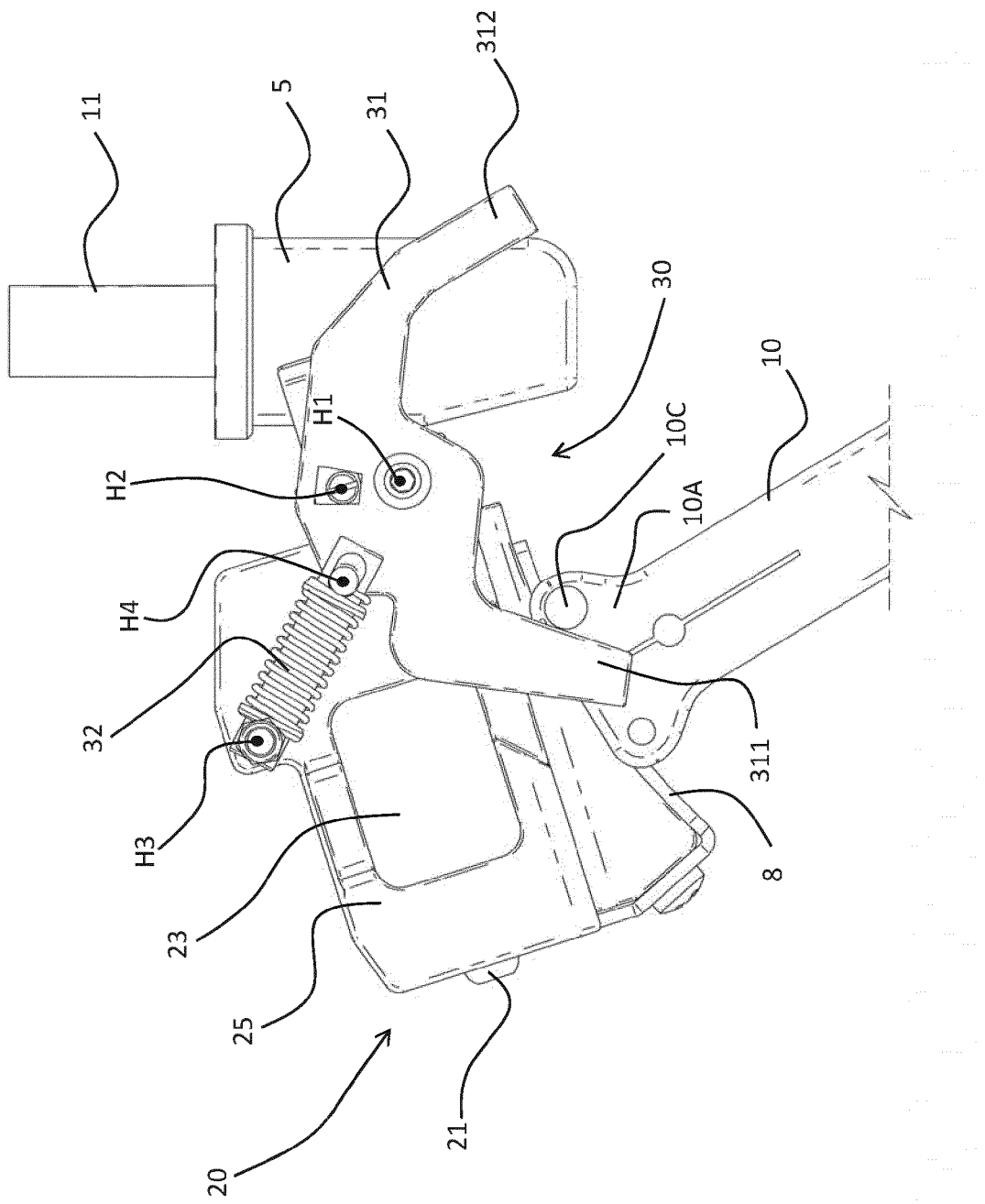


Fig. 4



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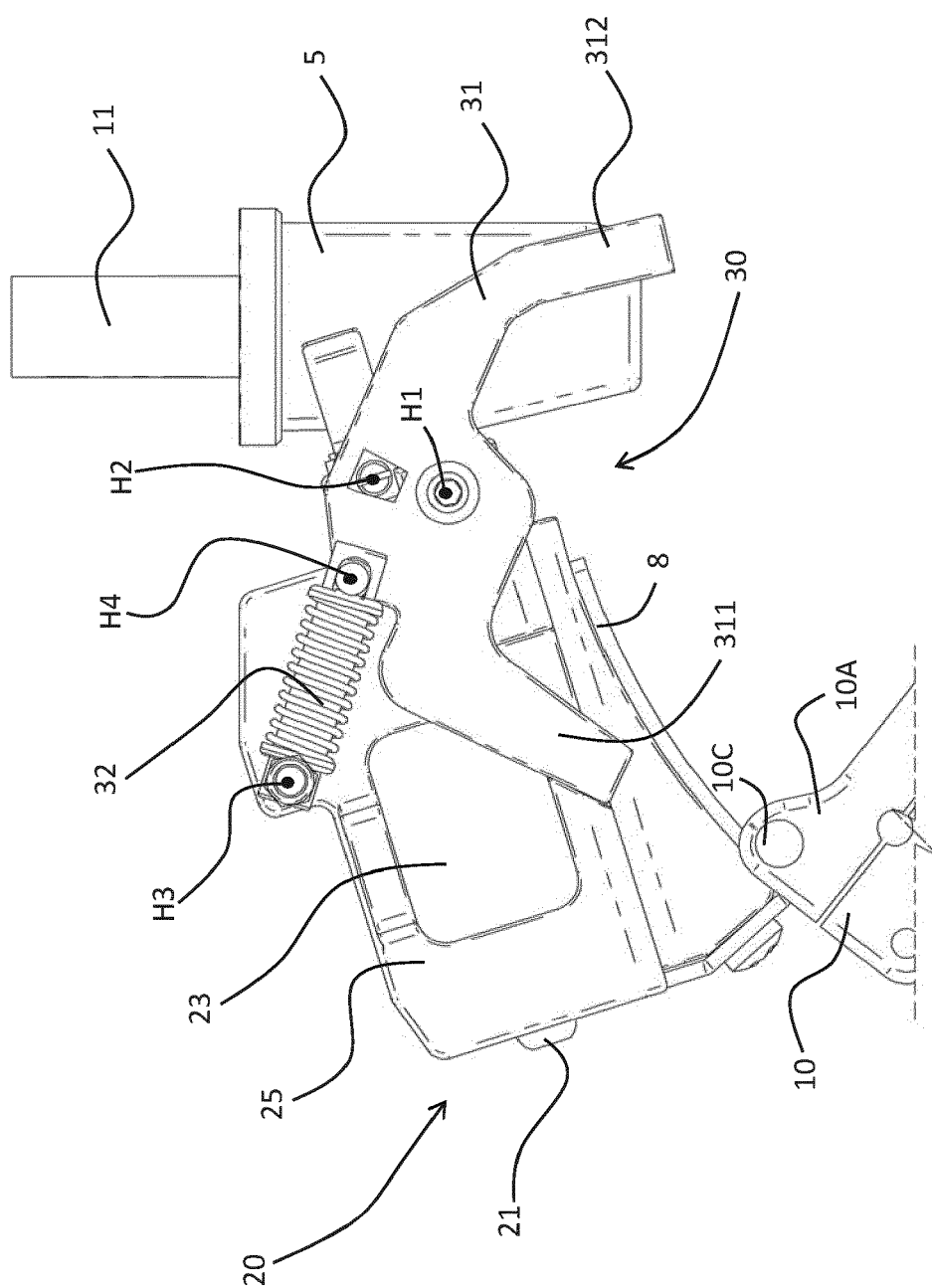
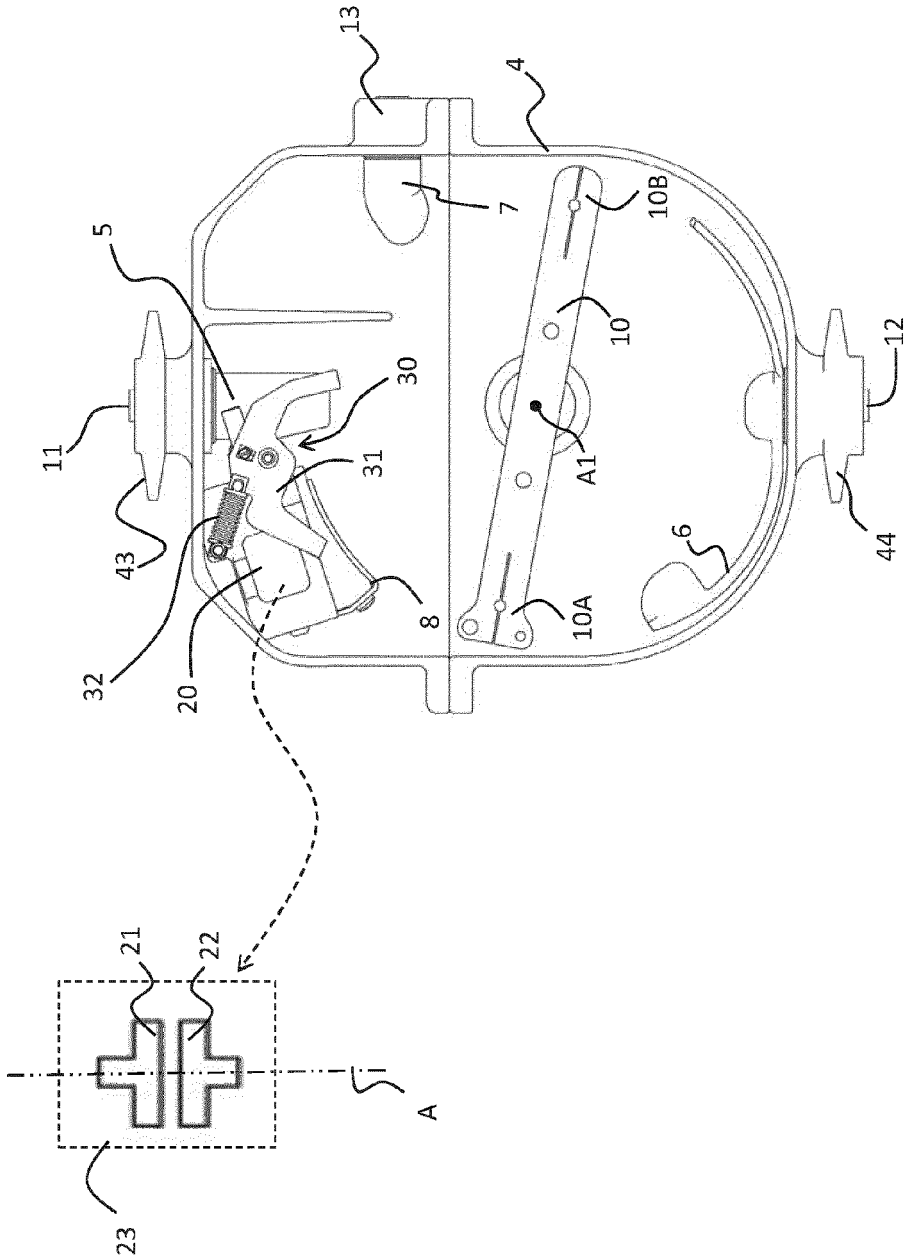
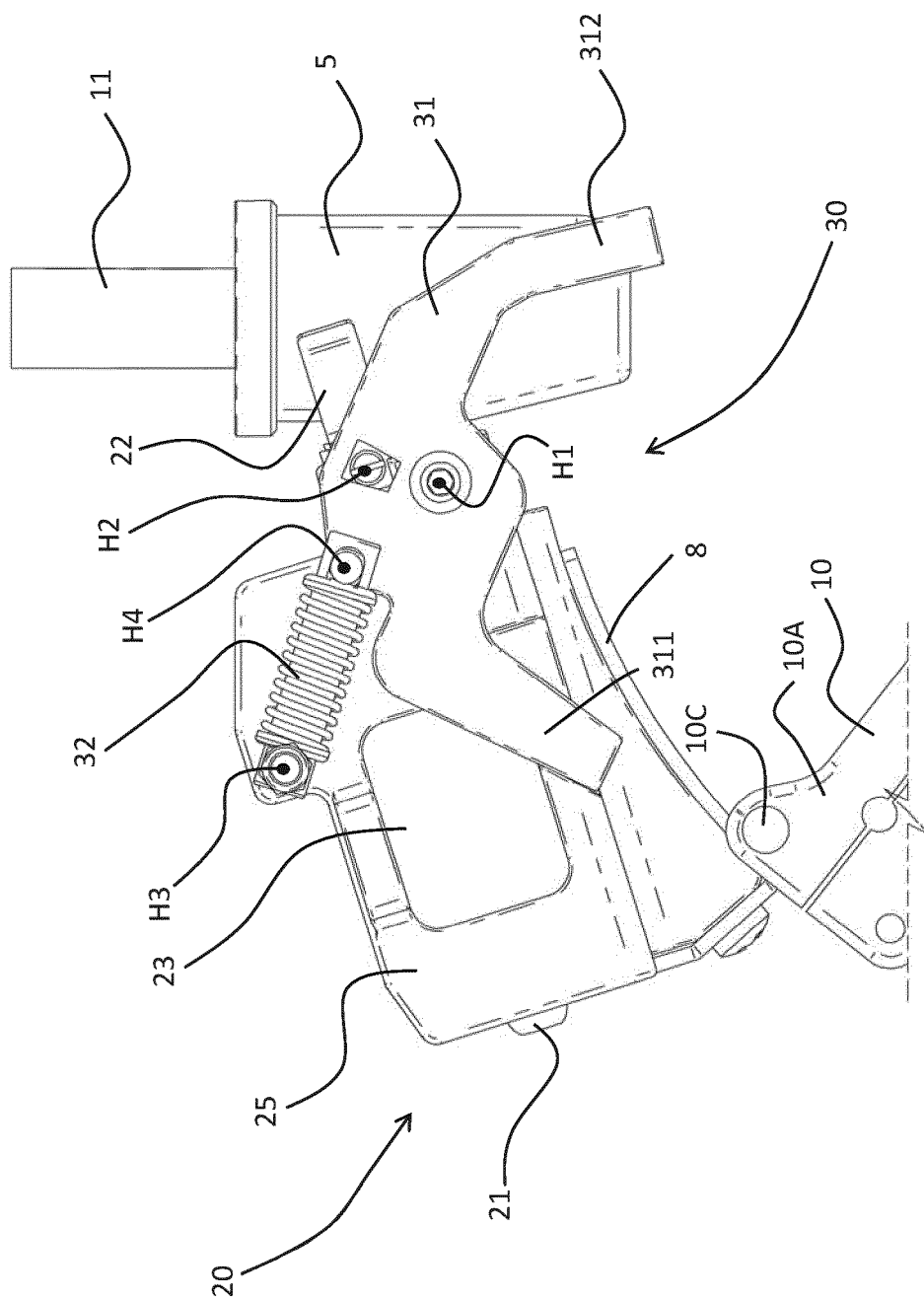


FIG. 7



P_B, C_2, P_4 , open state

FIG. 8



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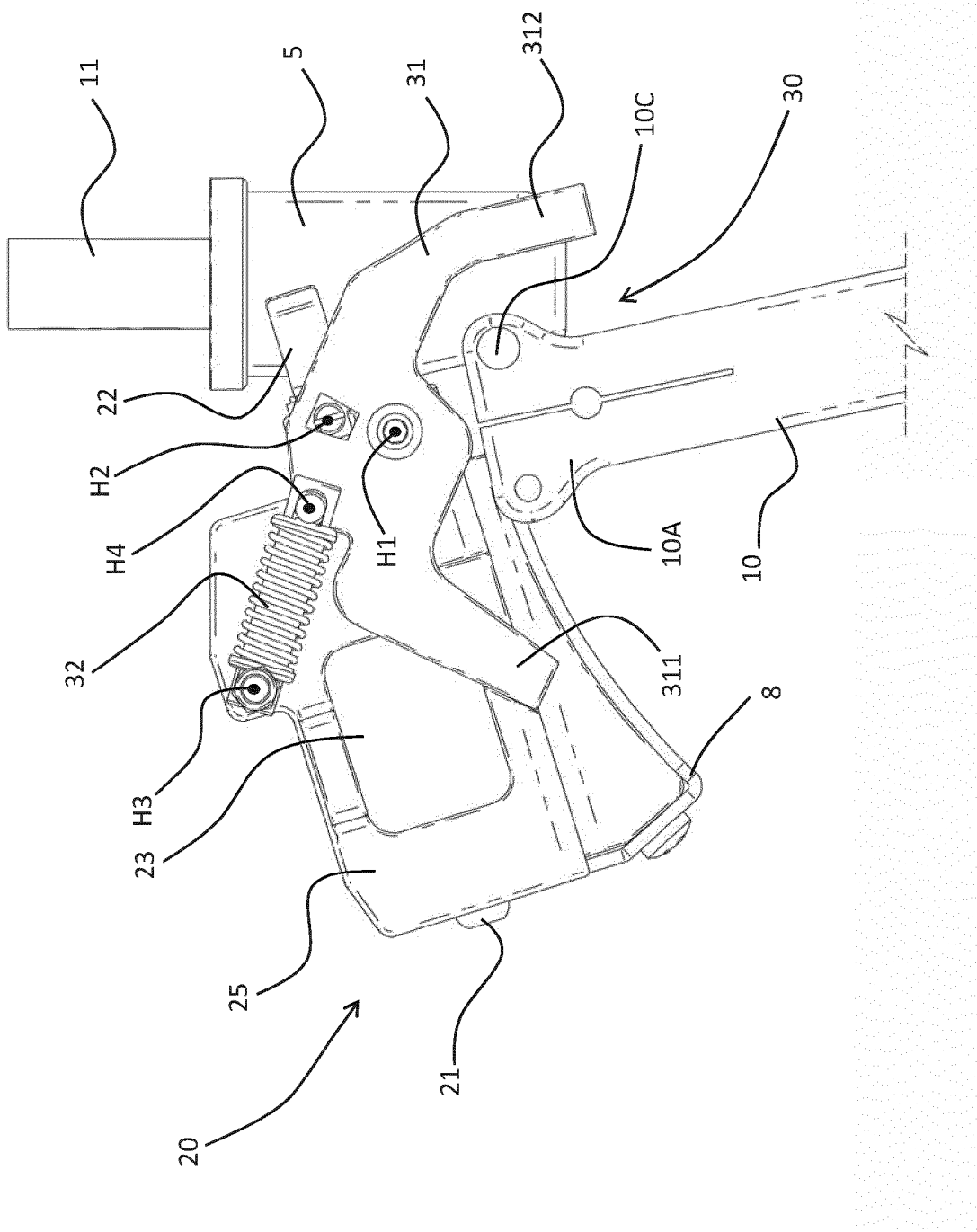


FIG. 10

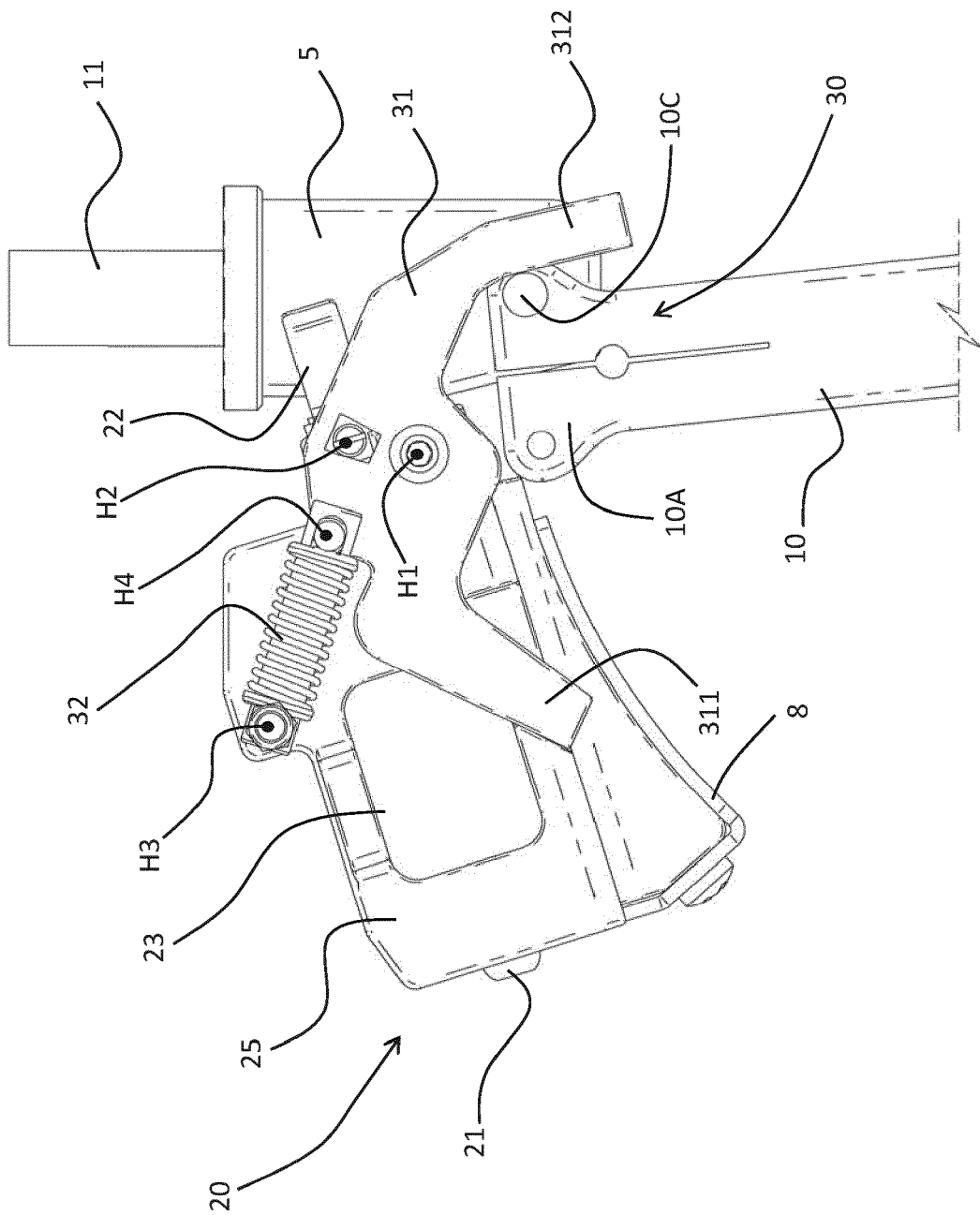


FIG. 11

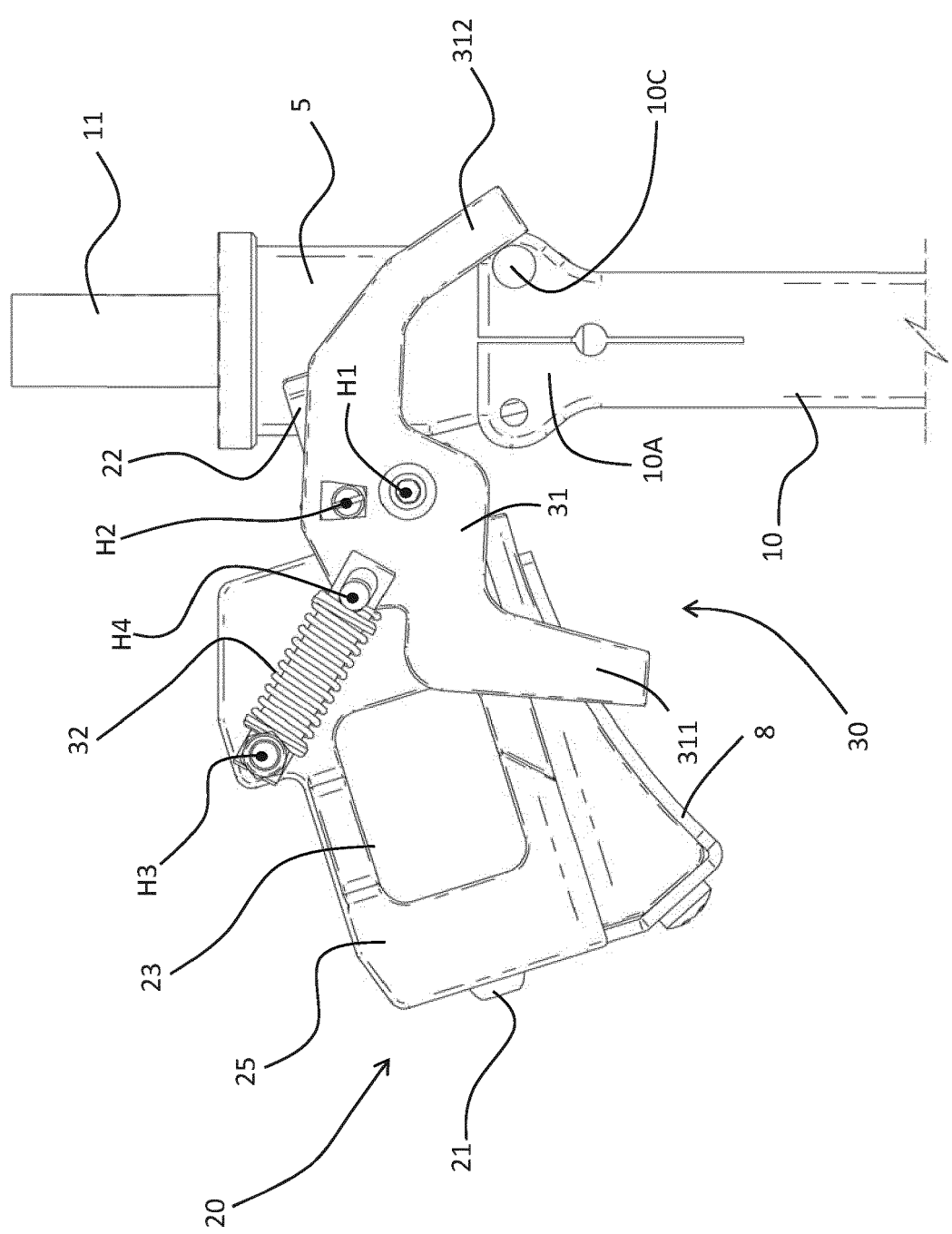
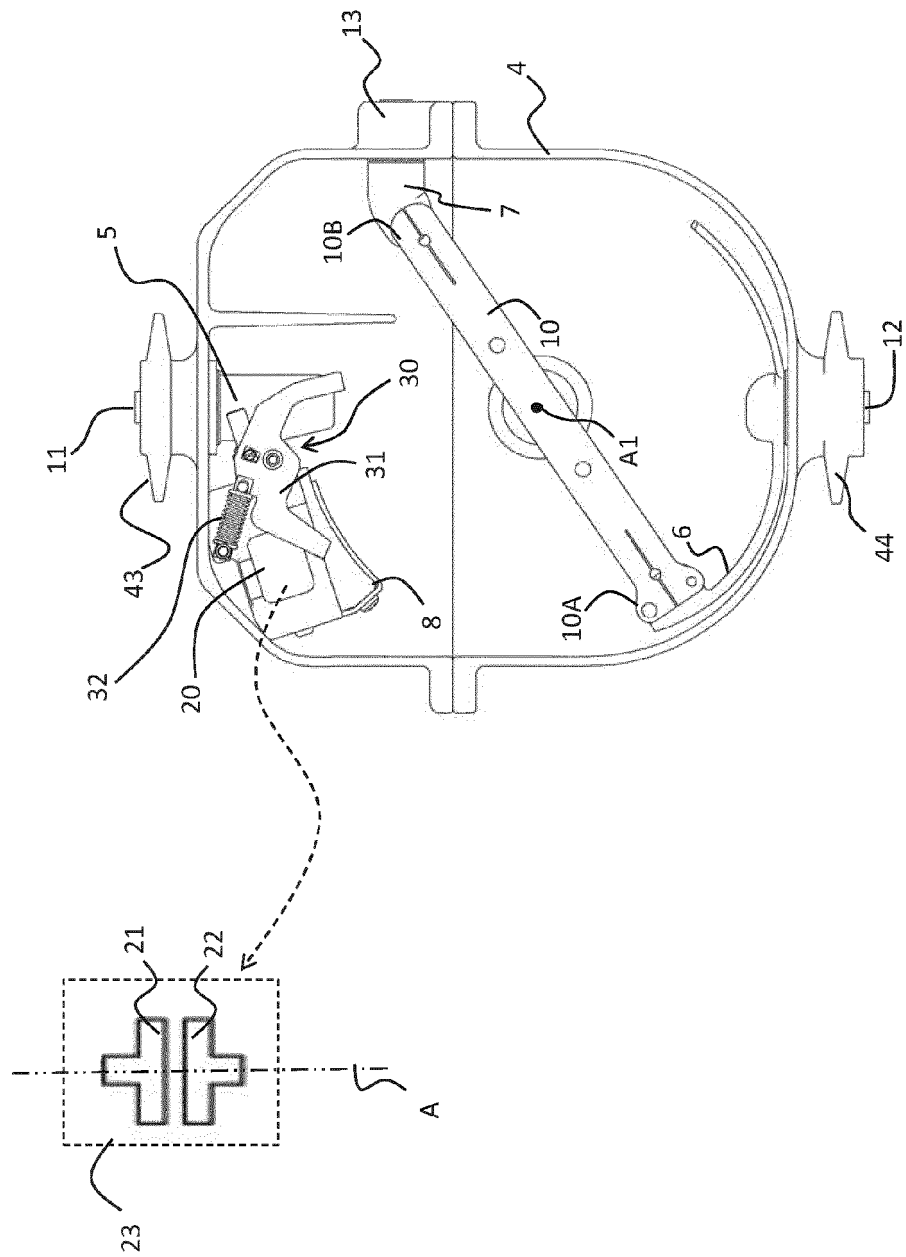


FIG. 12



P_C, C_2, P_4 , grounded state

FIG. 13

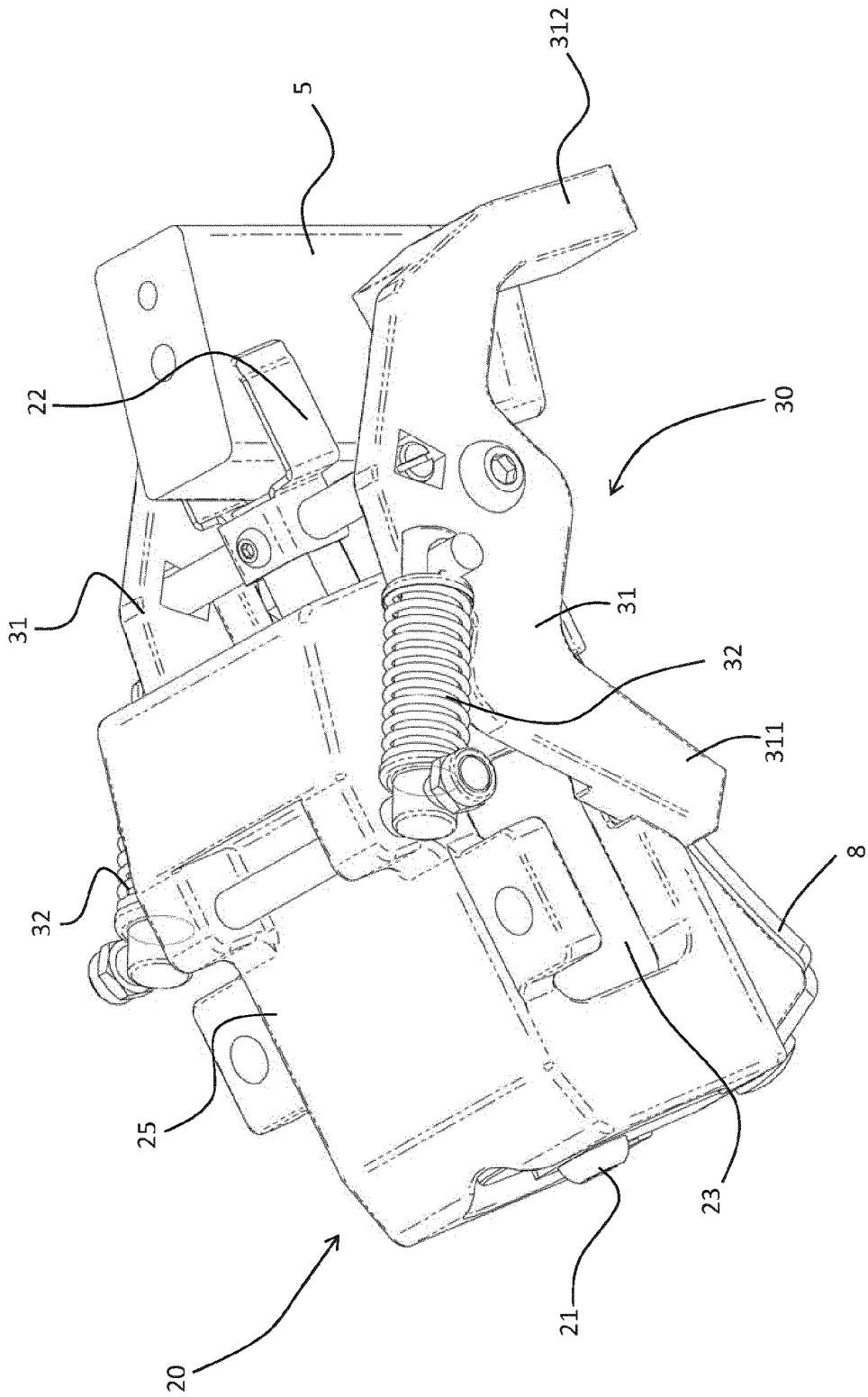


FIG. 14

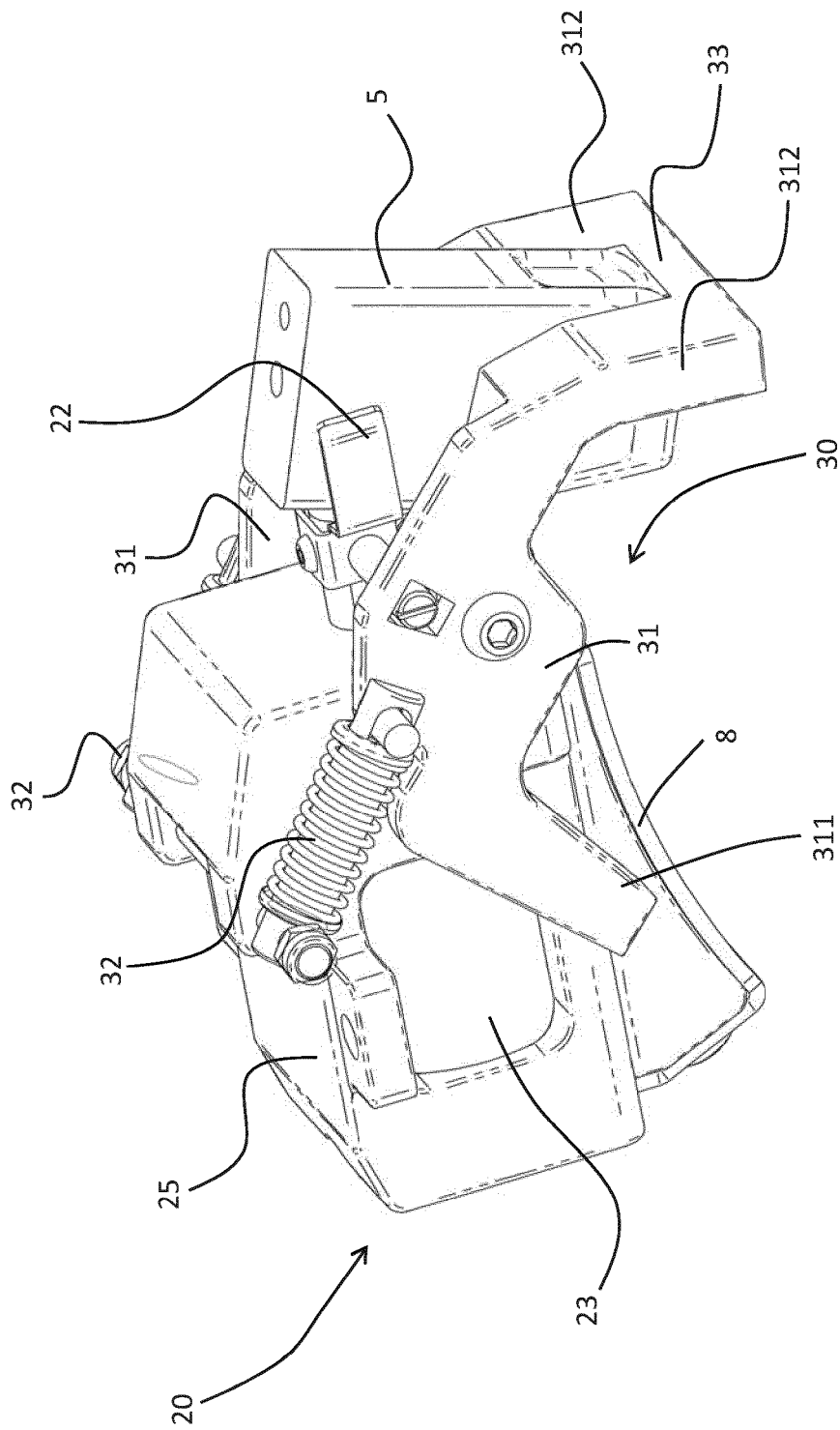


FIG. 15



EUROPEAN SEARCH REPORT

Application Number

EP 22 17 3047

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	WO 2014/001029 A1 (SIEMENS AG [DE]) 3 January 2014 (2014-01-03) * the whole document *	1-10	INV. H01H33/12 H01H33/666 H01H31/16
Y	US 2012/187090 A1 (GROSJEAN PATRICE [FR]) 26 July 2012 (2012-07-26) * paragraphs [0017] - [0021]; figures 1-7 *	1-10	
Y	US 2 954 450 A (MIKOS JOHN J) 27 September 1960 (1960-09-27) * column 6, line 58 - column 7, line 18 * * column 8, line 71 - column 9, line 18 * * figures 1-8 *	1-10	
Y	CN 1 148 255 A (FELTEN & GUILLEAUME ENERGIE [DE]) 23 April 1997 (1997-04-23) * the whole document *	5	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			

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Place of search

Munich

Date of completion of the search

3 November 2022

Examiner

Ramírez Fueyo, M

CATEGORY OF CITED DOCUMENTS

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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