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(54) **A MEDIUM VOLTAGE SWITCHING APPARATUS**

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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. The publication WO 2014/001029 A1 describes a medium voltage switching apparatus according to the preamble of claim 1.

[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 (SF_6) 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, SF_6 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 SF_6 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 structural 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 first pole terminal, a movable arc contact electrically connected to the fourth 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 be coupled or decoupled.

[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, the motion transmission mechanism comprises a slider member solidly coupled to said movable arc contact in such a way to move translationally together with said movable arc contact. The aforesaid slider member is reversibly movable between a first position, which corresponds to the coupled position of said movable arc contact, and a second position, which corresponds to the uncoupled position of said movable arc contact.

[0023] The slider member is configured to be actuated by said movable contact, during an opening manoeuvre of the switching apparatus. Said slider member moves from said first position to said second position, when said slider member is actuated by said movable contact. According to the invention, the motion transmission mechanism comprises a blocking member configured to block said slider member in said second position, when said slider member reaches said second position upon actuation by said movable contact, during an opening manoeuvre of the switching apparatus.

[0024] According to an aspect of the invention, said slider member is mechanically couplable to said movable contact through a cam coupling.

[0025] Preferably, said movable contact comprises one or more first actuating portions mechanically couplable to said slider member during an opening manoeuvre of the switching apparatus to actuate said slider member. Each first actuating portion has a cam profile.

[0026] According to an aspect of the invention, said slider member is actuated by said movable contact, when said movable contact electrically connects said fourth fixed contact to said second fixed contact, during an opening manoeuvre of the switching apparatus.

[0027] According to an aspect of the invention, said blocking member is configured to move translationally together with said slider member and take a blocking position when said slider member reaches said second position.

[0028] Preferably, said blocking member stably engages a fixed support to block said slider member in said second position, when said blocking member takes said blocking position.

[0029] According to an aspect of the invention, said blocking member is configured to be actuated by said movable contact, during a closing manoeuvre of said switching apparatus. Said blocking member is removed from said blocking position, when said slider member is actuated by said movable contact.

[0030] According to an aspect of the invention, said blocking member is actuated by said movable contact, when said movable contact electrically connects said fourth fixed contact to said second fixed contact, during a closing manoeuvre of the switching apparatus.

[0031] Preferably, said movable contact comprises one or more second actuating portions mechanically couplable to said blocking member during a closing manoeuvre of the switching apparatus to actuate said blocking member.

[0032] According to an aspect of the invention, for each electric pole, said first and second pole terminals are arranged at opposite sides of said switching apparatus relative to the rotation axis of said movable contact and are aligned one to another along a first alignment direction crossing the rotation axis of said movable contact. Said first fixed contact is laterally displaced relative to said first alignment direction.

[0033] According to an aspect of the invention, for each electric pole, said first pole terminal and said vacuum interrupter are at least partially accommodated in a portion of internal volume defined by a bushing of the insulating housing of said switching apparatus.

[0034] According to an aspect of the invention, said movable contact has a first movable contact region and a second movable contact region arranged at opposite positions relative to the rotation axis of said movable contact.

[0035] Said movable contact has said first movable contact region coupled to said first fixed contact and said second movable contact region coupled to said second fixed contact, so that said movable contact electrically connects said first and second fixed contacts, when said movable contact is in a first end-of-run position corresponding to a closed state of said switching apparatus.

[0036] Said movable contact has said first movable contact region coupled to said second fixed contact and said second movable contact region coupled to said third fixed contact, so that said movable contact electrically connects said second and third fixed contacts, when said movable contact is in a second end-of-run position corresponding to a grounded state of said switching apparatus. Said movable contact is coupled to no fixed contacts, when said movable contact is in an intermediate position between said first and second end-of-run positions, which corresponds to an open state of said switching apparatus.

[0037] 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.

[0038] 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 2-17 are schematic views partially showing the structure and operation of an electric pole of the switching apparatus of the invention;
- Figures 18-19 are schematic views showing some structural details of an electric pole of the switching apparatus, according to the invention.

[0039] With reference to the figures, the present invention relates to a switching apparatus 1 for medium voltage electric systems.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] 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.

[0044] The switching apparatus 1 comprises one or more electric poles 2.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] 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).

[0050] In the following, the switching apparatus of the invention will be described with reference to these embodiments for the sake of brevity only and without intending to limit the scope of the invention.

[0051] As a matter of fact, according to other embodiments of the invention (not shown), the switching apparatus of the invention might 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.

[0052] 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.

[0053] 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.

[0054] According to the embodiments shown in the cited figures, the first pole terminal 11 is at least partially accommodated in a portion of internal volume defined by the first bushing 43 while the second pole terminal 12 is at least partially accommodated in a portion of internal volume defined by the second bushing 44.

[0055] Preferably, for each electric pole, the first and second pole terminals 11, 12 are arranged at opposite sides of the switching apparatus and are aligned one to another along a first alignment direction D1 (figure 2).

[0056] 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.

[0057] 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 20 as better explained in the following.

[0058] 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 ori-

ented 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. With reference to the observation plane of figure 2 and 12, the above-mentioned first rotation direction R1 is oriented counter-clockwise while the above-mentioned second rotation direction R2 is oriented clockwise.

[0059] 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;
- 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;
- 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.

[0060] 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.

[0061] 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").

[0062] 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").

[0063] 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 in any way.

[0064] 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.

[0065] 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.

[0066] 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.

[0067] 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.

[0068] 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, and a second end-of-run position Pc, which corresponds to a grounded state of the switching apparatus. Conveniently, the movable contact 10 passes through an intermediate position P_B, which corresponds to an open state of the switching apparatus, when it moves between the first and second end-of-run positions P_A, P_C.

[0069] 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. In this way, the movable contact 10 can electrically connect or electrically disconnect these fixed contacts depending on the on-going manoeuvre.

[0070] 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.

[0071] When it is in the second end-of-run position Pc

(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 and, consequently, the second and third pole terminals 12, 13.

[0072] Preferably, 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" configuration). Preferably, in the switching apparatus of the invention, for each electric pole, the fourth fixed contact 8 is arranged in an intermediate position between the first fixed contact 5 and the second fixed contact 6 while the third fixed contact 7 is arranged in an intermediate position between the first fixed contact 5 and the second fixed contact 6.

[0073] Preferably, the first fixed contact 5 is arranged so as to be laterally displaced relative to the first alignment direction D1 of the first and second pole terminals 11, 12. For each electric pole, the first and second fixed contacts 5, 6 have contact regions arranged at opposite sides of the switching apparatus relative to the rotation axis A1 of the movable contact 10 and aligned one to another. The alignment direction of these contact regions is angularly spaced from the first alignment direction D1 of the first and second pole terminals 11, 12.

[0074] This solution allows improving the structural compactness of the electric poles of the switching apparatus while ensuring safe dielectric distances between the live internal components. As the first and second fixed contact 5, 6 have contact regions misaligned with the first and second pole terminals 11, 12, a free space in proximity of the first pole terminal 11 can be conveniently exploited for accommodating some cumbersome components of the electric pole, as it will better emerge from the following.

[0075] 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.

[0076] Preferably, the first fixed contact 5 is formed by a conductive body having a leg coupled to the first pole terminal 11 and a blade-shaped free end forming a contact region with the movable contact 10.

[0077] 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 blade-shaped free ends and protrusions forming different contact regions with the movable contact 10. 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 forming a contact region with the movable contact 10.

[0078] Preferably, the fourth fixed contact 8 is formed a contoured flat conductive body slidingly couplable to the movable contact 10.

[0079] Preferably, the fourth fixed contact 8 is supported by a support member 250, which is conveniently fixed to or made in a single piece with the support structure 25 of a vacuum interrupter 20 of the switching apparatus.

[0080] Preferably, the support member 250 is made of electrically insulating material. A conductor (not shown) is conveniently arranged in the internal volume of the support member 250 to connect electrically the fourth fixed contact 8 to a movable arc contact 22 of the vacuum interrupter 20.

[0081] The movable contact 10 has a first movable contact region 10A and a second movable contact region 10B arranged at opposite positions relative to the rotation axis A1 of the movable contact 10.

[0082] Preferably, the first and second movable contact regions 10A, 10B of the movable contact 10 are aligned one to another along a same direction.

[0083] 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 mechanically and electrically coupled to or uncoupled from the first fixed 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, Pc;
- the second movable contact region 10B of the movable contact 10 can be mechanically and electrically coupled 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.

[0084] 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.

[0085] As mentioned above, 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.

[0086] Preferably, when it is in the second end-of-run position Pc, 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.

[0087] Preferably, when it moves between the first and second end-of-run positions P_A and Pc, the movable contact 10 slidingly couples (at the first movable contact region 10A) to the fourth fixed contact 8.

[0088] 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 this latter couples to said fourth fixed contact 8 before decoupling from the first fixed contact 5, when said movable contact moves according to the first rotation direction R1 (during an opening manoeuvre of the switching apparatus), 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 (during a closing manoeuvre of the switching apparatus).

[0089] Advantageously, the movable contact 10 is formed by a shaped piece of conductive material.

[0090] 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) forming the second movable contact region 10B.

[0091] 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 as shown in the cited figures. Preferably, the switching apparatus 1 comprises an actuation assembly providing suitable actuation forces to actuate the movable contacts 10 of the electric poles.

[0092] 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 (figure 1).

[0093] The motion transmission shaft 9 thus provides rotational mechanical forces to actuate the movable contacts 10 during the manoeuvres of the switching apparatus.

[0094] 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.

[0095] 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.

[0096] According to the invention, for each electric pole 2, the switching apparatus 1 comprises a vacuum interrupter 20.

[0097] The vacuum interrupter 20 comprises a fixed arc contact 21 electrically connected to the first pole terminal 11, preferably in parallel to the first fixed contact 5.

[0098] Preferably, the fixed arc contact 21 is formed by an elongated piece of conductive material having one end coupled to the first pole terminal 11 and an opposite free end intended to be coupled to or decoupled from another arc contact.

[0099] 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.

[0100] As it is reversibly movable about the displacement axis A, the movable arc contact 22 can be coupled to or separated from the fixed arc contact 21, thereby being electrically connected to or electrically disconnected from this latter.

[0101] The movable arc contact 22 is electrically connected to the fourth fixed contact 8 through a conductor (e.g. a flexible conductor) or other equivalent connection means accommodated in the internal volume of the support member 250.

[0102] Preferably, the movable arc contact 22 is solidly coupled to a shaft member 24, which is preferably made of an electrically conductive material (figures 3, 5, 18-19).

[0103] Preferably, the shaft member 24 is aligned with the movable arc contact 22 along the translation axis A and it is conveniently arranged inside and coaxially with the hollow electrically insulating tube forming the support member 250 of the fourth fixed contact 8.

[0104] Preferably, the movable arc contact 22 is formed by an elongated piece of conductive material having an end coupled to the shaft member 24 and an opposite free end intended to be coupled with or separated from the fixed contact 21.

[0105] The vacuum interrupter 20 comprises a vacuum chamber 23, in which a vacuum atmosphere is present.

[0106] Conveniently, the fixed arc contact 21 and the movable arc contact 22 are enclosed in the vacuum chamber 23 and they are mutually coupled or decoupled inside said vacuum chamber, therefore being permanently immersed in a vacuum atmosphere.

[0107] 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. Advantageously, the fixed support structure 25 mechanically supports the support member 250, which in turn mechanically supports the fourth fixed contact 8.

[0108] Preferably, in the embodiments shown in the cited figures, for each electric pole, the vacuum interrupter 20 is at least partially accommodated (together with the first pole terminal 11) in a portion of internal volume defined by the first bushing 43 of the insulating housing 4 of the switching apparatus.

[0109] The above-illustrated solution allows displacing the vacuum interrupter 20 and the motion transmission mechanism 30 towards the top of the insulating housing 4, which allows reducing the overall height of the switching apparatus while ensuring safe dielectric distances between the live internal components.

[0110] For each electric pole 2, the switching apparatus 1 comprises a motion transmission mechanism 30 operatively coupled to the movable arc contact 22 (preferably through the shaft member 24) and actuatable 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.

[0111] According to the invention, the motion transmis-

sion mechanism 30 comprises a slider member 31 solidly coupled to the movable arc contact 22 in such a way to move translationally together with said movable arc contact.

[0112] Preferably, the motion transmission mechanism 30 comprises the shaft member 24 mechanically coupling the slider member 31 to the movable arc contact 22.

[0113] Preferably, the slider member 31 comprises a jig 311 mechanically coupled with an end of the shaft 24 in distal position relative to the movable arc contact 22, and one or more rollers 312 supported by the jig 311 and forming one or more sliding surfaces for the movable contact 10 (figures 18-19).

[0114] In the embodiment shown in the cited figures, the jig 311 is formed by a small plate of conductive material (e.g. steel) arranged in parallel to the fourth fixed contact 8 and fixed in a known manner to the shaft 24. Advantageously, two pairs of rollers 312 are arranged at opposite sides of the jig 311. Each pair of rollers 312 forms a slidable coupling surface for a corresponding contact blade of the movable contact 10.

[0115] According to alternative embodiments, the rollers 312 of the slider member 31 may be replaced by suitable sliding edges protruding laterally from the jig 311. Other solutions, which are here not described in details for the sake of brevity, are possible, according to the needs.

[0116] As mentioned above, the slider member 31 is translationally movable together with the movable arc contact 22 (and the shaft member 24). In particular, the slider member 31 is reversibly movable between a first position P1, which corresponds to the coupled position P3 of the movable arc contact 22, and a second position P2, which corresponds to the uncoupled position P4 of the movable arc contact 22.

[0117] Referring to the observation plane of figure 2, the first and second position P1, P2 of the slider member 31 correspond respectively to proximal (upper) and distal (lower) positions of said slider member relative to the vacuum chamber 23.

[0118] Preferably, the slider member 31 moves along the same translation axis A of the movable arc contact 22 (and the shaft member 24).

[0119] According to the invention, the slider member 31 is actuated by the movable contact 10, during an opening manoeuvre of said switching apparatus, when said movable contact moves according to the first rotation direction R1.

[0120] When it is actuated by the movable contact 10, the slider member 31 moves from the first position P1 to the second position P2 and it makes the movable arc contact 22 move from the coupled position P3 to the uncoupled position P4.

[0121] Preferably, the slider member 31 is mechanically couplable to the movable contact 10 through a cam coupling. In this way, the rotational motion of the movable contact 10 about the rotation axis A1 can easily cause a translational motion of the slider member 31 (and of the movable arc contact 22) along the translation axis A.

[0122] Preferably, the movable contact 10 comprises one or more first actuating portions 10D with a cam profile, which are mechanically couplable to the slider member 31.

[0123] In the embodiments shown in the cited figures, each first actuating portion 10D is formed by a first protrusion with cam profile, which raises from a lateral surface of a corresponding contact blade of the movable contact 10, conveniently at the first movable contact region 10A. Each first protrusion 10D is conveniently configured to couple slidingly with a corresponding pair of sliding rollers 312 of the slider member 31.

[0124] According to alternative embodiments, the cam coupling between the movable contact 10 and the slider member 31 may be configured differently. As an example, the movable contact 10 may include with a linear profile or including one or more rollers while the slider member 31 may include suitable sliding edges with a cam profile. Other solutions, which are here not described in details for the sake of brevity, are possible, according to the needs.

[0125] Preferably, the slider member 31 is mechanically coupled to and actuated by the movable contact 10, when this latter electrically connects the fourth fixed contact 8 to the second fixed contact 6 (in practice when the movable contact 10 is slidingly coupled to the fourth fixed contact 8 and the second fixed contact 6), during an opening manoeuvre of the switching apparatus.

[0126] According to the invention, the motion transmission mechanism 10 comprises a blocking member 32 configured to block the slider member 31 in the second position P2, when said slider member reaches the second position P2 upon actuation by the movable contact 10, during an opening manoeuvre of the switching apparatus.

[0127] Preferably, the blocking member 32 moves translationally together with the slider member 31 when this latter moves between the first and second positions P1, P2 (and the movable arc contact 22 moves between the coupled and uncoupled positions P3, P4).

[0128] Preferably, when the slider member 31 reaches the second position P2 (when moving from the first position P1 to the second position P2), the blocking member 32 takes a blocking position P5. At such a blocking position, the blocking member 32 stably engages a fixed support 250 and it blocks the slider member 31 in the second position P2. In this way, the movable arc contact 22 can be blocked in the uncoupled position P4.

[0129] For the sake of clarity, it is specified that the blocking member 32 stably engages a fixed support 250 in the sense that the blocking member 32 can maintain such an engagement condition until it is actuated to be removed from the blocking position P5.

[0130] Preferably, when it is in the blocking position P5, the blocking member 32 is actuated by the movable contact 10, during a closing manoeuvre of the switching

apparatus, when said movable contact moves according to the second rotation direction R2.

[0131] When it is actuated by the movable contact 10, the blocking member 32 is removed from the blocking position P5. In this situation, the slider member 31 is free to move from the second position P2 to the first position P1 and the movable arc contact 22 is free to move from the uncoupled position P4 to the coupled position P3. These translation movements of the movable arc contact 22 and the slider member 31 (together with the shaft member 24 and the blocking member 32 itself) are caused by the vacuum attraction force generated by the vacuum atmosphere in the vacuum chamber 23.

[0132] Advantageously, the blocking member 32 is formed by a shaped piece of conductive material.

[0133] Preferably (figures 8, 10, 13, 15, 18-19), the blocking member 32 comprises a support bush 320 coaxially coupled to the shaft member 24 in such a way that this latter passes through said bush. In this way, the support bush 320 results substantially sandwiched between suitable holding edges of the movable arc contact 22 and the shaft member 24, thereby being forced to move together with the movable arc contact 22, the shaft member 24 and the slider member 31 when these latter components move along the translation axis A. At the same time, the support bush 320 is free to rotate about the translation axis A relative to the movable arc contact 22, the shaft 24 and the slider member 31.

[0134] Preferably, the blocking member 32 comprises a first pin 321 and a second pin 322 protruding from a lateral surface of the support bush 320, conveniently at opposite sides of this latter. The first pin 321 of the blocking member is slidingly coupled to a slot 251 of the support member 250. Conveniently, the slot 251 has a twisted profile in such a way that the whole blocking member 32 is forced to rotate about the translation axis A, when it moves along said translation axis together with the movable arc contact 22, the shaft member 24 and the slider member 31. The slot 251 is configured so that the first pin 321 reaches a shaped end 251A of this slot, when the blocking member 32 reaches the blocking position P5 by moving along the translation axis A and, at the same time, rotating about such a translation axis.

[0135] The end 251A of the slot 251, which is conveniently located in distal position relative to the vacuum chamber 23, is shaped (for example with a hooked profile) in such a way that the first pin 321 stably engages the support member 250. In this way, the blocking member 32 is capable of blocking the slider member 31 in the second position P2 (and consequently the movable arc contact 22 in the uncoupled position P4) when it reaches the blocking position P5 (and the first pin 321 reaches the end 251A of the slot 251). The blocking member 32 can thus prevent any movement of the assembly formed by the slider member 31, the shaft member 24 and the movable arc contact 22 until it is removed from the blocking position P5 (and the first pin 321 is moved away from the end 251A of the slot 251).

[0136] The second pin 322 of the blocking member includes a shaped head that is conveniently positioned along the trajectory of the movable contact 10 when the blocking member 32 reaches the blocking position P5, following its roto-translation movement along the translation axis A. During a closing manoeuvre of the switching apparatus, the movable contact 10 hits the second pin 322 and actuates the blocking member 32, thereby causing a counter-rotation of this latter about the translation axis A. Due to this counter-rotation movement, the first pin 321 is moved away from the end 251A of the slot 251 and it is again free to slide along the slot 251. The blocking member 32 is removed from the blocking position P5 and it can freely move along the translation axis A together with the slider member 31, the shaft member 24 and the movable arc contact 22. In this situation, the slider member 31 moves from the second position P2 to the first position P1 and the movable arc contact 22 moves from the uncoupled position P4 to the coupled position P3 due to the vacuum attraction force.

[0137] Preferably, the movable contact 10 comprises one or more second actuating portions 10C, which are mechanically couplable to the blocking member 32, in particular to the second pin 322 of said blocking member.

[0138] In the embodiments shown in the cited figures, the movable contact 10 comprises a second actuating portion 10C formed by a second protrusion raising from a lateral surface of a suitable contact blade of the movable contact 10. The second protrusion 10C is configured to hit the second pin 322 of the blocking member 32 thereby causing a rotation of this latter about the translation axis A.

[0139] In principle, however, the second actuating portion 10C may be configured according to other solutions, which are here not described in details for the sake of brevity.

[0140] From above, it is apparent that the motion transmission mechanism is capable of taking alternatively a first configuration C1 and a second configuration C2.

[0141] 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. When the motion transmission mechanism takes the first configuration C1, the slider member 31 is in the first position P1 and the blocking member 32 is not stably engaged with the support member 250.

[0142] The motion transmission mechanism 30 can maintain stably the first configuration C1 until the slider member 31 is actuated by the movable contact 10, during an opening manoeuvre of the switching apparatus.

[0143] 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 uncou-

pled position P4 from the fixed arc contact 21.

[0144] When the motion transmission mechanism takes the second configuration C2, the slider member 31 is in the second position P2 and the blocking member 32 is in the blocking position P5, at which it is stably engaged with the support member 250.

[0145] The motion transmission mechanism 30 can maintain stably the second configuration C2 until the blocking member 32 is actuated by the movable contact 10, during a closing manoeuvre of the switching apparatus.

[0146] Any transition of configuration of the motion transmission mechanism 30 causes a corresponding movement of the movable arc contact 22 and a consequent change of condition of the vacuum interrupter 20.

[0147] The motion transmission mechanism 30 is configured to switch from the first configuration C1 to the second configuration C2 upon an actuation of the slider member 31 by the movable contact 10 while said movable contact is moving according to the first rotation direction R1 (opening manoeuvre of the switching apparatus) and it electrically connects the fourth fixed contact 8 to the second fixed contact 6 (as it is coupled to said fixed contacts).

[0148] 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.

[0149] The motion transmission mechanism 30 is configured to switch from the second configuration C2 to the first configuration C1 upon an actuation of the blocking member 32 by the movable contact 10, while said movable contact is moving according to the second rotation direction R2 (closing manoeuvre of the switching apparatus) and it electrically connects the first fixed contact 5 to the second fixed contact 6 (since it is coupled to said fixed contacts).

[0150] 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.

[0151] 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 8, 10, 13 and 15.

Transition from the first configuration C1 to the second configuration C2

[0152] Figure 8 shows the motion transmission mechanism 30 in the first configuration C1.

[0153] In this situation, the slider member 31 is in the first position P1, the movable arc contact 22 is in the coupled position P3 and the blocking member 32 is not stably engaged with the support member 250.

[0154] Upon actuation of the slider member 31 by the movable contact 10, the motion transmission mechanism 30 transmits a force to the movable arc contact 22, which is directed to decouple this latter from the fixed arc contact 21.

[0155] The movable arc contact 22 thus moves away from the fixed arc contact 21 notwithstanding the vacuum attraction force of the vacuum chamber 23 as the assembly formed by the slider member 31, the shaft member 24, the blocking member 32 and the movable arc contact 22 moves along the translation axis A, according to a first translation direction T1 (figure 8). While it is travelling along the translation axis A, the blocking member 32 coaxially rotates about said translation axis relative to the shaft member 24 and the movable arc contact 22, since the first pin 321 of the blocking member slides along the slot 251 with a twisted profile.

[0156] At the end, the slider member 31 reaches the second position P2 and the movable arc contact 22 reaches the uncoupled position P4. At the same time, the second pin 322 of the blocking member reaches the end 251A of the slot 251 (figure 8). The blocking member 32 thus reaches the blocking position P5, at which it stably engages the support member 250 (figures 10 and 13).

[0157] In this situation, the blocking member 32 prevents any counter-movement, along the translation axis A, of the assembly formed by the slider member 31, the shaft member 24, the blocking member 32 itself and the movable arc contact 22.

[0158] The movable arc contact 22 can thus stably maintain the uncoupled position P4 notwithstanding the vacuum attraction force generated by the vacuum atmosphere in the vacuum chamber 23.

Transition from the second configuration C2 to the first configuration C1

[0159] Figures 10, 13 show the motion transmission mechanism 30 in the second configuration C2. In this situation, the slider member 31 is in the second position P2, the movable arc contact 22 is in the uncoupled position P4 and the blocking member 32 is in the blocking position P5, at which it is stably engaged with the support member 250.

[0160] Upon actuation of the second pin 322 of the blocking member by the movable contact 10 (figure 15), the blocking member 32 counter-rotates about the translation axis A relative to the shaft member 24 and the movable arc contact 22 and it is removed from the clocking position P5. As the blocking member 32 is no more stably engaged with the support member 250, the assembly formed by the slider member 31, the shaft member 24, the blocking member 32 itself and the movable arc contact 22 is free to move along the translation axis A.

[0161] The movable arc contact 22 is subject to the vacuum attraction force, which is directed to couple this latter to the fixed arc contact 21.

[0162] The movable arc contact 22 thus moves towards from the fixed arc contact 21 as the assembly

formed by the slider member 31, the shaft member 24, the blocking member 32 and the movable arc contact 22 moves along the translation axis A, according to a second translation direction T2, opposite to the first direction translation T1 (figure 15).

[0163] While it is travelling along the translation axis A, the blocking member 32 coaxially counter-rotates about said translation axis relative to the shaft member 24 and the movable arc contact 22, as the pin 322 slides along the slot 251 with a twisted profile.

[0164] At the end, the slider member 31 reaches the first position P1, the movable arc contact 22 reaches the coupled position P3. The blocking member 32 is not stably engaged with the support member 250 (figure 8) and it does not exert any blocking action.

[0165] The movable arc contact 22 can stably maintain the coupled position P3 due the vacuum attraction force generated by the vacuum atmosphere in the vacuum chamber 23.

[0166] 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

[0167] When the switching apparatus is in a closed state, each electric pole 2 is in the operating condition illustrated in figures 2-3.

[0168] 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 coupled to the first and second fixed contacts 5, 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 any fixed contact;
- 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.

[0169] The first slider member 31 is in the first position P1, which is located along the motion trajectory of the movable contact 10. The blocking member 32 has the first pin 321 free to slide along the slot 251 and the second pin 322 positioned away from the motion trajectory of the movable contact 10.

[0170] 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.

Open state of the switching apparatus

[0171] When the switching apparatus is in an open state, each electric pole 2 is in the condition shown in figure 11.

[0172] In this situation, each electric pole 2 has:

- the movable contact 10 in the intermediate position P_B;
- the movable contact 10 decoupled from any fixed contact;
- the first, second, third and fourth fixed contacts 5, 6, 7, 8 electrically disconnected one from another;
- 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.

[0173] The first slider member 31 is in the second position P2, which is located away from the motion trajectory of the movable contact 10. The blocking member 32 is in the blocking position P5, at which it stably engages the support member 250, and it has the first pin 321 positioned at the end 251A of the slot 250 and the second pin 322 positioned along the motion trajectory of the movable contact 10.

[0174] No currents can flow between the first and second pole terminals 11, 12.

Grounded state of the switching apparatus

[0175] When the switching apparatus is in a grounded state, each electric pole 2 is in the condition illustrated in figure 17.

[0176] In this situation, each electric pole 2 has:

- the movable contact 10 in the second end-of-run position Pc;
- the movable contact 10 coupled to the second and third fixed contacts 6, 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 any fixed contact;
- 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;

[0177] The first slider member 31 is in the second position P2 while the blocking member 32 is in the blocking position P5 and it has the first pin 321 positioned at the end 251A of the slot 250 and the second pin 322 positioned along the motion trajectory of the movable contact 10.

[0178] 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

[0179] The switching apparatus 1 carries out an opening manoeuvre, when it switches from the closed state to the open state.

[0180] During an opening manoeuvre of the switching apparatus, the 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. The movable contact 10 thus moves away from the corresponding first fixed contact 5 (figure 4).

[0181] When the movable contact 10 starts moving according to the first rotation direction R1, the movable contact 10 couples (at the first movable contact region 10A) to the fourth fixed contact 8 while still being slidingly coupled to the first fixed contact 5. The movable contact 10 remains slidingly coupled (at the second movable contact region 10B) to the second fixed contact 6 (figures 4-5).

[0182] 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.

[0183] At this stage of the opening manoeuvre, the movable contact 10 does not interact with the motion transmission mechanism 30 yet.

[0184] Upon a further movement according to the first rotation direction R1, the movable contact 10 decouples from the first fixed contact 5 while remaining slidingly coupled to the fourth fixed contact 8 and the second fixed contact 6 (figures 6-7).

[0185] 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.

[0186] While it is slidingly coupled to the fourth fixed contact 8 and to the second fixed contact 6, the movable contact 10 (namely the first actuating portions 10D) couples to and actuates the slider member 31 (namely the rollers 312 - figures 6-7).

[0187] The actuation of the slider member 31 by the movable contact 10 causes a transition of the motion transmission mechanism 30 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.

[0188] 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.

[0189] 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.

[0190] The motion transmission mechanism 30 stably maintains the second configuration C2 with the slider member in the second position P2 and the blocking member 32 in the blocking position P5.

[0191] 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 (figures 9-10).

[0192] The movable contact 10 then reaches the intermediate position P_B, which corresponds to an open state of the switching apparatus (figure 11).

Closing manoeuvre

[0193] The switching apparatus 1 carries out a closing manoeuvre, when it switches from the open state to the close state.

[0194] Before carrying out a closing manoeuvre, the switching apparatus may have carried out a reconnecting manoeuvre in order to switch in an open state.

[0195] During a closing manoeuvre of the switching apparatus, the 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. The movable contact 10 thus moves towards the corresponding first fixed contact 5 (figures 12-16).

[0196] 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.

[0197] At this stage of the closing manoeuvre, the movable contact 10 does not interact with the motion transmission mechanism 30 yet (figures 12-14).

[0198] Upon a further movement according to the second rotation direction R2, the movable contact 10 (namely the second actuating portion 10C thereof) couples to and actuates the blocking member 32 (namely the second pin 322 thereof) while being still slidingly coupled to the fourth fixed contact 8 and to the second fixed contact

6 (figures 14-15). 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.

[0199] The actuation of the blocking member 32 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. The blocking member 32 is, in fact, removed from the blocking position P5 and the movable arc contact 22 is free to move towards the fixed arc contact 21 due to the vacuum attraction force of the vacuum chamber 23.

[0200] In the meanwhile, the movable contact 10 maintains the fourth fixed contact 8 electrically connected to the second fixed contact 6.

[0201] Upon a further movement according to the second rotation direction R2, the movable contact 10 couples to the first fixed contact 5 before decoupling from the fourth fixed contact 8 (figure 16).

[0202] Upon a further movement according to the second rotation direction R2, the movable contact 10 decouples from the fourth fixed contact 8 while remaining slidingly coupled to the first fixed contact 5 and to the second fixed contact 6.

[0203] 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.

[0204] 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

[0205] The switching apparatus 1 carries out a disconnecting manoeuvre, when it switches from an open state to a grounded state.

[0206] 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.

[0207] During a disconnecting manoeuvre of the switching apparatus, the movable contact 10 moves, according to the first rotation direction R1, between the intermediate position P_B and the second end-of-run position Pc.

[0208] When it reaches the second end-of-run position Pc, the movable contact 10 couples the second fixed contact 6 to the third fixed contact 7, thereby electrically connecting 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. 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

[0209] The switching apparatus 1 carries out a reconnecting manoeuvre, when it switches from a grounded state to an open state.

[0210] During a reconnecting manoeuvre of the switching apparatus, the movable contact 10 moves, according to the second rotation direction R2, between the second end-of-run position Pc and the intermediate position P_B.

[0211] In this way, the first movable contact 10 decouples from the second fixed contact 6 and from the third fixed contact 7, thereby electrically disconnecting the second fixed contact 6 from the third fixed contact 7. 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 therefore results at a floating voltage.

[0212] 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.

[0213] The operation of the switching apparatus occurs according to similar operating modes, if the switching apparatus is of the "single-disconnection" type.

[0214] The switching apparatus, according to the invention, provides remarkable advantages with respect to the known apparatuses of the state of the art.

[0215] 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.

[0216] The motion transmission mechanism 30 does not include levers rotating about rotation axes parallel to the rotation axis A1 of the movable contact 10. This solution allows reducing the size of the motion transmission mechanism.

[0217] As illustrated above, in operation, different members 31, 32 of the motion transmission mechanism are actuated by the movable contact 10 during the opening and closing manoeuvres of the switching apparatus. This solution improves and makes easier the synchronization between the movement of the movable arc contact 22 and the movement of the movable contact 10.

[0218] 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.

[0219] 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.

[0220] 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.

[0221] The switching apparatus, according to the invention, ensures, at the same time, high-level performances in terms of dielectric insulation and arc-quenching capabilities during the current breaking process and high levels of reliability for the intended applications.

[0222] The switching apparatus, according to the invention, is of relatively easy and cheap industrial production 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 first pole terminal (11), a movable arc contact (22) electrically connected to said fourth fixed contact (8) 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);

   characterized in that said motion transmission mechanism (30) comprises a slider member (31) solidly coupled to said movable arc contact (22) in such a way to move translationally together with said movable arc contact, said slider member (31) being reversibly movable between a first position (P1), which corresponds to the coupled position (P3) of said movable arc contact, and a second position (P2), which corresponds to the uncoupled position (P4) of said movable arc contact,

   wherein said slider member (31) is configured to be actuated by said movable contact (10), during an opening manoeuvre of said switching apparatus, said slider member (31) moving from said first position (P1) to said second position (P2), when said slider member is actuated by said movable contact (10),

   wherein said motion transmission mechanism (30) comprises a blocking member (32) configured to block said slider member (31) in said second position (P2), when said slider member reaches said second position (P2) upon actuation by said movable contact (10).

2. Switching apparatus, according to claim 1, **characterized in that** said slider member (31) is mechanically couplable to said movable contact (10) through a cam coupling.

3. Switching apparatus, according to claim 2, **characterized in that** said movable contact (10) comprises one or more first actuating portions (10D) mechanically couplable to said slider member (31) to actuate said slider member, wherein said first actuating portions (10D) have a cam profile.

4. Switching apparatus, according to one of the previous claims, **characterized in that** said slider member (31) is actuated by said movable contact (10),

when said movable contact electrically connects said fourth fixed contact (8) to said second fixed contact (6), during an opening manoeuvre of the switching apparatus.

5. Switching apparatus, according to one of the previous claims, **characterized in that** said blocking member (32) is configured to move translationally together with said slider member (31) and take a blocking position (P5) when said slider member reaches said second position (P2), said blocking member (32) stably engaging a fixed support (250) to block said slider member (31) in said second position (P2), when said blocking member takes said blocking position (P5).

6. Switching apparatus, according to one of the previous claims, **characterized in that** said blocking member (32) is configured to be actuated by said movable contact (10), during a closing manoeuvre of said switching apparatus, said blocking member (32) being removed from said blocking position (P5), when said slider member is actuated by said movable contact (10).

7. Switching apparatus, according to claim 6, **characterized in that** said blocking member (32) is actuated by said movable contact (10), when said movable contact electrically connects said fourth fixed contact (8) to said second fixed contact (6), during a closing manoeuvre of the switching apparatus.

8. Switching apparatus, according to one of the claims from 6 to 7, **characterized in that** said movable contact (10) comprises one or more second actuating portions (10C) mechanically couplable to said blocking member (32) to actuate said blocking member.

9. Switching apparatus, according to one of the previous claims, **characterized in that**, for each electric pole, said first and second pole terminals (11, 12) are arranged at opposite sides of said switching apparatus relative to the rotation axis (A1) of said movable contact (10) and are aligned one to another along a first alignment direction (D1) crossing the rotation axis (A1) of said movable contact (10), wherein said first fixed contact (5) is laterally displaced relative to said first alignment direction.

10. Switching apparatus, according to claim 9, **characterized in that**, for each electric pole, said first pole terminal (11) and said vacuum interrupter (20) are at least partially accommodated in a portion of internal volume defined by a bushing (43) of the insulating housing (4) of said switching apparatus arranged along said first alignment direction (D1).

11. Switching apparatus, according to one of the previous claims, **characterized in that** said movable contact (10) is reversibly movable between a first end-of-run position (P_A), which corresponds to a closed state of said switching apparatus, and a second end-of-run position (Pc), which corresponds to a grounded state of said switching apparatus, said movable contact (10) passing through an intermediate position (P_B), which corresponds to an open state of said switching apparatus, when moving between said first and second end-of-run positions (P_A, P_C),

wherein said movable contact (10) has a first movable contact region (10A) and a second movable contact region (10B) arranged at opposite positions relative to the rotation axis (A1) of said movable contact,
wherein said movable contact (10) has said first movable contact region (10A) coupled to said first fixed contact (5) and said second movable contact region (10B) coupled to said second fixed contact (6), thereby electrically connecting said first and second fixed contacts (5, 6), when said movable contact (10) is in said first end-of-run position (P_A); wherein said movable contact (10) is coupled to no fixed contacts, when said movable contact (10) is in said intermediate position (P_B);
wherein said movable contact (10) has said first movable contact region (10A) coupled to said second fixed contact (6) and said second movable contact region (10B) coupled to said third fixed contact (7), thereby electrically connecting said second and third fixed contacts (6, 7), when said movable contact (10) is in said second end-of-run position (Pc).

12. Switching apparatus, according to claim 11, **characterized in that** each movable contact region (10A, 10B) of said movable contact (10) comprises at least a contact blade.

13. Switching apparatus, according to one of the previous claims, **characterized in that** it is a load-break switch for medium voltage electric systems.

Patentansprüche

1. Schaltvorrichtung (1) für elektrische Mittelspannungssysteme, wobei die Schaltvorrichtung einen oder mehrere elektrische Pole (2) umfasst, wobei die Schaltvorrichtung für jeden elektrischen Pol Folgendes umfasst:

- einen ersten Polanschluss (11), einen zweiten Polanschluss (12) und einen Masseanschluss (13), wobei der erste Polanschluss (11) mit einem ersten Leiter einer elektrischen Leitung

elektrisch koppelbar ist, wobei der zweite Polanschluss (12) mit einem zweiten Leiter der elektrischen Leitung elektrisch koppelbar ist und der Masseanschluss (13) mit einem Erdungsleiter elektrisch koppelbar ist;
- eine Vielzahl von festen Kontakten, die voneinander beabstandet sind, wobei die Vielzahl von festen Kontakten einen ersten festen Kontakt (5) umfasst, der elektrisch mit dem ersten Polanschluss (11) verbunden ist, einen zweiten festen Kontakt (6), der elektrisch mit dem zweiten Polanschluss (12) verbunden ist, einen dritten festen Kontakt (7), der elektrisch mit dem Masseanschluss (13) verbunden ist, und einen vierten festen Kontakt (8);
- einen beweglichen Kontakt (10), der um eine entsprechende Drehachse (A1) gemäß entgegengesetzten ersten und zweiten Drehrichtungen (R1, R2) reversibel beweglich ist, so dass der bewegliche Kontakt mit den festen Kontakten (5, 6, 7, 8) gekoppelt oder von diesen entkoppelt werden kann;
- einen Vakuumschalter (20), umfassend einen festen Lichtbogenkontakt (21), der elektrisch mit dem ersten Polanschluss (11) verbunden ist, einen beweglichen Lichtbogenkontakt (22), der elektrisch mit dem vierten festen Kontakt (8) verbunden ist und entlang einer entsprechenden Translationsachse (A) zwischen einer mit dem festen Lichtbogenkontakt (21) gekoppelten Position (P3) und einer von dem festen Lichtbogenkontakt (21) entkoppelten Position (P4) reversibel beweglich ist, und eine Vakuumkammer (23), in der der feste Lichtbogenkontakt (21) und der bewegliche Lichtbogenkontakt (22) eingeschlossen sind und gekoppelt oder entkoppelt werden können;
- einen Bewegungsübertragungsmechanismus (30), der betriebsfähig mit dem beweglichen Lichtbogenkontakt (22) gekoppelt ist, wobei der Bewegungsübertragungsmechanismus durch den beweglichen Kontakt (10) betätigbar ist, um eine Bewegung des beweglichen Lichtbogenkontakts (22) entlang der Translationsachse (A) zu bewirken, wenn sich der bewegliche Kontakt um die Drehachse (A1) bewegt;
dadurch gekennzeichnet, dass der Bewegungsübertragungsmechanismus (30) ein Schieberelement (31) umfasst, das fest mit dem beweglichen Lichtbogenkontakt (22) so gekoppelt ist, dass es sich zusammen mit dem beweglichen Lichtbogenkontakt translatorisch bewegt, wobei das Schieberelement (31) zwischen einer ersten Position (P1), die der gekoppelten Position (P3) des beweglichen Lichtbogenkontakts entspricht, und einer zweiten Position (P2), die der entkoppelten Position (P4) des beweglichen Lichtbogenkontakts entspricht, reversibel beweglich ist,
wobei das Schieberelement (31) ausgebildet ist, um durch den beweglichen Kontakt (10) während eines Öffnungsvorgangs der Schaltvorrichtung betätigt zu werden, wobei sich das Schieberelement (31) von der ersten Position (P1) in die zweite Position (P2) bewegt, wenn das Schieberelement durch den beweglichen Kontakt (10) betätigt wird,
wobei der Bewegungsübertragungsmechanismus (30) ein Blockierelement (32) umfasst, das ausgebildet ist, um das Schieberelement (31) in der zweiten Position (P2) zu blockieren, wenn das Schieberelement die zweite Position (P2) bei Betätigung durch den beweglichen Kontakt (10) erreicht.

2. Schaltvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** das Schieberelement (31) über eine Nockenkupplung mechanisch mit dem beweglichen Kontakt (10) gekoppelt werden kann.

3. Schaltvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der bewegliche Kontakt (10) einen oder mehrere erste Betätigungsteile (10D) umfasst, die mechanisch mit dem Schieberelement (31) gekoppelt werden können, um das Schieberelement zu betätigen, wobei die ersten Betätigungsteile (10D) ein Nockenprofil aufweisen.

4. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Schieberelement (31) durch den beweglichen Kontakt (10) betätigt wird, wenn der bewegliche Kontakt während eines Öffnungsvorgangs der Schaltvorrichtung den vierten festen Kontakt (8) mit dem zweiten festen Kontakt (6) elektrisch verbindet.

5. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Blockierelement (32) ausgebildet ist, um sich zusammen mit dem Schieberelement (31) translatorisch zu bewegen und eine Blockierposition (P5) einzunehmen, wenn das Schieberelement die zweite Position (P2) erreicht, wobei das Blockierelement (32) stabil mit einem festen Träger (250) in Eingriff steht, um das Schieberelement (31) in der zweiten Position (P2) zu blockieren, wenn das Blockierelement die Blockierposition (P5) einnimmt.

6. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Blockierelement (32) ausgebildet ist, um während eines Schließvorgangs der Schaltvorrichtung durch den beweglichen Kontakt (10) betätigt zu werden, wobei das Blockierelement (32) aus der Blockierposition (P5) entfernt wird, wenn das Schieberelement durch den beweglichen Kontakt (10) betätigt wird.

7. Schaltvorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** das Blockierelement (32) durch den beweglichen Kontakt (10) betätigt wird, wenn der bewegliche Kontakt während eines Schließvorgangs der Schaltvorrichtung den vierten festen Kontakt (8) mit dem zweiten festen Kontakt (6) elektrisch verbindet.

8. Schaltvorrichtung nach einem der Ansprüche 6 bis 7, **dadurch gekennzeichnet, dass** der bewegliche Kontakt (10) einen oder mehrere zweite Betätigungsteile (10C) umfasst, die mechanisch mit dem Blockierelement (32) koppelbar sind, um das Blockierelement zu betätigen.

9. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** für jeden elektrischen Pol die ersten und zweiten Polanschlüsse (11, 12) an gegenüberliegenden Seiten der Schaltvorrichtung in Bezug auf die Drehachse (A1) des beweglichen Kontakts (10) angeordnet sind und entlang einer ersten Ausrichtungsrichtung (D1), die die Drehachse (A1) des beweglichen Kontakts (10) kreuzt, zueinander ausgerichtet sind, wobei der erste feste Kontakt (5) seitlich in Bezug auf die erste Ausrichtungsrichtung verschoben ist.

10. Schaltvorrichtung nach Anspruch 9, **dadurch gekennzeichnet, dass** für jeden elektrischen Pol der erste Polanschluss (11) und der Vakuumunterbrecher (20) zumindest teilweise in einem Abschnitt des Innenvolumens untergebracht sind, der durch eine Buchse (43) des Isoliergehäuses (4) der Schaltvorrichtung definiert ist, die entlang der ersten Ausrichtungsrichtung (D1) angeordnet ist.

11. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der bewegliche Kontakt (10) reversibel zwischen einer ersten Endposition (P_A), die einem geschlossenen Zustand der Schaltvorrichtung entspricht, und einer zweiten Endposition (Pc), die einem geerdeten Zustand der Schaltvorrichtung entspricht, bewegbar ist, wobei der bewegliche Kontakt (10) eine Zwischenposition (P_B) durchläuft, die einem offenen Zustand der Schaltvorrichtung entspricht, wenn er sich zwischen der ersten und der zweiten Endposition (P_A, Pc) bewegt,

    wobei der bewegliche Kontakt (10) einen ersten beweglichen Kontaktbereich (10A) und einen zweiten beweglichen Kontaktbereich (10B) aufweist, die an gegenüberliegenden Positionen relativ zur Drehachse (A1) des beweglichen Kontakts angeordnet sind,
    wobei der bewegliche Kontakt (10) den ersten beweglichen Kontaktbereich (10A) aufweist, der mit dem ersten festen Kontakt (5) gekoppelt ist, und den zweiten beweglichen Kontaktbereich (10B), der mit dem zweiten festen Kontakt (6) gekoppelt ist, wodurch der erste und der zweite feste Kontakt (5, 6) elektrisch verbunden werden, wenn sich der bewegliche Kontakt (10) in der ersten Endposition des Laufs (P_A) befindet;
    wobei der bewegliche Kontakt (10) mit keinen festen Kontakten gekoppelt ist, wenn sich der bewegliche Kontakt (10) in der Zwischenposition (P_B) befindet;
    wobei bei dem beweglichen Kontakt (10) der erste bewegliche Kontaktbereich (10A) mit dem zweiten festen Kontakt (6) gekoppelt ist und der zweite bewegliche Kontaktbereich (10B) mit dem dritten festen Kontakt (7) gekoppelt ist, wodurch der zweite und der dritte feste Kontakt (6, 7) elektrisch verbunden werden, wenn sich der bewegliche Kontakt (10) in der zweiten Endposition (Pc) befindet.

12. Schaltvorrichtung nach Anspruch 11, **dadurch gekennzeichnet, dass** jeder bewegliche Kontaktbereich (10A, 10B) des beweglichen Kontakts (10) mindestens ein Kontaktblatt umfasst.

13. Schaltvorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie ein Lasttrennschalter für elektrische Mittelspannungssysteme ist.

Revendications

1. Appareil de commutation (1) pour des systèmes électriques moyenne tension, ledit appareil de commutation comprenant un ou plusieurs pôles électriques (2), pour chaque pôle électrique, ledit appareil de commutation comprenant :

    - une première borne (11) de pôle, une deuxième borne (12) de pôle et une borne (13) de terre, ladite première borne (11) de pôle pouvant être couplée électriquement à un premier conducteur d'une ligne électrique, ladite deuxième borne (12) de pôle pouvant être couplée électriquement à un deuxième conducteur de ladite ligne électrique et ladite borne (13) de terre pouvant être couplée électriquement à un conducteur de mise à la terre ;
    - une pluralité de contacts fixes espacés les uns des autres, ladite pluralité de contacts fixes comprenant un premier contact fixe (5) connecté électriquement à ladite première borne (11) de pôle, un deuxième contact fixe (6) connecté électriquement à ladite deuxième borne (12) de pôle, un troisième contact fixe (7) connecté électriquement à ladite borne (13) de terre et un quatrième contact fixe (8) ;

- un contact mobile (10) mobile de manière réversible autour d'un axe de rotation (A1) correspondant selon des premier et deuxième sens de rotation (R1, R2) opposés, de sorte que ledit contact mobile peut être couplé auxdits contacts fixes (5, 6, 7, 8) ou découplé de ceux-ci ;
- un interrupteur à vide (20) comprenant un contact d'arc fixe (21) connecté électriquement à ladite première borne (11) de pôle, un contact d'arc mobile (22) connecté électriquement audit quatrième contact fixe (8) et mobile de manière réversible le long d'un axe de translation correspondant (A) entre une position couplée (P3) avec ledit contact d'arc fixe (21) et une position non couplée (P4) dudit contact d'arc fixe (21) et une chambre à vide (23), dans laquelle ledit contact d'arc fixe (21) et ledit contact d'arc mobile (22) sont enfermés et peuvent être couplés ou découplés ;
- un mécanisme de transmission de mouvement (30) couplé fonctionnellement audit contact d'arc mobile (22), ledit mécanisme de transmission de mouvement pouvant être actionné par ledit contact mobile (10) pour entraîner un mouvement dudit contact d'arc mobile (22) le long dudit axe de translation (A), lorsque ledit contact mobile se déplace autour dudit axe de rotation (A1) ;

caractérisé en ce que ledit mécanisme de transmission de mouvement (30) comprend un élément coulissant (31) couplé de manière solidaire audit contact d'arc mobile (22) de façon à se déplacer en translation conjointement avec ledit contact d'arc mobile, ledit élément coulissant (31) étant mobile de manière réversible entre une première position (P1), qui correspond à la position couplée (P3) dudit contact d'arc mobile, et une deuxième position (P2), qui correspond à la position non couplée (P4) dudit contact d'arc mobile,

ledit élément coulissant (31) étant configuré pour être actionné par ledit contact mobile (10), pendant une manoeuvre d'ouverture dudit appareil de commutation, ledit élément coulissant (31) se déplaçant de ladite première position (P1) à ladite deuxième position (P2), lorsque ledit élément coulissant est actionné par ledit contact mobile (10),

ledit mécanisme de transmission de mouvement (30) comprenant un élément de blocage (32) configuré pour bloquer ledit élément coulissant (31) dans ladite deuxième position (P2), lorsque ledit élément coulissant atteint ladite deuxième position (P2) lors de l'actionnement par ledit contact mobile (10).

2. Appareil de commutation, selon la revendication 1, **caractérisé en ce que** ledit élément coulissant (31) peut être couplé mécaniquement audit contact mobile (10) par l'intermédiaire d'un accouplement à came.

3. Appareil de commutation, selon la revendication 2, **caractérisé en ce que** ledit contact mobile (10) comprend une ou plusieurs premières parties d'actionnement (10D) pouvant être couplées mécaniquement audit élément coulissant (31) pour actionner ledit élément coulissant, lesdites premières parties d'actionnement (10D) présentant un profil de came.

4. Appareil de commutation, selon l'une des revendications précédentes, **caractérisé en ce que** ledit élément coulissant (31) est actionné par ledit contact mobile (10), lorsque ledit contact mobile relie électriquement ledit quatrième contact fixe (8) audit deuxième contact fixe (6), pendant une manoeuvre d'ouverture de l'appareil de commutation.

5. Appareil de commutation, selon l'une des revendications précédentes, **caractérisé en ce que** ledit élément de blocage (32) est configuré pour se déplacer en translation conjointement avec ledit élément coulissant (31) et adopter une position de blocage (P5) lorsque ledit élément coulissant atteint ladite deuxième position (P2), ledit élément de blocage (32) s'engageant de manière stable sur un support fixe (250) pour bloquer ledit élément coulissant (31) dans ladite deuxième position (P2), lorsque ledit élément de blocage adopte ladite position de blocage (P5).

6. Appareil de commutation, selon l'une des revendications précédentes, **caractérisé en ce que** ledit élément de blocage (32) est configuré pour être actionné par ledit contact mobile (10), pendant une manoeuvre de fermeture dudit appareil de commutation, ledit élément de blocage (32) étant retiré de ladite position de blocage (P5), lorsque ledit élément coulissant est actionné par ledit contact mobile (10).

7. Appareil de commutation, selon la revendication 6, **caractérisé en ce que** ledit élément coulissant (32) est actionné par ledit contact mobile (10), lorsque ledit contact mobile relie électriquement ledit quatrième contact fixe (8) audit deuxième contact fixe (6), pendant une manoeuvre de fermeture de l'appareil de commutation.

8. Appareil de commutation, selon l'une des revendications de 6 à 7, **caractérisé en ce que** ledit contact mobile (10) comprend une ou plusieurs deuxièmes parties d'actionnement (10C) pouvant être couplées mécaniquement audit élément de blocage (32) pour actionner ledit élément de blocage.

9. Appareil de commutation, selon l'une des revendi-

cations précédentes, **caractérisé en ce que**, pour chaque pôle électrique, lesdites première et deuxième bornes (11, 12) de pôle sont agencées sur des côtés opposés dudit appareil de commutation par rapport à l'axe de rotation (A1) dudit contact mobile (10) et sont alignées l'une par rapport à l'autre le long d'une première direction d'alignement (D1) coupant l'axe de rotation (A1) dudit contact mobile (10), ledit premier contact fixe (5) étant déplacé latéralement par rapport à ladite première direction d'alignement.

10. Appareil de commutation, selon la revendication 9, **caractérisé en ce que**, pour chaque pôle électrique, ladite première borne (11) de pôle et ledit interrupteur à vide (20) sont au moins partiellement logés dans une partie de volume interne définie par une douille (43) du boîtier isolant (4) dudit appareil de commutation, agencée le long de ladite première direction d'alignement (D1).

11. Appareil de commutation, selon l'une des revendications précédentes, **caractérisé en ce que** ledit contact mobile (10) est mobile de manière réversible entre une première position de fin de course (P_A), qui correspond à un état fermé dudit appareil de commutation, et une deuxième position de fin de course (Pc), qui correspond à un état mis à la terre dudit appareil de commutation, ledit contact mobile (10) passant par une position intermédiaire (P_B), qui correspond à un état ouvert dudit appareil de commutation, lorsqu'il se déplace entre lesdites première et deuxième positions de fin de course (P_A, P_C),

ledit contact mobile (10) ayant une première région de contact mobile (10A) et une deuxième région de contact mobile (10B) agencées à des positions opposées par rapport à l'axe de rotation (A1) dudit contact mobile,
ledit contact mobile (10) ayant ladite première région de contact mobile (10A) couplée audit premier contact fixe (5) et ladite deuxième région de contact mobile (10B) couplée audit deuxième contact fixe (6), reliant ainsi électriquement lesdits premier et deuxième contacts fixes (5, 6), lorsque ledit contact mobile (10) se trouve dans ladite première position de fin de course (P_A) ;
ledit contact mobile (10) n'étant couplé à aucun contact fixe, lorsque ledit contact mobile (10) se trouve dans ladite position intermédiaire (P_B) ;
ledit contact mobile (10) ayant ladite première zone de contact mobile (10A) couplée audit deuxième contact fixe (6) et ladite deuxième zone de contact mobile (10B) couplée audit troisième contact fixe (7), reliant ainsi électriquement lesdits deuxième et troisième contacts fixes (6, 7), lorsque ledit contact mobile (10) se trouve dans ladite deuxième position de fin de course (Pc).

12. Appareil de commutation, selon la revendication 11, **caractérisé en ce que** chaque zone de contact mobile (10A, 10B) dudit contact mobile (10) comprend au moins une lame de contact.

13. Appareil de commutation, selon l'une des revendications précédentes, **caractérisé en ce qu'**il s'agit d'un interrupteur coupe-charge pour des systèmes électriques moyenne tension.

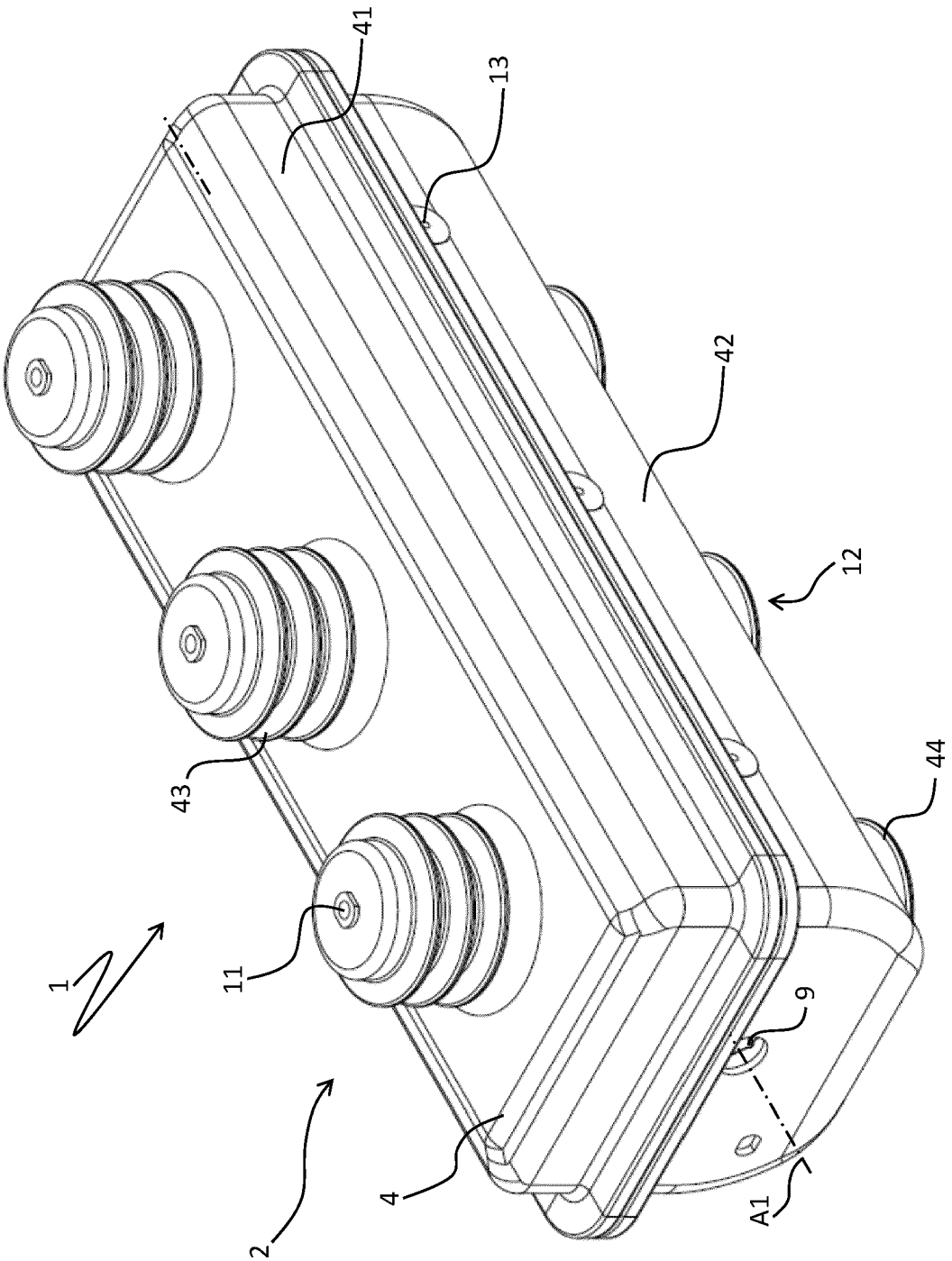


FIG. 1

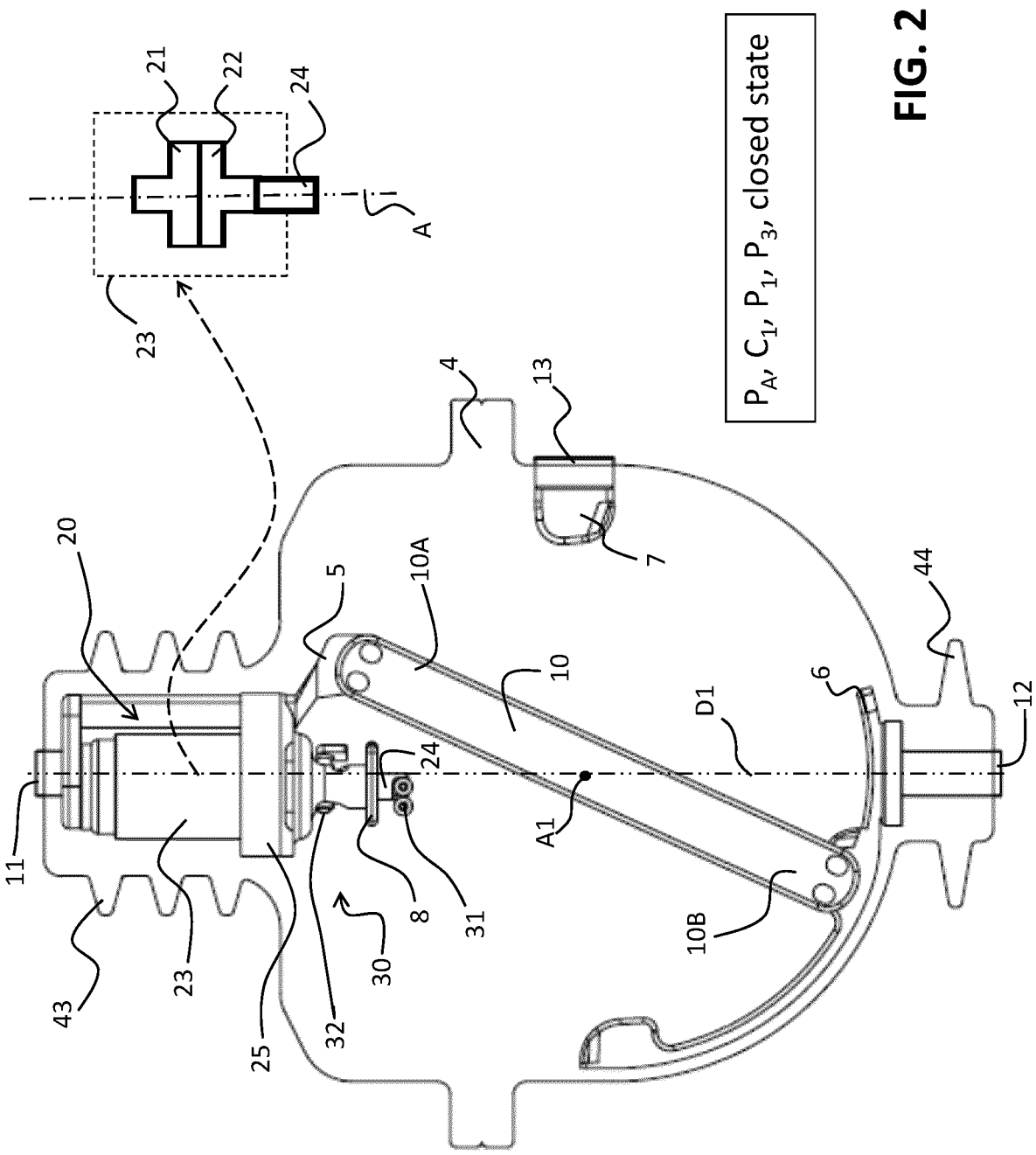

P_A, C_1, P_1, P_3, closed state
21
22
24
23
A
4
13
7
20
5
10A
10
44
6
12
D1
24
11
A1
43
23
25
32
30
8
31
10B

FIG. 2

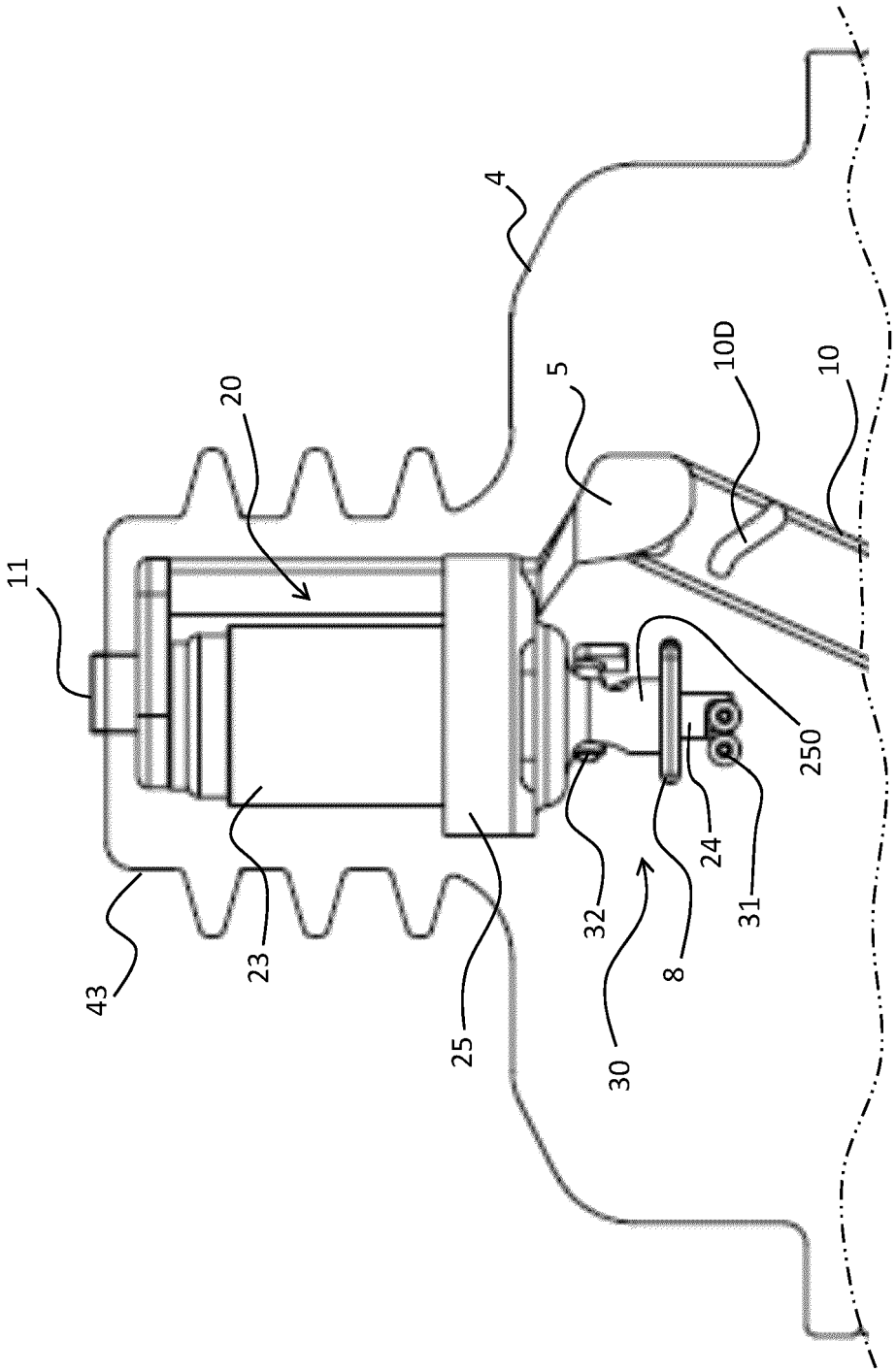


FIG. 3

FIG. 4

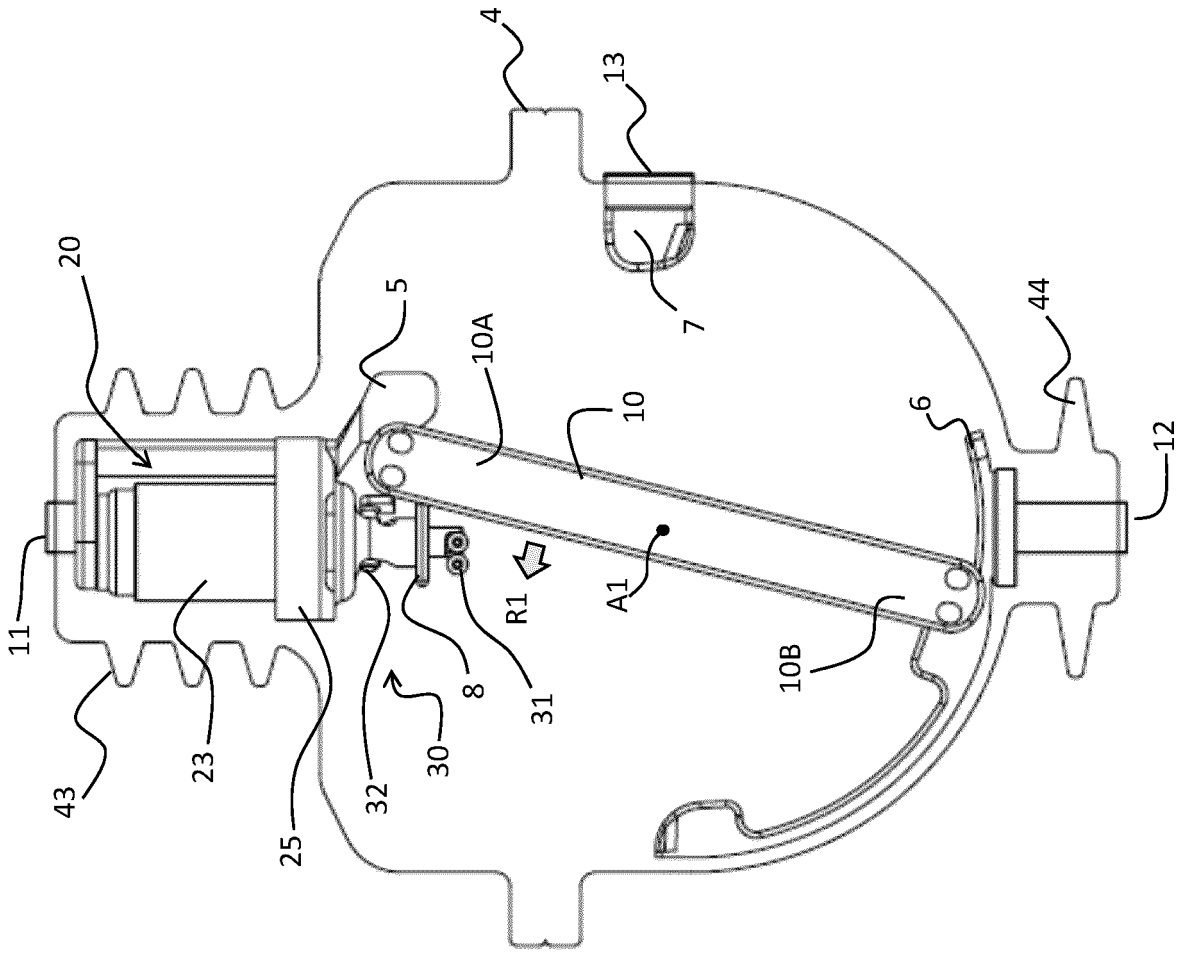


FIG. 5

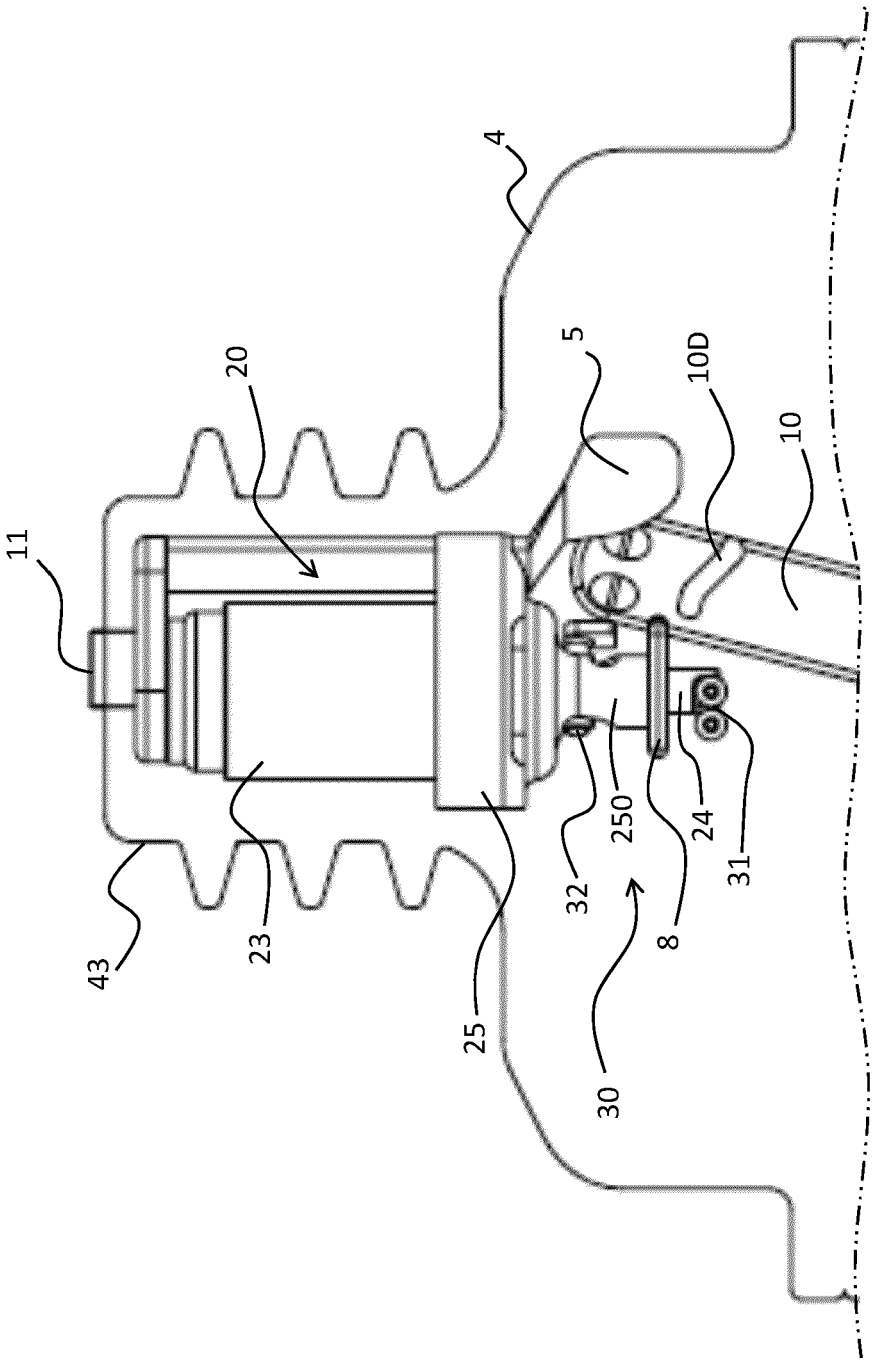
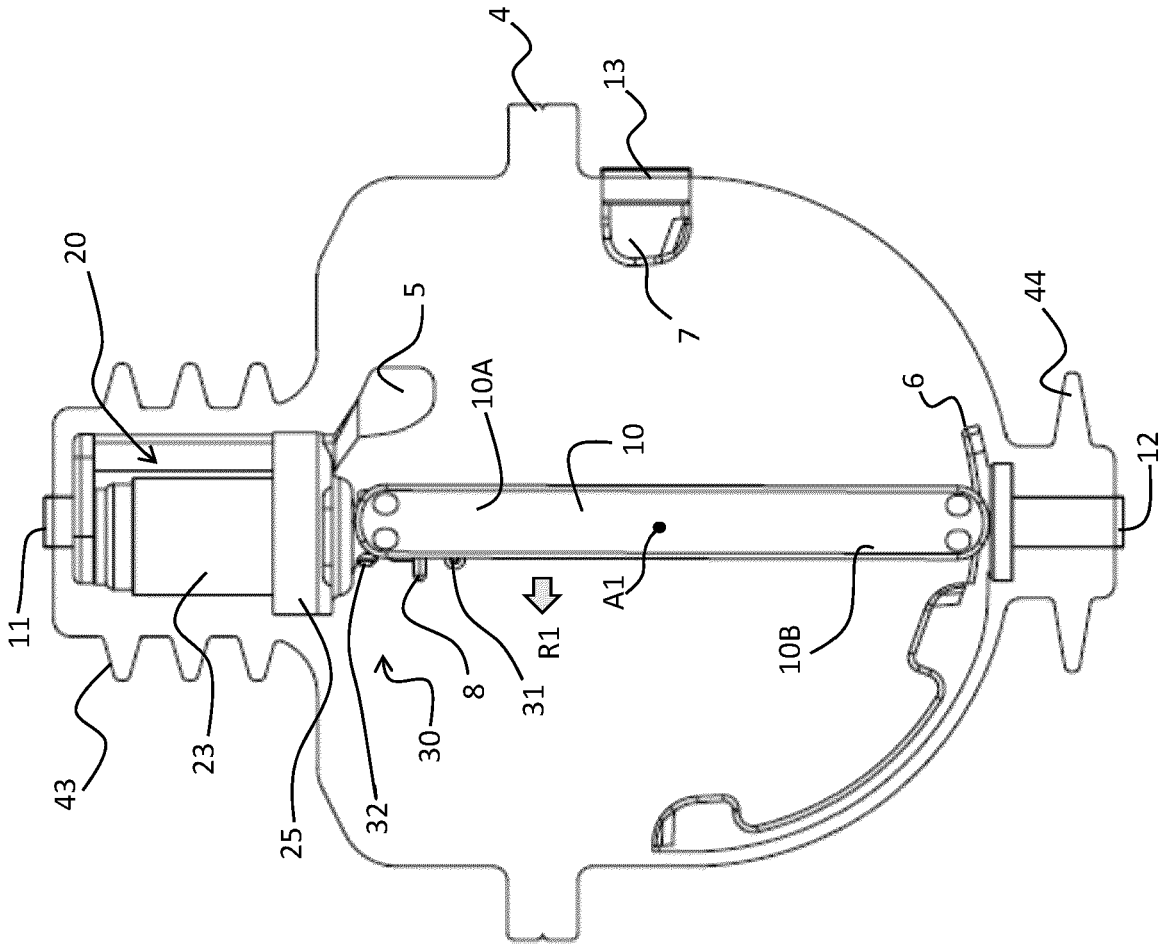


FIG. 6



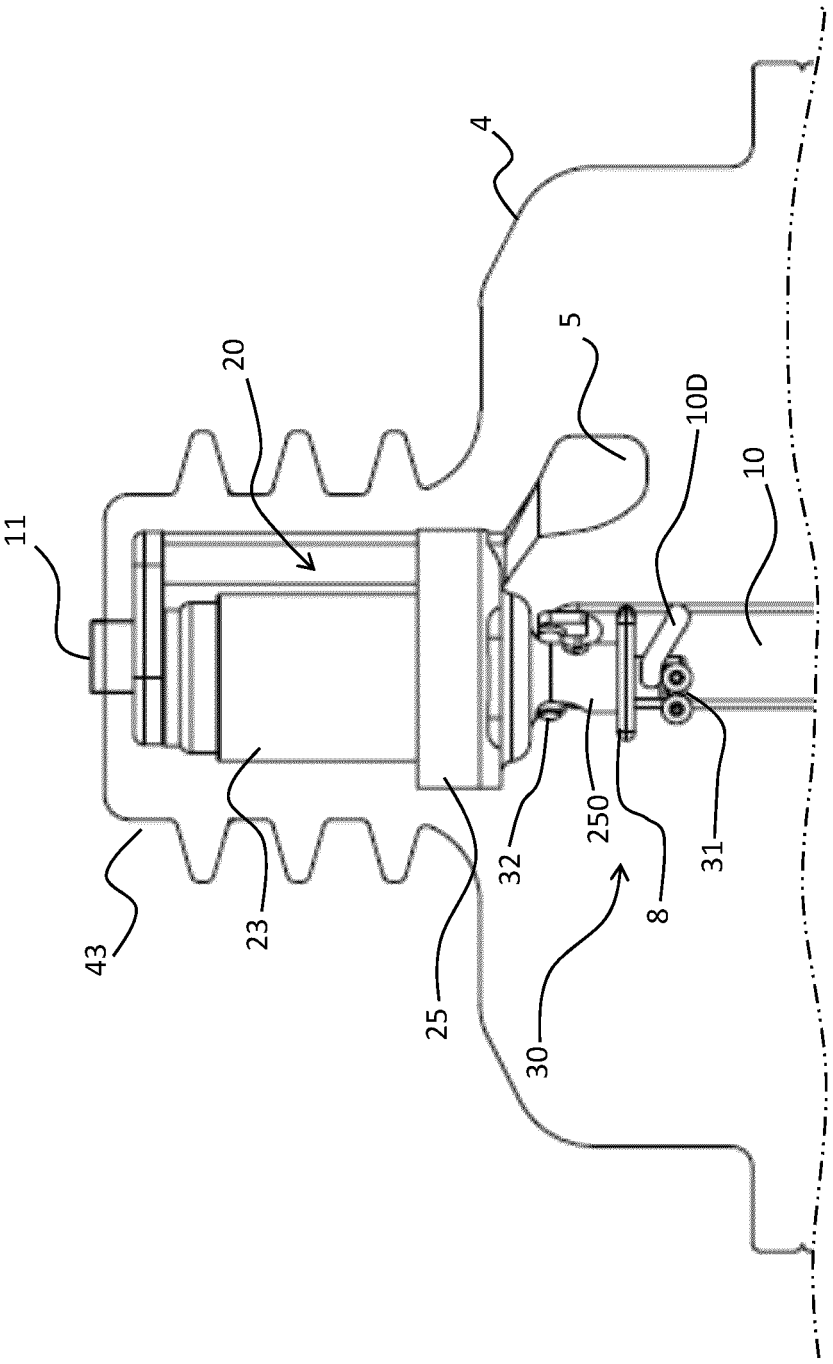


FIG. 7

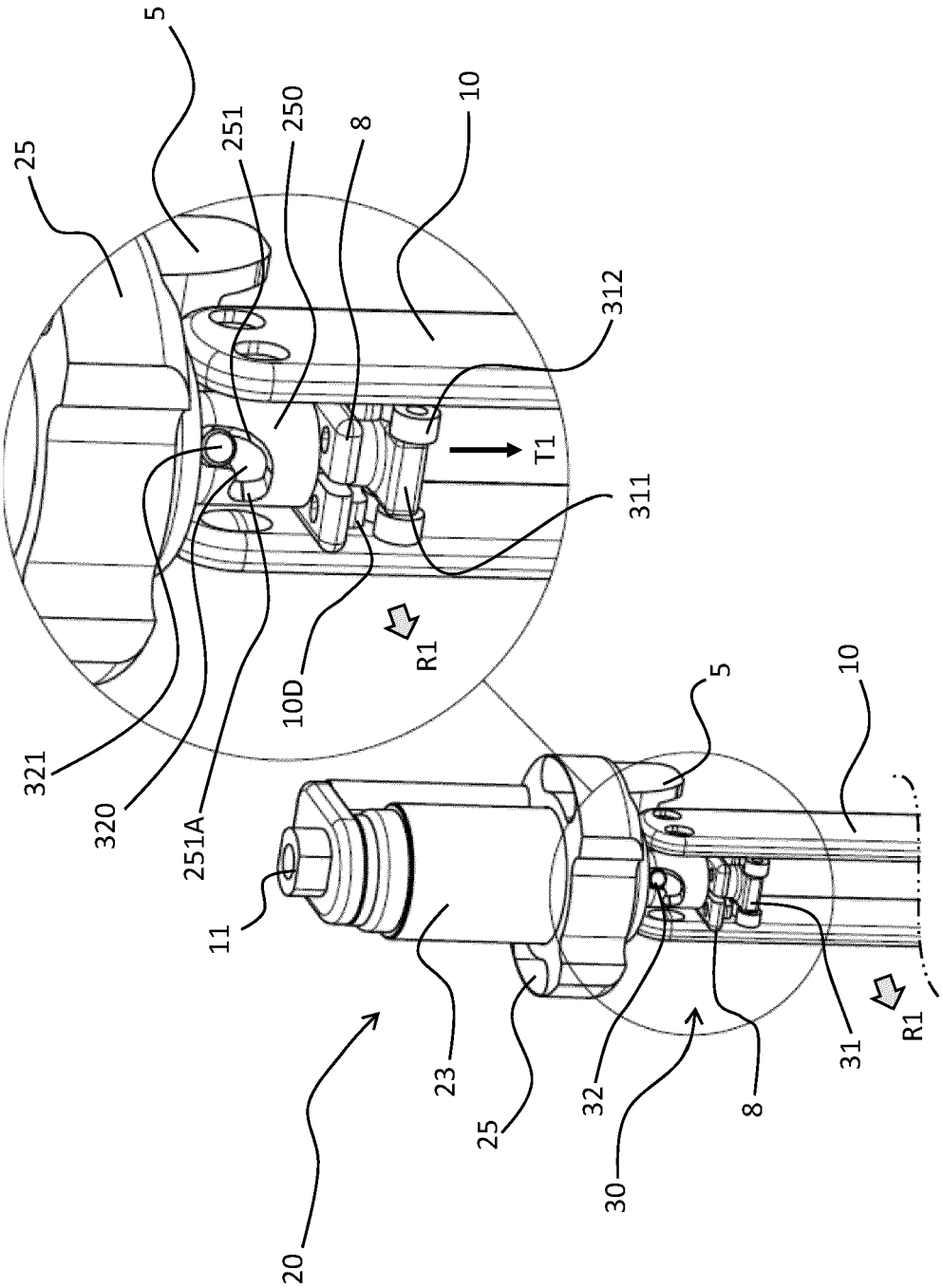

5
25
251
250
8
10
312
T1
311
R1
10D
321
320
251A
11
20
23
25
32
30
8
31
R1
10
5

FIG. 8

FIG. 9

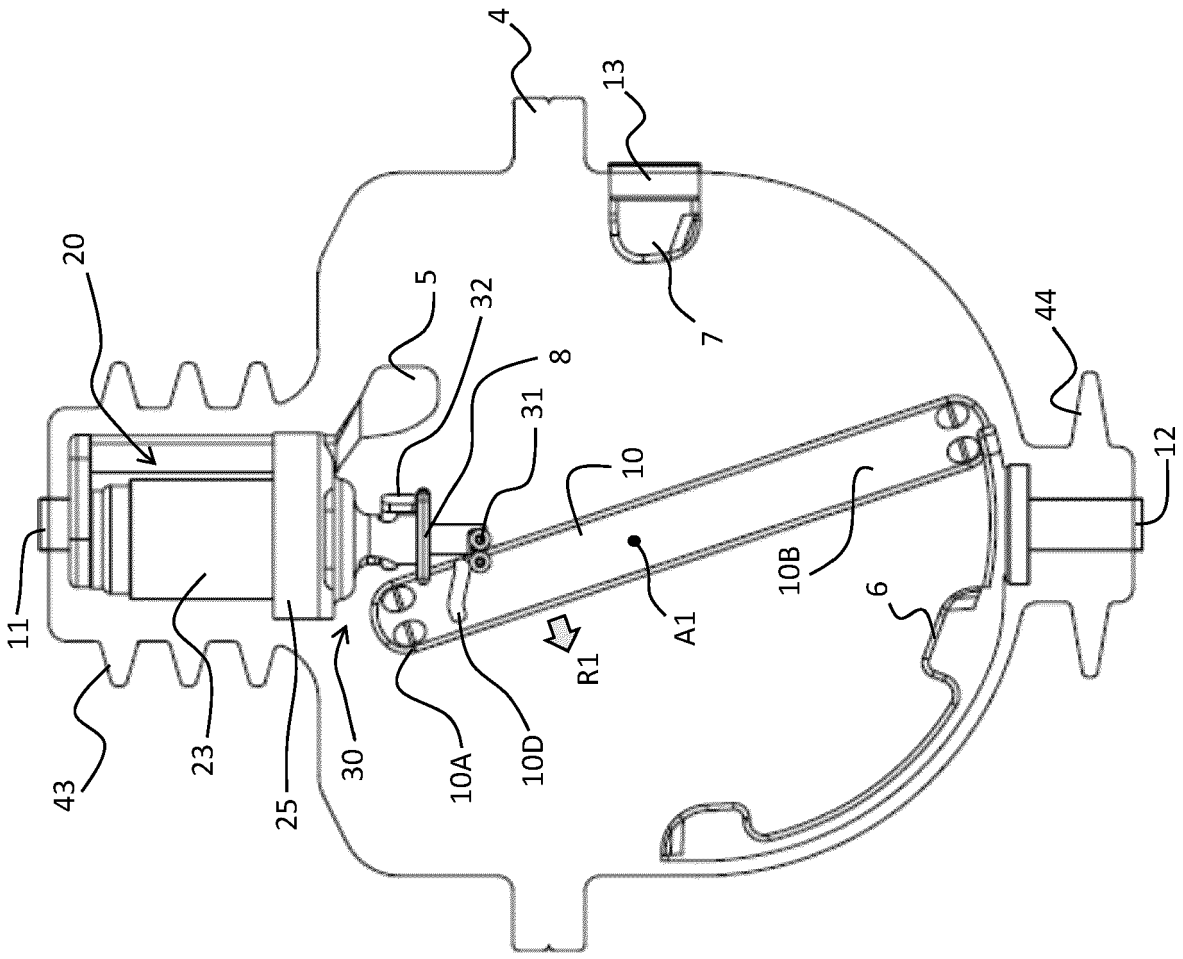
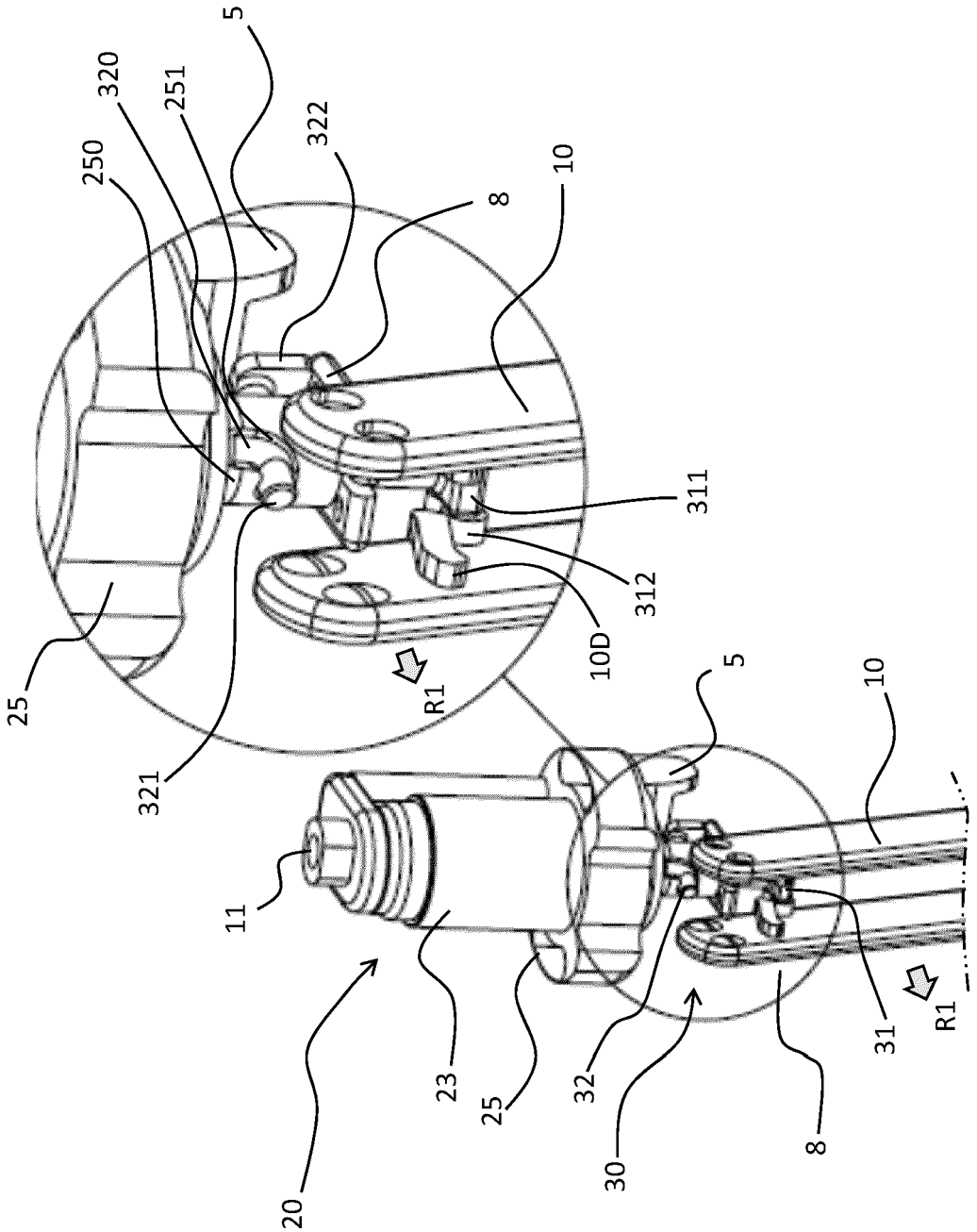


FIG. 10


5
320
251
250
322
8
10
311
312
10D
25
R1
321
11
20
23
25
32
30
8
31
R1
10
5

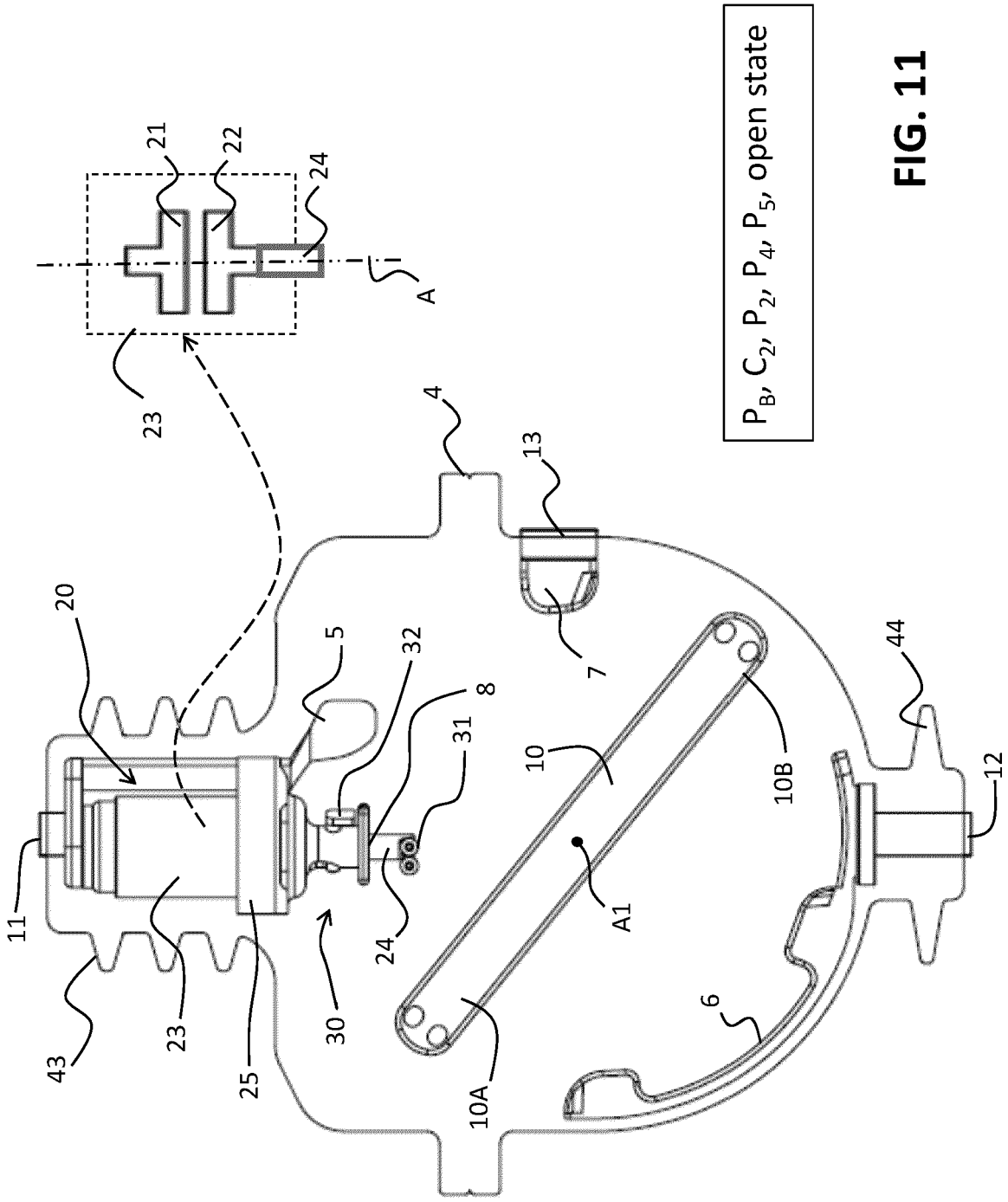

P_B, C_2, P_2, P_4, P_5, open state
21
22
24
A
23
4
13
20
5
32
8
31
7
10
10B
44
12
11
24
A1
43
23
30
25
10A
6

FIG. 11

FIG. 12

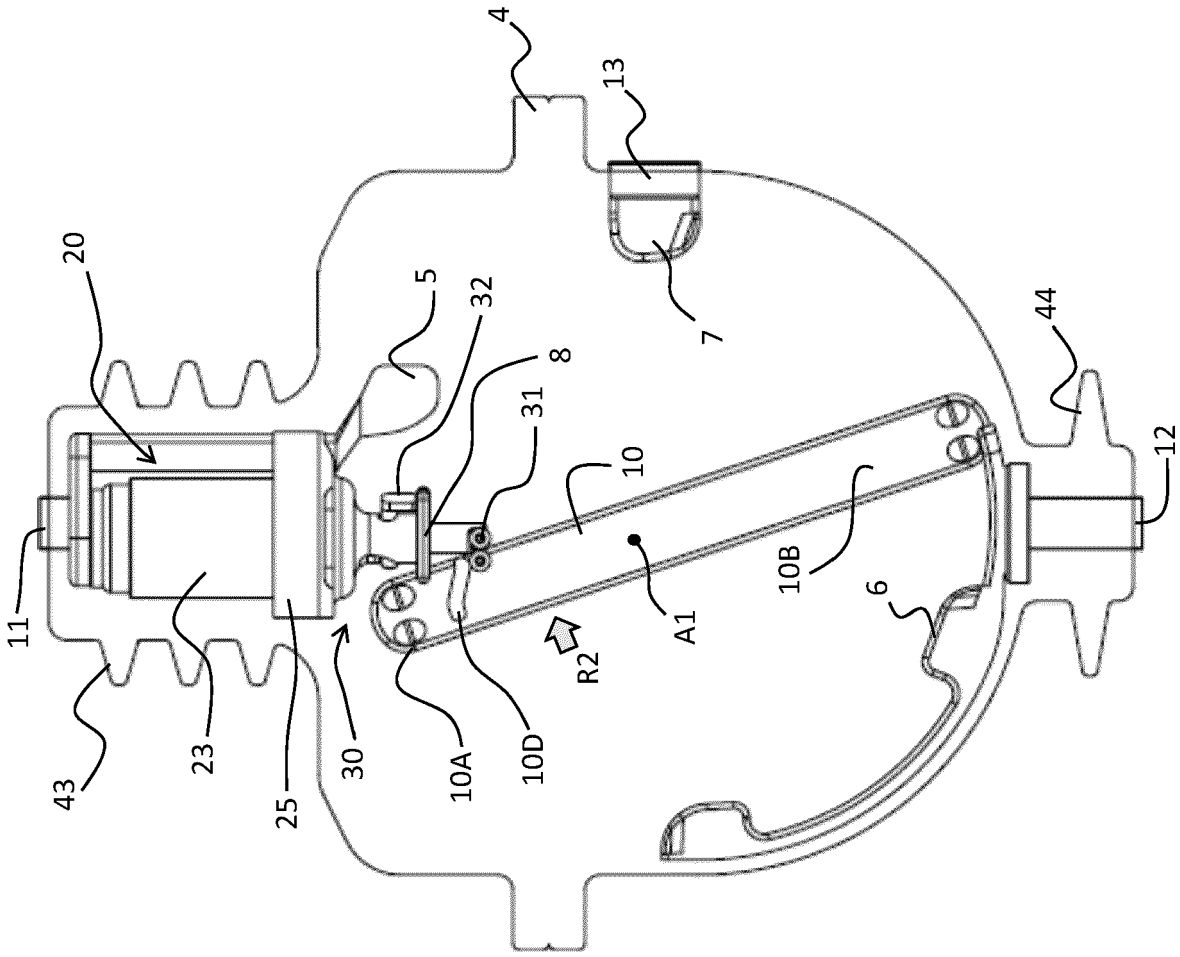


FIG. 13

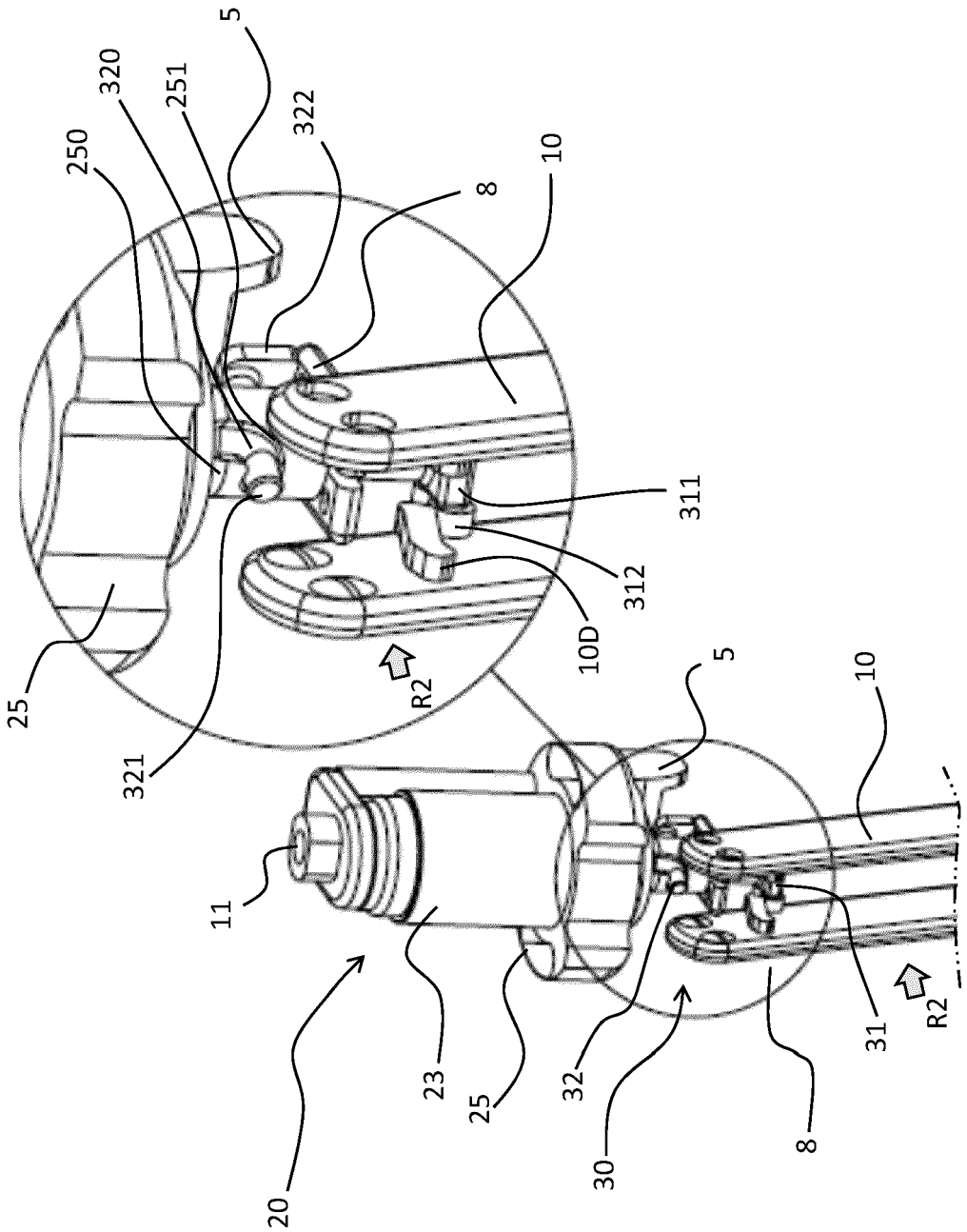

5
320
251
322
250
8
10
311
312
10D
25
R2
321
11
5
10
20
23
25
32
30
8
31
R2

FIG. 14

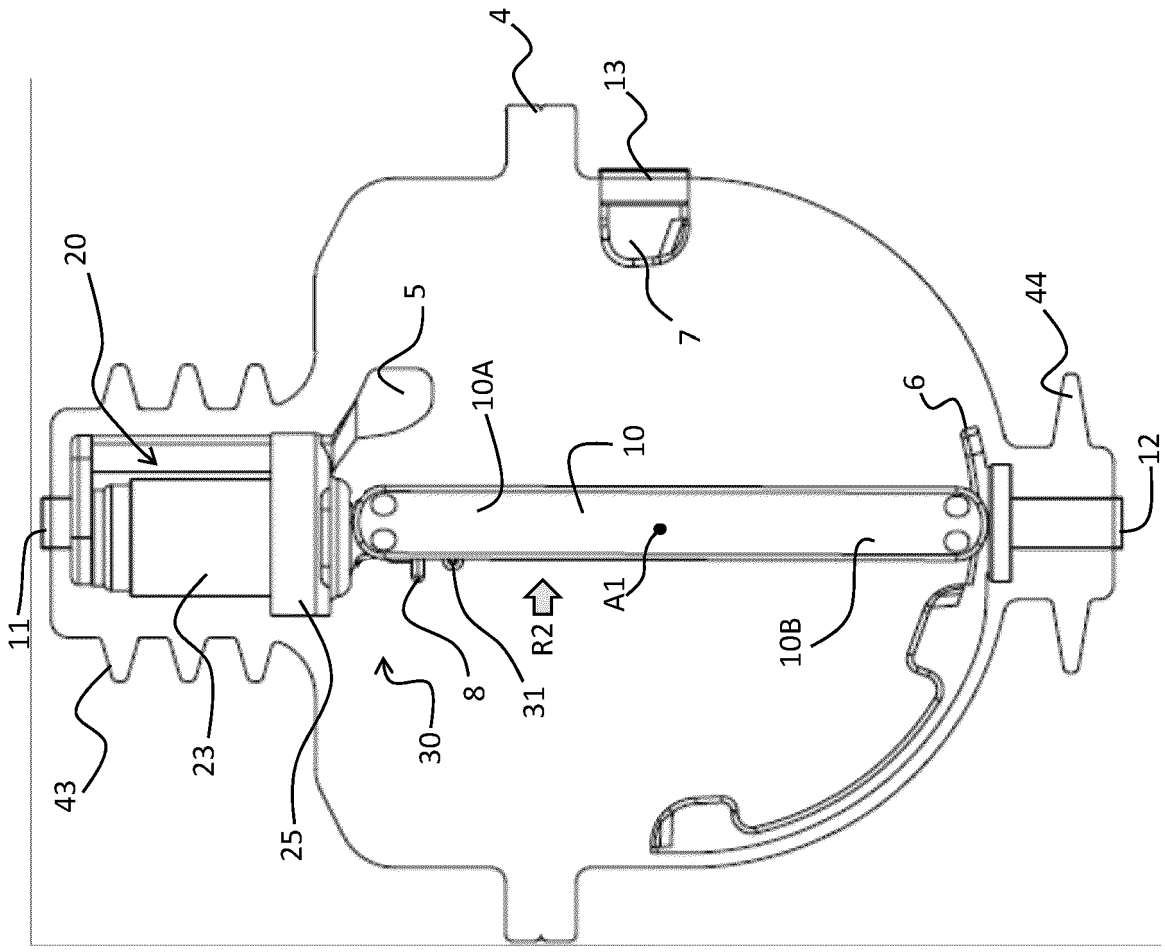


FIG. 15

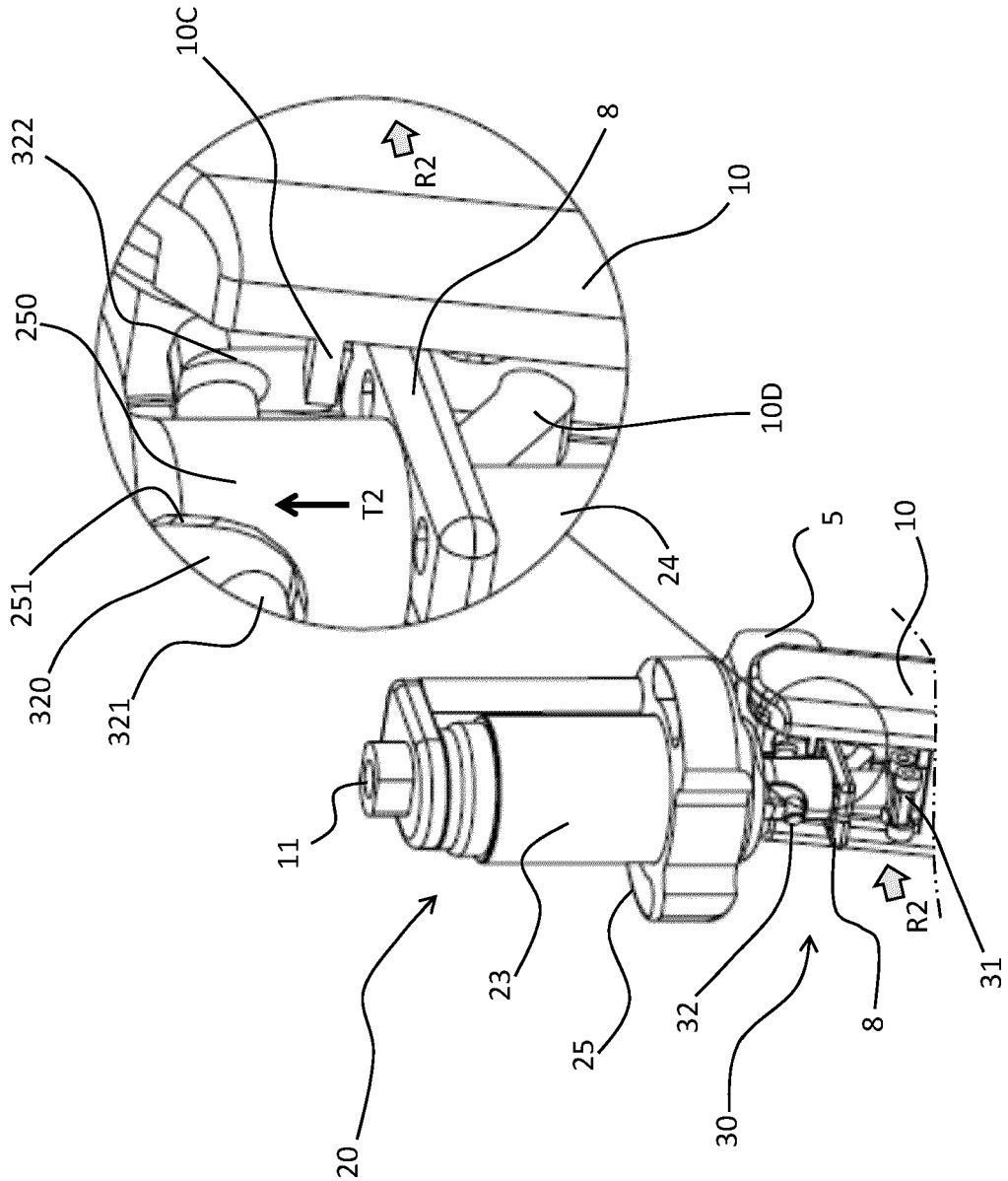
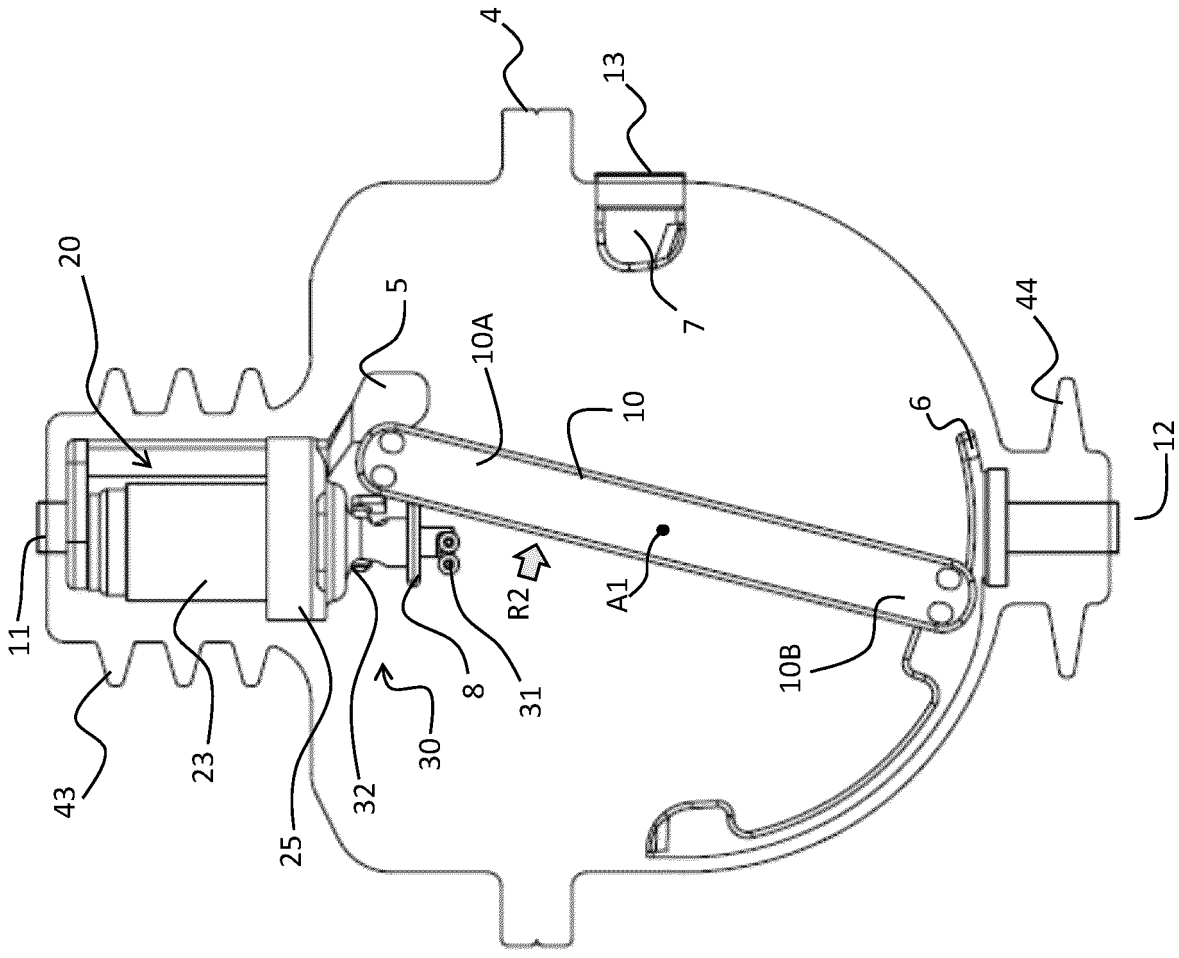

10C
322
R2
8
10
250
10D
T2
251
24
5
10
320
321
11
23
25
32
8
R2
31
20
30

FIG. 16



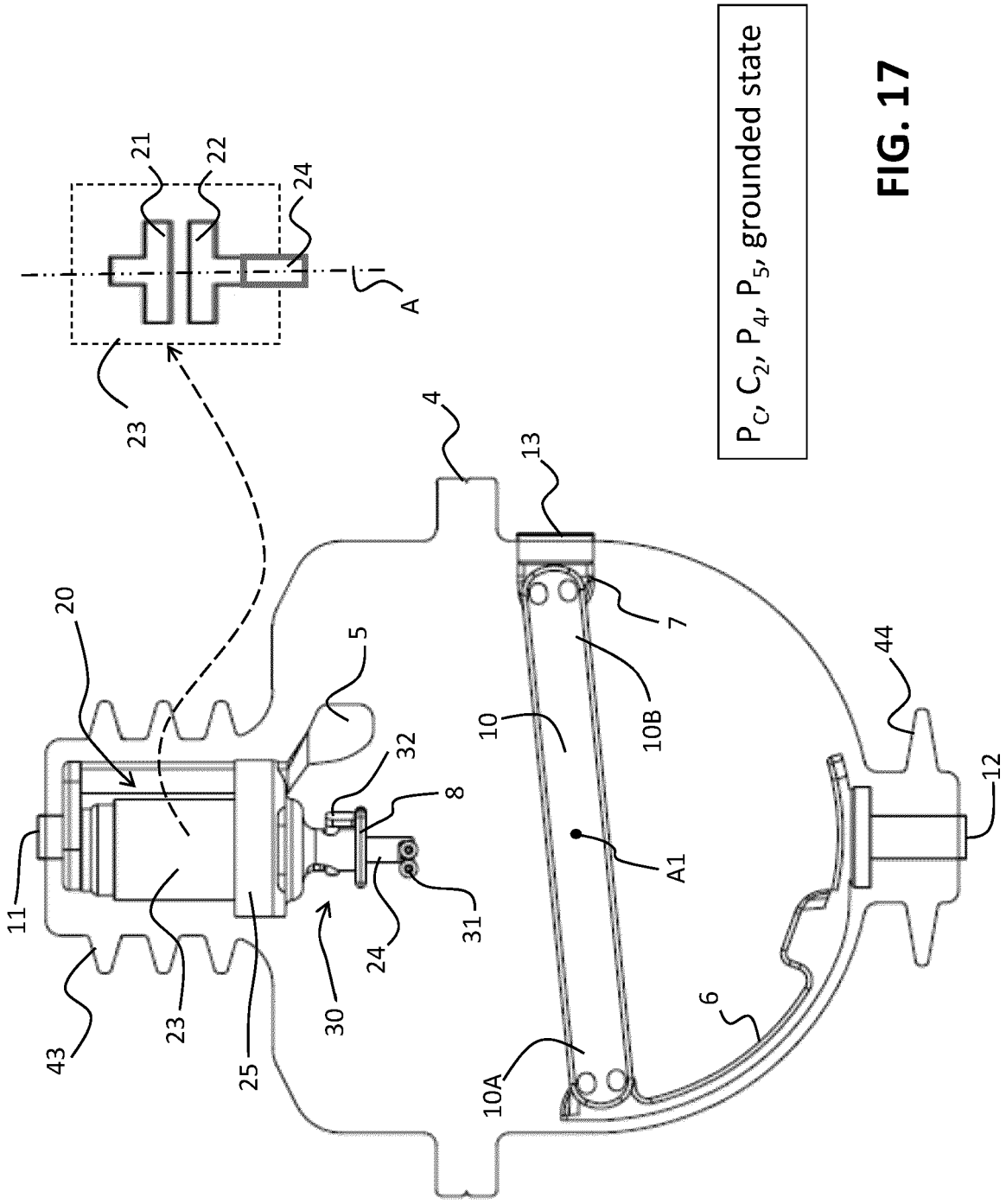

P_C, C_2, P_4, P_5, grounded state
21
22
24
A
23
4
13
20
5
7
44
10
10B
32
8
12
A1
11
23
24
31
43
30
25
6
10A

FIG. 17

FIG. 18

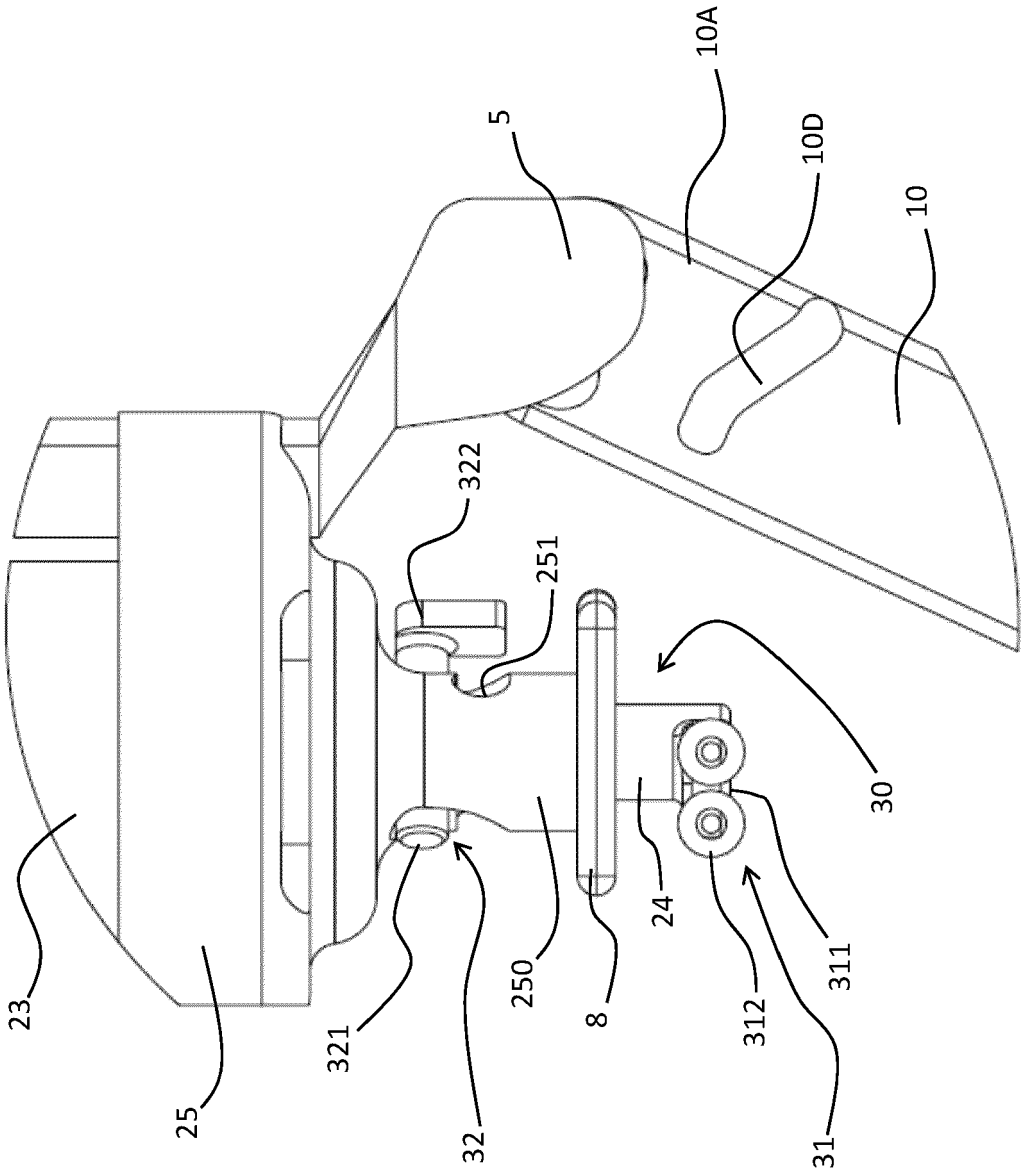
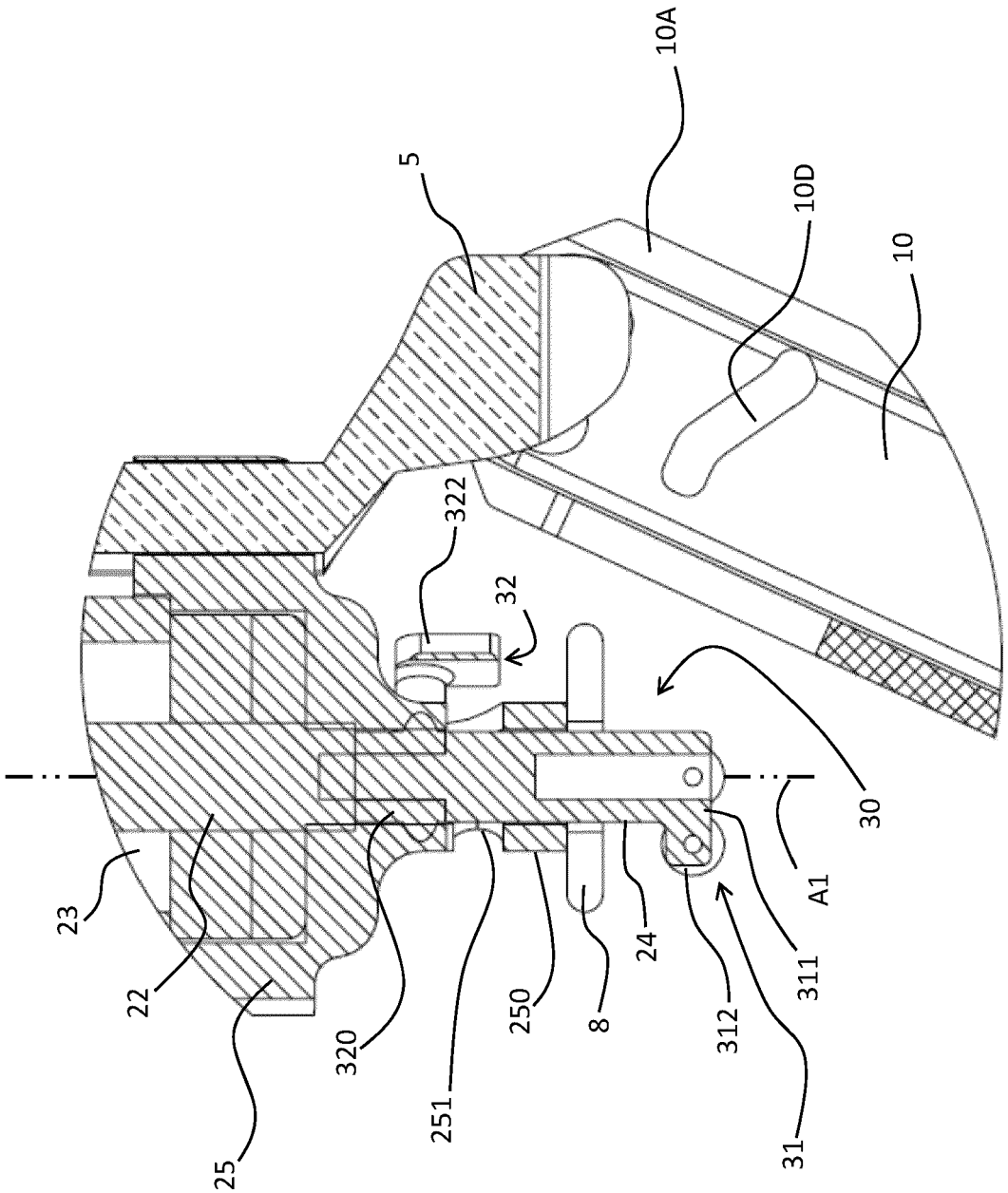


FIG. 19



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Patent documents cited in the description

- WO 2014001029 A1 **[0002]**