



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.09.2024 Bulletin 2024/39

(51) International Patent Classification (IPC):
H01H 9/30 (2006.01)

(21) Application number: **23163263.9**

(52) Cooperative Patent Classification (CPC):
H01H 9/302; H01H 2009/305

(22) Date of filing: **21.03.2023**

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

- **Cucchi, Irene**
CH-8045 Zurich (CH)
- **Studniarek, Michal**
CH-8134 Adliswil (CH)
- **Jonsson Seither, Erik**
NO-7054 Ranheim (NO)
- **Støa-Aanensen, Nina Sasaki**
NO-7049 Trondheim (NO)
- **Engel, Edgar**
CH-5415 Nussbaumen (CH)

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

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

(72) Inventors:
• **Lantz, Gabriel**
CH-8037 Zurich (CH)

(54) **A SWITCHING APPARATUS FOR MEDIUM VOLTAGE ELECTRICAL SYSTEMS**

(57) A switching apparatus for medium voltage electrical systems, said switching apparatus comprising:
- one or more electric poles;
- an outer enclosure defining an internal volume, in which said electric poles are accommodated;
- 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 (51), and an open position, at which said movable contact member is decoupled

from said fixed contact.

The switching apparatus comprises, for each electric pole, a cover member made of electrically insulating material and arranged in a fixed position relative to said outer enclosure.

Said cover member is located between said fixed contact member and a side of said outer enclosure, towards which said movable contact member moves, during an opening manoeuvre of said switching apparatus.

Said cover member is configured to intercept and deviate hot gases directed towards said outer enclosure, during an opening manoeuvre of said switching apparatus.

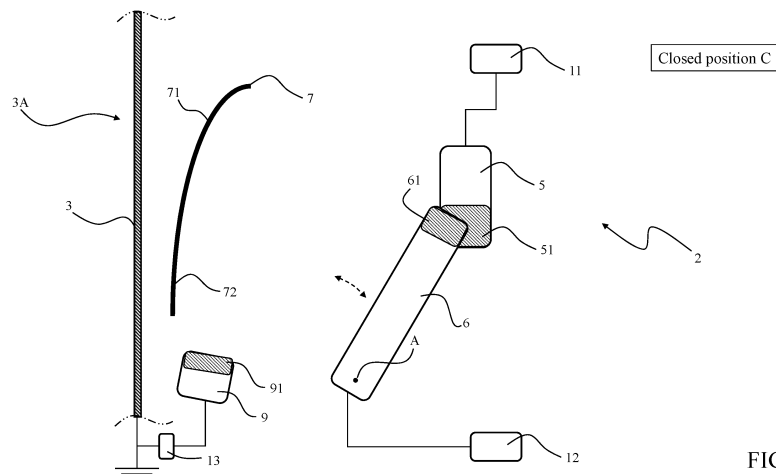


FIG. 2

Description

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

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

[0003] These switching apparatuses, which are generally used in secondary distribution electric grids, are capable of providing circuit-breaking functionalities (typically breaking and making a current) 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 powerful 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] Some load-break switches have been developed, in which 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 more recent switching apparatuses still have some aspects to improve, particularly 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 arise 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) in proximity of this latter.

[0009] It has been seen that these restriking arcing phenomena, which are basically due to the lower thermal capacity 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 restriking arcing phenomena may cause serious damages to the switching apparatus as they may involve internal components of the switching apparatus, which are not generally designed to bear high electric and thermal stresses.

[0011] The main aim of the present invention is to provide

a switching apparatus for medium-voltage electrical systems, which allows overcoming or mitigating the drawbacks of the known art. Within this aim, a purpose of the present invention is to provide a switching apparatus employing an environment-friendly insulation gas, in which restriking arcing phenomena between the movable 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.

[0012] 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.

[0013] 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.

[0014] 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.

[0015] In a general definition, the switching apparatus, according to the invention comprises:

- one or more electric poles;
- an outer enclosure defining an internal volume, in which said electric poles are accommodated;
- for each electric pole, a fixed contact member including a fixed contact and arranged in a fixed position relative to said enclosure;
- for each electric pole, a movable contact member including a movable contact and reversibly movable (preferably about a rotation axis) 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 movable contact member is electrically and mechanically decoupled from said fixed contact.

[0016] The switching apparatus comprises, for each electric pole, a cover member made of electrically insulating material and arranged in a fixed position relative to said outer enclosure.

[0017] Said cover member is located between said fixed contact member and a side of said outer enclosure, towards which said movable contact member moves, during an opening manoeuvre of said switching apparatus.

[0018] Said cover member is configured to intercept and deviate hot gases directed towards said outer enclosure, during an opening manoeuvre of said switching apparatus.

[0019] According to some embodiments of the invention, said cover member is located in an intermediate position between the open position of said movable contact member and said outer enclosure.

[0020] According to some embodiments of the invention, said cover member is located in such a way to cross a motion trajectory of said movable contact member, when said movable contact member moves between said closed position and said open position. In this case, said cover member includes a slot to allow said movable contact member to pass through said cover member, at least partially.

[0021] According to some embodiments of the invention, said cover member is located in such a way to cross the motion trajectory of said movable contact member at the open position of said movable contact member.

[0022] According to some embodiments of the invention, said cover member is located in such a way to cross the motion trajectory of said movable contact member at an intermediate position between the open position and the closed position of said movable contact member. According to some embodiments of the invention, said cover member is made by a continuous electrically insulating material.

[0023] According to other embodiments of the invention, said cover member is made by a porous or holed electrically insulating material.

[0024] According to an aspect of the invention, said cover member has a curved geometric profile along a section plane parallel to a movement plane of said movable contact member. Preferably, said cover member has a convex curved surface facing said outer enclosure and an opposite concave curved surface facing the fixed contact member of said electric pole. According to some embodiments of the invention, said cover member has a C-shaped geometric profile along a section plane parallel to a movement plane of said movable contact member. According to some embodiments of the invention, said cover member has a spiral-shaped geometric profile along a section plane parallel to a movement plane of said movable contact member. Such a spiral-shaped geometric profile develops about a central axis perpendicular to a movement plane of said movable contact member.

[0025] According to some embodiments of the invention, said switching apparatus is of the multiphase type and it comprises a plurality of cover members, one for each electric pole. Each cover member is structurally independent from the other cover members.

[0026] According to some embodiments of the invention, said switching apparatus is of the multiphase type and it comprises a single cover structure including a plurality of adjacent cover sections. Each cover section forms a cover member for a corresponding electric pole.

[0027] Preferably, each cover member is formed by a sheet of electrically insulating material.

[0028] As an alternative, each cover member may be formed by an open-box structure including a bottom wall formed by a sheet of electrically insulating material and one or more lateral wings of electrically insulating material protruding perpendicularly relative to said bottom wall. According to an industrial application of the present

invention, the switching apparatus is a load break switch for medium voltage electrical systems.

[0029] 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 2-5 show different schematic views of an electric pole of the switching apparatus, according to an embodiment of the invention, in different operating states;
- Figures 6-11 show schematic views of an electric pole of the switching apparatus, according to further embodiments of the invention;
- Figures 12-13 show schematic views of the electric poles of the switching apparatus, according to a further embodiment of the invention;
- Figure 14 shows a schematic view of the electric poles of the switching apparatus, according to yet a further embodiment of the invention.

[0030] With reference to the figures, the present invention relates to a switching apparatus 1 for medium voltage electric systems.

[0031] For the purpose of the present application, 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.

[0032] The switching apparatus 1 is particularly adapted to operate as a load-break switch. In this case, it will be designed for providing circuit-breaking functionalities under specified circuit conditions (normally nominal conditions or fault conditions) as well as circuit-disconnecting functionalities, in particular grounding a load-side section of an electric circuit.

[0033] The switching apparatus 1 comprises one or more electric poles 2.

[0034] 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.

[0035] The switching apparatus 1 comprises an outer enclosure 3 conveniently defining an internal volume where the electric poles are accommodated.

[0036] 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.

[0037] According to some embodiments of the invention, however, the outer enclosure 3 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 axis A1.

The electric poles 2 are conveniently arranged side by side along the main longitudinal axis A1 at corresponding transversal planes perpendicular to the main longitudinal axis (figure 1).

[0039] The internal volume of the switching apparatus 1 is filled with 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 50 (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 during a manoeuvre of the switching apparatus.

[0044] For the sake of clarity, it is specified that the terms "coupled", "decoupled" and other similar terms used in this disclosure relate to both an electrical and mechanical coupling or decoupling of different parts unless otherwise specified or self-evident from the description or figures. 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 a fixed contact 51. Preferably, the fixed contact member 5 is electrically connected to the first pole terminal 11 while the second fixed contact member 6 is electrically connected to the second pole terminal 12. To this aim, the contact members 5, 6 include suitable arrangements for electrical connection with the corresponding pole terminals.

[0045] The switching apparatus 1 comprises, for each electric pole, a movable contact member 6 including a movable contact 61.

[0046] The movable contact member 6 is reversibly movable between a closed position C and an open position O.

[0047] 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 whereas 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.

[0048] Preferably, each movable contact member 6 moves along to a corresponding movable plane. Referring to the cited figures, such a movement plane is, for example, a reference plane parallel to the observation plane of figures 1-10.

[0049] 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 axis A1 of the switching apparatus, between the closed position C and the open position O.

[0050] 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.

[0051] With reference to an observation plane of the cited figures, the above-mentioned first and second rotation direction are oriented counter-clockwise and clockwise, respectively. 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.

[0052] 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.

[0053] The earthing contact member 9 is electrically connected to the ground terminal 13 through suitable electrical connection arrangements.

[0054] According to these last embodiments of the invention, each movable contact member 6 is reversibly movable between the open position O and an earthed position E.

[0055] At the earthed position E (figure 5), the movable contact 61 of the movable contact member is coupled to the earthing contact 91 of the earthing contact member.

[0056] 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.

[0057] 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. 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 open position O and the earthed position E.

[0058] According to other 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] According to some embodiments of the invention, 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 (figure 6).

[0066] 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 4 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.

[0067] 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.

tus.

[0068] 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 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.

[0069] Advantageously, 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.

[0070] 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 rotation axis A of each movable contact member 6 and transmit rotational forces to the movable contact members.

[0071] 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.

[0072] In general, also the above-described components of the switching apparatus may be arranged according to solutions of known type and will be not described in further details, for the sake of brevity.

[0073] 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.

[0074] According to the invention, the switching apparatus 1 comprises, for each electric pole, a cover member 7 made of electrically insulating material and arranged in a fixed position relative to the outer enclosure 3.

[0075] In each electric pole, the cover member 7 is located between the fixed contact member 5 and a side 3A of the outer enclosure 3, towards which the movable contact member 6 moves, during an opening manoeuvre of the switching apparatus.

[0076] In practice, the cover member 7 is located between the fixed contact member 5 and the side 3A of the outer enclosure 3, which is more proximal to the movable contact member 6, when this latter is in the open position O.

[0077] The cover member 7 is configured to intercept the hot gases directed towards the outer enclosure 3 during the movement of the movable contact 6 towards the open position O, possibly upon the inflation of com-

pressed gas by the puffer assembly 8.

[0078] In general, these hot gases are formed at the arcing region 4 of the electric pole and generated by electric arcs arising between the electric contacts 5, 6 under separation.

[0079] During an opening manoeuvre of said switching apparatus, these hot gases move away from the arcing region 4 and flow towards the outer enclosure 3, possibly upon the inflation of compressed gas by the puffer assembly 8.

[0080] The cover member 7 collects these hot gases and redirects them away from the outer enclosure 3, thereby prolonging the length of their path, which effectively contributes to cool them down (figure 3).

[0081] By virtue of the above-described shielding action, the cover member 7 allows preventing hot gases from coming into contact with the outer enclosure or other conductive components in proximity to this latter, at least when said hot gases are still at high temperatures.

[0082] In this way, the formation of conductive paths through the dielectric medium (insulation gas) is hindered and possible restrike arcing phenomena between the movable contact member 6 and the outer enclosure 3 (or other conductive parts in proximity of the outer enclosure, (e.g., busbars) can be remarkably reduced or prevented.

[0083] The arc-quenching and dielectric insulation capabilities of the switching apparatus, during an opening manoeuvre, thus result greatly improved compared to traditional apparatuses of the state of the art.

[0084] According to some embodiments of the invention (figures 1-6, 8-10, 14), the cover member 7 is made by a continuous electrically insulating material, which makes the cover member quite effective in stopping incoming hot gases before they reach the outer enclosure 3.

[0085] According to other embodiments of the invention (figure 7), the cover member 7 is made by porous electrically insulating material or by an electrically insulating material having suitable passthrough holes. In this case, the cover member 7 still deviates most of incoming hot gases but it allows a portion of hot gases to pass through it. The quantity of hot gases redirected towards the fixed contact member 5 or the pole terminals 11, 12 is obviously reduced compared to the solutions in which a continuous material is used. However, this circumstance provides the advantage of reducing the probability of restrike arcing phenomena between the electric contacts 5, 6 under separation or between the movable contact member 6 and the pole terminals 11, 12. On the other hand, the hot gases passing through the cover member 7 are remarkably cooled down before they reach the outer enclosure 3, which allows effectively preventing restrike arcing phenomena towards the outer enclosure.

[0086] Advantageously, the cover member 7 is maintained in its operating position through suitable support means (not shown). As an example, the cover member 7 may be fixed to the outer enclosure 3 through a suitable support made of electrically insulating material.

[0087] According to some embodiments of the invention (figures 1-8, 14), the cover member 7 is located in proximity of the outer enclosure 3, more particularly in an intermediate position between the open position O of the movable contact member 6 and the outer enclosure 3. The cover member 7 thus results always interposed between the movable contact member 6 and the outer enclosure 3 while the movable contact member is moving from the closed position C to the open position O, during an opening manoeuvre of the switching apparatus (even when the movable contact member reaches the open position O).

[0088] This solution has shown to be of relatively simple industrial implementation and quite effective in collecting the hot gases coming from the contact region 4 of the electric pole. The performances of the switching apparatus are thus not deteriorated in terms of dielectric strength. According to other embodiments of the invention (figures 9-11), the cover member 7 is located in such a way to cross the motion trajectory of the movable contact member 6, when this latter moves between the closed position C and the open position O. In these embodiments of the invention, the cover member 7 conveniently includes a slot 77 to allow the movable contact member 6 to pass through it, at least partially (figure 11).

[0089] According to an implementation variant (figure 9), the cover member 7 is located in such a way to cross the motion trajectory of the movable contact member 6 at the open position O of this latter. In this case, when it reaches the open position O, the movable contact member 6 substantially stops at the slot 77 of the cover member 7 and it slightly protrudes from the cover member 7, towards the outer enclosure 3.

[0090] According to another implementation variant (figure 10), the cover member 7 is located in such a way to cross the motion trajectory of the movable contact member 6 at an intermediate position between the open position O and the closed position C of the movable contact member.

[0091] In this case, the movable contact member 6 passes through the slot 77 of the cover member 7 before reaching the open position O.

[0092] Both these last solutions allow compacting the overall size of the electric pole while ensuring a satisfactory dielectric insulation between the live parts.

[0093] According to an aspect of the invention, the cover member 7 is made of a shaped sheet of electrically insulating material (for example a plastic material) having a size suitably designed according to the dimensions of the corresponding electric pole.

[0094] In this case, the cover member 7 has a pair of opposite longitudinal sides (for example having a longer dimension), which extend along planes perpendicular to the rotation axis A of the corresponding movable contact member 6, and a pair of opposite transversal sides (for example having a shorter dimension), which extends in parallel to the rotation axis A.

[0095] Additionally, the cover member 7 has opposite

first and second surfaces 71, 72 and a relatively small thickness (few mms) compared to the size of these surfaces.

[0096] The cover member 7 is conveniently arranged in parallel to the portion of outer enclosure that would be normally hit by the hot gases during an opening manoeuvre of the switching apparatus. When the cover member is installed in its operating position, the first surface 71 of the cover member faces the outer enclosure 3 and the opposite second surface 72 faces the fixed contact member 5.

[0097] During an opening manoeuvre of the switching apparatus, the second surface 72 is exposed to the incoming hot gases. These latter hit this surface of the cover member and are deviated along it, thereby being diverted away from the outer enclosure 3.

[0098] According to some embodiments of the invention, the cover member 7 is made by a sheet of electrically insulating material having a curved geometric profile, seen along a section plane parallel to a movement plane of the movable contact member 6 (therefore perpendicular to the rotation axis A of this latter in the embodiments shown in the cited figures). Referring to the cited figures, the above-mentioned section plane is, for example, a reference plane parallel to the observation plane of figures 1-10.

[0099] Preferably, the cover member 7 has a convex curved surface 71 facing the outer enclosure 3 and an opposite concave curved surface 72 facing the fixed contact member 5.

[0100] In general, the adoption of a curve profile favors the collection and diversion of the incoming hot gases.

[0101] According to some embodiments of the invention, the cover member 7 has substantially a C-shaped geometric profile with a concavity oriented towards the fixed contact member 5 as shown in figure 1-7, 9-10.

[0102] This solution is particularly simple and cheap to be implemented in practice.

[0103] According to other embodiments of the invention (figures 8, 14), the cover member 7 has a spiral-shaped geometric profile with a concavity oriented towards the fixed contact member 5 and developing about a central axis B perpendicular to a movement plane of the movable contact member (therefore parallel to the rotation axis of said movable contact member in the embodiments shown in the cited figures).

[0104] This solution is particularly effective in collecting and cooling down the incoming hot gases and redirecting these latter along directions parallel to the above-mentioned central axis B.

[0105] In principle, however, the cover member 7 may be formed by a sheet of electrically insulating material having geometric profiles different from those shown in the cited figures. As an example, the cover member 7 may have V-shaped geometric profile with a concavity facing the fixed contact member.

[0106] According to other embodiments, the cover member 7 may have a profile different from a curved line.

[0107] As an example, the cover member 7 may have a profile shaped as polygonal broken line, conveniently with a concavity facing the fixed contact member

[0108] As a further example, the cover member 7 may have a flat or angled profile.

[0109] When it is of the multi-phase type, in general terms, the switching apparatus comprises a plurality of cover members 7, namely a cover member for each electric pole 2.

[0110] According to some embodiments of the invention (figure 12), each cover member 7 is structurally independent (i.e., stand-alone) from the other cover members. Each cover member is conveniently maintained in its operating position through a corresponding support (not shown), which is fixed to the outer enclosure 3.

[0111] According to other embodiments of the invention (figure 13), the switching apparatus 1 comprises a single cover structure 70 including a plurality of adjacent cover sections 7A, each forming a cover member 7 for a corresponding electric pole 2.

[0112] The cover structure 70 may be conveniently maintained in its operating position through a corresponding support (not shown) fixed to the outer enclosure 3.

[0113] According to alternative embodiments of the invention (figure 14), each cover member 7 may have an open-box structure, which is oriented in such a way to be open towards the fixed contact member 5 of the corresponding electric pole.

[0114] In this case, the cover member 7 has preferably a bottom wall 76 made by a shaped sheet of electrically insulating material, which can be realized according to the solutions described above (for example according to the embodiment of figure 8).

[0115] The cover member 7 further includes one or more lateral wings 75 protruding perpendicularly from the bottom wall 76 and preferably extending towards the fixed contact member 5 of the corresponding electric pole, substantially in parallel with the motion trajectory of the movable contact member 6.

[0116] According to an implementation variant, the cover member 7 has a pair of lateral wings 75 arranged at opposite sides of the bottom wall 76.

[0117] According to another implementation variant, the cover member 7 has a single lateral wing 75 arranged at a suitable side of the bottom wall 76.

[0118] The above-illustrated solution is particularly advantageous when the switching apparatus is of the multi-phase type. In fact, the arrangement of cover members provided with lateral wings 75 favor the segregation of the electric poles, thereby preventing or limiting the flow of hot gases from one electric pole to another during an opening manoeuvre of the switching apparatus. The probability of having electric arcs bridging neighboring electric poles of the switching apparatus, during an opening manoeuvre, is thus drastically reduced.

[0119] When the multi-phase switching apparatus comprises stand-alone cover members, these latter may

include a pair of lateral wings 75 arranged as described above or a single lateral wing 75 arranged at a side adjacent to another electric pole of the switching apparatus. When the multi-phase switching apparatus comprises a single cover structure 70, this latter may comprise one or more lateral wings 75, each arranged between two adjacent cover sections 7A as described above.

[0120] The switching apparatus 1, according to the invention, provides relevant advantages with respect to corresponding known switching systems of the state of the art.

[0121] The switching apparatus 1 is provided with an arc-breaking assembly 4 having improved current breaking capabilities.

[0122] The arrangement of a cover member 7 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 outer enclosure (particularly during the "recovery phase" of the dielectric medium), even if the internal volume of the switching apparatus is filled with an insulation gas having a lower thermal insulation capacity compared to SF₆.

[0123] The arrangement a cover member 7 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.

[0124] The switching apparatus, according to the invention, can thus be realized with a relatively simple and compact structure.

[0125] 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. A switching apparatus (1) for medium voltage electrical systems, said switching apparatus comprising:

- one or more electric poles (2);
- an outer 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 movable contact member is decoupled from said fixed contact;

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

(7) made of electrically insulating material and arranged in a fixed position relative to said outer enclosure (3), said cover member being located between said fixed contact member (5) and a side (3A) of said outer enclosure, towards which said movable contact member (6) moves, during an opening manoeuvre of said switching apparatus, said cover member (7) being configured to intercept and deviate hot gases directed towards said outer enclosure (3), during an opening manoeuvre of said switching apparatus.

2. Switching apparatus, according to claim 1, **characterised in that** said cover member (7) is located in an intermediate position between the open position (O) of said movable contact member (6) and said outer enclosure (3).

3. Switching apparatus, according to claim 1, **characterised in that** said cover member (7) is located in such a way to cross a motion trajectory of said movable contact member (6), when said movable contact member moves between said closed position (C) and said open position (O), said cover member including a slot (77) to allow said movable contact member to pass through said cover member, at least partially.

4. Switching apparatus, according to claim 3, **characterised in that** said cover member (7) is located in such a way to cross the motion trajectory of said movable contact member (6) at the open position (O) of said movable contact member.

5. Switching apparatus, according to claim 3, **characterised in that** said cover member (7) is located in such a way to cross the motion trajectory of said movable contact member (6) at an intermediate position between the open position (O) and the closed position (C) of said movable contact member.

6. Switching apparatus, according to one of the previous claims, **characterised in that** said cover member (7) is made by a continuous electrically insulating material.

7. Switching apparatus, according to one of the claims from 1 to 5, **characterised in that** said cover member (7) is made by a porous or holed electrically insulating material.

8. Switching apparatus, according to one of the previous claims, **characterised in that** said cover member (7) has a curved geometric profile along a section plane parallel to a movement plane of said movable contact member (6).

9. Switching apparatus, according to claim 8, **charac-**

terised in that said cover member (7) has a C-shaped geometric profile along a section plane parallel to a movement plane of said movable contact member (6).

10. Switching apparatus, according to claim 8, **characterised in that** said cover member (7) has a spiral-shaped geometric profile along a section plane parallel to a movement plane of said movable contact member (6), said spiral-shaped geometric profile developing about a central axis (B) perpendicular to a movement plane of said movable contact member.

11. Switching apparatus, according to one of the claims from 8 to 10, **characterised in that** said cover member (7) has a convex curved surface (71) facing said outer enclosure (3) and an opposite concave curved surface (72) facing the fixed contact member (5) of said electric pole.

12. Switching apparatus, according to one of the previous claims, **characterised in that** it comprises a plurality of cover members (7), each cover member being structurally independent from the other cover members.

13. Switching apparatus, according to one of the claims from 1 to 11, **characterised in that** it comprises a cover structure (70) including a plurality of adjacent cover sections (7A), each cover section forming a cover member (7) for a corresponding electric pole.

14. Switching apparatus, according to one of the previous claims, **characterised in that** said cover member (7) is formed by a sheet of electrically insulating material.

15. Switching apparatus, according to one of the previous claims, **characterised in that** said cover member (7) is formed by an open-box structure including a bottom wall (76) formed by a sheet of electrically insulating material and one or more lateral wings (75) of electrically insulating material protruding perpendicularly relative to said bottom wall.

16. 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).

17. 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 the fixed contact member (5) of said electric pole in such a way to blow hot gases away, during an opening manoeuvre of said switching apparatus.

18. 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).

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

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

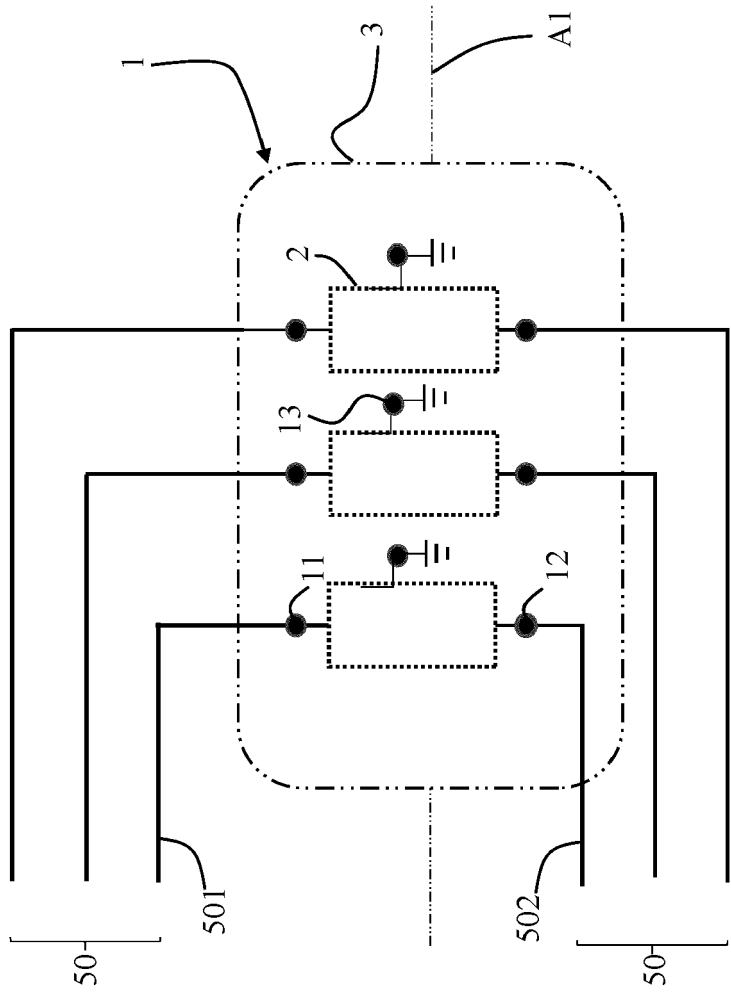


FIG. 1

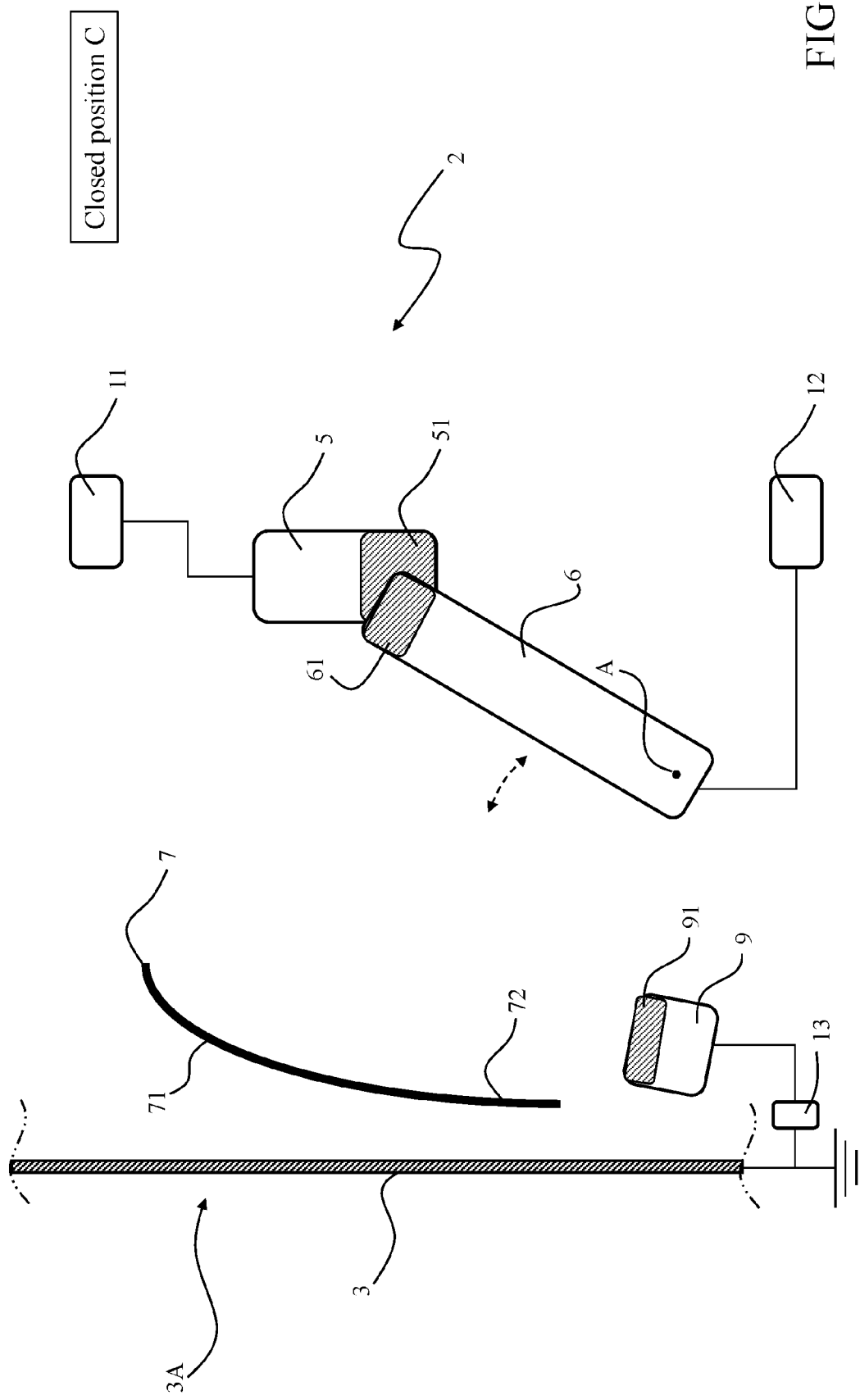


FIG. 2

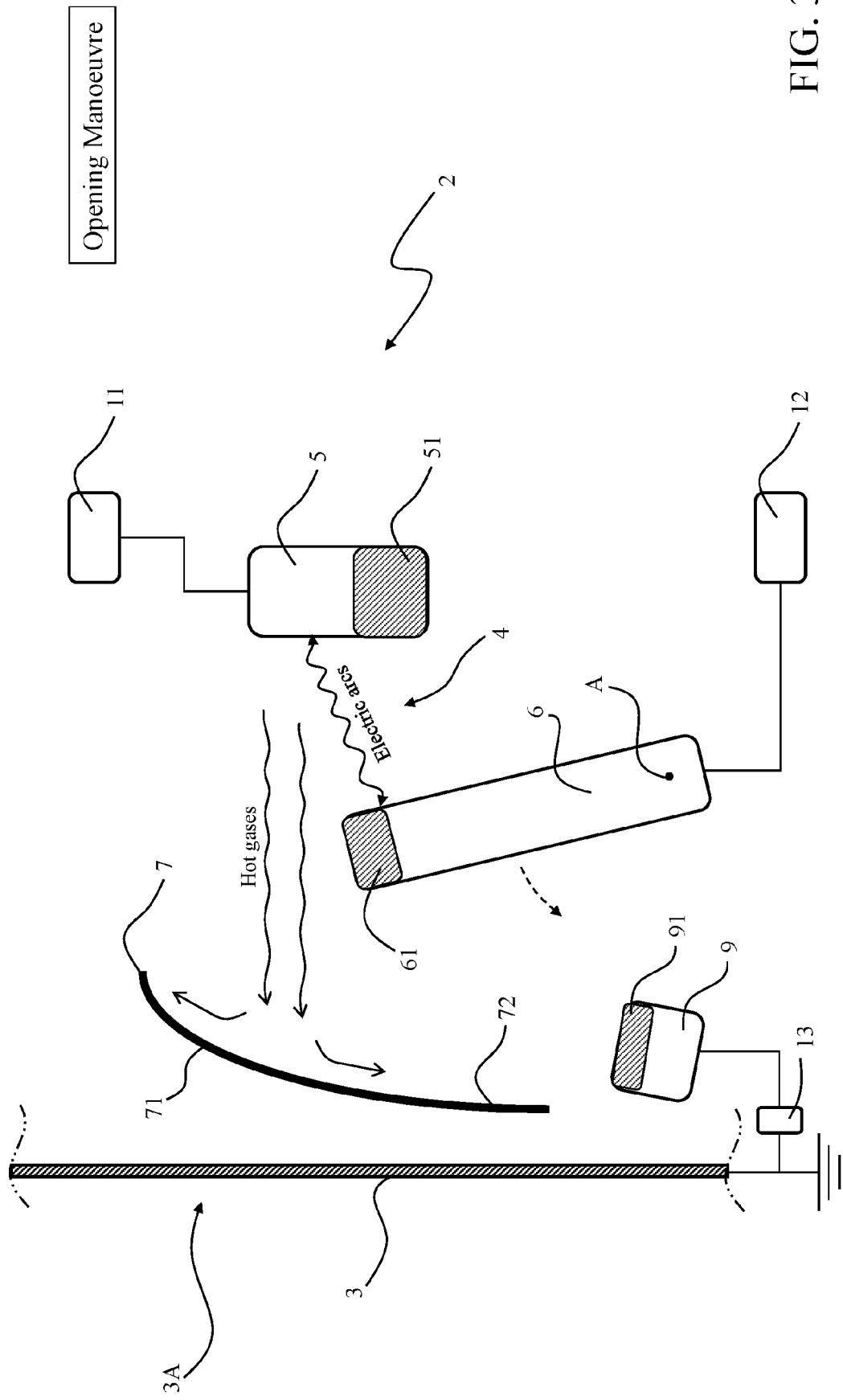


FIG. 3

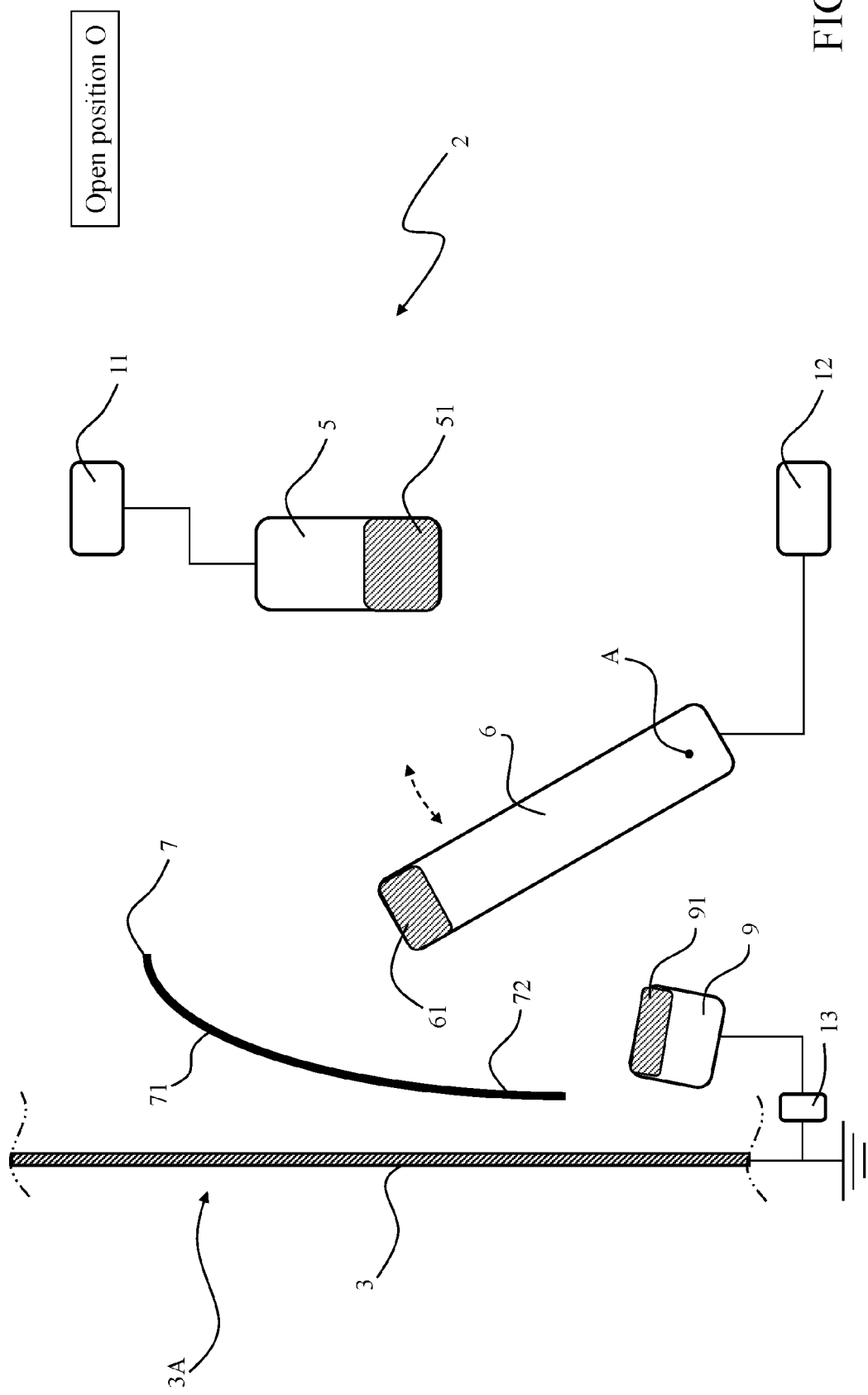


FIG. 4

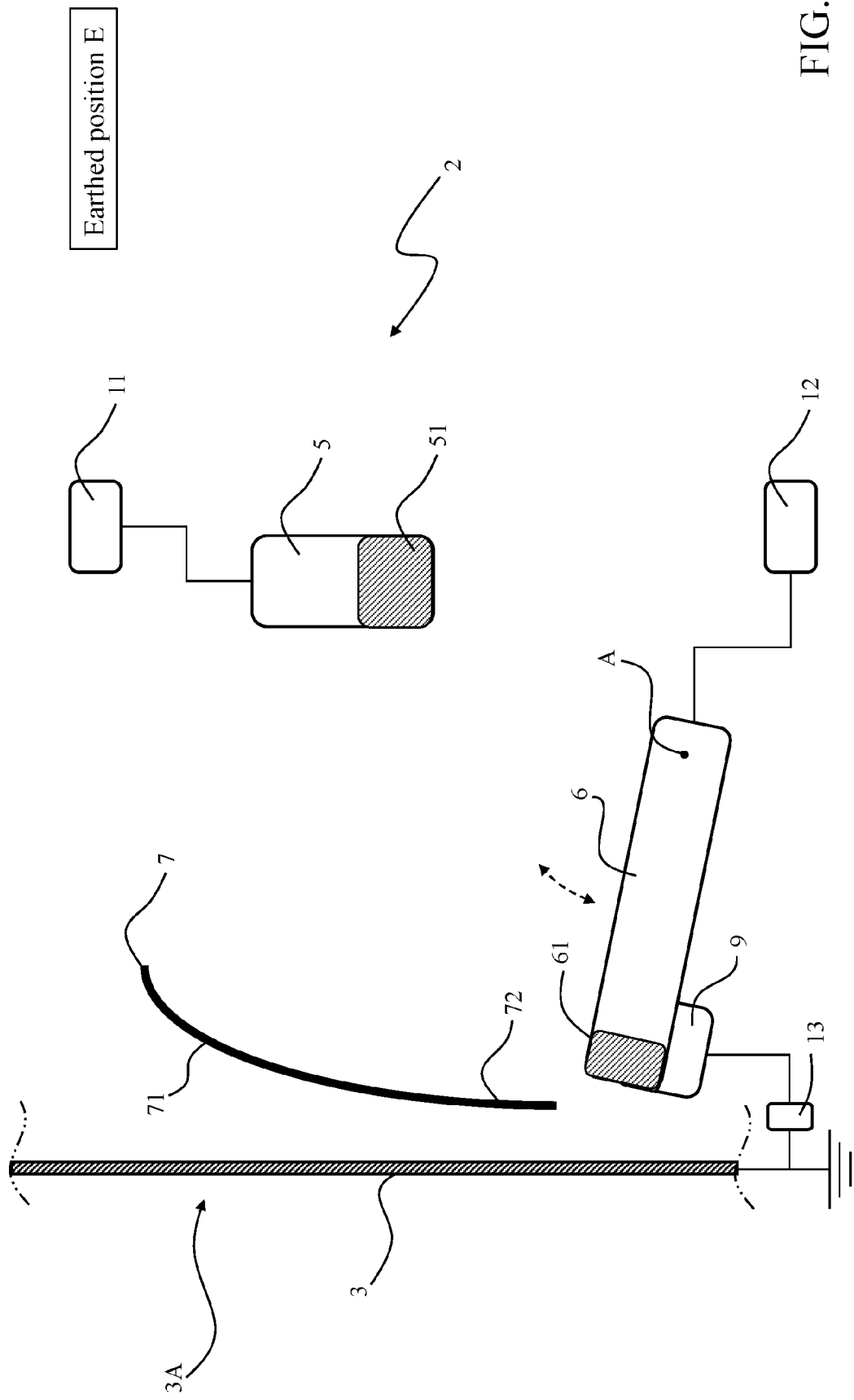


FIG. 5

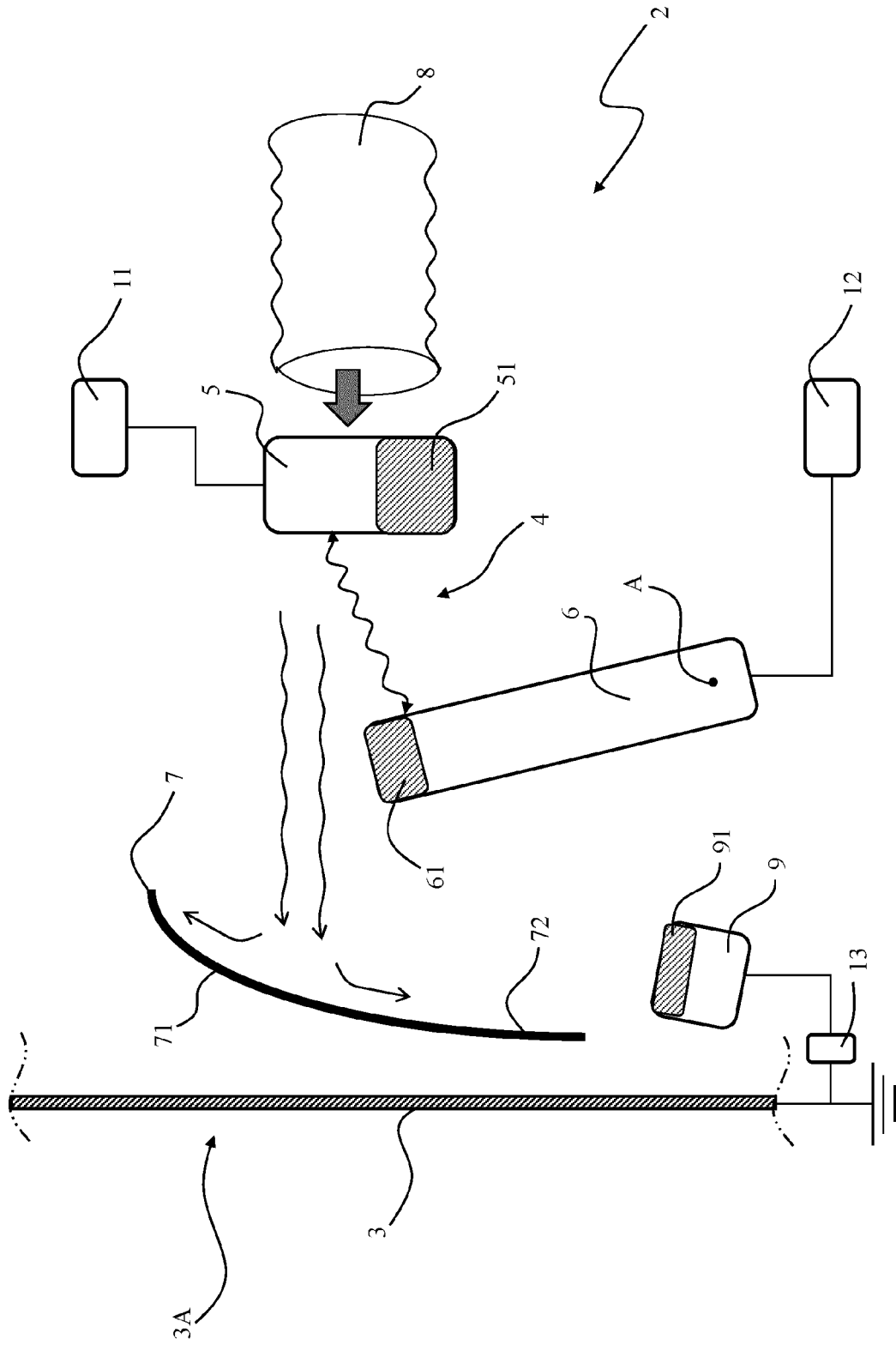


FIG. 6

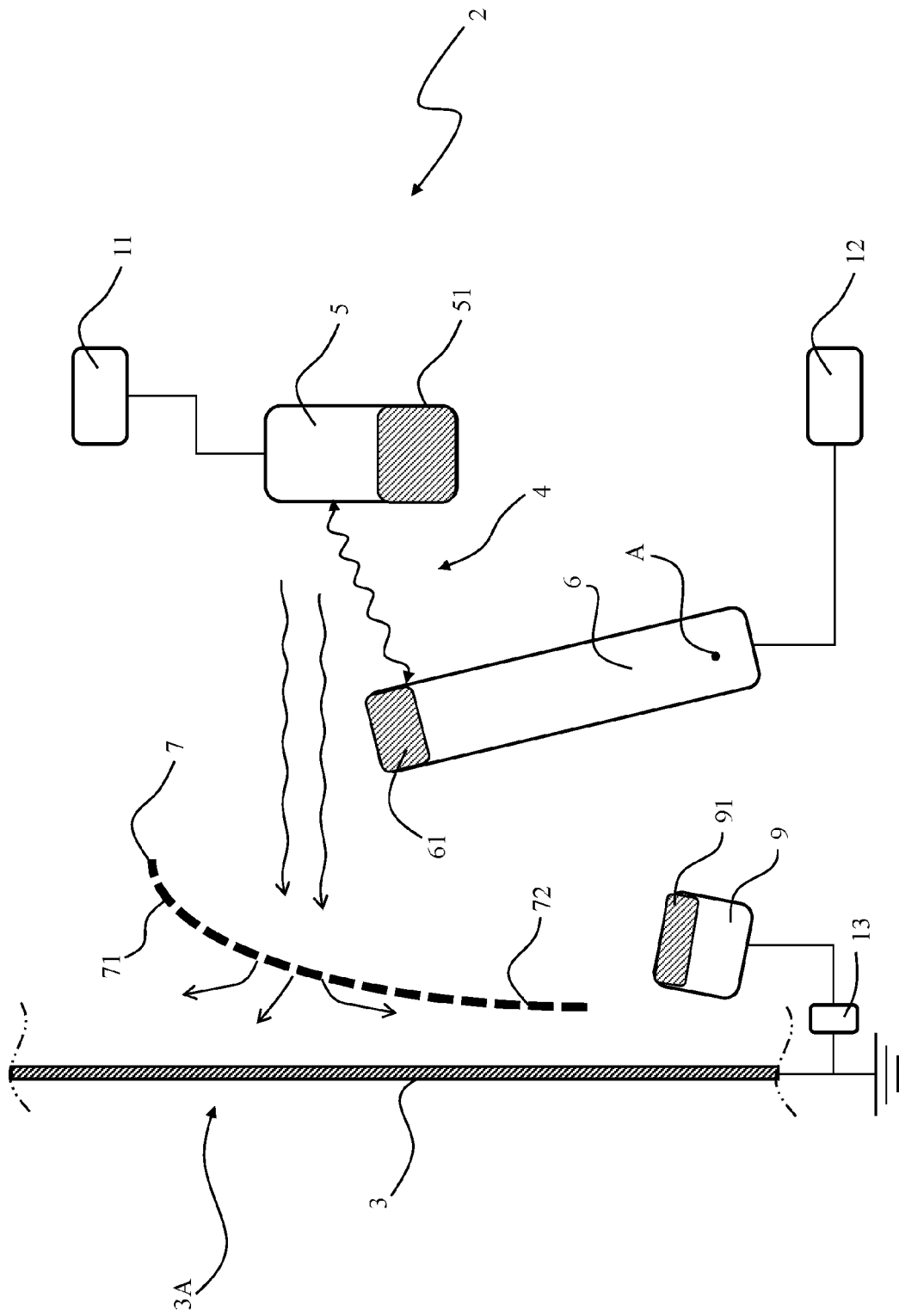


FIG. 7

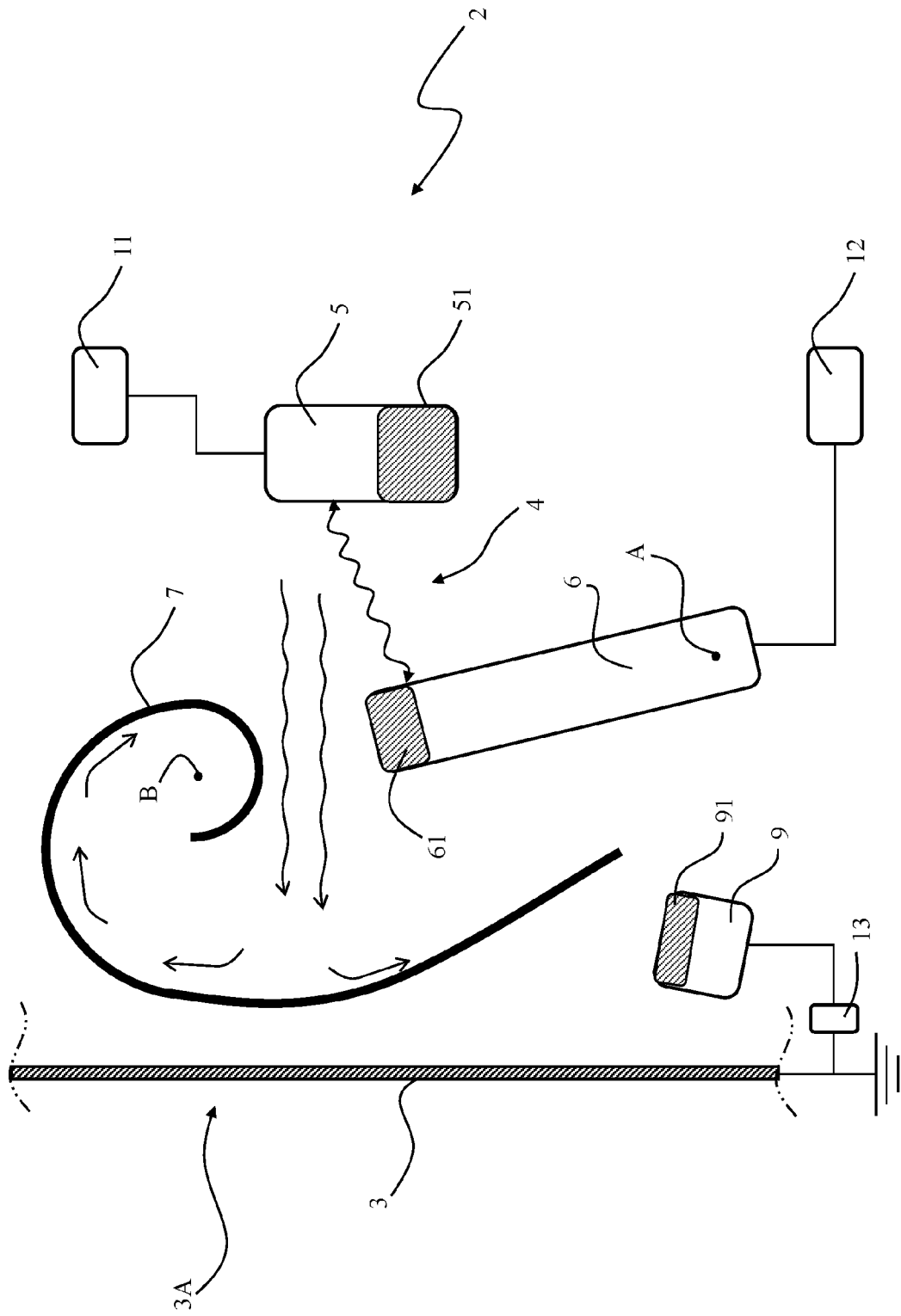


FIG. 8

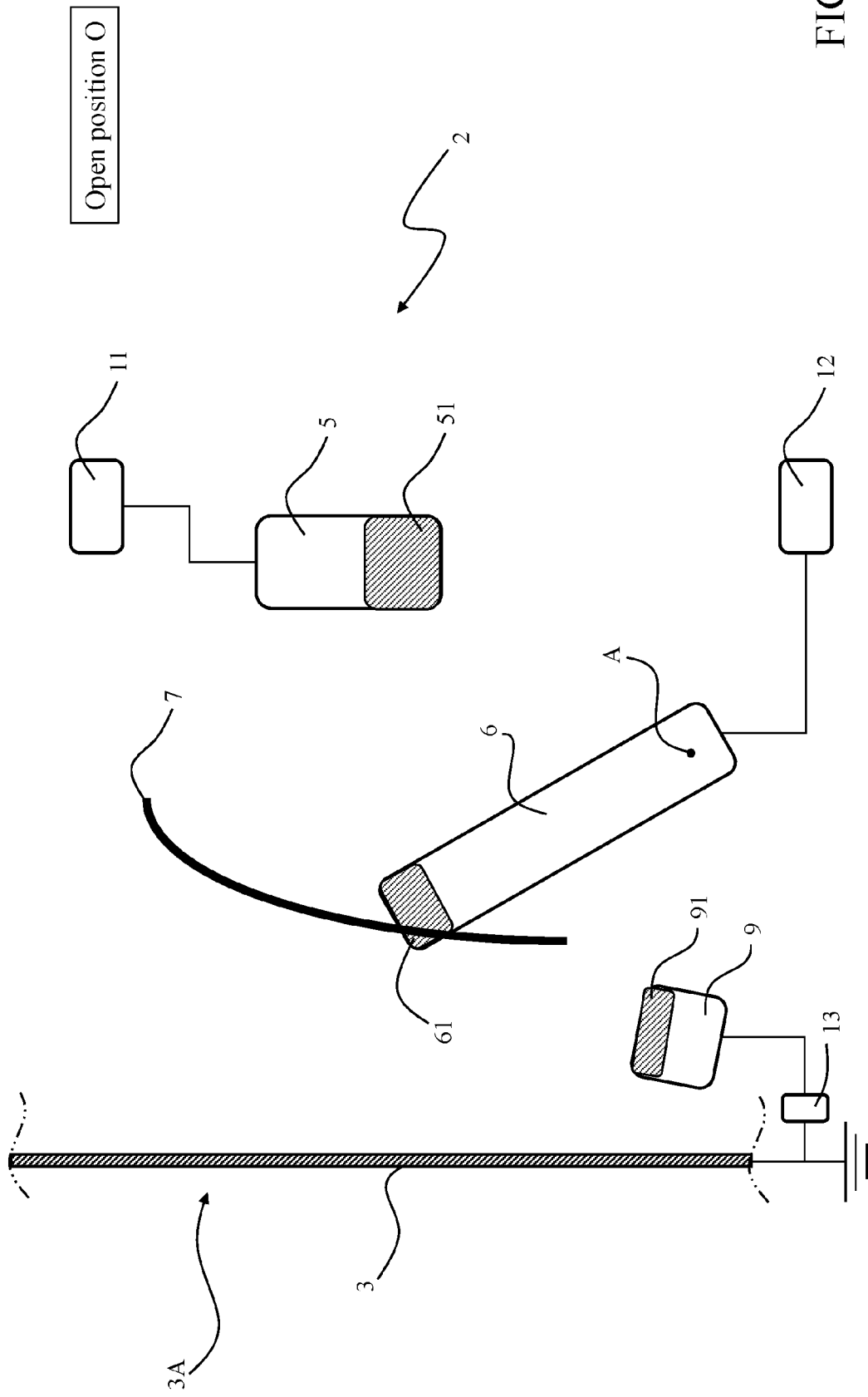


FIG. 9

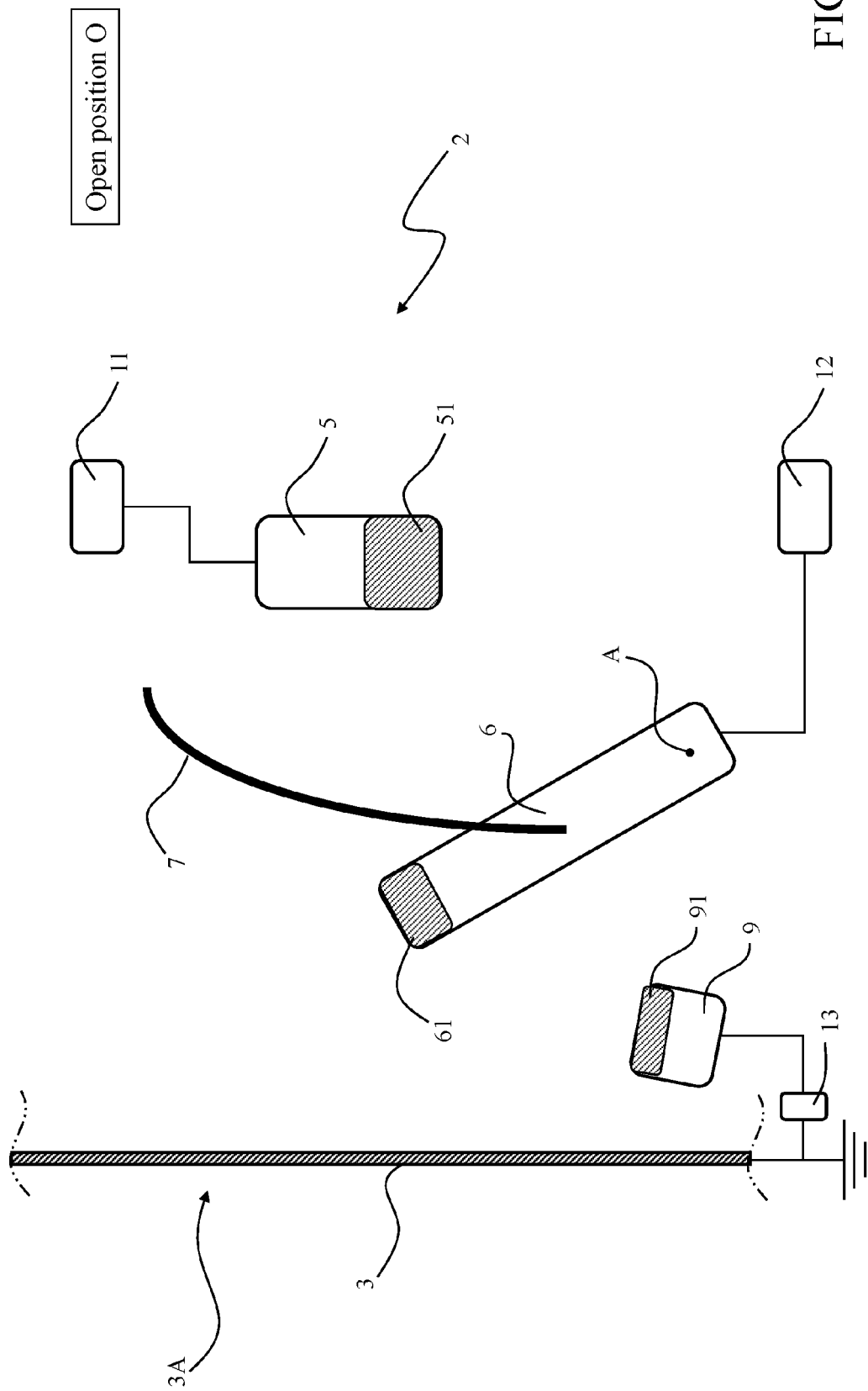
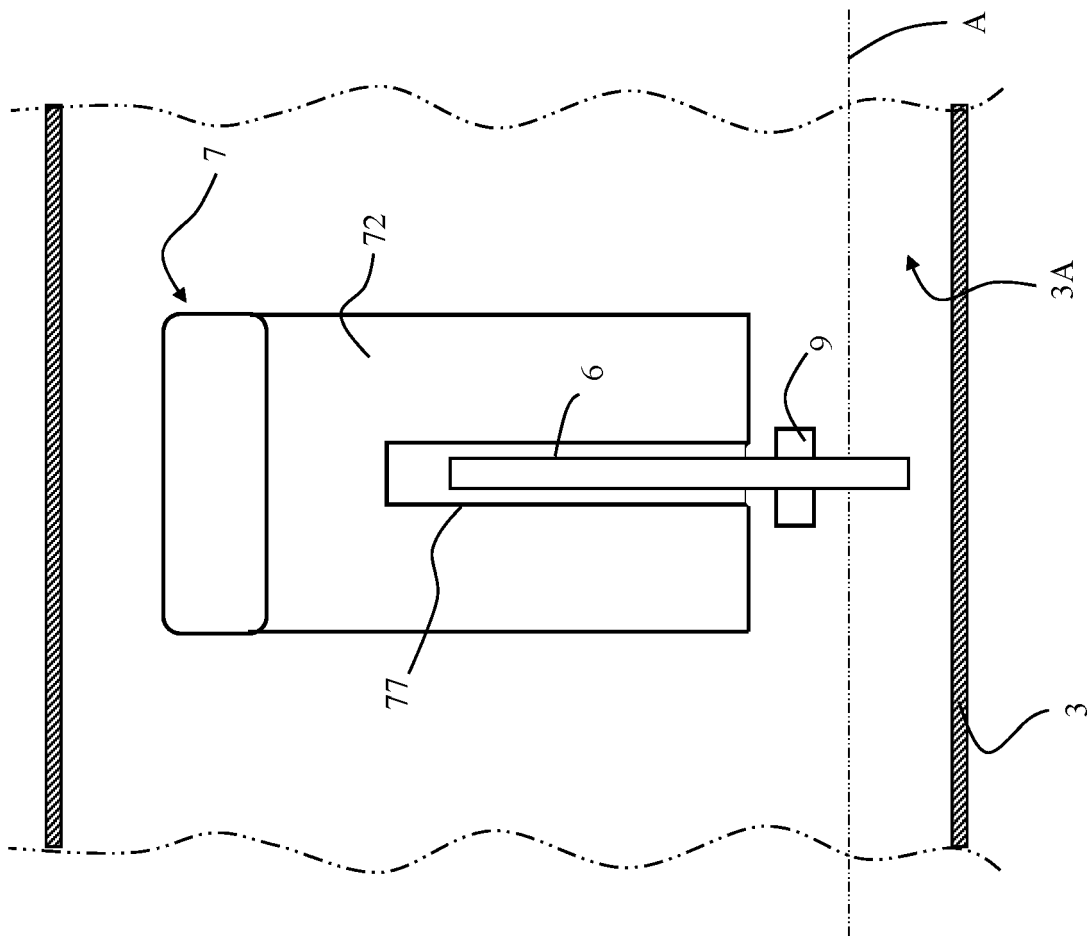


FIG. 10

FIG. 11



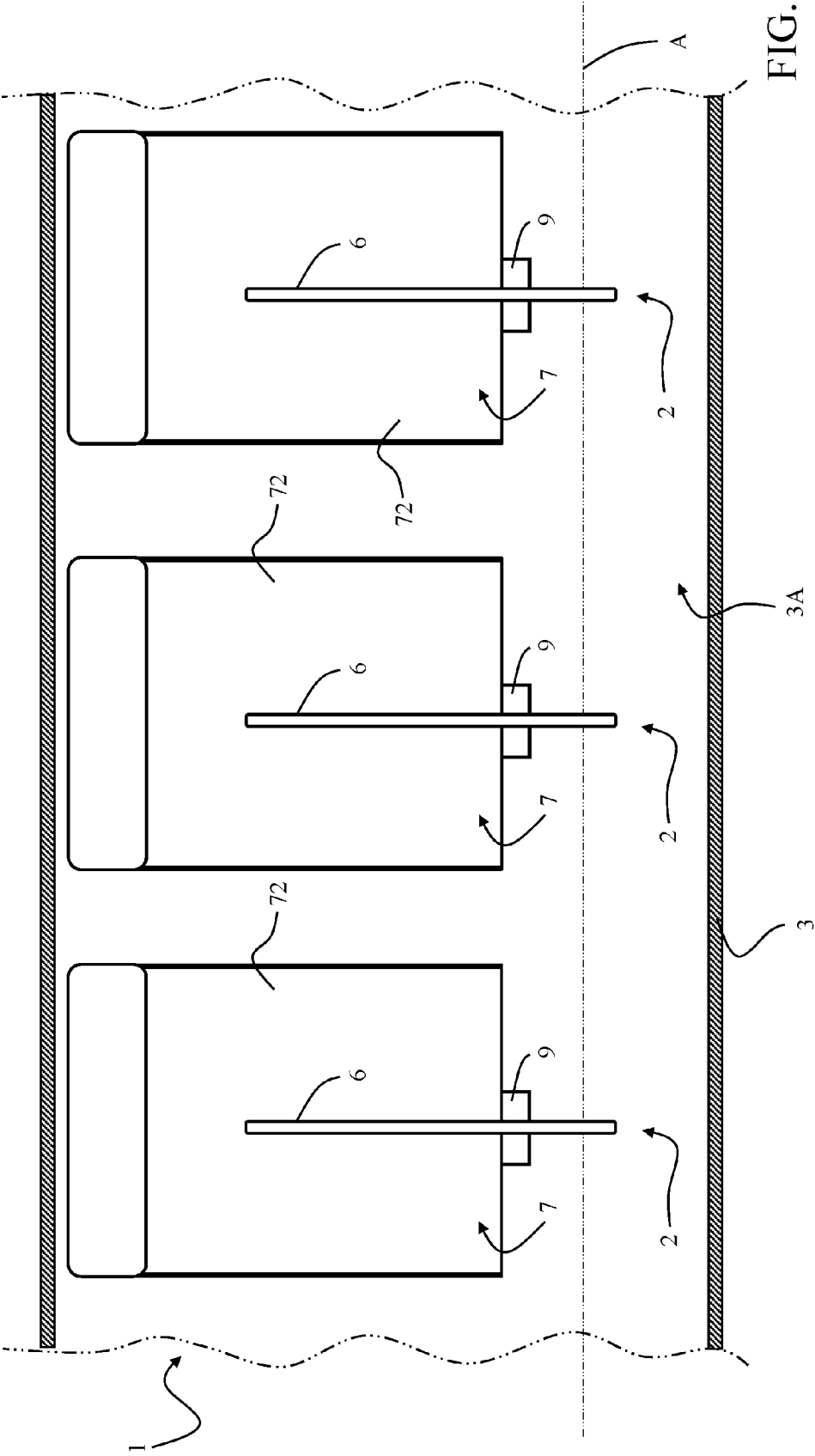
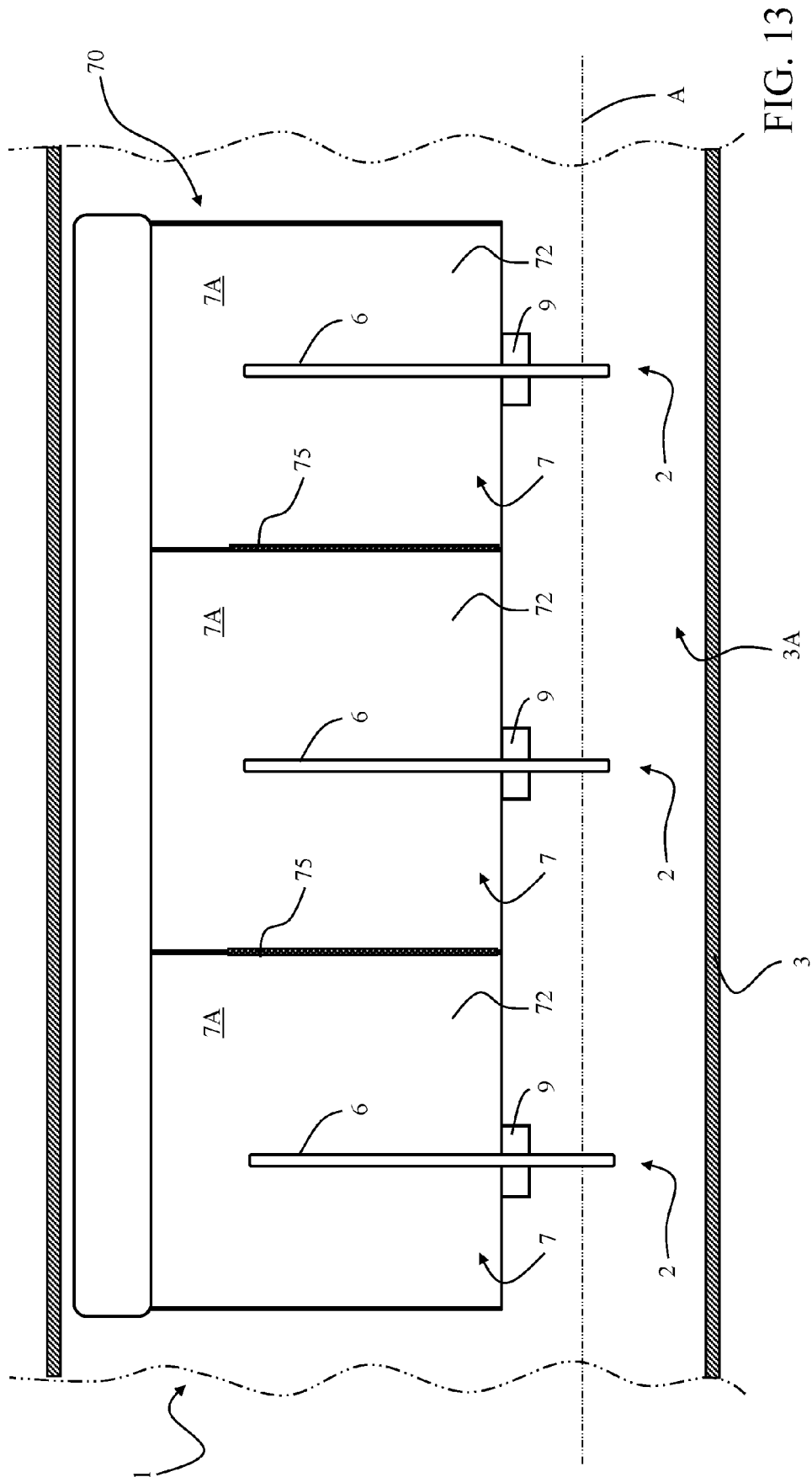


FIG. 12



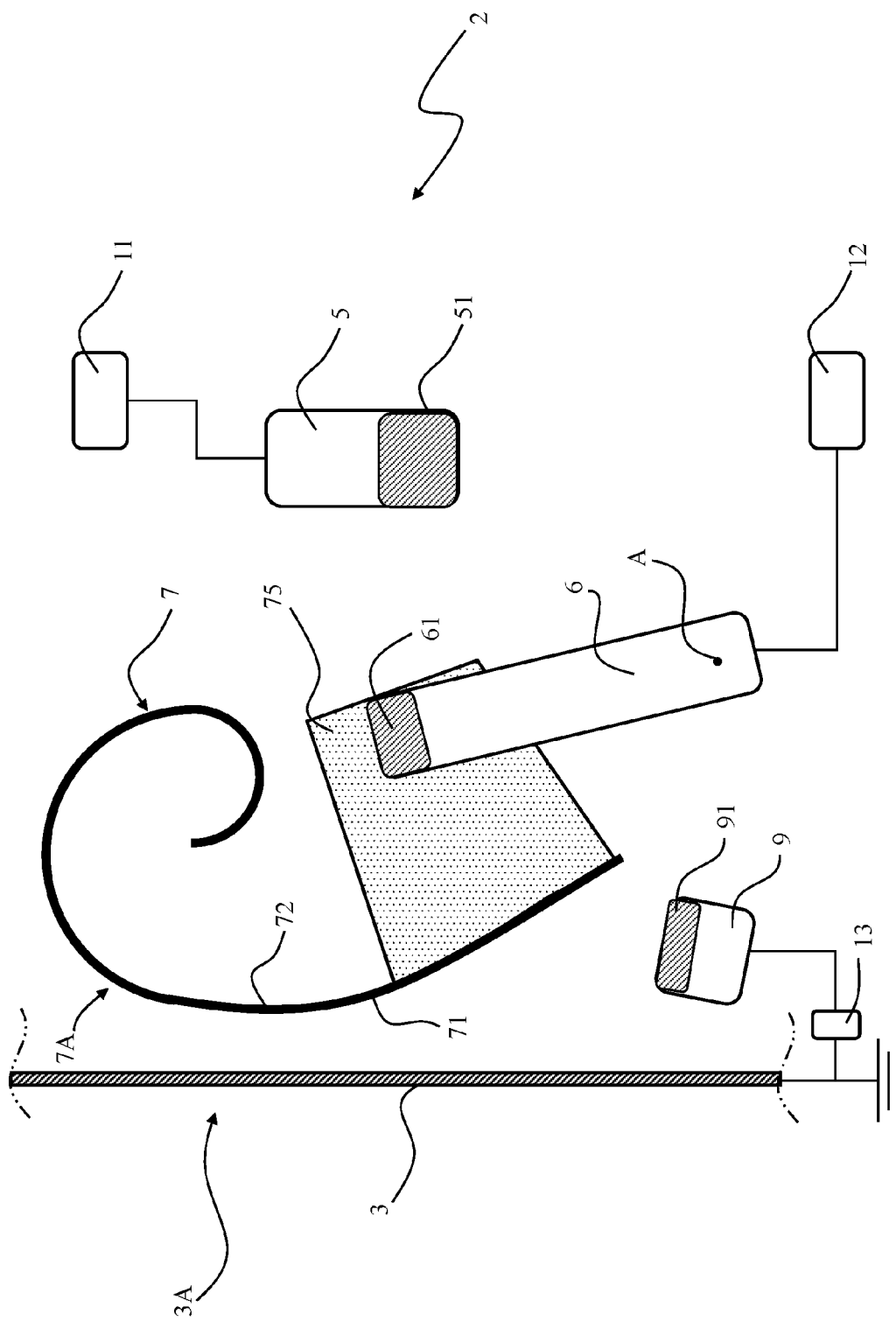


FIG. 14



EUROPEAN SEARCH REPORT

Application Number

EP 23 16 3263

5

10

15

20

25

30

35

40

45

50

55

1

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/014279 A1 (RODRIGUES DIDIER [FR] ET AL) 15 January 2015 (2015-01-15) * the whole document *	1, 2, 6, 8, 9, 11, 12, 14, 16, 17, 19, 20	INV. H01H9/30
X	JP H02 256110 A (MATSUSHITA ELECTRIC WORKS LTD) 16 October 1990 (1990-10-16) * the whole document *	1, 6, 15, 18-20	
A	US 2017/278660 A1 (DAVIS ALISHA MARIE [US] ET AL) 28 September 2017 (2017-09-28) * paragraphs [0026] - [0042]; figures 1-13 *	1-20	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 21 August 2023	Examiner Ledoux, Serge
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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

EP 23 16 3263

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

21-08-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2015014279 A1	15-01-2015	CN 104025234 A	03-09-2014
		EP 2795648 A1	29-10-2014
		FR 2985081 A1	28-06-2013
		JP 6174597 B2	02-08-2017
		JP 2015505143 A	16-02-2015
		US 2015014279 A1	15-01-2015
		WO 2013093033 A1	27-06-2013
JP H02256110 A	16-10-1990	JP H02256110 A	16-10-1990
		JP H06101263 B2	12-12-1994
US 2017278660 A1	28-09-2017	NONE	