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(71) Applicant: **ABB Schweiz AG**
5400 Baden (CH)

(72) Inventors:
- **Lantz, Gabriel**
  CH-8037 Zurich (CH)
- **Cucchi, Irene**
  CH-8045 Zurich (CH)
- **Studniarek, Michal**
  CH-8134 Adliswil (CH)

(74) Representative: **De Bortoli, Eros et al**
Zanoli & Giavarini S.p.A.
Via Melchiorre Gioia, 64
20125 Milano (IT)

(54) A SWITCHING APPARATUS FOR ELECTRICAL SYSTEMS

(57) A switching apparatus comprising:
- one or more electric poles;
- an outer enclosure defining an internal volume;
- for each electric pole, a fixed contact member arranged in a fixed position relative to said enclosure and including a fixed contact;
- for each electric pole, a movable contact member including a movable contact and reversibly movable between a closed position, at which said movable contact is coupled to said fixed contact, and an open position, at which said at movable contact is decoupled from said fixed contact.

The switching apparatus comprises, for each electric pole, a shielding member including a conductive body having first surfaces defining a coupling cavity for said movable contact member and second surfaces having a rounded profile and facing one or more surrounding components of said electric pole.

Said shielding member is arranged in a fixed position relative to said movable contact member and said enclosure in such a way that said movable contact member is accommodated in said coupling cavity and is surrounded at least partially by said conductive body, when said movable contact member reaches said open position.

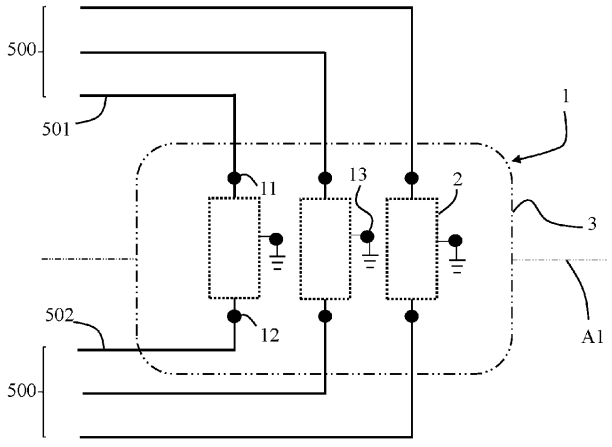

FIG. 1

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Description

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

[0002] Load-break switches are well known in the field of medium-voltage electrical systems.

[0003] These switching apparatuses, which are generally used in secondary distribution electric grids, are capable of breaking and making currents under specified circuit conditions as well as providing circuit-disconnecting functionalities (normally earthing a load-side section of an electric circuit).

[0004] Most traditional load-break switches have their electric poles immersed in a sulphur hexafluoride (SF_6) atmosphere as this insulation gas ensures excellent performances in terms of dielectric insulation and arc-quenching capabilities when currents are interrupted.

[0005] As is known, however, SF_6 is a very potent greenhouse gas, and its usage is subject to severe restrictions for environmental preservation purposes. For this reason, over the years, there has been made a considerable effort to design load-break switches not employing SF_6 as an insulation gas.

[0006] Most recent load-break switches have electric poles are immersed in pressurized dry air or in an environment-friendly insulation gas, such as mixtures of oxygen, nitrogen, carbon dioxide and/or fluorinated gases.

[0007] Unfortunately, the experience has shown that these modern switching apparatuses still have some aspects to improve, especially in relation to their arc-quenching and dielectric insulation capabilities during an opening manoeuvre.

[0008] More particularly, in these switching apparatuses, during opening manoeuvres, undesired arcing phenomena have often been observed to raise between the movable contact members of the electric poles and the metallic outer enclosure (normally put at ground voltage) or other conductive components (e.g., busbars or grounded parts) of the switch poles.

[0009] It has been seen that these restrike arcing phenomena, which are basically due the lower heat capacity and dielectric withstand of the used environment-friendly insulation gas compared to SF_6, generally occur during the so-called "dielectric recovery phase", which immediately follows the extinguishing phase of the electric arcs normally arising between the electric contacts under separation in the electric poles, during an opening manoeuvre of the switching apparatus.

[0010] Obviously, such restrike arcing phenomena may cause serious damages to the switching apparatus as they may involve some of the internal components of the switching apparatus, which are not generally designed to bear high electric and thermal stresses.

[0011] A way to circumvent these issues might be increasing the dielectric distances between live and grounded components of the electric poles. However, this solution would entail an overall size increase of the switching apparatus substantially unacceptable for many electrical applications. Another possible way to mitigate the above-mentioned problems would be mounting suitable shielding members (electric field diffusers) on the live components of the electric poles, particularly on the movable contact members. However, it has been experienced that this solution may negatively influence other electrical performances of the switching apparatus (such as its current breaking capability), which are mostly linked to the design of the movable contact members of the electric poles.

[0012] The main aim of the present invention is to provide a switching apparatus for electrical systems, in particular medium-voltage electrical systems, which allows overcoming or mitigating the drawbacks of the known art.

[0013] Within this aim, a purpose of the present invention is to provide a switching apparatus employing an environment-friendly insulation gas, in which restrike arcing phenomena between the contact members and the outer enclosure or other internal conductive components (e.g., busbars, earthing contacts, and the like) of the switch poles are remarkably reduced or prevented.

[0014] A further purpose of the present invention is to provide a switching apparatus, which can provide high level electrical performances, particularly in relation to their current breaking capability.

[0015] A further purpose of the present invention is to provide a switching apparatus, which has a simple and compact structure with a relatively low number of internal components.

[0016] A further purpose of the present invention is to provide a switching apparatus, which is relatively simple and cheap to be manufactured at industrial levels.

[0017] The above aim and purposes, as well as other purposes that will emerge clearly from the following description and attached drawings, are provided, according to the invention, by a switching apparatus for medium-voltage electrical systems, according to the following claim 1 and the related dependent claims.

[0018] In a general definition, the switching apparatus, according to the invention comprises one or more electric poles, which are accommodated in an internal volume of the switching apparatus, which is defined by an outer enclosure.

[0019] For each electric pole, the switching apparatus comprises:

- a fixed contact member including a fixed contact and arranged in a fixed position relative to said enclosure;
- a movable contact member including a movable contact and reversibly movable between a closed position, at which said movable contact is electrically and mechanically coupled to said fixed contact, and an open position, at which said at movable contact is electrically and mechanically decoupled from said fixed contact.

[0020] The switching apparatus further comprises, for

each electric pole, a shielding member including a conductive body having first surfaces defining a coupling cavity for said movable contact member and second surfaces having a rounded profile and facing one or more surrounding components of said electric pole.

[0021] The shielding member is arranged in a fixed position relative to said movable contact member and said outer enclosure and is mechanically couplable with said movable contact member when this latter reaches said open position.

[0022] Particularly, the shielding member is positioned in such a way that said movable contact member is accommodated in said coupling cavity and is surrounded at least partially by said conductive body, when said movable contact member reaches said open position.

[0023] Preferably, said conductive body is put at the same voltage potential of said movable contact member, at least when said movable contact member is accommodated in said coupling cavity. According to some embodiments of the invention, said conductive body comprises conductive contact springs fixed to and protruding from said first surfaces. Said contact springs slidingly couple with said movable contact member and electrically connect said conductive body to said movable contact member, when movable contact member is accommodated in said coupling cavity.

[0024] According to other embodiments of the invention, said shielding member includes electrical connection means electrically connecting said conductive body to said movable contact member in a permanent manner.

[0025] According to some embodiments of the invention, the coupling cavity of said conductive body is shaped as a pass-through cavity, so that said movable contact member goes inside and outside said coupling cavity at opposite sides of said conductive body.

[0026] According to other embodiments of the invention, the coupling cavity of said conductive body is shaped as a blind cavity, so that said movable contact member goes inside and outside said coupling cavity only at a same side of said conductive body.

[0027] According to some embodiments of the invention, said conductive body is made of multiple separated parts of conductive material.

[0028] According to other embodiments of the invention, said conductive body is made of in a single piece of conductive material.

[0029] According to an industrial application of the present invention, the switching apparatus is a load break switch for medium-voltage electrical systems.

[0030] Further features and advantages of the present invention will be more apparent from the description of preferred but not exclusive embodiments of the present invention, shown by way of examples in the accompanying drawings, wherein:

- Figure 1 schematically represents a switching apparatus, according to the present invention;
- Figures 2-4 show schematic views of an electric pole of the switching apparatus, according to some embodiments of the invention;
- Figures 5-12 show schematic views of a shielding member (electric field diffuser) included in each electric pole of the switching apparatus, according to some embodiments of the invention.

[0031] With reference to the figures, the present invention relates to a switching apparatus 1.

[0032] The switching apparatus, according to the invention, is particularly adapted for use in medium-voltage electric systems, i.e., in electrical systems operating at voltage levels 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.

[0033] More particularly, the switching apparatus 1 is particularly adapted to operate as a load-break switch for medium-voltage electrical systems. In this case, it will be designed for providing circuit-breaking or current-making functionalities under nominal conditions as well as circuit-disconnecting functionalities, in particular grounding a load-side section of an electric circuit. In principle, however, the switching apparatus, according to the invention may be used also in low-voltage electrical systems or even in high-voltage electrical systems and it may be be designed for providing circuit-breaking functionalities also under fault conditions (circuit breaker).

[0034] The switching apparatus 1 comprises one or more electric poles 2.

[0035] 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.

[0036] The switching apparatus 1 preferably comprises an outer enclosure 3 conveniently defining an internal volume where the electric poles are accommodated.

[0037] Preferably, the outer enclosure 3 is made of conductive material (e.g., a metal material). In this case, the outer enclosure 3 may be electrically connected to a ground conductor to be put at a ground voltage as shown in the cited figures. According to some embodiments of the invention, however, the outer enclosure 3 may be at floating potential or may be made of electrically insulating material.

[0038] Preferably, the outer enclosure 3 has an elongated shape (e.g., substantially cylindrical, or parallelepiped-like) developing along a main longitudinal direction A1. The electric poles 2 are conveniently arranged side by side along the main longitudinal direction A1 at corresponding reference planes perpendicular to the longitudinal direction A1 (figure 1).

[0039] The internal volume of the switching apparatus 1 is filled with an insulation gas for dielectric insulation purposes. Preferably, such an insulation gas is dry air or another insulating gas having a low environmental impact, such as mixtures of oxygen, nitrogen, carbon dioxide and/or fluorinated gases.

[0040] Preferably, for each electric pole, the switching apparatus 1 comprises a first pole terminal 11 and a second pole terminal 12.

[0041] According to some embodiments of the invention (for example when the switching apparatus is a load break switch), the switching apparatus 1 comprises, for each electric pole, also a ground terminal 13 in addition to the above-mentioned pole terminals 11, 12 (figure 1).

[0042] The first pole terminal 11 is electrically connected to a corresponding first conductor 501 of an electric line 500 (e.g., a phase conductor electrically connected to an equivalent electric power source) while the second pole terminal 12 is electrically connected to a second conductor 502 of an electric line (e.g., a phase conductor electrically connected to an equivalent electric load). When it is present, the ground terminal 13 is electrically connected to a ground conductor.

[0043] In general terms, for each electric pole, the switching apparatus 1 comprises at least a pair of electric contacts 51, 61 (each electrically connected to a corresponding pole terminal), which can be mutually coupled and decoupled.

[0044] For the sake of clarity, it is specified that the terms "coupled," "decoupled" and other similar terms used in this disclosure relate to an electrical and mechanical coupling or decoupling of different parts unless otherwise specified or self-evident from the description or figures.

[0045] The switching apparatus 1 comprises, for each electric pole, a fixed contact member 5 arranged in a fixed position relative to the outer enclosure 3 and including at least a fixed contact 51. Preferably, the fixed contact member 5 is electrically connected to the first pole terminal 11 through suitable electrical connection arrangements.

[0046] The switching apparatus 1 comprises, for each electric pole, a movable contact member 6 including a movable contact 61.

[0047] Preferably, the movable contact member 6 is electrically connected to the second pole terminal 12 through suitable electrical connection arrangements.

[0048] The movable contact member 6 is reversibly movable between a closed position C (figure 2) and an open position O (figure 3).

[0049] At the closed position C, the movable contact 61 is coupled to the fixed contact 51 while, at the open position O, the movable contact 61 is decoupled from the fixed contact 51.

[0050] A transition of each movable contact member 6 from the closed position C to the open position O forms an opening manoeuvre of the switching apparatus while a transition of each movable contact member 6 from the open position O to the closed position C forms a closing manoeuvre of the switching apparatus.

[0051] Preferably, each movable contact member 6 moves along a corresponding motion plane. Referring to the cited figures, such a motion plane is, for example, a reference plane parallel to the observation plane of figures 2-4.

[0052] In the embodiments shown in the cited figures, the movable contact member 6 is rotatably movable about a rotation axis A, which is preferably parallel to or coincident with main longitudinal direction A1 of the switching apparatus, between the closed position C and the open position O.

[0053] The movable contact member 6 can rotate according to a first rotation direction, which is conveniently oriented away from the corresponding fixed contact member 5, or according to a second rotation direction, which is opposite to the above-mentioned first rotation direction and is oriented towards the corresponding fixed contact member 5.

[0054] The movable contact member 6 rotates according to the above-mentioned first rotation direction, during an opening manoeuvre of the switching apparatus, and according to the above-mentioned second rotation direction, during a closing manoeuvre of the switching apparatus. With reference to an observation plane of figures 2-4, the above-mentioned first and second rotation direction are oriented counter-clockwise and clockwise, respectively.

[0055] According to other embodiments of the invention (not shown), however, the movable contact member 6 may be roto-translationally movable or translationally movable between the above-mentioned closed position C and open position O.

[0056] According to some embodiments (e.g., when the switching apparatus is a load break switch), the switching apparatus 1 comprises, for each electric pole, an earthing contact member 9 arranged in a fixed position relative to the outer enclosure 3 and including an earthing contact 91 as shown in the cited figures.

[0057] The earthing contact member 9 is electrically connected to the ground terminal 13 through suitable electrical connection arrangements.

[0058] According to these embodiments, each movable contact member 6 is reversibly movable between the open position O and an earthed position E.

[0059] At the earthed position E (figure 4), the movable contact 61 of the movable contact member is coupled to the earthing contact 91 of the earthing contact member 9.

[0060] A transition of each movable contact member 6 from the open position O to the earthed position E forms a disconnecting manoeuvre of the switching apparatus whereas a transition of each movable contact member 6 from the earthed position E to the open position O forms a reconnecting manoeuvre of the switching apparatus.

[0061] In the embodiments shown in the cited figures, the movable contact member 6 is rotatably movable about the rotation axis A between the open position O and the earthed position E.

[0062] The movable contact member 6 rotates according to the above-mentioned first rotation direction, during a disconnecting manoeuvre of the switching apparatus, and according to the above-mentioned second rotation direction, during a reconnecting manoeuvre of the switching apparatus.

[0063] As mentioned above, however, according to other embodiments (not shown), the movable contact

member 6 may be roto-translationally movable or translationally movable between the open position O and the earthed position E.

[0064] According to further embodiments of the invention (e.g., when the switching apparatus is a circuit breaker or a contactor - not shown), the switching apparatus may comprise only the fixed and movable contact members 5, 6 for each electric pole.

[0065] In an industrial implementation of the switching apparatus, each fixed contact member 5 may be formed by or include a shaped body of electrically conductive material and the corresponding fixed contact 51 may be formed by one or more contact surfaces of said shaped body.

[0066] As an example, each fixed contact member 5 may be formed by a shaped piece of conductive material provided with one or more contact blades including suitable free end surfaces forming the fixed contact 51.

[0067] Similarly, each movable contact member 6 may be formed by or include a shaped body of electrically conductive material and the corresponding movable contact 61 may be formed by one or more contact surfaces of said shaped body.

[0068] As an example, each movable contact member 6 may be formed by a blade-shaped piece of conductive material having suitable free end surfaces forming the movable contact 61.

[0069] When present, also each earthing contact member 9 may be formed by or include a shaped body of electrically conductive material and the corresponding earthing contact 91 may be formed by one or more contact surfaces of said shaped body.

[0070] As an example, each earthing contact member 9 may be formed by a shaped piece of conductive material provided with one or more contact blades including suitable free contact surfaces forming the earthing contact 91.

[0071] In the embodiments of the invention shown in figures 2-4, the switching apparatus 1 comprises, for each electric pole, a puffer assembly 8 configured to provide a flow of compressed gas towards the fixed contact member 5 of the electric pole, during an opening manoeuvre of the switching apparatus.

[0072] The puffer assembly 8 is configured to provide a flow of compressed gas when the movable contact member 6 starts separating from the fixed contact member 5, during an opening manoeuvre of the switching apparatus. In this way, hot gases formed at an arcing region of the electric pole (i.e., at a portion of internal volume affected by electric arcs arising between the electric contacts 51, 61 under separation) are timely blown away, thus effectively contributing to extinguish these arcing phenomena.

[0073] Preferably, the puffer assembly 8 includes a drive mechanism (not shown) linked to the movable contact member 6. In this way, the operation of the puffer assembly is coordinated with the movements of the movable contact member 6 and the puffer assembly 8 can intervene timely as soon as the movable contact member 6 starts moving away from the fixed contact member 5, during an opening manoeuvre of the switching apparatus.

[0074] According to other embodiments of the invention (not shown), however, the switching apparatus 1 does not comprise puffer assemblies in the electric poles.

[0075] In general, most of the components of the switching apparatus described above, such as the outer enclosure 3, the pole terminals 11, 12, 13, the contact members 5, 6, 9 and, possibly, the puffer assembly 8 of each electric pole, may be arranged according to solutions of known type. Therefore, in the following, they will be described only in relation to the aspects of interest of the invention, for the sake of brevity.

[0076] Preferably, the switching apparatus 1 comprises a motion transmission shaft (not shown) made of electrically insulating material and an actuation assembly (not shown) configured to provide suitable actuation forces to actuate the movable components of the switching apparatus. The above-mentioned motion transmission shaft is mechanically coupled to such a movable actuation assembly and to the movable contact member 6 of each electric pole. The motion transmission shaft can thus transmit mechanical forces to move the movable contact member 6 of each electric pole during the manoeuvres of the switching apparatus.

[0077] In the embodiments shown in the cited figures, the above-mentioned motion transmission shaft preferably rotates about a rotation axis parallel to or coinciding with the main longitudinal direction A1 of the switching apparatus (or the rotation axis A of each movable contact member 6, when said contact members move rotationally) and transmit rotational forces to the movable contact members.

[0078] In the embodiments in which the movable contact members move roto-translationally or translationally, the above-mentioned motion transmission shaft may be arranged differently, according to the needs.

[0079] In general, also the above-described components of the switching apparatus may be arranged according to solutions of known type and they will be not described in further details, for the sake of brevity.

[0080] Besides, the switching apparatus 1 may comprise a variety of additional components (not shown in the cited figures), which may be realized according to solutions of known type and are here not described for the sake of brevity.

[0081] According to the invention, the switching apparatus 1 comprises, for each electric pole, a shielding member 10 including a conductive body 101.

[0082] The conductive body 101 has first surfaces 106 defining a coupling cavity 102 intended to accommodate the movable contact member 6 of the corresponding electric pole.

[0083] The conductive body 101 further has second surfaces 107 facing the surrounding components (for example the outer enclosure 3, the fixed contact member

5 and possibly the earthing contact member 9) of the corresponding electric pole. As it is apparent from the cited figures, the second surfaces 107 form, in practice, the outer surfaces of the conductive body 101. Obviously, during operation of the switching apparatus, these outer surfaces will result perpendicular to the lines of force of the electric fields arising between the conductive body 101 and the surrounding conductive components of the electric pole.

[0084] Advantageously, the outer surfaces 107 of the conductive body 101 have a rounded profile, i.e., they do not show sharp edges or corners. In this way, they favor a uniform and homogeneous spatial distribution of the electric field lines and hinder the arising of undesired electric arcs between the conductive body 101 and the surrounding conductive components of the electric pole.

[0085] Preferably, each shielding member 10 comprises supporting means 108, 109 configured to hold the conductive body 101 in its operating position by mechanically coupling this latter to another support component, for example the outer enclosure 3 or the movable contact member 6 of the corresponding electric pole.

[0086] In the embodiment of figure 5, said support means include suitable spacers 109, preferably made of electrically insulating material. In the embodiment of figures 8-10, said support means include a supporting bolt 108 preferably made of electrically conductive material.

[0087] The above-mentioned support means may be arranged to solutions of different type. According to the invention, each shielding member 10 is arranged in a fixed position relative to the movable contact member 6 of the corresponding electric pole.

[0088] Each shielding member 10 is however mechanically couplable with the corresponding movable contact member 6, when this latter reaches the open position O.

[0089] More particularly, each shielding member 10 is arranged in such a way to cross the motion trajectory of the movable contact member 6 at a position corresponding to the open position O of this latter. In this way, the movable contact member 10 can be accommodated in the coupling cavity 102 of the shielding member 10 and be surrounded at least partially by the conductive body 101, when the movable contact member 6 reaches the open position O during an opening manoeuvre of the switching apparatus.

[0090] According to some embodiments of the invention, especially when the electric poles 2 comprise earthing contact members 9 (for example when the switching apparatus is configured as a load break switch), the coupling cavity 102 of the conductive body 101 is configured as a pass-through cavity, so that the movable contact member 6 can go inside and outside it at opposite sides of the conductive body.

[0091] In these embodiments of the invention, the movable contact member 6 passes through the coupling cavity 102 during the operation of the switching apparatus. In practice, the movable contact member goes inside the coupling cavity 102 when it reaches the open position O during an opening manoeuvre (at a side of the conductive body facing the fixed contact member 5) or a reconnecting manoeuvre 102 (at an opposite side of the conductive body facing the earthing contact member 9) of the switching apparatus, and it goes outside the coupling cavity 102 when it moves away from the open position O during a disconnecting manoeuvre (at a side of the conductive body facing the earthing contact member 9) or a closing manoeuvre (at an opposite side of the conductive body facing the fixed contact member 5) of the switching apparatus. According to other embodiments of the invention, for example when the electric poles 2 do not comprise earthing contact members (e.g., when the switching apparatus is configured as a circuit breaker or a contactor), the coupling cavity 102 of the conductive body 101 may be configured as a blind cavity. In this case, the movable contact member 6 goes inside and outside the coupling cavity 102 at a same side of said conductive body only.

[0092] In these embodiments of the invention, the movable contact member 6 reaches an end-of-run position when it is accommodated in the coupling cavity 102. In practice, the movable contact member 6 goes inside the coupling cavity 102 (at a side of the conductive body facing the fixed contact member 5) when it reaches the open position O during an opening manoeuvre of the switching apparatus, and it goes outside the coupling cavity 102 (at the same side of the conductive body) when it moves away from the open position O during a closing manoeuvre of the switching apparatus.

[0093] As it is apparent from the above, the shielding member 10 of each electric pole forms an electric field diffuser or homogenizer operatively associated to the movable contact member 6 of the corresponding electric pole.

[0094] When the movable contact member 6 is accommodated in the coupling cavity 102, the conductive body 101 of the shielding member surrounds the movable contact member 6 and homogenizes the electric field around this latter, thereby reducing the probability of undesired breakdown phenomena.

[0095] Differently from the solutions of the state of the art, the shielding member 10 is stationary relative to the movable contact member 6 (in practice, it does not move together with this latter). The shielding member 10 operatively couples to the movable contact member 6 only when this latter reaches the open position O.

[0096] During an opening manoeuvre of the switching apparatus, the shielding member 10 provides for homogenizing the electric field around the movable contact member 6 during the last phase of said manoeuvre (the so-called "dielectric recovery phase"), when the movable contact member 6 reaches the open position O. The shielding member 10 can thus effectively prevent or reduce possible restrike arcing phenomena between the movable contact member 6 and other live or grounded components of the corresponding electric pole, even if the movable contact member 6 has been designed to

optimize other electrical performances (current breaking capability) of the switching apparatus and not specifically to this aim. As a result, the performances of the switching apparatus are improved in terms of dielectric insulation among the conductive components of the electric poles.

[0097] On the other hand, the shielding member 10 is physically separated from the movable contact member 6 during most of the opening manoeuvre, particularly during the initial phase of this latter, when the movable contact member 6 moves away from the corresponding fixed contact member 5 and the corresponding electric contacts 51, 61 start mutually separating. The shielding member 10 has thus no appreciable influence on other electrical performances of the switching apparatus, particularly on its braking capability.

[0098] Preferably, the conductive body 101 is put at the same voltage potential of the movable contact member 6, at least when said movable contact member is accommodated in the coupling cavity 102 of the conductive body 101. In this way, possible arcing phenomena between the movable contact member 6 and said conductive body can be effectively prevented.

[0099] According to some embodiments of the invention, the conductive body 101 of the shielding member 10 is put at the same voltage potential of the movable contact member 6, only when this latter reaches the open position O.

[0100] In the embodiments of figures 5-7, the shielding member 10 comprises conductive contact springs 105 fixed to the conductive body 101 and protruding from the first surfaces 106 of this latter in such a way to come into a sliding contact with the movable contact member 6, when this latter goes inside the coupling cavity 102. In this way, the contact springs 105 can electrically connect the conductive body 101 and the movable contact member 6, when this latter is accommodated in the coupling cavity 102.

[0101] According to other embodiments of the invention, the conductive body 101 of the shielding member 10 is permanently put at the same voltage potential of the movable contact member 6. In this case, the shielding member 10 comprises electrical connection means electrically connecting the conductive body 101 to the movable contact member 6 in a permanent manner. In the embodiment of figures 8-10, such electrical connection means comprises a bolt 108 made of conductive material and rotatably coupling the movable contact member 6 to the stationary conductive body 101. The movable contact member 6 can thus move relative to the conductive body 101 about the rotation axis A and, at the same time, be electrically connected to said conductive body. It is evidenced how, in the embodiment of figures 8-10, the conductive bolt 108 operates also as a supporting element holding the conductive body 101 in its operating position (possibly in cooperation with other support components).

[0102] According to some embodiments of the invention, the conductive body 101 is made of multiple separated parts 101A, 101B of conductive material.

[0103] In the embodiment of figures 5-7, the conductive body 101 includes a pair of shells 101A, 101B made of conductive material, which are mutually juxtaposed and spaced apart one from another. The conductive shells 101A, 101B have preferably an elongated shape (e.g., half-oval) and are mutually juxtaposed along a plane substantially parallel to their main longitudinal axes.

[0104] The conductive shells 101A, 101B include opposite internal surfaces 106 (in this case with a concave shape) mutually facing and forming the above-mentioned first surfaces of the conductive body.

[0105] The first surfaces 106 of the conductive shells 101A, 101B define a coupling cavity 102 between said shells, which is conveniently shaped as an elongated slot.

[0106] The shells 101A, 101B include oppositely oriented surfaces 107 (in this case with a convex shape), which form the second surfaces of the conductive body.

[0107] The second surfaces 107 of the conductive shells 101A, 101B have a rounded profile and define the outer surface of the conductive body 101.

[0108] In this embodiment of the invention, the movable contact member 6 moves about the rotation axis A. When it reaches the open position O (for example during an opening manoeuvre of the switching apparatus), the movable contact member 6 is accommodated in the coupling cavity 102 and it is partially surrounded by the conductive shells 101A, 101B.

[0109] When the corresponding electric pole comprises an earthing contact 9, the movable contact member 6 can pass through the coupling cavity 102 between the conductive shells 101A, 101B (at opposite sides of these latter), when it has to move away from the open position O to reach an earthing position E (disconnecting manoeuvre) or a closed position C (closing manoeuvre). Advantageously, the conductive shells 101A, 101B comprises contact springs 105 protruding from the opposite (concave) first surfaces 106 and coming into a sliding contact with the movable contact member 6, when this latter reaches the open position O and is accommodated in the coupling cavity 102.

[0110] Each conductive shell 101A, 101B is held in position by one or more supporting components 109 (e.g., supporting spacers or similar components) conveniently made of electrically insulating material.

[0111] In the embodiment of figures 8-10, the conductive body 101 of the shielding element 10 is arranged similarly to the embodiment of figures 5-7 for many aspects.

[0112] In this case, the separated conductive shells 101A, 101B have a slightly different elongated shape and are provided with elongated apertures 104 extending along their main longitudinal axes. The first and second surfaces 106, 107 of each conductive shell 101A, 110B define in cooperation the corresponding elongated aperture 104.

[0113] The movable contact member 6 is rotatably coupled to the conductive shells 101A, 101B by means of a

bolt 108, so that it can move relatively to said conductive shells. The bolt 108 has also the function of joining together the conductive shells. Conveniently, the bolt 108 is made of an electrically conductive material. In this way, the conductive shells 101A, 101B are electrically connected to the movable contact member 6. This solution allows permanently putting the conductive shells 101A, 101B and the movable contact member 6 at a same voltage without the need of contact springs.

[0114] According to some embodiments of the invention, the conductive body 101 is made of a single piece of conductive material.

[0115] In the embodiment of figures 11-12, the conductive body 101 in a reversed-U shaped piece of conductive material.

[0116] The conductive body 101 has a pair of parallel, mutually facing, elongated side portions 101D having suitable free ends and a transversal portion 101C joining the side portions 101D distally from the free ends of said side portions.

[0117] The side portions 101D and the joining portion 101C have internal surfaces 106 (in this case having a flat shape) forming the above-mentioned first surfaces of the conductive body.

[0118] The first surfaces 106 of the conductive portions 101C, 101D define a coupling cavity 102 conveniently shaped as an elongated slot.

[0119] The conductive portions 101C, 101D include outer rounded surfaces 107 (in this case having a convex shape), which form the second surfaces of the conductive body defining the outer surface of the conductive body 101.

[0120] The mutually facing conductive portions 101D are provided with elongated apertures 104A extending along their main longitudinal axes. The first and second surfaces 106, 107 of each conductive portion 101D define in cooperation the corresponding elongated aperture 104A.

[0121] In this embodiment of the invention, also, the movable contact member 6 moves about the rotation axis A. When it reaches the open position O (for example during an opening manoeuvre of the switching apparatus), the movable contact member 6 is accommodated in the coupling cavity 102 and it is partially surrounded by the conductive portions 101C, 101D of the conductive body.

[0122] When the corresponding electric pole comprises an earthing contact 9, the movable contact member 6 can pass through the coupling cavity 102 between the conductive portions 101C, 101D (at opposite sides of the conductive body), when it has to move away from the open position O to reach an earthing position E (disconnecting manoeuvre) or a closed position C (closing manoeuvre).

[0123] Advantageously, the conductive portions 101D may comprise contact springs (not shown) protruding from the opposite first surfaces 106 and coming into a sliding contact with the movable contact member 6, when this latter reaches the open position O.

[0124] The conductive body 101 is held in position by one or more supporting components 109 (e.g., supporting spacers or similar components) conveniently made of electrically insulating material.

[0125] The switching apparatus 1, according to the invention, provides relevant advantages with respect to corresponding known switching systems of the state of the art.

[0126] The arrangement of a stationary shielding member (electric field diffuser) for each electric pole, as described above, allows remarkably reducing or preventing restrike arcing phenomena between the movable contact members of the electric poles and the surrounding conductive components, even if the internal volume of the switching apparatus is filled with an insulation gas having a lower dielectric insulation capacity compared to SF_6.

[0127] On the other hand, since it operatively couples with the corresponding stationary shielding member only when it reaches an open position, each movable contact member can be suitably designed to optimize the electrical performances of the switching apparatus without relevant constraints deriving from the presence of the shielding member.

[0128] The arrangement of a shielding member 10 for each electric pole is relatively easy to carry out at industrial level and it does not have a substantial impact on the structural complexity and size of the electric poles.

[0129] The switching apparatus, according to the invention, can thus be realized with a relatively simple and compact structure.

[0130] The switching apparatus, according to the invention, is thus relatively easy to manufacture at industrial level at competitive industrial costs compared to the available solutions of the state of the art.

Claims

1. Switching apparatus (1) comprising:

- one or more electric poles (2);
- an enclosure (3) defining an internal volume, in which said electric poles are accommodated;
- for each electric pole, a fixed contact member (5) including a fixed contact (51) and arranged in a fixed position relative to said enclosure;
- for each electric pole, a movable contact member (6) including a movable contact (61) and reversibly movable between a closed position (C), at which said movable contact is coupled to said fixed contact (51), and an open position (O), at which said at movable contact is decoupled from said fixed contact;

characterised in that said switching apparatus comprises, for each electric pole, a

shielding member (10) including a conductive body (101) having first surfaces (106) defining a coupling cavity (102) for said movable contact member (6) and second surfaces (107) having a rounded profile and facing one or more surrounding components (3, 5) of said electric pole,
wherein said shielding member (10) is arranged in a fixed position relative to said movable contact member (6) and said enclosure (3),
wherein said movable contact member is accommodated in said coupling cavity (102) and is surrounded at least partially by said conductive body (101), when said movable contact member reaches said open position (O).

2. Switching apparatus, according to claim 1, **characterised in that** said conductive body (101) is put at the same voltage potential of said movable contact member (6), at least when said movable contact member is accommodated in said coupling cavity (102).

3. Switching apparatus, according to claim 2, **characterised in that** said conductive body (101) comprises conductive contact springs (105) arranged said first surfaces (106), said contact springs slidingly coupling with said movable contact member (6) and electrically connecting said conductive body (101) to said movable contact member, when movable contact member is accommodated in said coupling cavity (102).

4. Switching apparatus, according to claim 2, **characterised in that** said shielding member (10) includes electrical connection means (108) electrically connecting said conductive body (101) to said movable contact member (6) in a permanent manner.

5. Switching apparatus, according to one of the previous claims, **characterised in that** said coupling cavity (102) is shaped as a pass-through cavity, so that said movable contact member (6) goes inside and outside said coupling cavity at opposite sides of said conductive body (101).

6. Switching apparatus, according to one of the claims from 1 to 4, **characterised in that** said coupling cavity (102) is shaped as a blind cavity, so that said movable contact member (6) goes inside and outside said coupling cavity only at a same side of said conductive body (101).

7. Switching apparatus, according to one of the previous claims, **characterised in that** said conductive body (101) is made of multiple separated parts (101A, 101B) of conductive material.

8. Switching apparatus, according to one of the claims from 1 to 6, **characterised in that** said conductive body (101) is made in a single piece of conductive material.

9. Switching apparatus, according to one of the previous claims, **characterised in that** it comprises, for each electric pole, an earthing contact member (9) arranged in a fixed position relative to said enclosure and including an earthing contact (91), said movable contact member being reversibly movable between said open position (O) and an earthed position (E), at which said at least a movable contact (61) is coupled to said earthing contact (91).

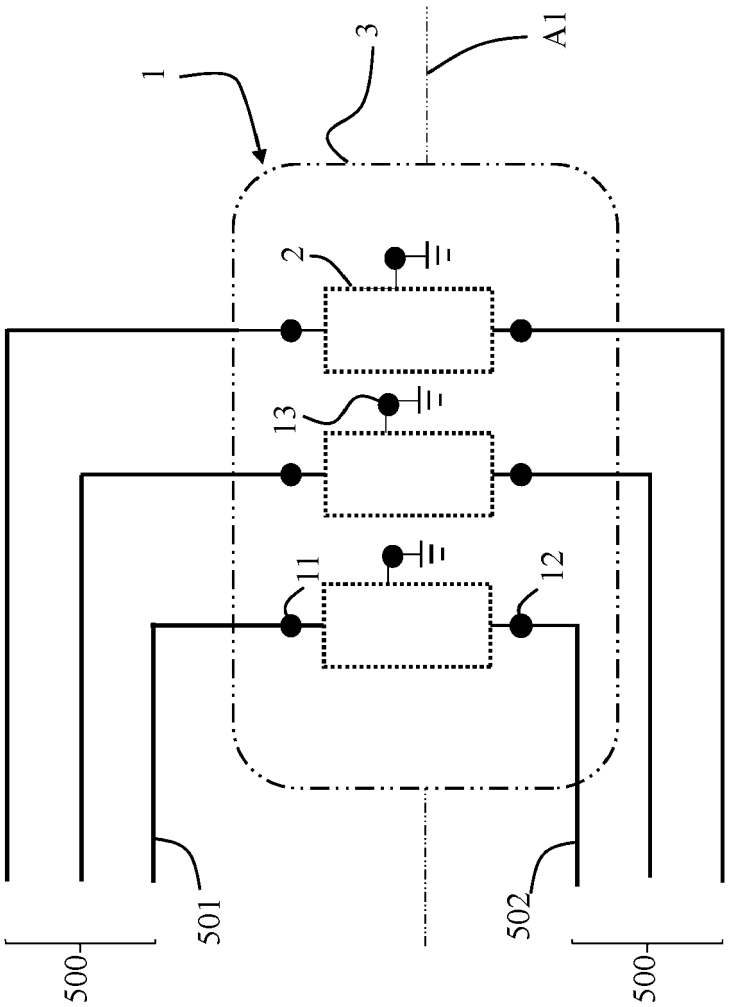
10. Switching apparatus, according to one of the previous claims, **characterised in that** it comprises, for each electric pole, a puffer assembly (8) configured to provide a flow of compressed gas towards said fixed contact member (5) in such a way to blow hot gases away, during an opening manoeuvre of said switching apparatus.

11. Switching apparatus, according to one of the previous claims, **characterised in that** said movable contact member (6) is rotatably movable about a rotation axis (A).

12. Switching apparatus, according to one or more of the previous claims, **characterised in that** it is a medium-voltage load-break switch.

13. A medium-voltage electrical system comprising a switching apparatus (1), according to one or more of the previous claims.

FIG. 1



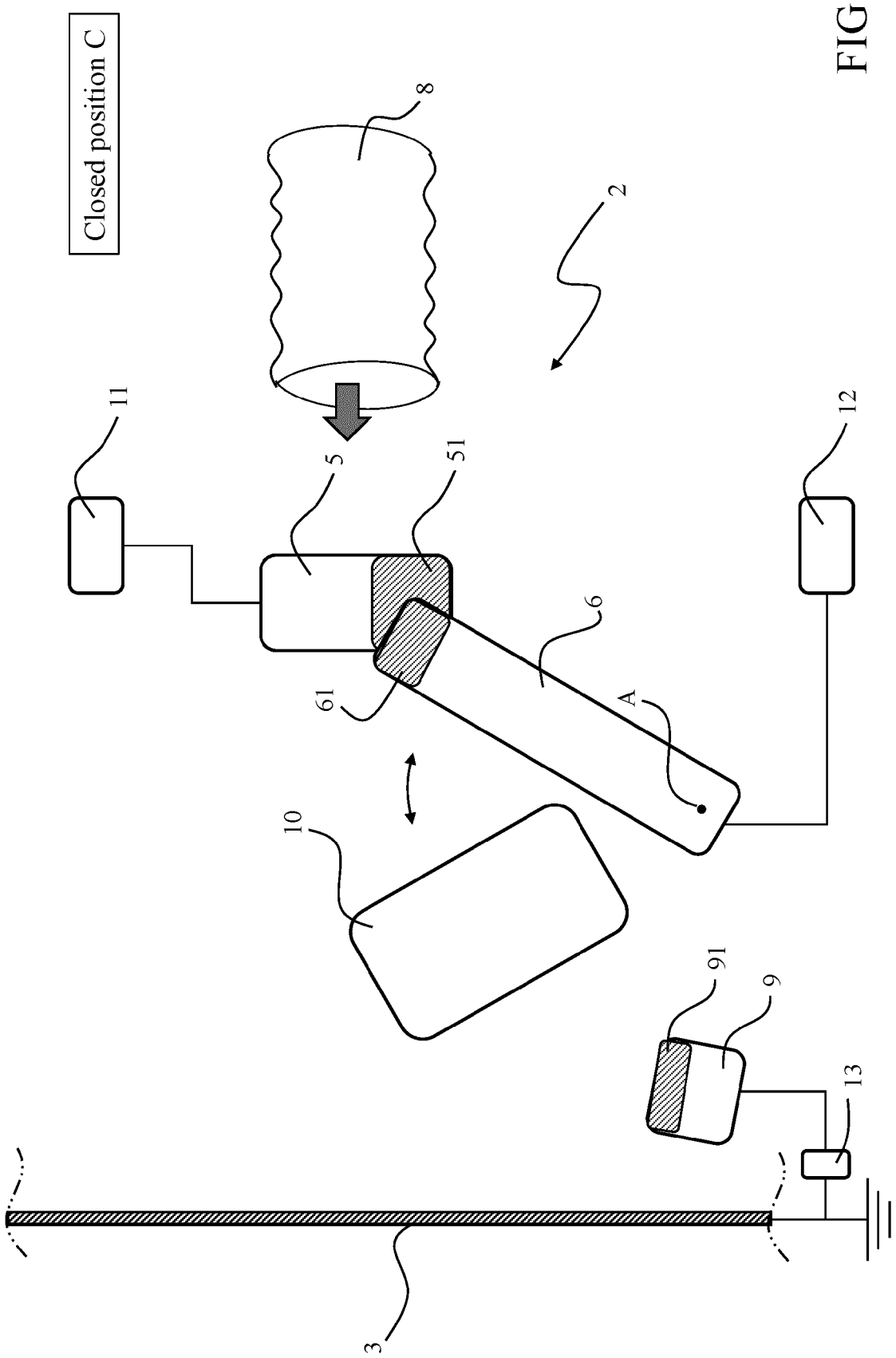


FIG. 2

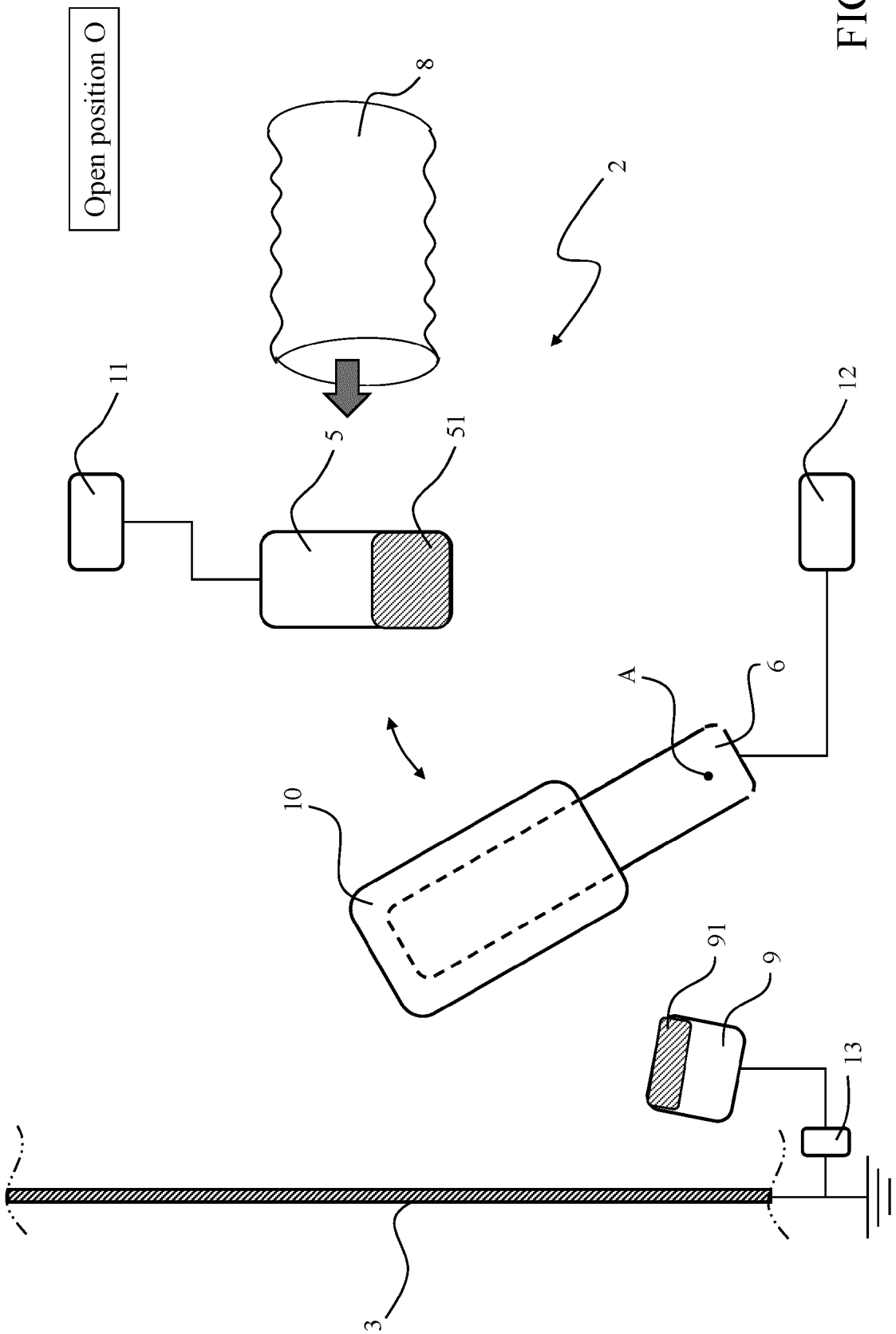


FIG. 3

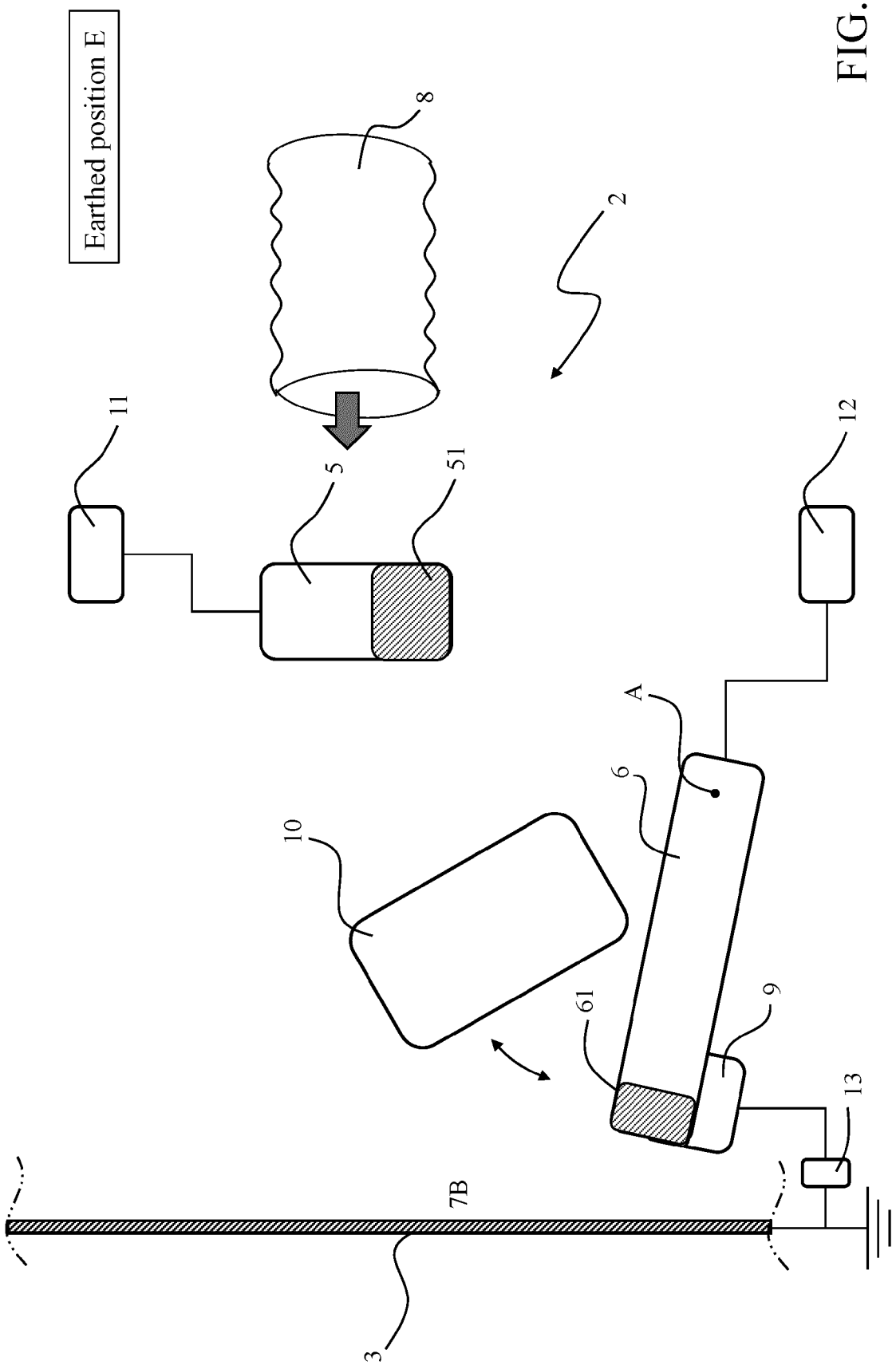


FIG. 4

FIG. 5

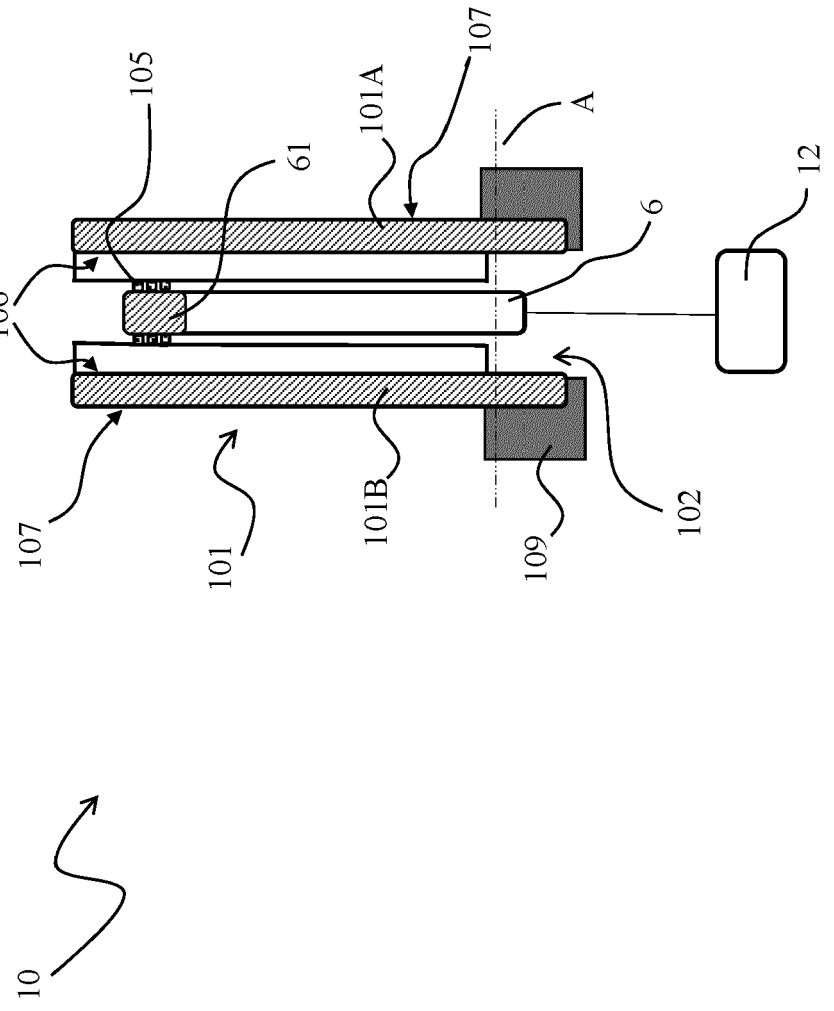


FIG. 6

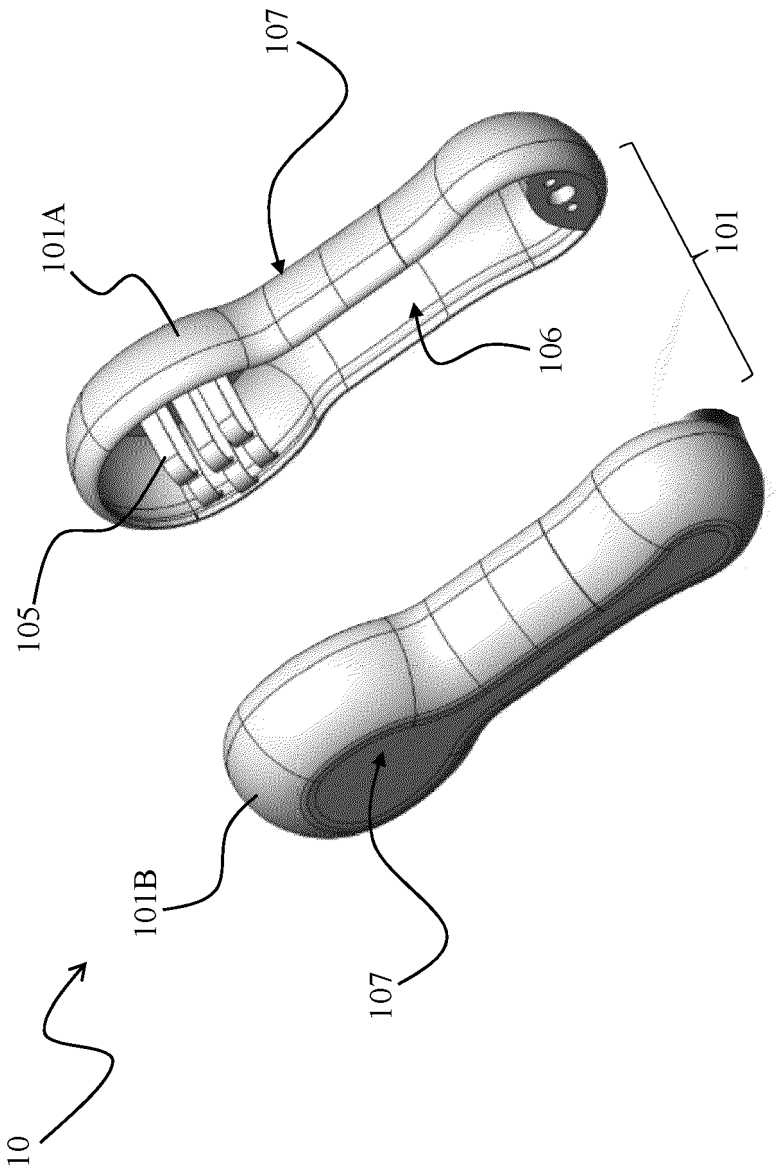


FIG. 7

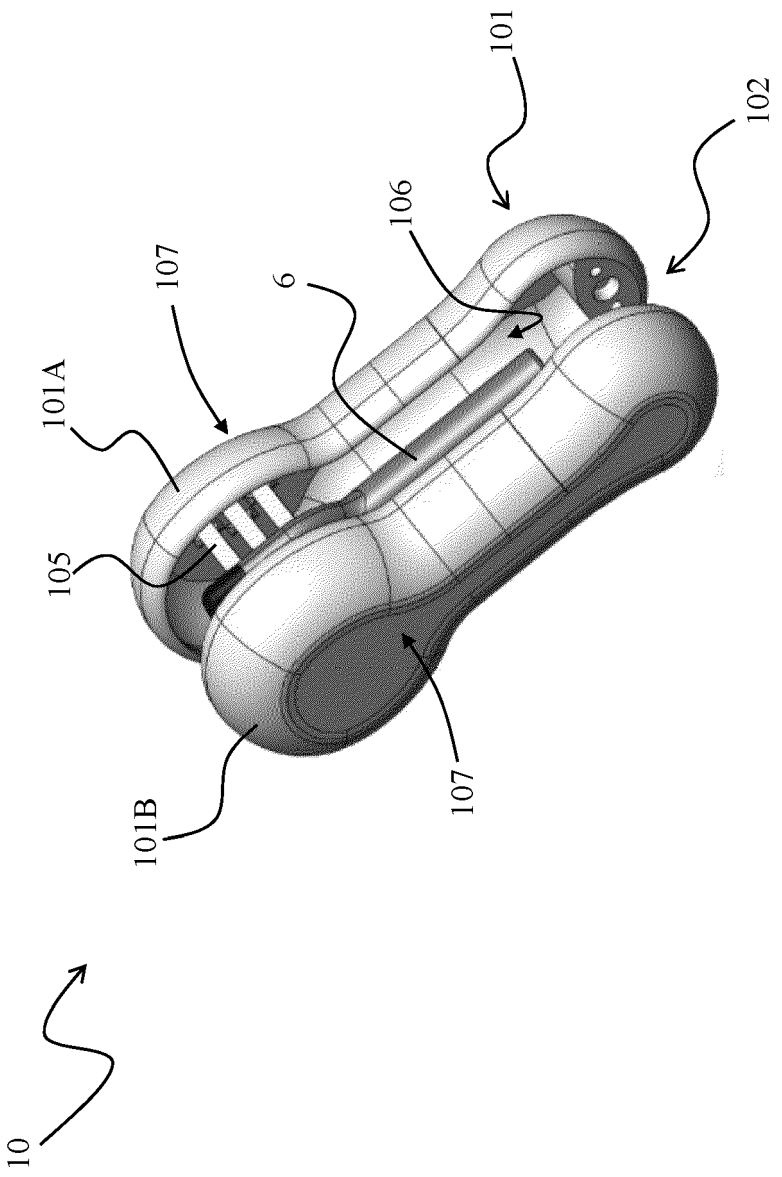


FIG. 8

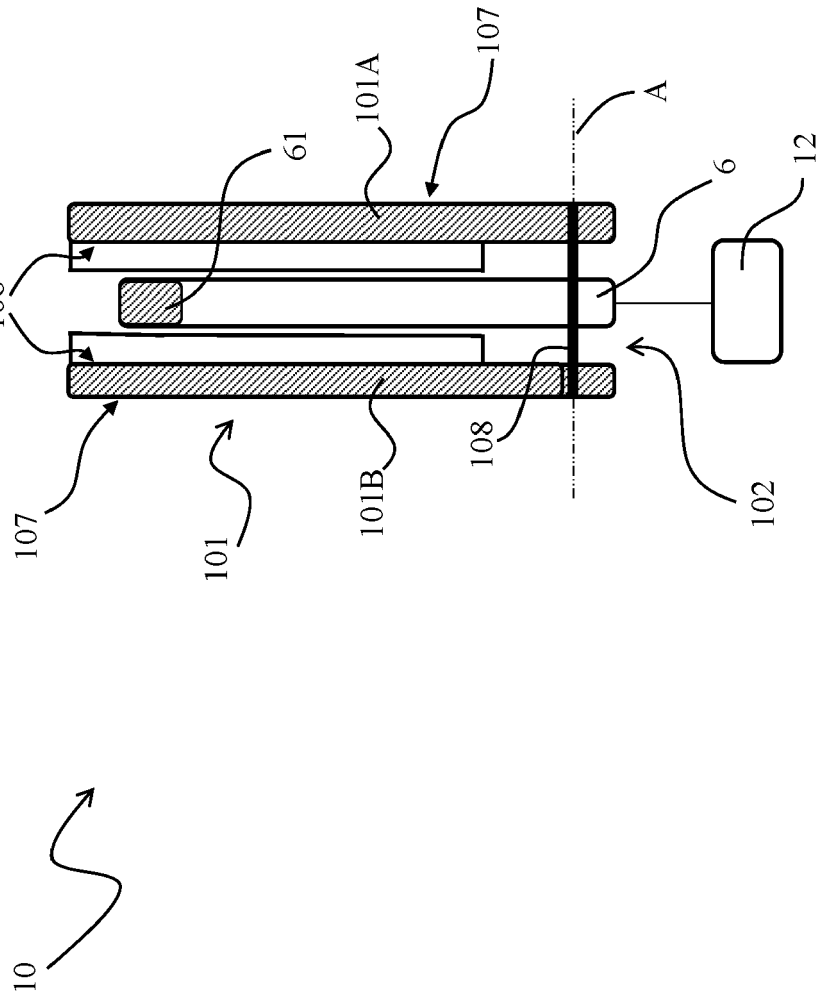


FIG. 9

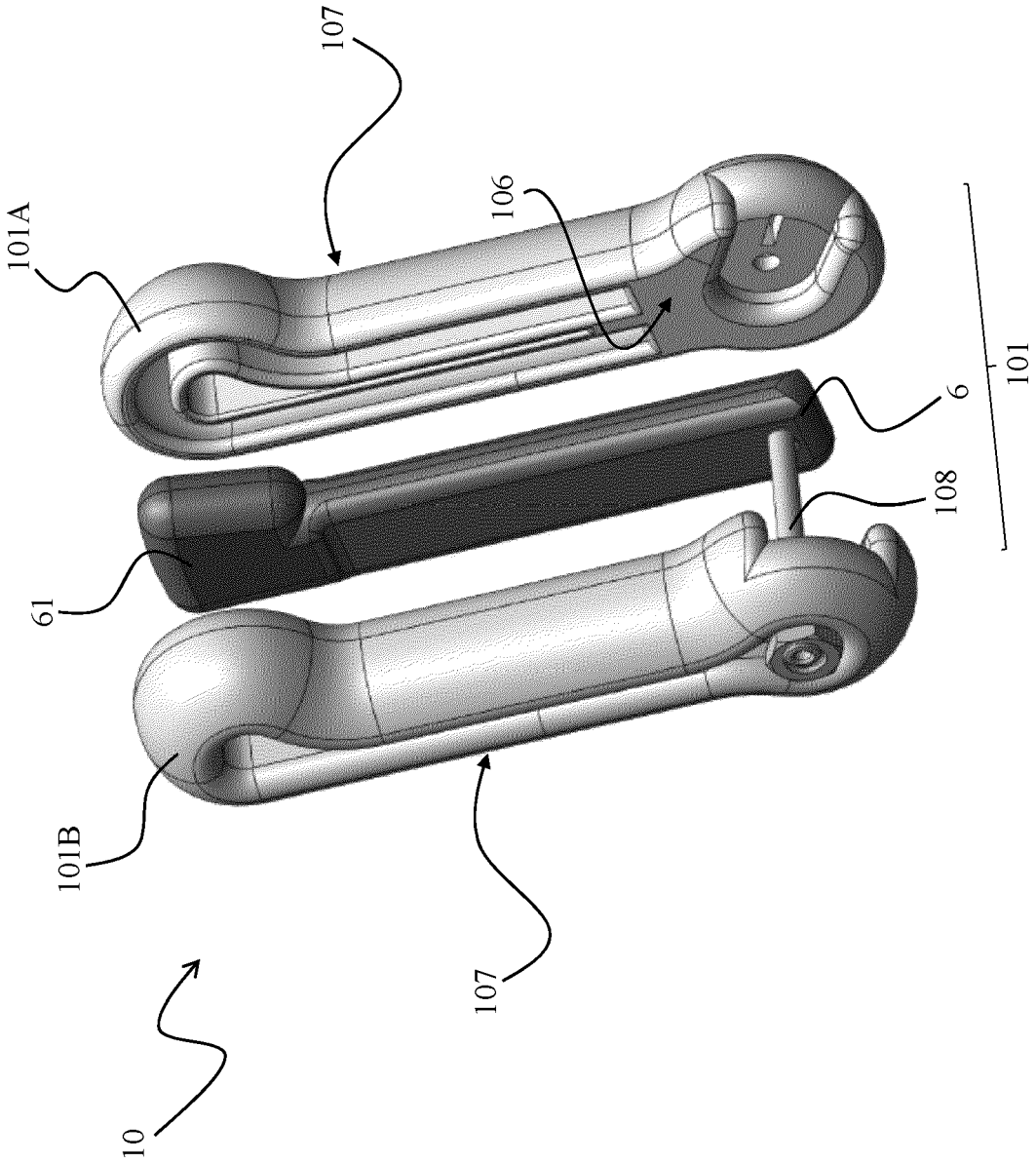


FIG. 10

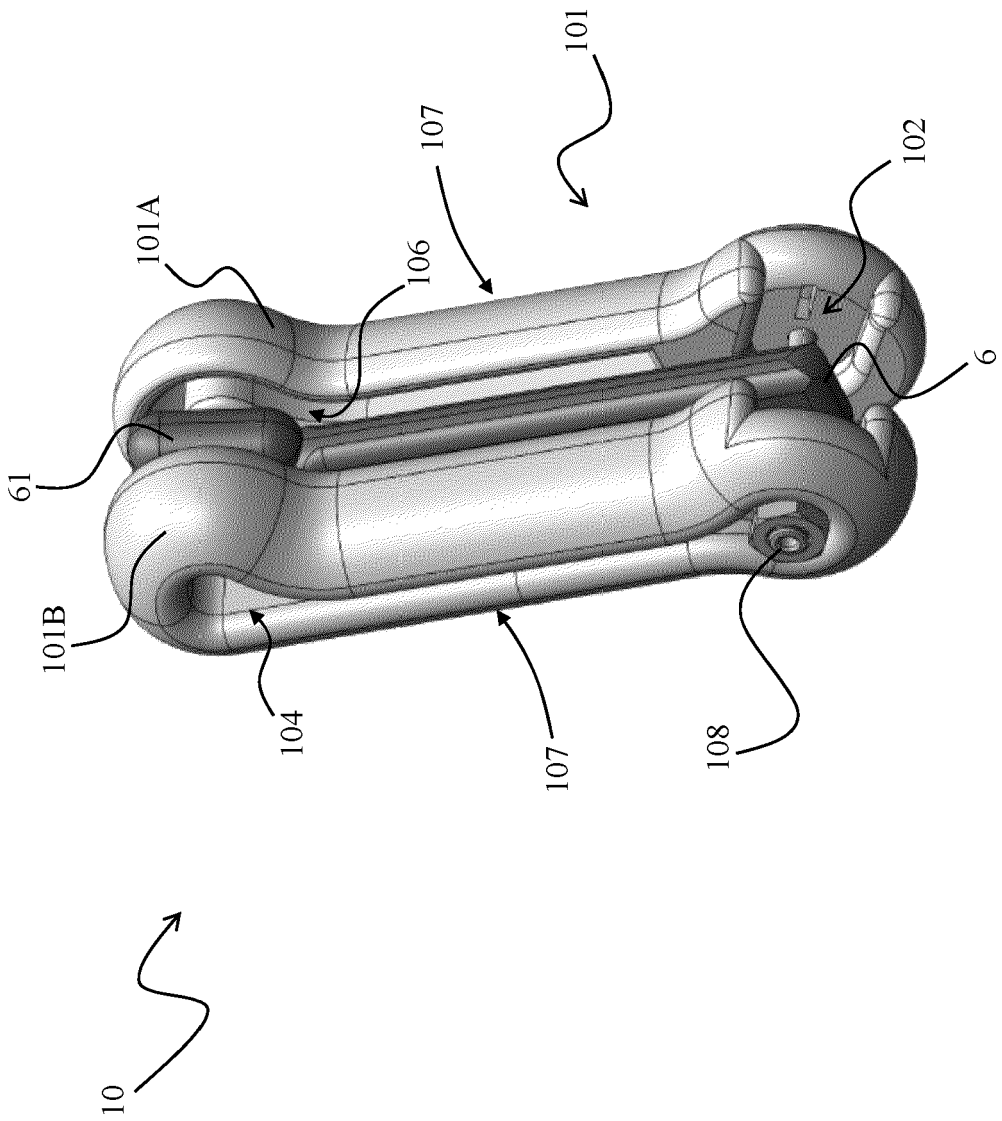


FIG. 11

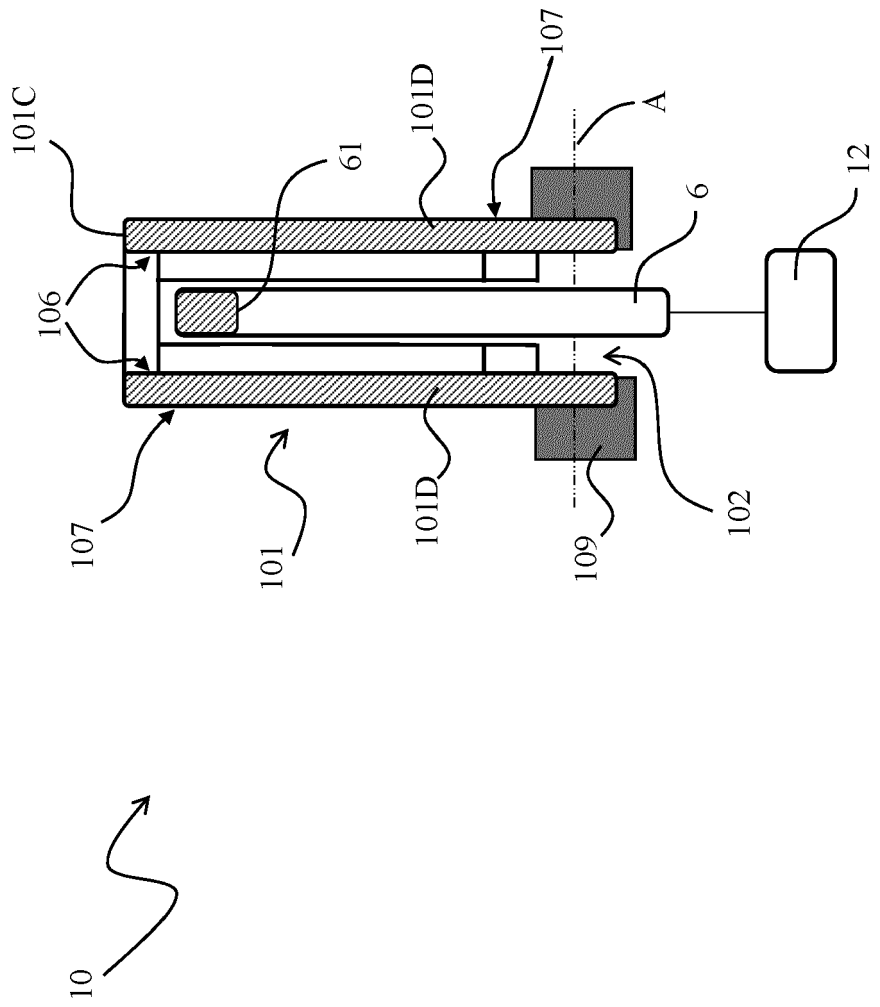
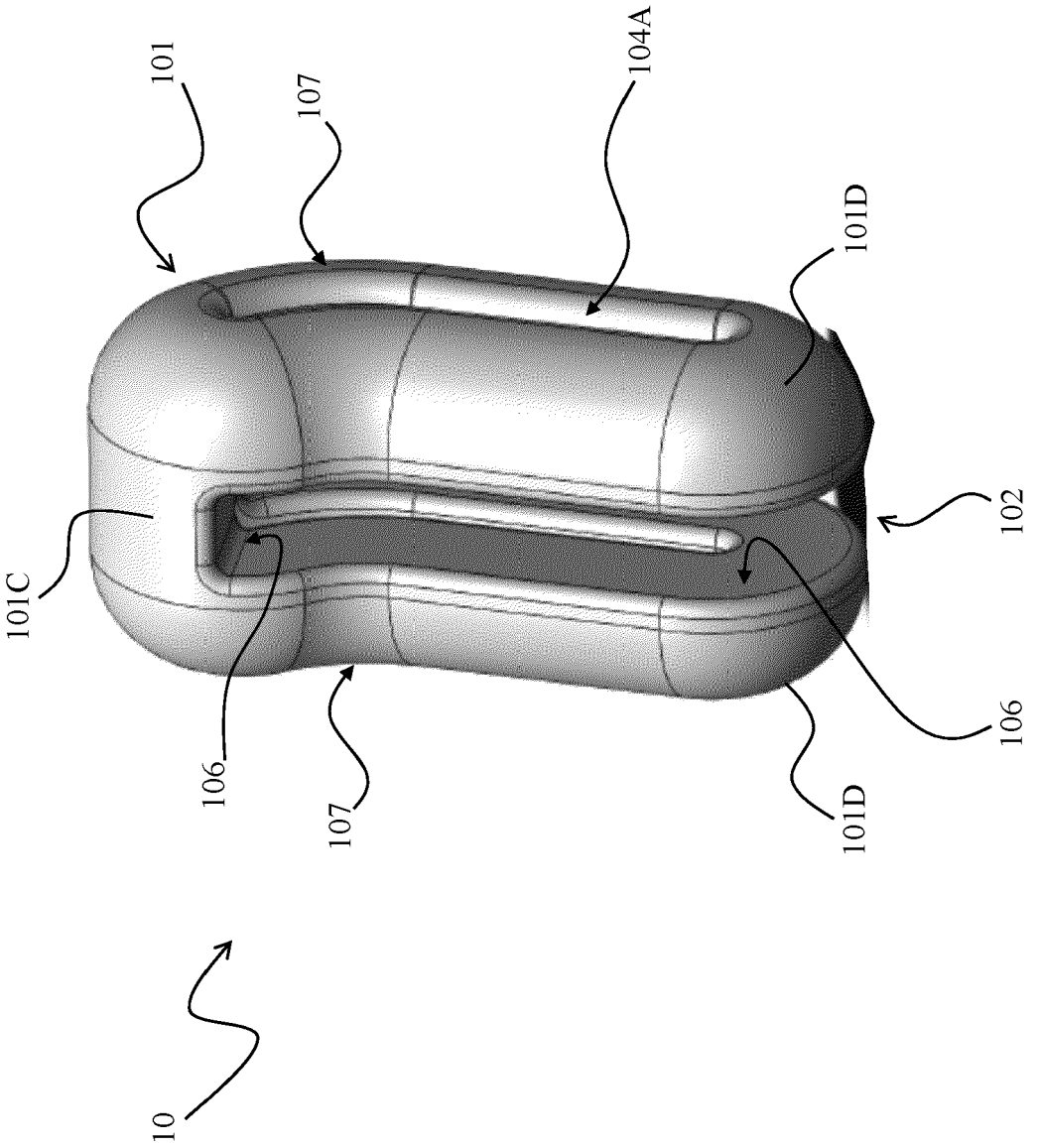


FIG. 12



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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 1273

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H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	5 October 2023	Simonini, Stefano

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