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(54) AN ELECTRIC POLE UNIT FOR MEDIUM VOLTAGE GAS-INSULATED CIRCUIT BREAKERS

(57) An electric pole unit (1) for a MV gas-insulated circuit breaker characterised in that it comprises:
- an insulating housing (2) defining an internal volume (3), in which a dielectric gas is contained;
- a first pole terminal (11) and a second pole terminal (12);
- an interruption unit (6), which is positioned in the internal volume of said electric pole unit, said interruption unit comprising:
- a fixed contact assembly (4), which is electrically coupled to said first pole terminal (11);
- a moving contact assembly (5), which is adapted to be coupled with or separated from said fixed contact assembly during a switching operation of said circuit breaker;
- a compression cylinder (7), which is adapted to define a gas compression chamber (62) of said interruption unit, said moving contact assembly being operatively coupled with said compression cylinder so as to move along said compression chamber during a switching operation of said circuit breaker.

Said compression cylinder (7) is at least partially made of conductive material and is electrically coupled with said second pole terminal (12).

Said electric pole unit comprises sliding contact means (8) electrically coupling said moving contact assembly (5) and said compression cylinder.

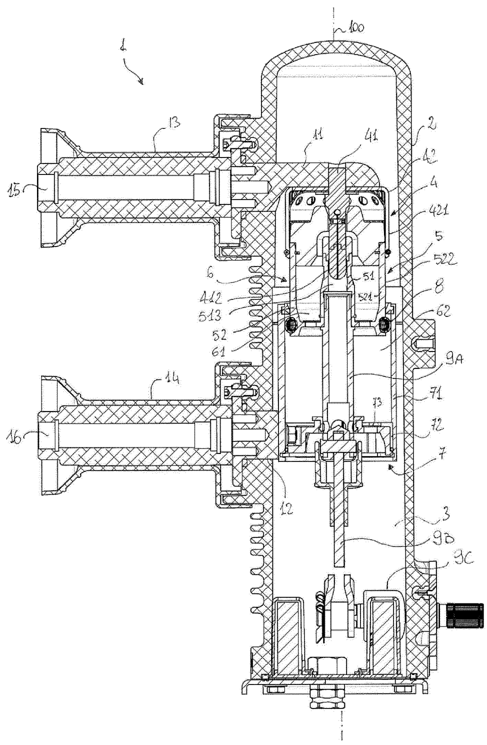

Fig. 1

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Description

[0001] The present invention relates to the field of the medium voltage (MV) gas-insulated circuit breakers.

[0002] For the purposes of the present application, the term "medium voltage" is referred to apparatuses operating at voltages 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.

[0003] More particularly, the present invention relates to an electric pole unit for a MV gas-insulated circuit breaker.

[0004] Gas-insulated circuit breakers are widely used in MV electric power distribution networks. As is known, in these switching apparatuses, current breaking is obtained by separating electric contacts in a dielectric gas medium (typically SF_6) having excellent arc-quenching properties.

[0005] In gas-insulated circuit breakers, certain dielectric distances among the internal components must be ensured for electric insulation purposes.

[0006] Generally, such dielectric distances are longer than those adopted in vacuum circuit breakers. As gas-insulated circuit breakers and vacuum circuit breakers are often used in a same switchgear, gas-insulated circuit breakers may be required to have switchgear contacts at the same dielectric distance adopted for vacuum circuit breakers in order to reduce the overall size of the switchgear.

[0007] In these cases, gas-insulated circuit breakers may have electric pole units with particularly complex configurations.

[0008] Electric pole units of this type are typically characterised by a high resistivity of the current path, which may entail the raising of overheating phenomena when high currents flow through the pole unit.

[0009] Further, these electric pole units often incorporate complex and expensive solutions to ensure a satisfactory dielectric insulation among the internal components.

[0010] Another relevant drawback resides in the high costs for manufacturing these electric pole units at industrial level.

[0011] The aim of the present invention is to provide an electric pole unit for a MV gas-insulated circuit breaker, which allows overcoming the above-mentioned problems.

[0012] More in particular, it is an object of the present invention to provide an electric pole unit, which is particularly suitable for use in switchgears requiring relatively short distances between the switchgears contacts.

[0013] Another object of the present invention is to provide an electric pole unit, which shows excellent performances in terms of electric conductivity of the current path and in terms of dielectric insulation among the internal components.

[0014] Another object of the present invention is to provide an electric pole unit, which has a relatively simple structure with a relatively low size.

[0015] Another object of the present invention is to provide an electric pole unit, which can be industrially manufactured at competitive costs.

[0016] In order to achieve the above aim and objects, the present invention provides an electric pole unit for a MV gas-insulated circuit breaker, according to the following claim 1 and related dependent claims.

[0017] Further aspects of the invention relate to a MV gas-insulated circuit breaker, according to the following claim 13, and to a MV switchgear, according to the following claim 14.

[0018] Further characteristics and advantages of the invention will emerge from the description of preferred, but not exclusive, embodiments of the electric pole unit, according to the invention, non-limiting examples of which are provided in the attached drawings, wherein:

- Figures 1-4 show schematic views of an embodiment of the electric pole unit, according to the invention, in an embodiment;
- Figure 5 shows a schematic view of a portion of a further embodiment of the electric pole unit, according to the invention;
- Figure 6 shows a schematic view of a portion of a further embodiment of the electric pole unit, according to the invention;
- Figure 7 shows a schematic view of a portion of a further embodiment of the electric pole unit, according to the invention.

[0019] Referring to the cited figures, the present invention relates to an electric pole unit 1 for a MV gas-insulated circuit breaker.

[0020] According to the invention, the pole unit 1 comprises an insulating housing 2 that is advantageously made of electrically insulating material.

[0021] The housing 2 is advantageously formed by an elongated hollow body having a substantially cylindrical shape with a main longitudinal axis 100 (figure 1).

[0022] The housing 2 defines an internal volume 3, in which a dielectric gas (as an example SF_6) is contained.

[0023] Advantageously, the whole internal volume 3 of the pole unit 1 is filled with the mentioned dielectric gas at a suitable pressure, preferably higher than the atmospheric pressure. According to the invention, the pole unit 1 comprises a first pole terminal 11 and a second pole terminal 12.

[0024] The pole terminals 11, 12 may be mechanically fixed to the housing 2 by means of flanges. Preferably, the pole unit 1 comprises first and second bushings 13, 14 that are mechanically coupleable (e.g. by means of connecting screws) with the housing 2 at the first and second pole terminals 11, 12, respectively.

[0025] The first and second bushings 13, 14 comprise first and second switchgear contacts 15, 16 respectively.

[0026] The first and second switchgear contacts 15, 16 are electrically coupled with the first and second pole terminals 11, 12, respectively, when the first and second bushings 13, 14 are mechanically coupled with the housing 2.

[0027] For the sake of clarity, in the following:

- the term "electrically coupled" used for two generic elements means that an electrical connection is established between these elements;
- the term "mechanically coupled" used for two generic elements means that a mechanical connection is established between these elements;
- the terms "insulating" or "conductive" have to be intended as "electrically insulating" or "electrically conductive", if no additional indications are present.

[0028] The pole unit 1 comprises an interruption unit 6 positioned within the internal volume 3. According to the invention, the interruption unit 6 comprises a fixed contact assembly 4, which is electrically coupled to the first pole terminal 11 (and consequently to the first switchgear terminal 15).

[0029] Preferably, the fixed contact assembly 4 is also mechanically coupled to the first pole terminal 11 and is kept in its operating position by this latter.

[0030] Preferably, the fixed contact assembly 4 comprises a fixed contact main portion 42 and a fixed contact arching portion 41, which are made of conductive material and are electrically coupled one to another.

[0031] Preferably, the portions 41, 42 of the fixed contact assembly 4 are also mechanically coupled one to another.

[0032] Preferably, the fixed contact main portion 42 comprises a plurality of contact fingers 421 protruding from an annulus shaped contact base 422 (in a direction substantially parallel to the axis 100).

[0033] Preferably, the contact base 422 is in proximal position with respect to the first pole terminal 11 and the contact fingers 421 protrudes in a distal direction with respect to the first pole terminal 11.

[0034] Preferably, the contact fingers 421 are arranged in such a way to define a substantially cylindrical volume (extending along the axis 100), in which the fixed contact arching portion 41 is arranged.

[0035] Preferably, the contact base 422 is mechanically and electrically connected with the fixed contact arching portion 41 (figure 3).

[0036] Preferably, the fixed contact arching portion 41 comprises a cylindrically shaped body extending along the axis 100.

[0037] Such a shaped body has a first constrained end 411, which is mechanically and electrically coupled with the main contact arching portion 42 (in particular with the contact base 422) and with the first pole terminal 11.

[0038] Further, said shaped body has a second free-standing end 412, which is positioned within the volume defined by the contact fingers 421 (figure 3).

[0039] According to the invention, the interruption unit 6 comprises a moving contact assembly 5, which is adapted to be coupled with or separated from the fixed contact assembly 4, during a switching operation of the circuit breaker including the pole unit 1.

[0040] To this aim, the moving contact assembly 5 is adapted to move along the axis 100, during a switching operation of the circuit breaker including the pole unit 1.

[0041] Preferably, the moving contact assembly 5 comprises a moving contact main portion 52 and a moving contact arching portion 51, which are made of conductive material and are electrically coupled one to another.

[0042] Preferably, the moving contact assembly 5 comprises also a base portion 53.

[0043] Preferably, the portions 51, 52, 53 of the moving contact assembly 5 are integral one to another and form a substantially cup-shaped body having a central contact cavity 513 centred with the axis 100.

[0044] Preferably, the base portion 53 is formed by a base wall extending along a plane substantially perpendicular to the axis 100.

[0045] Preferably, the base wall 53 has an annulus shape centred with the axis 100.

[0046] The base wall 53 is arranged in a distal position with respect to the fixed contact assembly 4 and comprises first ports 54 for the passage of the dielectric gas.

[0047] Advantageously, the ports 54 are provided with suitable pressure valves to regulate the flow of dielectric gas.

[0048] Preferably, the moving contact assembly 5 comprises an external wall 521 having a tubular shape centred with the axis 100 and extending perpendicularly from the base wall 53 (in a direction substantially parallel to the axis 100) towards the fixed contact assembly 4.

[0049] The external wall 521 of the moving contact assembly 5 forms the moving contact main portion 52.

[0050] Advantageously, the external wall 521 is arranged so as to couple with the contact fingers 421 of the fixed contact main portion 42, when the moving contact assembly 5 and the fixed contact assembly 4 are mutually coupled (figure 1).

[0051] In this way, an electric coupling between the moving contact main portion 52 and the fixed contact main portion 42 can be obtained.

[0052] Preferably, the moving contact assembly 5 comprises an internal wall 511 spaced from the external wall 521.

[0053] The internal wall 511 has a tubular shape centred with the axis 100 and protrudes perpendicularly from the base wall 53 (in a direction substantially parallel to the axis 100) towards the fixed contact assembly 4.

[0054] The internal wall 511 of the moving contact assembly 5 forms the moving contact arching portion 51 of this latter.

[0055] The internal wall 511 defines the elongated contact cavity 513 centred with the axis 100. Advantageously, the internal wall 511 is arranged so as to couple with the free-standing end 412 of the body of the fixed contact arching portion 41.

[0056] In fact, the free-standing end 412 is at least partially inserted in the contact cavity 513 and the external surface of the free-standing end 412 is coupled with the internal surface of the contact cavity 513, when the moving contact assembly 5 and the fixed contact assembly 4 are coupled (figure 1).

[0057] In this way, an electric coupling between the moving contact arching portion 52 and the fixed contact arching portion 42 can be obtained.

[0058] Preferably, the moving contact assembly 5 comprises a nozzle portion 55, which may be made of insulating material.

[0059] The nozzle portion 55 is fixed to the moving contact portions 51, 52 (more particularly to the walls 511, 521) perpendicularly to the axis 100 and in a proximal position with respect to the fixed contact assembly 4.

[0060] The nozzle portion 55 comprises a central hole 551 centred with the axis 100 (and the contact cavity 513).

[0061] The fixed contact arching portion 41 (in particular of the free-standing end 412) passes through the hole 551, when the moving contact assembly 5 is coupled with the fixed contact assembly 4.

[0062] The portions 51, 52, 53, 55 of the moving contact assembly 5 define a blasting chamber 61 of the interruption unit 6, in which the dielectric gas may be subject to overpressures caused by the arc energy, particularly when the moving contact arching portion 51 moves away from the fixed contact arching portion 41.

[0063] Preferably, the pole unit 1 comprises a moving contact arm 9A, which is mechanically coupled to the moving contact assembly 5 to transmit a linear motion (along the axis 100) to this latter (in a direction towards or away from the fixed contact assembly 4).

[0064] The contact arm 9A may be made of conductive or insulating material.

[0065] Preferably, a proximal end (with respect to the fixed contact assembly 4) of the contact arm 9A is at least partially inserted in the contact cavity 513 to mechanically couple with the base wall 53 and the internal wall 51.

[0066] Preferably, the pole unit 1 comprises an operating rod 9B, which is mechanically coupled to the moving contact arm 9A to transmit a linear motion (along the axis 100) to this latter (in a direction towards or away from the fixed contact assembly 4).

[0067] Preferably, a proximal end (with respect to the fixed contact assembly 4) of the operating rod 9B is mechanically coupled with a distal end of the contact arm 9A.

[0068] The operating rod 9B may have a curved shaped along a plane perpendicular to the section planes of figures 1-3 (as it is evident from figures 2-3).

[0069] The operating rod 9B is preferably made of insulating material.

[0070] Preferably, the pole unit 1 comprises a kinematic chain 9C, which is mechanically coupled to the operating rod 9B.

[0071] Preferably, a distal end (with respect to the fixed contact assembly 4) of the operating rod 9B is mechanically coupled with the kinematic chain 9C.

[0072] Preferably, the kinematic chain 9C is mechanically coupleable with an actuator (not shown). Preferably, the kinematic chain 9C is configured to transform a rotary motion transmitted by such an actuator (e.g. an electric motor) in a linear motion transmitted to the operating rod 9B (in a direction towards or away from the fixed contact assembly 4).

[0073] According to the invention, the interruption unit 6 comprises a compression cylinder 7, which defines a gas compression chamber 62 of the interruption unit 6 (figure 2).

[0074] The compression cylinder 7 is advantageously fixed to the housing 2.

[0075] The moving contact assembly 5 is operatively coupled with the compression cylinder 7 so as to move along the compression chamber 62 during a switching operation of the circuit breaker.

[0076] The moving contact assembly 5 is at least partially inserted in the compression cylinder 7 and moves within the compression chamber 61 in a direction parallel to the axis 100, towards or away from the fixed contact assembly 4.

[0077] More particularly, the moving contact assembly 5 is operatively coupled with the compression cylinder 7 so as to operate as a piston compressing the dielectric gas contained in the compression chamber 62, when moving away from the fixed contact assembly 4. Preferably, the compression cylinder 7 is open towards the fixed contact assembly 4 so as to allow the coupling between the moving contact assembly 5 and the fixed contact assembly 4. Preferably, the compression cylinder 7 comprises a base wall portion 72 extending along a plane substantially perpendicular to the axis 100.

[0078] The base wall portion 72 is arranged in a distal position with respect to the fixed contact assembly 4 and comprises second ports 73 for the passage of the dielectric gas.

[0079] The second ports 73 are advantageously provided with suitable pressure valves to regulate the flow of dielectric gas.

[0080] The base wall portion 72 may be of conductive or insulating material.

[0081] Preferably, the compression cylinder 7 comprises a lateral wall portion 71.

[0082] Preferably, the lateral wall portion 71 has a tubular shape centred with the axis 100 and extends perpendicularly to the base wall portion 72 (in a direction substantially parallel to the axis 100) towards the fixed contact assembly 4.

[0083] According to the invention, the compression cylinder 7 is at least partially made of conductive material and is electrically coupled to the second pole terminal 12.

[0084] Preferably, the lateral wall portion 71 is at least partially made of conductive material and is electrically coupled to the second pole terminal 12.

[0085] In a preferred embodiment of the invention, the lateral wall portion 71 is made of conductive material (e.g. copper) and is mechanically and electrically coupled with the second pole terminal 12.

[0086] According to the invention, the electric pole unit 1 comprises sliding contact means 8, which electrically couple the moving contact assembly 5 and the compression cylinder 7.

[0087] As the compression cylinder 7 is electrically coupled with the second pole terminal 12, the sliding contact means 8 allows obtaining an electric current path 200 passing through the moving contact assembly 5, the compression cylinder 7 and the second pole terminal 12.

[0088] In a preferred embodiment of the invention, the sliding contact means 8 electrically couple the moving contact assembly 5 and the lateral wall potion 71 (made of conductive material) of the compression cylinder 7.

[0089] In such an embodiment, the electric current path 200 passes through the moving contact assembly 5, the lateral wall portion 71 and the second pole terminal 12.

[0090] In a preferred embodiment of the invention (figure 4), the sliding contact means 8 are mechanically coupled with the moving contact assembly 5, more particularly with the moving contact main portion 52.

[0091] Preferably, the sliding contact means 8 comprise at least a sliding contact element mechanically coupled with the moving contact main portion 52, more particularly with the external wall 521.

[0092] Preferably, the sliding contact element 8 is mechanically coupled with the external surface 522 of the external wall 521, advantageously at a distal position with respect to the fixed contact assembly 4, e.g. in proximity of the base wall 53.

[0093] Advantageously, the sliding contact element 8 is designed so as to be always in contact with the internal surface 712 of the lateral wall portion 71 of the compression cylinder 7.

[0094] In a preferred embodiment of the invention (figure 4), the sliding contact element 8 comprises a spring made of conductive material (e.g. copper).

[0095] This solution remarkably simplifies the arrangement of the sliding contact means 8, as the spring 8 (which may be advantageously pre-compressed) may be easily mounted on the external surface 522 of the external wall 521.

[0096] Preferably the spring 8 is accommodated (preferably in a fixed manner) in a groove 522A obtained at the external surface 522 of the moving contact main portion 52 (in particular of the external wall 521).

[0097] This allows the spring 8 to maintain a stable position during the movement of the moving contact assembly 5.

[0098] In an alternative embodiment of the invention (figure 5), the sliding contact means 8 are integral part of the moving contact assembly 5, more particularly of the moving contact main portion 52.

[0099] Preferably, the sliding contact means 8 are integral part of the external wall 521.

[0100] In this case, the sliding contact means 8 preferably comprise one or more external protrusions of the moving contact main portion 52, more particularly of the external wall 521.

[0101] Preferably, the external protrusions 8 are obtained at the external surface 522 of the external wall 521, advantageously at a distal position with respect to the fixed contact assembly 4, e.g. in proximity of the base wall 53.

[0102] Advantageously, the external protrusions 8 are designed so as to be always in contact with the internal surface 712 of the lateral wall portion 71 of the compression cylinder 7.

[0103] In a further alternative embodiment of the invention (figure 6), the sliding contact means 8 are integral part of the compression cylinder 7.

[0104] Preferably, the sliding contact means 8 are integral part of the lateral wall portion 71.

[0105] In this case, the sliding contact means 8 preferably comprise one or more external protrusions of the compression cylinder 7, more particularly of the lateral wall portion 71.

[0106] Preferably, the external protrusions 8 are obtained at the internal surface 712 of the lateral wall portion 71, advantageously at a distal position with respect to the fixed contact assembly 4, e.g. in proximity of the base wall portion 72.

[0107] Advantageously, the external protrusions 8 are designed so as to be always in contact with the external surface 522 of the external wall 521 of the moving contact main portion 52.

[0108] In a further alternative embodiment of the invention (figure 7), the sliding contact means 8 are mechanically coupled with the compression cylinder 7, more particularly with the moving contact main portion 52.

[0109] In this case, the sliding contact means 8 preferably comprise at least a sliding contact element mechanically coupled with the moving contact main portion 52, more particularly with the lateral wall portion 71.

[0110] Preferably, the sliding contact element 8 is mechanically coupled with the internal surface 712 of the lateral wall portion 71, advantageously at a distal position with respect to the fixed contact assembly 4, e.g. in proximity of the base wall portion 72.

[0111] Advantageously, the sliding contact element 8 is designed so as to be always in contact with the external surface 522 of the external wall 521 of the moving contact main portion 52.

[0112] The sliding contact element 8 may be, for example, a conductive ring accommodated (preferably in a fixed manner) in a seat 712A obtained at the internal surface 712 of the lateral wall portion 71 of the compression cylinder 7.

[0113] Operation of the electric pole unit 1 are briefly illustrated hereinafter.

[0114] Initially, the circuit breaker including the pole unit 1 is supposed to be in a closed condition. The corresponding operative condition of the electric pole unit 1 is represented in figure 1.

[0115] In this situation, the moving contact assembly 5 is operatively coupled with the fixed contact assembly of the electric pole unit 1.

[0116] In particular, the moving contact arching portion 51 and the moving contact main portion 52 are operatively coupled with the fixed contact arching portion 41 and the fixed contact main portion 42, respectively.

[0117] A current path is present between the pole terminals 11, 12.

[0118] Such a current path passes through the portions 41, 42 of fixed contact assembly 4, the portions 51, 52 of moving contact assembly 5, the sliding contact means 8 and the compression cylinder 7 (in particular the lateral wall portion 71).

[0119] During an opening operation of the circuit breaker, the moving contact assembly 5 is moved away from the fixed contact assembly 4.

[0120] The movement of the moving contact assembly 5 causes a compression of the dielectric gas within the compression chamber 62.

[0121] The compressed dielectric gas flows through the first ports 54 to the blast chamber 61

[0122] During the movement of the moving contact assembly 5, the electric pole unit 1 reaches the intermediate operative condition represented in figure 2.

[0123] In this situation, the moving contact assembly 5 is still partially coupled with the fixed contact assembly 4 of the electric pole unit 1.

[0124] However, differently from the operative condition shown in figure 1, the moving contact arching portion 51 and the moving contact main portion 52 are separated whereas the fixed contact arching portion 41 and the fixed contact main portion 42 are still coupled.

[0125] A current path is still present between the pole terminals 11, 12.

[0126] Such a current path passes through the fixed contact arching portion 41, the moving contact arching portion 51, the sliding contact means 8 and the compression cylinder 7 (in particular the lateral wall portion 71).

[0127] No arching phenomena are normally present in this case, as the fixed contact arching portion 41 and the moving contact arching portion 51 are still coupled.

[0128] Until arching portions 41, 51 are coupled, the compressed dielectric gas flows from the compression chamber 62 into the blast chamber 61.

[0129] By continuing the movement of the moving contact assembly 5, the electric pole unit 1 reaches the operative condition represented in figure 3.

[0130] In this situation, the moving contact assembly 5 is fully separated from the fixed contact assembly of the electric pole unit 1.

[0131] Arching phenomena are normally present in this case.

[0132] When low currents (e.g. nominal currents) are to be interrupted, arching phenomena (and possible arc re-striking phenomena) are normally quenched by the flow of compressed gas entering the blast chamber 61.

[0133] In this case, the electric pole 1 executes a current breaking operation of the puffer type, in which the compressed dielectric gas is driven towards the electric contacts to obtain arc quenching.

[0134] When high currents (e.g. short circuit currents) are to be interrupted, arching phenomena causes pressure waves in the blast chamber 61, which cause the closing of the pressure valves of the first ports 54.

[0135] In this case, the electric pole 1 executes a current breaking operation of the self-blast type, in which the the arc energy is used to produce high pressure waves in the dielectric gas within the blast chamber 61. Such pressure waves in the dielectric gas ensure the obtaining of arc quenching.

[0136] When quenching of arching phenomena is obtained, no electric current path is present between the pole terminals 11, 12 and the electric current passing through the electric pole unit1 is finally interrupted.

[0137] The circuit breaker including the electric pole unit 1 is now supposed to be in an open condition.

[0138] The corresponding operative condition of the electric pole unit 1 is represented in figure 3.

[0139] In this situation, the moving contact assembly 5 is fully separated from the fixed contact assembly 4.

[0140] No current path is present between the pole terminals 11, 12.

[0141] During a closing operation of the circuit breaker, the moving contact assembly 5 is moved towards the fixed contact assembly 4.

[0142] During the movement of the moving contact assembly 5, the electric pole unit 1 reaches the intermediate operative condition represented in figure 2.

[0143] The moving contact assembly 5 are partially coupled with the fixed contact assembly of the electric pole unit 1.

[0144] In particular, the moving contact arching portion 51 and the moving contact main portion 52 are still separated whereas the fixed contact arching portion 41 and the fixed contact main portion 42 are coupled one to another.

[0145] A current path is established between the pole terminals 11, 12.

[0146] Such a current path passes through the fixed contact arching portion 41, the moving contact arching portion 51, the sliding contact means 8 and the compression cylinder 7 (in particular the lateral wall portion 71).

[0147] By continuing the movement of the moving contact assembly 5, the electric pole unit 1 reaches the operative condition represented in figure 1.

[0148] The moving contact assembly 5 is fully coupled with the fixed contact assembly of the electric pole unit 1.

[0149] In particular, the moving contact arching portion 51 and the moving contact main portion 52 are operatively coupled with the fixed contact arching portion 41 and the fixed contact main portion 42, respectively.

[0150] A current path is present between the pole terminals 11, 12.

[0151] Such a current path passes through the portions 41, 42 of fixed contact assembly 4, the portions 51, 52 of moving contact assembly 5, the sliding contact means 8 and the compression cylinder 7 (in particular the lateral wall portion 71).

[0152] A full electrical continuity through the electric pole unit1 is finally established.

[0153] From the above, it is evident how the sliding contact means 8 ensure an electric coupling between the moving contact assembly 5 and the compression cylinder 7 (and consequently the second pole terminal 12) at any position of the moving contact assembly 5 relative to the fixed contact assembly 4.

[0154] This fact represents a remarkable difference with respect to the solutions of the state of the art, which are typically arranged so as to obtain an electric coupling between a moving contact arm and a pole terminal.

[0155] Such an innovating feature allows obtaining a shorter and more linear current path with respect to the solutions of the state of the art.

[0156] As the current path has an improved geometry, shorter dielectric distances may be adopted to ensure electric insulations among the internal components and the bushings 13, 14 may have a same structure, thereby being fully interchangeable to simplify the assembling process of the pole unit 1.

[0157] The electric pole unit 1, according to the invention, may be subject to several variants falling within the scope of the invention.

[0158] For example, the housing 2, the fixed contact assembly 4, the moving contact assembly 5, the bushings 13-14, the contact arm 9A, the operating rod 9B and/or the kinematic chain 9C may be arranged according to other solutions of known type.

[0159] The electric pole unit 1, according to the invention, allows achieving the intended aims and objects.

[0160] The sliding contact means 8 allow obtaining an improved current path between the pole terminals 11, 12.

[0161] The electric pole unit 1 therefore offers excellent performances in terms of electric conductivity of the current path and in terms of dielectric insulation among the components. The electric pole unit 1 is characterised by a compact and relatively simple structure, which makes it particularly suitable for use in switchgears requiring relatively short distances between the switchgears contacts.

[0162] The electric pole unit 1 has proven to be easier and less expensive to assembly at industrial level and install on the field with respect to traditional solutions of the state of the art.

Claims

1. An electric pole unit (1) for a MV gas-insulated circuit breaker **characterised in that** it comprises:

   - an insulating housing (2) defining an internal volume (3), in which a dielectric gas is contained;
   - a first pole terminal (11) and a second pole terminal (12);
   - an interruption unit (6), which is positioned in the internal volume of said electric pole unit, said interruption unit comprising:

     - a fixed contact assembly (4), which is electrically coupled to said first pole terminal (11);
     - a moving contact assembly (5), which is adapted to be coupled with or separated from said fixed contact assembly during a switching operation of said circuit breaker;
     - a compression cylinder (7) defining at least partially a gas compression chamber (62) of said interruption unit, said moving contact assembly being operatively coupled with said compression cylinder so as to move along said compression chamber during a switching operation of said circuit breaker;

   wherein said compression cylinder (7) is at least partially made of conductive material and is electrically coupled with said second pole terminal (12),
   wherein said electric pole unit comprises sliding contact means (8) electrically coupling said moving contact assembly (5) and said compression cylinder.

2. An electric pole unit, according to claim 1, **characterised in that** said compression cylinder comprises a lateral wall portion (71), which is made of conductive material and is electrically coupled with said second pole terminal (12), said sliding contact means (8) electrically coupling said moving contact assembly (5) and the lateral wall portion of said compression cylinder.

3. An electric pole unit, according to claim 1 or 2, **characterised in that** said sliding contact means (8) are mechanically coupled with said moving contact assembly (5).

4. An electric pole unit, according to claim 3, **characterised in that** said moving contact assembly (5) comprises a moving contact main portion (51), said sliding contact means (8) comprising at least a sliding contact element (8) mechanically coupled with said moving contact main portion.

5. An electric pole unit, according to claim 4, **characterised in that** said sliding contact element (8) comprises a conductive spring.

6. An electric pole unit, according to claim 5, **characterised in that** said conductive spring (8) is accommodated in a groove (522A) obtained at the external surface (522) of said moving contact main portion.

7. An electric pole unit, according to claim 1 or 2, **char-**

acterised in that said sliding contact means (8) are integral part of said moving contact assembly.

8. An electric pole unit, according to claim 7, **characterised in that** said moving contact assembly (5) comprises a moving contact main portion (51), said sliding contact means (8) comprise one or more external protrusions (54) of said moving contact main portion.

9. An electric pole unit, according to claim 1 or 2, **characterised in that** said sliding contact means (8) are mechanically coupled with said compression cylinder (7).

10. An electric pole unit, according to claims 2 and 9, **characterised in that** said sliding contact means comprise at least a sliding contact element (8) mechanically coupled with said compression cylinder at the lateral wall portion (71) of said compression cylinder.

11. An electric pole unit, according to claim 1 or 2, **characterised in that** said sliding contact means (8) are integral part of said compression cylinder (7).

12. An electric pole unit, according to claims 2 and 11, **characterised in that** said sliding contact means comprise one or more internal protrusions (73) of the lateral wall portion (71) of said compression cylinder.

13. A MV gas-insulated circuit breaker **characterised in that** it comprises one or more pole units (1), according to one or more of the previous claims.

14. A MV switchgear **characterised in that** it comprises a MV gas-insulated circuit breaker, according to claim 13.

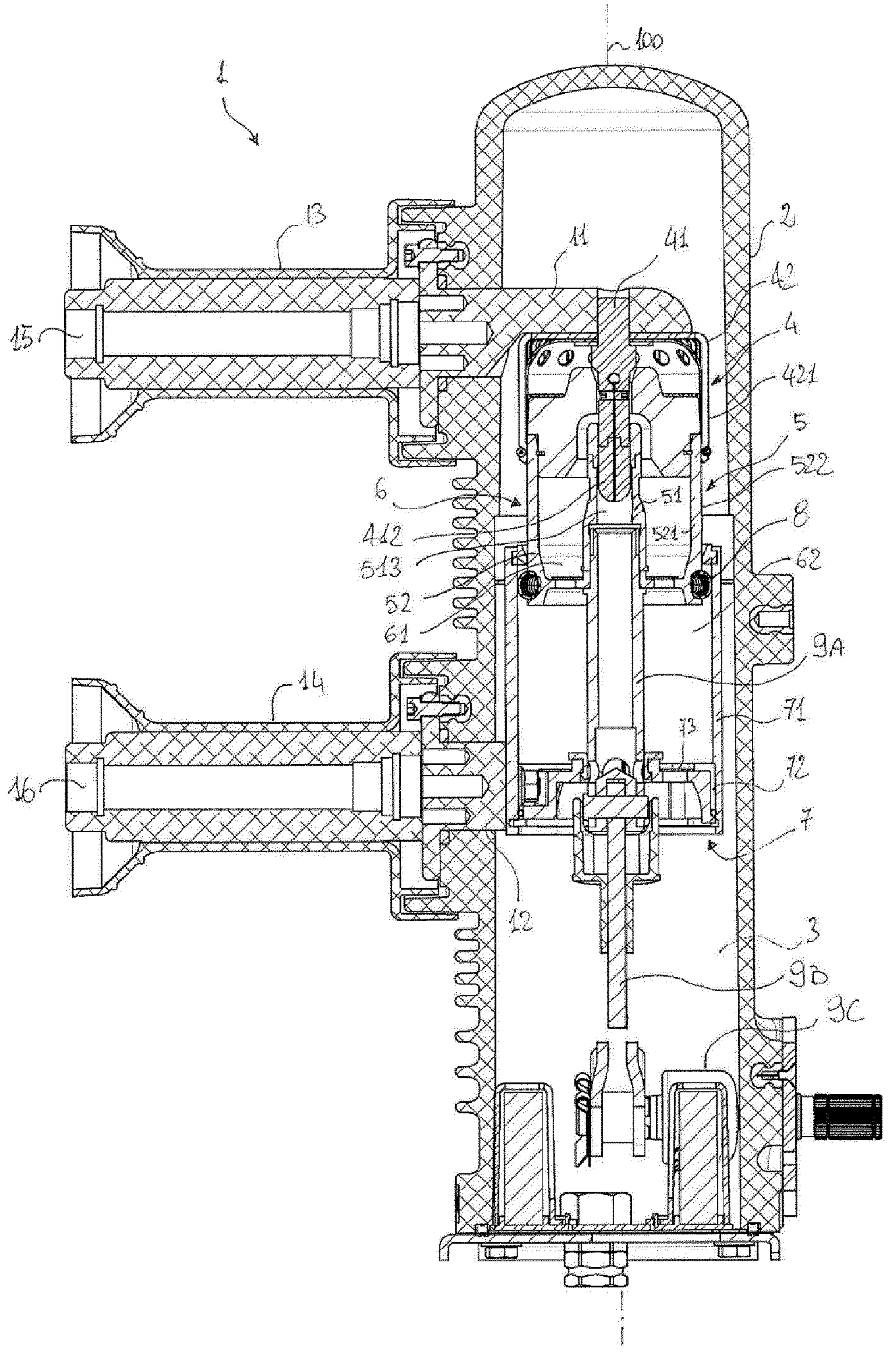
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Fig. 1

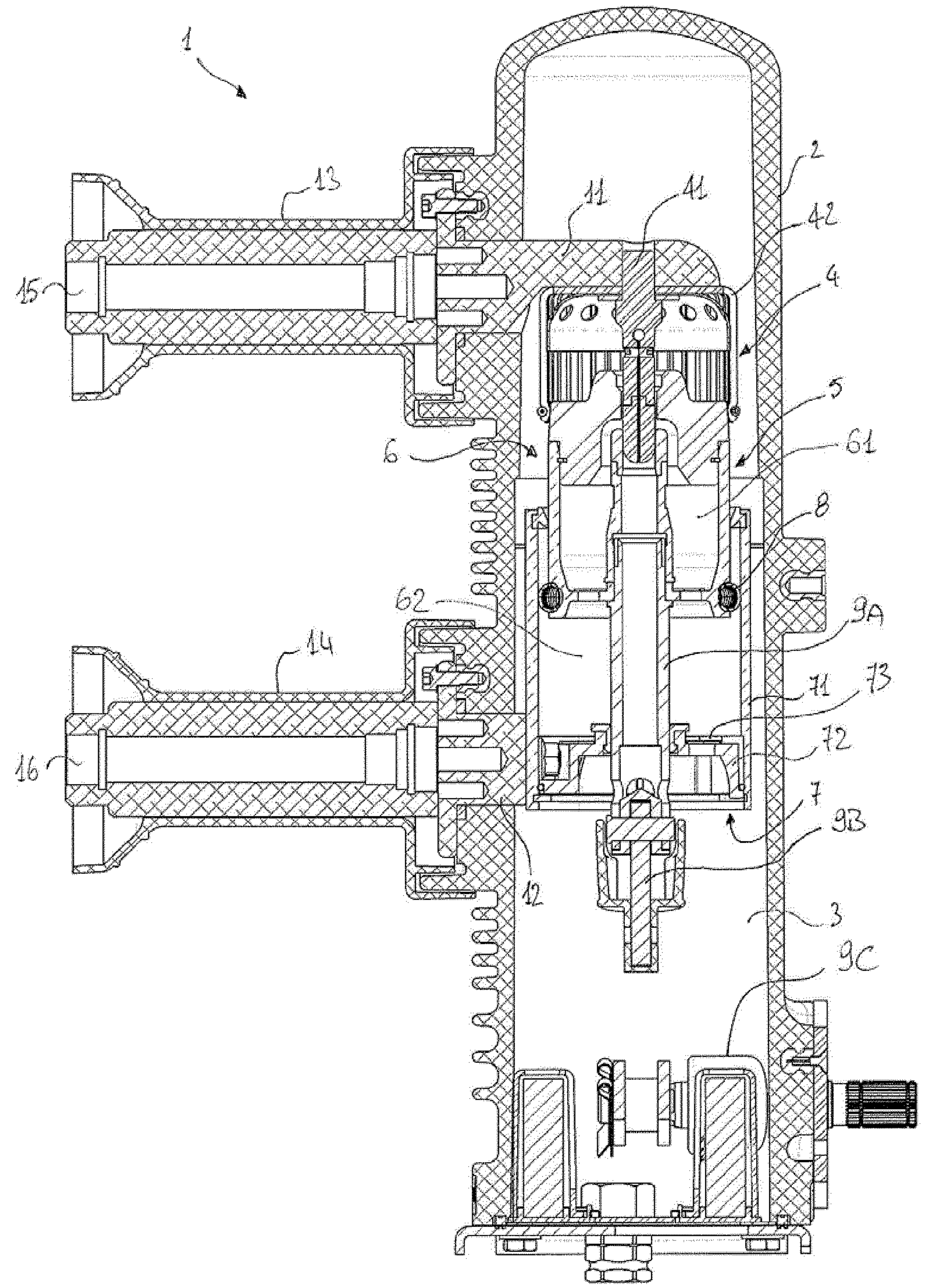

Fig. 2

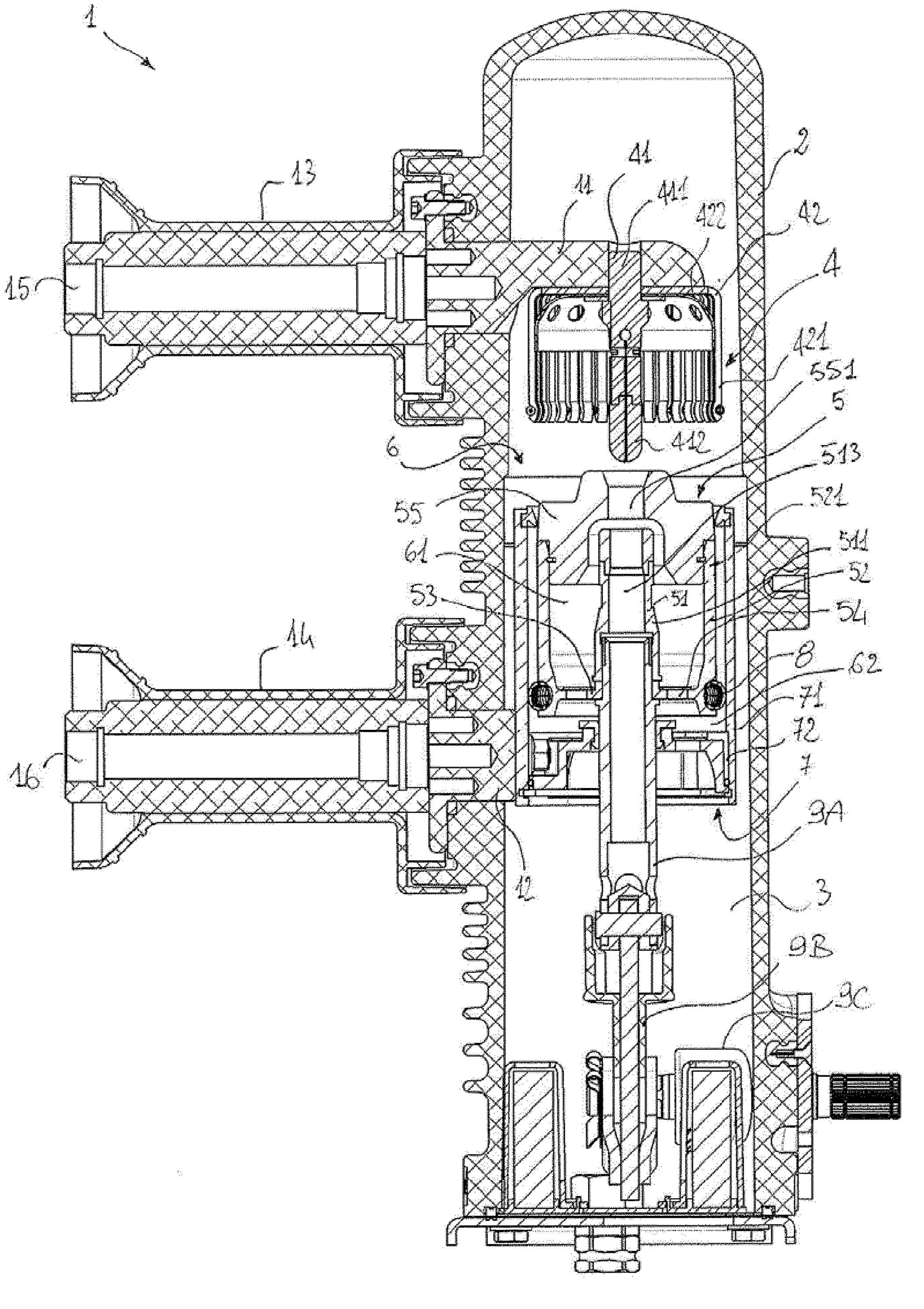
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Fig. 3

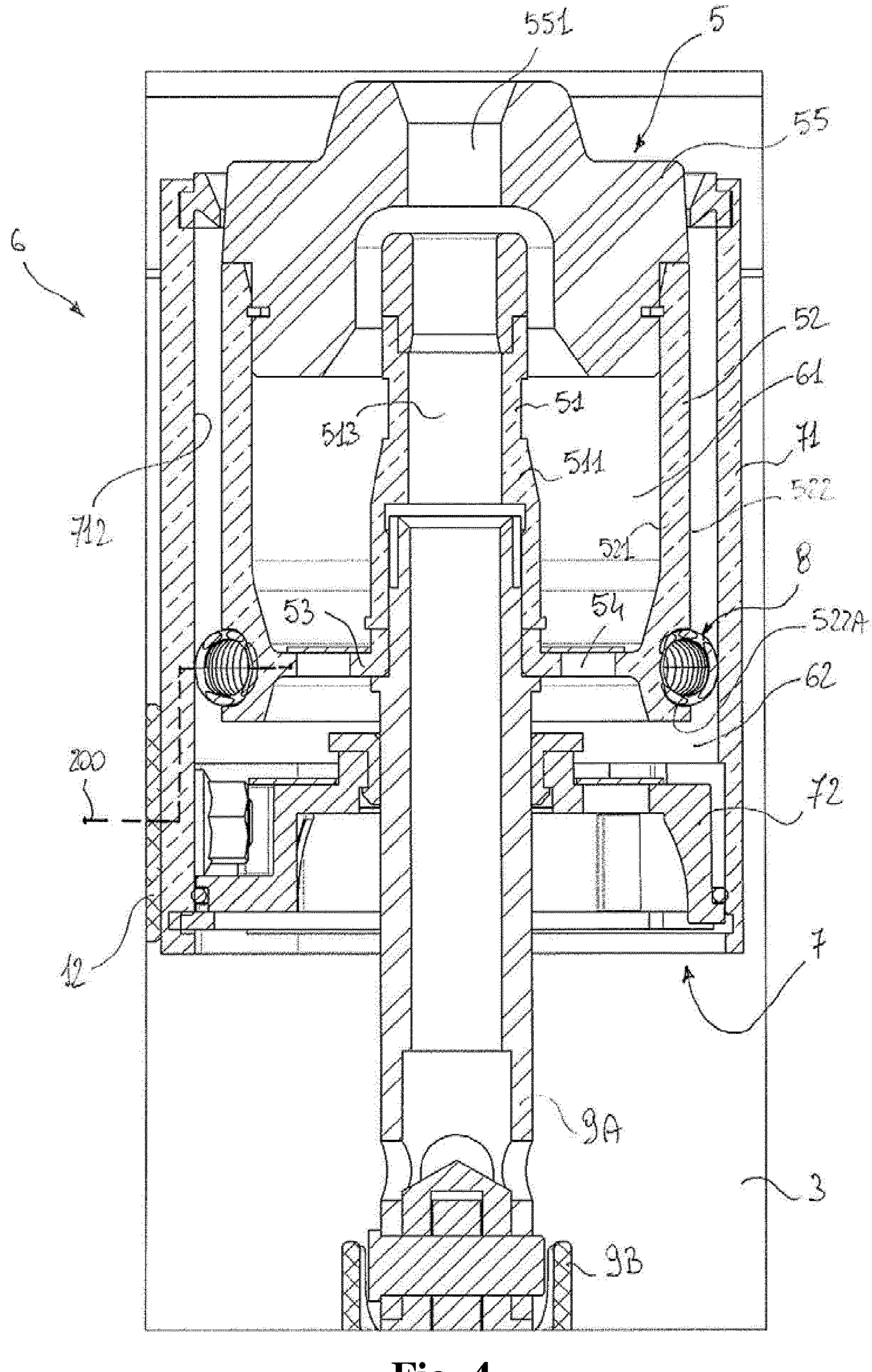
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Fig. 4

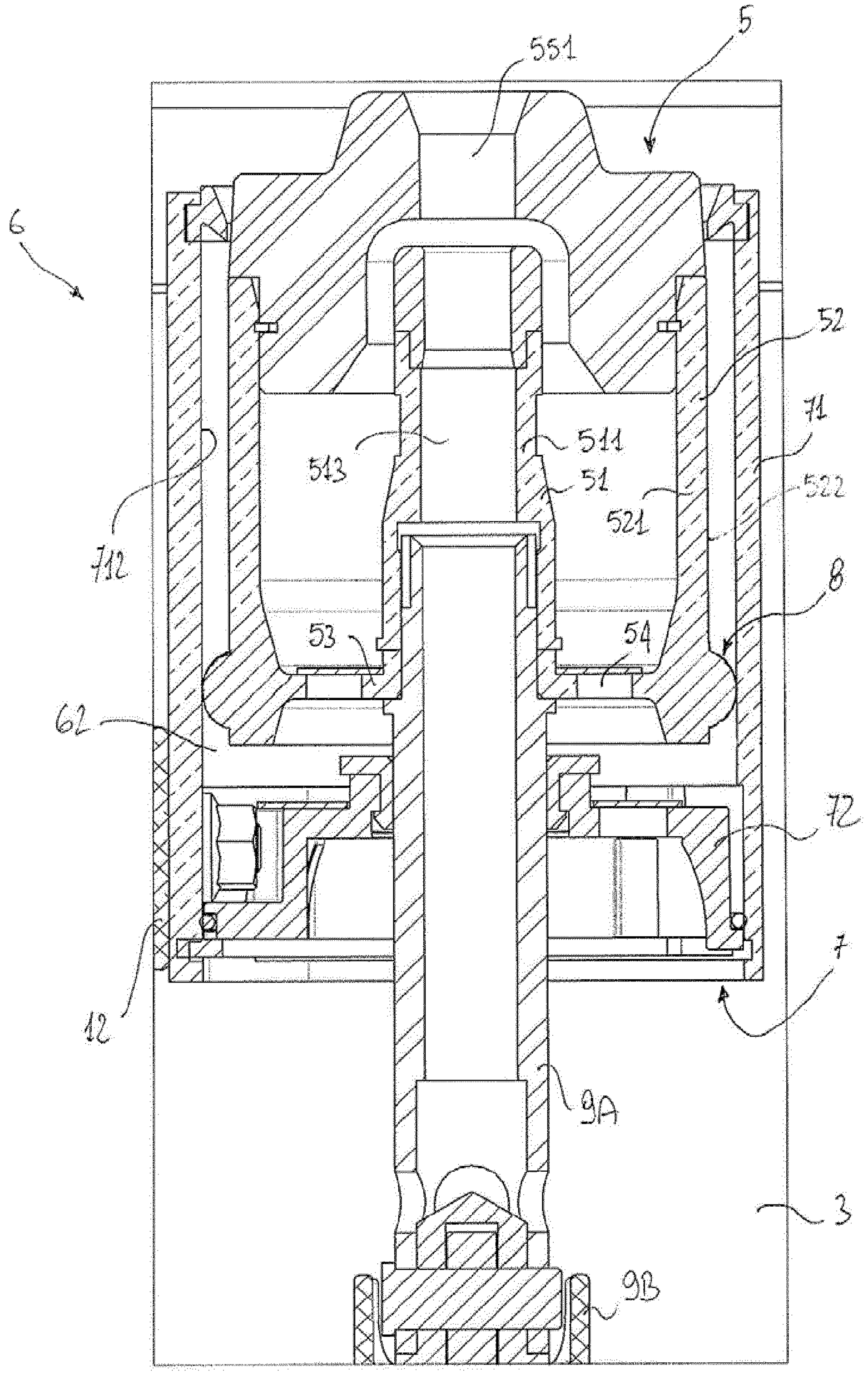

Fig. 5

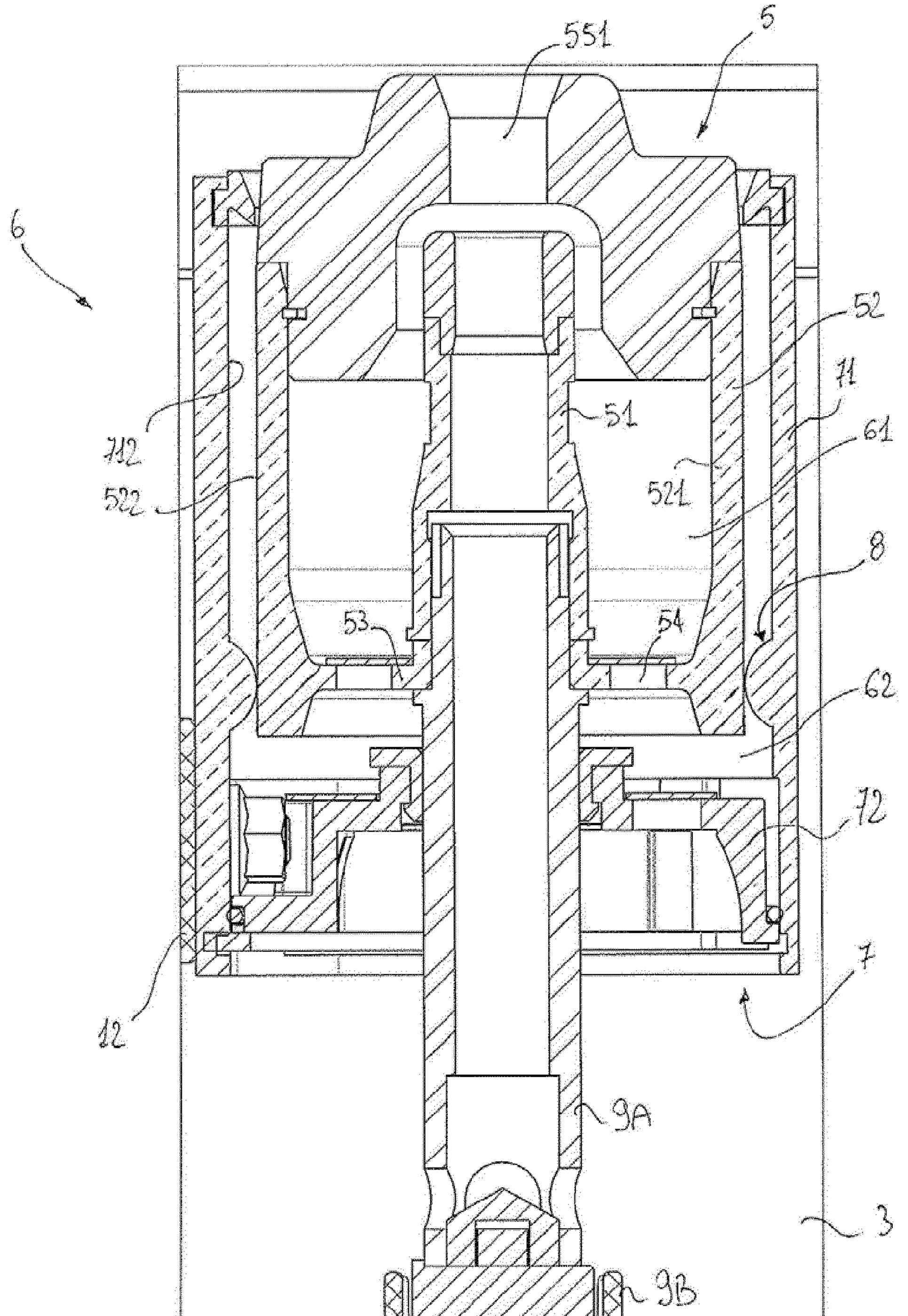

Fig. 6

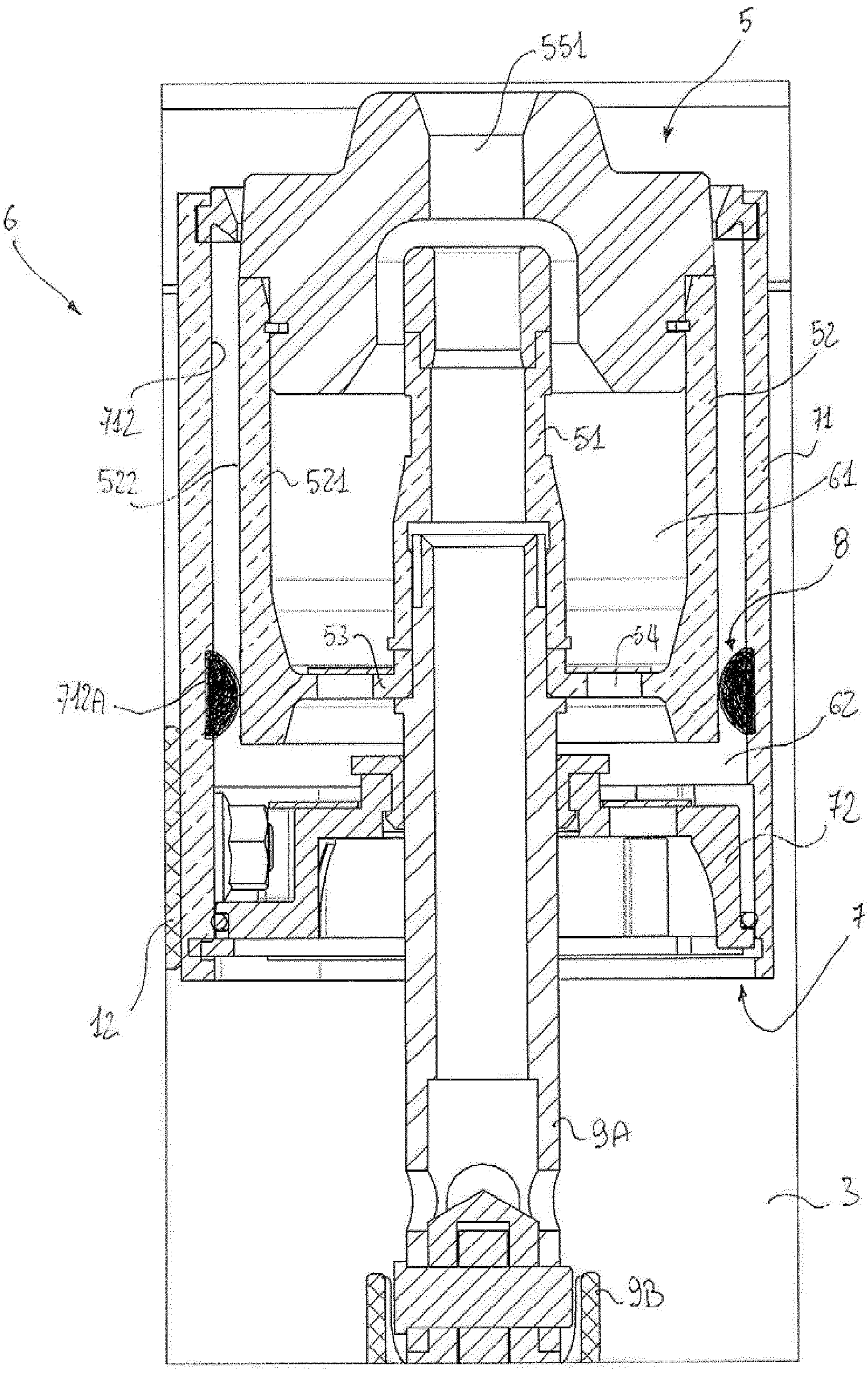

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 7511

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 Y	US 5 977 502 A (MIZOGUCHI HITOSHI [JP] ET AL) 2 November 1999 (1999-11-02) * column 12, line 1 - column 16, line 53; figures 3,4a-4c * * column 1, line 4 - line 30 *	1-4,7-14 5,6	INV. H01H33/90
X Y	US 2013/168357 A1 (YAGINUMA NORIYUKI [JP] ET AL) 4 July 2013 (2013-07-04) * paragraph [0022] - paragraph [0032]; figures 1-4 *	1-4,7-14 5,6	
X Y	DE 10 2010 020979 A1 (SIEMENS AG [DE]) 17 November 2011 (2011-11-17) * paragraph [0046]; figures 1-3 *	1-4,7-14 5,6	
Y	US 2009/261071 A1 (NUFER JUERG [CH] ET AL) 22 October 2009 (2009-10-22) * paragraph [0073]; figure 1 *	5,6	

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 October 2015	Dobbs, Harvey

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CATEGORY OF CITED DOCUMENTS

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EP 15 16 7511

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13-10-2015

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 5977502	A	02-11-1999	CN	1226073	A	18-08-1999
			EP	0933795	A2	04-08-1999
			JP	4174094	B2	29-10-2008
			JP	H11213828	A	06-08-1999
			US	5977502	A	02-11-1999
US 2013168357	A1	04-07-2013	CN	103187202	A	03-07-2013
			JP	5516568	B2	11-06-2014
			JP	2013140693	A	18-07-2013
			KR	20130076777	A	08-07-2013
			US	2013168357	A1	04-07-2013
DE 102010020979	A1	17-11-2011	CN	102985990	A	20-03-2013
			DE	102010020979	A1	17-11-2011
			EP	2569795	A1	20-03-2013
			RU	2012153565	A	20-06-2014
			US	2013056444	A1	07-03-2013
			WO	2011141321	A1	17-11-2011
US 2009261071	A1	22-10-2009	CN	101573774	A	04-11-2009
			EP	1939910	A1	02-07-2008
			EP	2126947	A2	02-12-2009
			US	2009261071	A1	22-10-2009
			WO	2008080858	A2	10-07-2008

EPO FORM P0459

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