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(54) **NEW DESIGN OF SPLITTER PLATE HOLDER FOR APPLICATION IN MEDIUM VOLTAGE GAS
INSULATED LOAD BREAK SWITCHES**

NEUES DESIGN EINES TEILERPLATTENHALTERS ZUR ANWENDUNG IN GASISOLIERTEN
MITTELSPANNUNGSLASTTRENNSCHALTERN

NOUVELLE CONCEPTION DE SUPPORT DE PLAQUE DE RÉPARTITION POUR UNE
APPLICATION DANS DES SECTIONNEURS SOUS CHARGE ISOLÉ DE GAZ MOYENNE TENSION

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Description**TECHNICAL FILED**

[0001] The present disclosure relates to gas insulated switches and circuit breakers. In particular the present disclosure relates to a gas insulated switch with an arrangement of splitter plates and a splitter plate holder.

BACKGROUND

[0002] A gas insulated switch is configured to break electric currents, in particular AC currents, for example currents characterized by a root mean square (rms) AC current value. For a given nominal rms AC current the switch may interrupt the circuit with a given nominal probability, for example 50% or more or for example 99% or more or for example 99,999% or more or for example with a probability of substantially 100%. The switch is surrounded by gas and during circuit breaking an electric arc extends from a first contact to a second contact of the switch.

[0003] It is necessary to extinguish said electric arc in order to break the circuit and interrupt the current. For example a voltage difference across the arc can be increased in order to reduce the electric current of the arc up to the point where the arc extinguishes. For AC currents the arc extinction and the opening of the circuit may in particular occur at current zero. To facilitate the arc extinction and/or an increase of a voltage difference across the arc, the arc may be lengthened, for example increasing the physical distance between contacts of the switch, and/or the arc may be cooled and/or a section of the arc may be reduced and/or the arc may be split into smaller arcs forming a series.

[0004] Arc splitting is obtained with the use of splitter plates that attract the electric arc between adjacent splitter plates for example by Lorentz forces and segment the original arc into a series of smaller arcs between adjacent splitter plates. The electric resistance of the arc is increased and an extinction of the arc is facilitated, in particular at current zero in the case of AC currents.

[0005] The geometry of the splitter plates and/or materials used for the splitter plates and/or for a splitter plate holder may lead for example to an electric arc that may not extinguish and/or to a failed interruption of an electric current and/or to a damage of for example a splitter plate holder. Further improvements are therefore needed to facilitate the extinction of the electric arc. Further improvements are demanded to increase the likelihood of an arc extinction and/or of a circuit interruption in the presence of a given electric current for example without a substantial increase in the dimensions of the gas insulated switch and preventing damages for example to the splitter plates and/or a splitter plate holder.

[0006] CN105405707B describes a gas insulated load switch and its arc-control device. Document EP1098331 discloses an arc chute for a molded case circuit breaker

including an arc extinguishing apparatus provided with end caps.

[0007] Therefore a gas insulated switch with improved splitter plates and/or with an improved splitter plate holder may be beneficial in order to better break an electric current, for example increasing the probability of opening an electric circuit for a given root mean square (rms) value of an AC current.

SUMMARY

[0008] The present disclosure provides in particular improved medium voltage gas insulated switches.

[0009] According to an aspect, a medium voltage gas insulated switch is described in claim 1.

[0010] Further aspects, details and advantages are evident from the dependent claims, the description and the figures.

BRIEF DESCRIPTION OF DRAWINGS**[0011]**

FIG. 1 schematically shows a medium voltage gas insulated switch.

FIG. 2A schematically shows a medium voltage gas insulated switch with a plurality of splitter plates with some features according to embodiments of the present disclosure.

FIG. 2B schematically shows a splitter plate with some features according to embodiments of the present disclosure together with a radial distance between the splitter plate and an electric arc. Some features of the invention, e.g. an insulating extension, are not shown in FIG. 2A and FIG. 2B.

FIG. 3A schematically shows a splitter plate and exterior side walls, inner leg insulating walls and an insulating extension according to the invention.

FIG. 3B schematically shows a plurality of splitter plates and exterior side walls, inner leg insulating walls and insulating extensions according to some embodiment of the present disclosure.

FIG. 3C schematically shows a splitter plate and angled exterior side walls, inner leg insulating walls and an insulation extension according to embodiments of the present disclosure.

FIG. 3D schematically shows a substantially trapezoidal splitter plate, angled exterior side wall, inner leg insulating walls and an insulating extension according to embodiments of the present disclosure.

FIG. 3E schematically shows exterior side walls of

a splitter plate holder with some features according to some embodiments of the present disclosure. Some features, e.g. an insulating extension, are not shown.

FIG. 3F schematically shows exterior side walls of a splitter plate holder and an insulating extension according to some embodiments of the present disclosure.

FIG. 3G schematically shows exterior side walls and an insulating extension according to some embodiments of the present disclosure.

FIG. 3H shows exterior side walls and inner leg insulating walls according to some embodiments of the present disclosure.

FIG. 3I shows exterior side walls and inner leg insulating walls according to some embodiments of the present disclosure.

FIG. 3J shows exterior side walls of a splitter plate holder according to some embodiments of the present disclosure.

FIG. 3K show exterior side walls with an angled surface according to some embodiments of the present disclosure.

FIG. 3L shows exterior side walls with a convergent profile according to some embodiments of the present disclosure.

FIG. 3M shows exterior side walls with a convergent divergent profile.

FIG. 4 schematically shows a medium voltage gas insulated switch with a plurality of splitter plates and a splitter plate holder according to some embodiments of the present disclosure.

FIG. 5 schematically shows a medium voltage gas insulated switch with a plurality of splitter plates and a splitter plate holder according to some embodiments of the present disclosure.

FIG. 6 schematically shows a medium voltage gas insulated switch with a plurality of splitter plates, exterior side walls, inner leg insulating walls and an insulating extensions according to some embodiments of the present disclosure.

FIG. 6A schematically shows a medium voltage gas insulated switch with a plurality of splitter plates, exterior side walls, inner leg insulating walls and an insulating extensions according to some embodiments of the present disclosure.

FIG. 7 schematically shows a medium voltage gas insulated switch with a plurality of splitter plates, exterior side walls, inner leg insulating walls and insulating extensions according to some embodiments of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0012] A gas insulated switch is a device configured to interrupt an electric current between a first electric contact and a second electric contact. Therefore a gas insulated switch is a device configured to open an electric circuit, for example an AC circuit. Typically the switch is also configured to close the electric circuit, such that the circuit can be opened and closed repeatedly operating the switch.

[0013] The switch is typically operated by actuators and configured to interrupt medium voltage circuits.

[0014] FIG. 1 schematically shows a gas insulated switch 100. The gas insulated switch 100 may for example be a medium voltage gas insulated switch. The gas insulated switch 100 includes a first electric contact 102 and a second electric contact 104. Between the contacts a gas is present.

[0015] Embodiments of the present disclosure may in particular improve the performance of switches in the presence of air or a CO_2/O_2 mixture.

[0016] The first electric contact 102 is electrically connected to one terminal of an electric circuit and the second electric contact 104 is electrically connected to another terminal of the electric circuit. The first electric contact 102 is movable with respect to the second electric contact 104, for example the second electric contact 104 may be rotatable with respect to the first electric contact 102 around a rotation axis 122, perpendicular to the plane of FIG. 1.

[0017] The first electric contact 102 can come in contact with the second electric contact 104 in order to allow a current flow between the first electric contact 102 and the second electric contact 104 closing the electric circuit. The first electric contact 102 and the second electric contact 104 can also be separated, i.e. a physical distance between the two contacts can be increased, in order to break a current flowing between the first electric contact and the second electric contact and/or vice versa.

[0018] The first electric contact 102 and the second electric contact 104 are only schematically shown in the figures. The contacts may be knife contacts and they may have different geometries with respect to each other. The second electric contact 104 may be substantially different from the first electric contact 102. Different components of the switch, not shown in the figures, may lock and/or release the electrical contacts. In embodiments of the present disclosure actuators may be present to automate the relative rotation and/or movement between the electric contacts.

[0019] For example the first electric contact and the second electric contact 104 can rotate relative to each

other around a rotation axis 122 identified by a unit vector $\vec{z}$ defining an axis z . The unit vector $\vec{z}$ describing the rotation axis 122 is orthogonal to the plane in which the trajectory of the electric contacts is located. The plane in which the relative trajectory of the electric contacts 102, 104 is located may be spanned by orthogonal unit vectors $\vec{x}$, $\vec{y}$. A Cartesian coordinate system 130 Oxyz is identified by the vectors $\vec{x}$, $\vec{y}$, $\vec{z}$ with respective axes x , y , z and the origin O. The second electric contact 104 is therefore configured to be rotatable with respect to the first electric contact 102 around the rotation axis 122 corresponding to the z axis with a relative rotation 120 in the Oxy plane of the coordinate system 130.

[0020] In some embodiments both electric contacts 102, 104 are located above the rotation axis 122 with respect to the earth. Therefore a flow of hot gas originating for example near the first electric contact 102 and/or the second electric contact 104 flows substantially away from the rotation axis 122 corresponding to the y axis of the coordinate system 130.

[0021] The figures only show schematically some exemplary embodiments of the present disclosure.

[0022] When the first electric contact 102 contacts the second electric contact 104 the electric circuit is closed and a current can flow between the first electric contact 102 and the second electric contact 104. A torque is then applied in order to rotate the second electric contact 104 with respect to the first electric contact 102. When the relative rotation 120 of the electric contacts starts as a consequence of the applied torque, the second electric contact 104 rotates away from the first electric contact 102 with a relative rotation 120 around the rotation axis 122 and typically an electric arc 110 forms between the first electric contact 102 and the second electric contact 104. The electric arc 110 may on average form in a spatial region 116 around a curved line 112.

[0023] The position of the electric arc 110 and its trajectory are substantially random and are located in a spatial region 116 around a curved line 112.

[0024] Circular areas may symbolically indicate surfaces where the first electric contact contacts the second electric contact. Said surfaces may have any suitable geometry. The electric arc may extend from the first electric contact to the second electric contact and/or vice versa along all the conducting surfaces of the contacts, i.e. for example also outside the circular areas in the figure.

[0025] It is necessary to extinguish the electric arc 110 in order to interrupt the current flow between the electric contacts 102, 104 and open the circuit.

[0026] The electric arc 110 may ionize and heat the gas surrounding the electric arc 110. Typically the electric arc 110 extends in a region 116 located vertically above the rotation axis 122 with respect to the earth. For example with respect to the Cartesian coordinate system 130 the unit vector $\vec{y}$ typically extends in a vertical direction pointing upwards and/or has substantial vertical component. The force of gravity may therefore for example be oriented according to $(-\vec{y})$. The gas ionized and heated

by the electric arc 110 becomes lighter than the gas initially surrounding the switch and the ionized and heated gas therefore travels upwards in a direction substantially parallel to $\vec{y}$ and/or having a significant component in the y direction.

[0027] FIG. 2A schematically shows the gas insulated switch 100 with a plurality 200 of splitter plates 200-1, 200-2, ..., 200-i, The splitter plate 200-1 is the splitter plate closest to the first electric contact 102 and 200-i denotes the i -th splitter plate in the plurality 200 of splitter plates 200-1, 200.2, ..., 200-i, It is convenient to fix a cylindrical coordinate system $O\rho\theta z$ where a radial axis ρ 212 extends radially away from the rotation axis 122, a z axis 214 coincides with the rotation axis 122 and with the z axis of the Cartesian coordinate system 130 and θ identifies an angle 210 in the Oxy plane where the trajectory of the electric contacts is located. The ρ coordinate 212 identifies therefore a radial distance ρ from the axis of rotation 122. The θ coordinate 210 identifies an angle in the Oxy plane of the Cartesian coordinate system 130. For every point in space, a unit vector $\vec{\rho}$ points in the direction of increasing radial distance, i.e. of increasing coordinate ρ .

[0028] In some embodiments, for example the splitter plates 200-1, 200-2, ..., 200-i, ... in the plurality 200 of splitter plates may be substantially planar, for example substantially extending in a radial plane containing the rotation axis 122. For example each splitter plate 200-i in the plurality 200 of splitter plates may be substantially contained in a radial plane containing the rotation axis 122. It is intended that the splitter plates are substantially planar, i.e. the thickness of the splitter plate is considered irrelevant, such that it makes sense to consider each splitter plate as substantially contained in a plane, although each splitter plate has a finite thickness.

[0029] For example said radial plane may be spanned by rotation axis 122 and by a segment connecting for example the center of mass of the splitter plate 200-i with the rotation axis 122, for example by a segment perpendicular to the rotation axis 122. For example each splitter plate 200-i may be located in a radial plane Ozp containing a z axis corresponding to the rotation axis 122 and a ρ axis extending radially outwards from the rotation axis 122, the ρ axis being indicative of a radial distance from said rotation axis. For example the z axis and the ρ axis are perpendicular and span the plane Ozp that contains the splitter plate 200-i.

[0030] The splitter plate 200-i denotes a generic splitter plate in the plurality 200 and therefore the properties and features of the generic splitter plate 200-i hold for all the splitter plates in the plurality 200 of splitter plates and 200-($i-1$) and 200-($i+1$) indicate, if present, the predecessor and the successor of the splitter plate 200-i in the plurality 200 respectively.

[0031] The arrangement of splitter plates is used to attract the electric arc 110 between adjacent splitter plates by Lorentz forces. In a splitting process, the electric arc is segmented in segments located between adjacent

splitter plates and it becomes possible to more easily extinguish the arc. For example a voltage drop across the arc is increased.

[0032] The arrangement of splitter plates 200-1, 200-2, ..., 200-i, ... may be formed by splitter plates that extend in a radial direction ρ and each splitter plate in the plurality 200 is located in a plane that contains the rotation axis 122, z of the coordinate system 130. Therefore when the electric arc 110 travels upwards in the direction of increasing y coordinates and/or increasing ρ coordinates, the average length of the arc segments between adjacent splitter plates may also increase in consequence of the splitter plates being nonparallel in some of the embodiments of the present disclosure.

[0033] In embodiments of the present disclosure where the splitter plates are non-parallel, the arc resistance increases more than in the case of parallel splitter plates and an arc extinction at zero current becomes more likely. A splitter plate arrangement of nonparallel splitter plates, according for example to some of the embodiments of the present disclosure, improves therefore the performance of a gas insulated switch when compared for example to a switch with substantially parallel splitter plates. In particular higher currents can be interrupted.

[0034] FIG. 2B shows the generic i-th splitter plate 200-i of the plurality 200 of splitter plates. The splitter plate 200-i is substantially located in a plane extending in the z, ρ plane, with the coordinate ρ denoting the radial distance from the rotation axis (130, z), i.e. the coordinate 212.

[0035] The radial plane Ozp that contains the substantially planar splitter plate 200-i, and the rotation axis of the second electric contact, depends on the splitter plate 200-i, i.e. different splitter plates are contained in different radial planes

[0036] The second electric contact 104 passes at least in part in a region 230 for the transit of the second electric contact. Therefore the trajectory of the second electric contact 104 during the rotation 120 around the rotation axis 122 intersects the Ozp plane spanned by 212, 214 in a region 220 indicating the intersection of the trajectory of the second electric contact with the radial plane $Oz\rho$.

[0037] The splitter plates in the plurality 200 of splitter plates may be ferromagnetic and configured to attract the electric arc 110 in the direction of increasing ρ coordinate 212 by Lorentz forces.

[0038] The distance 240 denotes a radial distance between the curved line 112 around which the electric arc extends and the splitter plate 200-i. To facilitate the understanding, in FIG. 2B a circle 112- Ozp indicates the position where the curved line 112 intersects the plane of the figure, i.e. the radial plane $Oz\rho$. When the second electric contact during its rotation is located in correspondence to the splitter plate 200-i, the electric arc may extend in a region around the curved line 112, for example within said circle. Nevertheless, the position of the electric arc is substantially random, such that the electric

arc may extend along the whole conducting surface of the second electric contact.

[0039] Due to Lorentz forces due to the ferromagnetism of the splitter plates in the plurality 200, the electric arc 110 travels substantially upwards in the direction of increasing radial coordinate 212 overcoming the distance 240.

[0040] The electric arc 110 further leaves the region 230 for the transit of the second electric contact entering a region between adjacent splitter plates 200-i and 200-(i+1) and/or between adjacent splitter plates 200-i and 200-(i-1). When the electric arc leaves the region 230 traveling substantially upwards in the direction of increasing ρ coordinate 212, a current flowing in the region 230 is prevented or reduced and a voltage drop across the electric arc increases in such a way that the electric arc easily extinguishes.

[0041] In some of the embodiments of the present disclosure the distance 240, i.e. the radial distance between the curved line 112 around which the electric arc extends and the splitter plate 200-i may be substantially constant.

[0042] In some embodiments of the present disclosure for example each splitter plate 200-i in the plurality 200 may be arranged in a substantially identical way in a radial plane Ozp containing the splitter plate 200-i. For example each splitter plate 200-i in the plurality 200 of splitter plates may be substantially contained in a plane that also contains the axis of rotation 122, the splitter plate 200-i being arranged at substantially the same distance from said axis of rotation 122. For example the radial distance 240 between the curved line 112 around which the electric arc extends and the splitter plate 200-i may be substantially constant. For example each splitter plate in the plurality of splitter plates may extend radially outwardly at substantially the same distance from the axis of rotation 122.

[0043] In some embodiments of the present disclosure the splitter plates are not parallel to each other and are for example radially arranged. For example the intersection of all the planes that contain a splitter plate of the plurality 200 may be the rotation axis 122 and each splitter plate may be arranged at substantially the same distance from said rotation axis 122.

[0044] In some embodiments of the present disclosure the plurality 200 of splitter plates does not move relative to the first electric contact 102.

[0045] In some alternative embodiments of the present disclosure the second electric contact may not only rotate with respect to the first electric contact and may for example also translate with respect to the first electric contact. In embodiments where the second electric contact also translates with respect to the first electric contact the previously stated properties and features may hold analogously with the difference that the splitter plates are not necessarily radially aligned with respect to an axis of rotation.

[0046] In some embodiments multiple axis of rotation may be present, i.e. the first and second electric contact

may for example rotate piecewise with respect to each other with different axes of rotation for each piecewise rotational interval.

[0047] Having a distance between the trajectory of the second electric contact and the i -th splitter plate that is constant produces the effect that the electric arc is more uniformly guided in the space between adjacent splitter plates of the plurality of splitter plates and/or out of the region 230 for the transit of the second electric contact. All the splitter plates in the plurality 200 of splitter plates provide uniformly the same benefits. A more uniform upwards movement of the electric arc into the space between adjacent splitter plates is provided and each pair of splitter plates more uniformly contributes in attracting the arc.

[0048] Having a distance between the average initial position of the electric arc and the i -th splitter plate that is constant produces the effect that the electric arc is more uniformly guided in the space between adjacent splitter plates of the plurality of splitter plates and/or out of the region 230 for the transit of the second electric contact. All the splitter plates in the plurality 200 of splitter plates provide uniformly the same benefits. A uniform propagation and upwards movement and extinction of the electric arc is improved.

[0049] The non-parallel arrangement of the splitter plates further increases a voltage drop of the electric arc once split. When the electric arc 110 travels upwards, a distance between adjacent splitter plates that the electric arc must overcome increases over time. This improves a voltage drop along the electric arc facilitating an extinction of the electric arc 110.

[0050] The typical angle between adjacent splitter plates is between 1 and 10 degrees, depending on number of splitter plates. A number of 10-20 splitter plates may be present. The distance between splitter plates and contact may be 5-20 mm. The splitter plates are about 50x50x1.5. The application is for medium voltage (1-72 kV), in particular for a voltage from 12 kV to 36 kV. The gases can be air, CO₂/O₂, Airplus or even SF₆. The length increase with the radial distance ρ , instead of being always the same for parallel plates. A material for splitter plates may be ferromagnetic steel. The holder are any polymer, pmma, pa6, pbt. Interrupted currents may be load currents from 100 A to 2-4 kA.

[0051] The typical intervals between splitter plates are 1 to 10 mm with 1 to 40 splitter plates. The thickness of the splitter plates may be from 1 to 5 mm

[0052] FIG. 3A schematically shows a splitter plate 200-i, an insulating extension 506, inner leg insulation walls 502 and exterior side walls 500 according to the invention.

[0053] Each splitter plate 200-i of the plurality 200 of splitter plates is at least in part covered/enclosed by inner leg insulations walls 502 that cover at least in part the legs of the splitter plate in the region 230 for the transit of the second electric contact 104.

[0054] The splitter plate 200-i may be substantially "U"

shaped, with the legs of the splitter plate, i.e. the legs of the "U" directed towards the rotation axis z , 214 of the second electric contact.

[0055] In some embodiments wherein splitter plates 200-1, 200-2, ... have substantially a "U" shaped form, the top of the "U" being directed towards the rotation axis 122, z ; and the splitter plate holder 510 further includes exterior side walls 500 along the sides of the "U", inner leg insulating walls 502 covering legs of the "U", and an insulating extension 506 of the bottom of the "U" directed away from the rotation axis 122.

[0056] The inner leg insulating walls 502 may prevent that the electric arc attaches to legs of the splitter plate 200-i and/or to a region of the splitter plates characterized by low radial coordinates. An upper insulating extension 506 may extend radially outwardly, i.e. in the direction of increasing radial coordinate ρ . The insulating upper extension may allow a flow of gas to travel radially outwardly, but prevent a propagation of the electric arc, for example avoiding that the electric arc may bridge around the splitter plate 200-i, i.e. skip the splitter plate 200-i.

[0057] Furthermore exterior side walls 500 may be provided that extend orthogonally to the radial $Oz\rho$ plane containing the splitter plate 200-i and the rotation axis 122.

[0058] Therefore the exterior side walls 500 that are made of nonconductive material laterally enclose the space between adjacent splitter plates 200-i and 200-($i+1$) and/or between adjacent splitter plates 200-($i-1$) and 200-i. The insulating extension 506 extends in the plane $Oz\rho$ containing the rotation axis z of the second electric contact and a radial axis ρ perpendicular to z and passing through the splitter plate 200-i. The exterior side walls 500 extend substantially perpendicular to the insulating extension 506 and substantially parallel to the curved line 112 around which the region 116 is located where the electric arc 110 extends, or at least the exterior side walls include points at substantial distance from the plane $Oz\rho$.

[0059] The inner leg insulating walls 502 extend substantially parallel to the exterior side walls 500. The inner leg insulating walls 502 and the exterior side walls 500 extend in the space between adjacent splitter plates blocking a flow of gas in a direction parallel to the rotation axis z of the second electric contact. The insulating extensions 506 blocks the propagation of the electric arc, but does not block a flow of gas in a radial direction, i.e. along the radial axis ρ .

[0060] The inner leg insulating walls 502, the insulating extension 506 and the exterior side walls 500 are made of electrically insulating material, like for example plastic, ceramic, polymer, etc.

[0061] The material of the exterior side walls 500 and/or the inner leg insulating walls 502 and/or the insulating extension 506 may be non-conducting plastic, like for example POM, PTFE, PA6 and/or non-conducting ceramic, polymer, etc.

[0062] The inner leg insulating walls 502 may further

insulate/cover the bottom of the splitter plate legs, i.e. sides of the splitter plate legs facing towards the rotation axis of the second electric contact. In particular the inner leg insulating walls 502, extending substantially perpendicular to the splitter plates and covering the sides and the bottom of the legs of the splitter plates, may block any downward propagation of hot gas near the legs of the splitter plates and prevent the arc from attaching to the bottom of the splitter plate legs.

[0063] The inner leg insulating walls are used to prevent that hot gas present in the inter-splitter plate region propagates radially downwards, i.e. towards the rotation axis of the second electric contact, blocking any flow of gas near the legs of the splitter plates, in particular in the region between the legs of adjacent splitter plates.

[0064] FIG. 3B schematically shows a plurality of splitter plates and exterior side walls, inner leg insulating walls and insulating extensions according to some embodiment of the present disclosure.

[0065] In some embodiments of the present disclosure the splitter plate holder is a splitter plate holder 510 that may include side walls 500 and/or inner leg insulating walls 502 that may in particular cover legs of the splitter plates. In some embodiments an insulating extension 506 may extend radially outwardly to prevent a propagation of the electric arc, but allowing a radial flow of gas. In some embodiments, further splitter plate holder elements 700 may be configured to reinforce the side walls 500 and/or to keep the splitter plates in place. Therefore in some embodiments the splitter plate holder 510 may further include splitter plate holder elements 700 in particular for providing an improved mechanical stability.

[0066] The material of the splitter plate holder may be any insulating polymer or epoxy, for example Pmma, PBT, PTFE,... The splitter plates are usually ferromagnetic steel. The extension upwards 506 is between 1-20 mm.

[0067] The exterior side walls 500 may extend parallel to the the Oxy plane that contains the rotational trajectory of the second electric contact. Side walls on both sides of the splitter plates enclose the rotational trajectory of the second electric contact. For each splitter plate 200-i in the plurality 200 of splitter plates the insulating extension 506 extends orthogonally to said Oxy plane and parallel to the splitter plate.

[0068] Between each pair of adjacent splitter plates a space remains present not covered by plastic/insulating material. The exterior side walls 500 only extend on two extremities of the splitter plates and the insulating extension 506 does not or at least not fully cover the surface of the splitter plates. Therefore the surface of the splitter plate 200-i will face a corresponding surface of the splitter plate 200-(i+1) and/or 200-(i-1) without the presence of any plastic in-between and the electric arc 110 can still extend from the metallic surface of the splitter plate 200-i to a corresponding metallic surface of the splitter plate 200-(i+1) and/or 200-(i-1) without the presence of plastic. Therefore the exterior side walls 500 together with the

inner leg insulating walls 502 still allow a substantially upwards movement of the electric arc e.g. due to Lorentz forces and furthermore allow heated gas to escape radially outwardly as exemplarily shown by the flow of gas 520 for a pair of adjacent splitter plates. In particular the insulating extension 506 of the splitter plate 200-i allows the flow of gas 520.

[0069] The exterior side walls 500 prevent the electric arc from moving outside the space between adjacent splitter plates. The electric arc 110 cannot therefore move along the z axis in such a way to circumvent a splitter plate. For example the electric arc cannot pass directly from a surface of the splitter plate 200-(i-1) to a surface of a further distant splitter plate 200-(i+1) without intersecting and/or touching a surface of the intermediate splitter plate 200-i.

[0070] The exterior side walls 500 and/or the inner leg insulating walls 502 and/or the insulating extension 506 further prevent a flow of gas parallel to the z axis such that the gas can only flow radially outwardly as exemplarily illustrated by the flow of gas 520.

[0071] The presence of the inner leg insulating walls 502 of the splitter plate 200-i may guide the trajectory of the electric arc upwardly and may create a vortex of gas that is further beneficial to extinguish the electric arc.

[0072] The figures only exemplarily show the geometry of the splitter plates and/or of the exterior side walls and/or of the inner leg insulating walls and/or the insulating extension. In some embodiments different or alternative geometries may be present.

[0073] For example FIG. 3C schematically shows a splitter plate and angled exterior side walls, inner leg insulating walls and an insulating extension according to embodiments of the present disclosure.

[0074] The side walls 500 may be angled to form an angled surface 550 of the exterior side walls 500. The angled surface 550 may extend away from the rotation axis in order for example to provide a chimney effect that further improves the flow of gas in the region between adjacent splitter plates.

[0075] FIG. 3D schematically shows a substantially trapezoidal splitter plate, exterior side walls, inner leg insulating walls and an insulating extension according to embodiments of the present disclosure.

[0076] The splitter plate 200-i may have a different shape, for example a trapezoidal shape of the outer perimeter. For example one exterior side of the splitter plate 200-i may be angled following an angled segment 560 of the splitter plate 200-i converging to the distant exterior side wall 500 with increasing radial distance from the rotation axis. Therefore the splitter plate holder 200-i may be substantially trapezoidal. This may also further improve a flow of gas between splitter plates improving the extinction of the electric arc.

[0077] In embodiments of the present disclosure, the splitter plates are held in place by the exterior side walls and/or by a splitter plate holder and a direct contact between splitter plates is prevented.

[0078] The inner leg insulating walls 502 and the exterior side walls 500 may form a single body, for example a substantially rigid body. Also the splitter plate holder, the splitter plates and the first electric contact may form a substantially rigid body, whereas the second electric contact is e.g. rotatable with respect to the rigid body. The splitter plate holder is at least in part made of electrically insulating material to avoid an electric contact between different splitter plates.

[0079] The Figures from FIG. 3E to FIG. 3M show details of splitter plate holders according to embodiments of the present disclosure, in particular details of the exterior side walls and/or of the inner leg insulating walls and/or of the insulating extension.

[0080] FIG. 3E illustrates exterior side walls 500 of the splitter plate holder 510 laterally enclosing the splitter plate 200-i to allow a flow of gas 520 in increasing radial direction, i.e. in the direction of increasing radial coordinates ρ .

[0081] The side walls 500 force a flow of gas to flow in a substantially radial direction away from the rotation axis of the second electric contact, i.e. in the direction of the flow of gas 520, i.e. radially outwardly.

[0082] The flow of gas may be produced by the electric arc ionizing the gas and may be a flow of hot gas.

[0083] FIG. 3F shows the presence of an electrically insulating extension 506 extending radially outwardly. The insulating extension 506 blocks the electric arc 110 but may allow the flow 520 of hot gas.

[0084] FIG. 3G shows the insulating extension 506 partially overlapping with the splitter plate 200-i. The insulating extension 506 leaves at least in part a surface of the splitter plate 200-i uncovered in order to allow the electric arc to extend between conducting surfaces of adjacent splitter plates, i.e. between a conducting surface of the splitter plate 200-i and the adjacent splitter plate 200-(i+1) and/or 200-(i-1).

[0085] FIG. 3H shows that the inner leg insulating wall 502 may fill all the space surrounding a legs of the splitter plate 200-i or at least surrounding a portion of a legs of the splitter plate 200-i. In embodiments according to FIG. 5H, the inner leg insulating wall 502 therefore not only forms a wall parallel to the exterior side wall 500, but fills all the space in a region around a legs of the splitter plate 200-i and/or around an extremity of a leg of the splitter plate.

[0086] FIG. 3I shows inner leg insulating walls 502 of the splitter plate 200-i covering legs of the splitter plate 200-i. In FIG. 5I the inner leg insulating walls 502 covers a greater surface of the legs of the splitter plate 200-i than in FIG. 5H.

[0087] FIG. 3J show a substantially trapezoidal splitter plate 200-i and exterior side walls 500 substantially following the angled geometry of the sides of the splitter plate 200-i.

[0088] FIG. 3K shows exterior side walls 500 with an angled surfaces 550 facilitating the flow of gas 520 in a radial outward direction. The exterior side walls 500 with

the angled surfaces 550 facilitate in particular an outflow of hot gas, flowing radially outwardly from the spatial region 116 where the electric arc is present.

[0089] FIG. 3L shows exterior side walls 500 with a convergent profile to facilitate an inflow of gas towards the spatial region 116 where the electric arc is present. The flow of gas 520 is facilitated in a region closer to the rotation axis, i.e. an inflow of gas is facilitated towards the region where the electric arc extends, as schematically illustrated by the two arrows at the bottom of FIG. 3L.

[0090] FIG. 3M shows exterior side walls 500 with a convergent-divergent profile combining the benefits of the side walls illustrated in FIG. 3K with the benefits of the side walls illustrated in FIG. 3L. The convergent divergent profile of the exterior side walls 500 of FIG. 3M facilitates both an inflow and an outflow of hot gas.

[0091] FIG. 4 schematically shows a gas insulated switch with a plurality of splitter plates 200 and a splitter plate holder 300 according to some embodiments of the present disclosure. The gas insulated switch may be in particular configured to interrupt an AC current in a medium voltage electric circuit.

[0092] The splitter plate holder 300 is configured to reciprocally electrically insulate adjacent splitter plate holders. The splitter plate holder 300 is only schematically shown and may correspond to the splitter plate holder 510 including for example exterior side walls 500 of electrically insulating material.

[0093] The plurality 200 of splitter plates 200-1, 200-2, ..., 200-i, ... may be supported by a splitter plate holder 300, for example corresponding to the splitter plate holder 510.

[0094] In some embodiments the splitter plate holder 300 may have the form of a circular arc.

[0095] In some embodiments the splitter plate holder (300, 510) has substantially the form of a circular arc.

[0096] In some embodiments the radius of the circular arc is greater than a maximal radial distance of the second electric contact from the rotation axis (122, z).

[0097] In some embodiments the radius of the circular arc is smaller than a maximal radial distance of the second electric contact from the rotation axis (122, z).

[0098] The maximal radial distance of the second electric contact from the rotation axis is a maximal radial distance of material points forming the second electric contact from the rotation axis, for example a distance of a tip of the second electric contact from the rotation axis. Said distance is time invariant and constant when the second electric contact rotates.

[0099] In some embodiments, as exemplarily shown in FIG. 4, the splitter plate holder 300 has substantially the form of a circular arc. The radius of the circular arc may be smaller than a maximal radial distance of the second electric contact from the rotation axis z.

[0100] In some embodiments, as exemplarily shown in FIG. 5, the splitter plate holder 300 has substantially the form of a circular arc. The radius of the circular arc may be greater than a radial distance of the second elec-

tric contact from the rotation axis (122, z).

[0101] The splitter plate holder 300 may have the form of a circular arc and is made at least in part of electrically insulating material. The radius of the circular arc formed by the splitter plate holder 300 is greater than the tip of the second electric contact 104 and therefore greater than a radial distance of the second electric contact from the rotation axis z.

[0102] The splitter plate holder may further be fixed to the first electric contact 102. The first electric contact 102, the splitter plate holder 300 and the splitter plates in the plurality 200 of splitter plates may form therefore a unity and/or may be configured to be a rigid body.

[0103] The splitter plate holder 300 may be formed at least in part by electrically insulating material in order to mutually electrically insulate each pair of splitter plates in the plurality 200 of splitter plates. The splitter plate holder may be at least in part of plastic material.

[0104] In yet other embodiments the splitter plates may be located along any circular arc at a radial distance ρ from the rotation axis 122.

[0105] The splitter plate holder 300, for example corresponding to the splitter plate holder 510, may in particular include exterior side walls 500 configured to laterally enclose at least in part a spatial region 116 where the electric arc 110 may extend.

[0106] FIG. 6 FIG. 6 schematically shows a gas insulated switch with a plurality of splitter plates, exterior side walls, inner leg insulating walls, and an insulating extension according to some embodiments of the present disclosure.

[0107] . The exterior side walls 500 may be fixed with the first electric contact 102. The first electric contact 102, the exterior side walls 500, the inner leg insulating walls 502 and the splitter plates 200-1, 200-2, ..., 200-i, ... of the plurality 200 of splitter plates may therefore form a rigid body that includes the insulating extension 506

[0108] When the second electric contact 104 rotates with respect to the first electric contact 102, the electric arc 110 around the curved line 112 substantially located in the region 230 travels substantially upwards in a direction of increasing radial coordinate ρ . The splitter plate holder 510 may be located substantially vertically above the rotation axis of the second electric contact and fixes to the first electric contact.

[0109] The electric arc becomes trapped between adjacent metallic surfaces of the splitter plates, i.e. between surfaces not covered by plastic/insulators, without the possibility of escaping sideways as a consequence of the presence of the exterior side walls 500. The hot and/or ionized gas produced by the electric arc flows also substantially upwards in a direction of increasing radial ρ coordinates away from the rotation axis, for example parallel to the flow of gas 520.

[0110] The inner leg insulating walls 520 may prevent that the electric arc 110 attaches to the bottom of the legs of the splitter plates and/or to the legs of the splitter plates.

[0111] FIG. 6A further shows that the splitter plate hold-

er may be reinforced by one or more splitter plate holder elements 700.

[0112] FIG. 7 schematically shows a gas insulated switch with a plurality of splitter plates, exterior side walls 500, inner leg insulating walls 502 and an insulating extension 506 according to some embodiments of the present disclosure. The embodiment illustrated in FIG. 7 may form an alternative embodiment where the splitter plates in the plurality 200 of splitter plates are substantially parallel to each other.

[0113] In embodiments of the present disclosure the inner leg insulating walls 502 may also insulate the extremities of the legs of the splitter plates, in particular the extremities of the legs towards the rotation axis of the second electric contact.

[0114] The splitter plate holder 510 may include side walls 500, inner leg insulating walls 502, and insulating extensions 506.

[0115] The embodiment schematically illustrated in FIG. 7 is similar to the embodiment schematically illustrated in FIG. 6, but the splitter plates 200-1, 200-2, ..., 200-i, ... are substantially parallel.

[0116] The splitter plate holder 510 may be fixed to the first electric contact 102.

[0117] The splitter plate holder 510 of FIG. 7 that includes the exterior side walls 500 and the inner leg insulating walls 502 may hold the splitter plates 200-1, 200-2, ..., 200-i, ... in the plurality 200 of splitter plates parallel to each other, for example parallel to each other and extending substantially vertically. For example each splitter plate in the plurality 200 of splitter plates may extend in parallel to the force of gravity.

[0118] In yet other embodiments the splitter plates in the plurality of splitter plates may have a different geometry.

[0119] For example a splitter plate holder 510 may hold the splitter plates 200-1, 200-2, ..., 200-i, ... in the plurality of splitter plates 200 substantially parallel to each other and vertically aligned, but the splitter plates may have a varying geometry. For example, if the splitter plate holder is fixed to the first electric contact 102, splitter plates further away from the first electric contact 102 may have increased vertical extension, in order to better follow the trajectory of the second electric contact 104, for example in order to have a constant distance from the second electric contact 104.

[0120] In yet alternative embodiments the splitter plates of the plurality 200 of splitter plates may be arranged substantially parallel to each other in such a way that the distance of each splitter plate from the curved line 112 around which the electric arc extends is still substantially constant.

[0121] Therefore FIG. 7 only exemplarily shows one embodiment in which the splitter plates in the plurality 200 of splitter plates are arranged substantially in parallel to each other. For example each splitter plate 200-i may extend in parallel to an axis y, for example in a plane parallel to a plane Ozy spanned by the axis y and by the

axis z of rotation of the second electric contact 104, wherein the axis y may be substantially parallel to the second electric contact when the second electric contact is in contact with the first electric contact.

[0122] In FIG. 7 each splitter plate 200-i has substantially the same geometry and substantially the same distance from the axis x, the axis x being perpendicular to the axis of rotation z of the second electric contact 104 and to the axis y. In alternative embodiments different splitter plates 200-i and 200-(i+1) may have a different extension, for example a different extension along the y axis, and/or being positioned at a different distance from the axis x.

[0123] Therefore according to embodiments of the present disclosure, the splitter plates may be substantially parallel to each other and arranged in a variety of positions. The splitter plates may be held in place by the splitter plate holder 510 with side walls 500 and with the inner leg insulating walls 502. The splitter plate holder 510 may also hold the insulating extensions 506. The side walls may be further reinforced by reinforcing elements to improve mechanical stability.

[0124] The splitter plate holder 510 supporting a plurality 200 of substantially parallel splitter plates may be fixed to the first electric contact.

[0125] Parallel splitter plates, as shown for example in FIG. 7 may extend substantially vertically or at least parallel to a vector with a vertical component.

[0126] In embodiments where the splitter plate holder 510 has a curved geometry with exterior side walls 500 forming side covers, which also hold the splitter plates 200-1, 200-2, ..., 200-i, ..., the splitter plate holder forms an arrangement that leads to a better cooling of the electric arc 110, a better interaction of the electric arc 110 with the splitter plates and to a better control of the arc movement between the splitter plates. The arrangement experimentally leads to a significant improvement in the interruption performance both in air and CO₂/O₂ and/or Airplus and/or SF₆ as a background gas.

[0127] According to some embodiments of the present disclosure, the splitter plates are arranged on curved splitter plate holder 510, that follow the trajectory of the moving contact, for example of the second electric contact 104 such that a constant distance between the moving contact 104 and the splitter plates 200-1, 200-2, ..., 200-i, ... throughout the travel of the moving contact 104 is maintained. According to embodiments of the present disclosure, various approaches can be implemented to hold the splitter plates. In some embodiments the splitter plates are held from the top, i.e. radially distant from the rotation axis. In some embodiments the splitter plates are held from the bottom, i.e. close to the rotation axis. In some embodiments the splitter plates may be held from the side.

[0128] According to embodiments of the present disclosure, the distance between the moving contact, for example the second electric contact 104, and the splitter plates is kept constant for all splitter plates 200-1,

200-2, ..., 200-i, All the splitter plates in the plurality 200 interact with the electric arc 110 and participate effectively to its cooling.

[0129] In some embodiments, the use of the curved splitter plate holder with splitter plates leads to a constant distance between the splitter plates and the moving contact. With this geometry, the distance between the splitter plates and the moving contact is maintained constant for the entire travel of the moving contact.

[0130] As a further consequence of such an arrangement, according to some embodiments, two successive splitter plates 200-i and 200-(i+1) and/or 200-(i-1) and 200-i form a divergent geometry, i.e. with increasing radial coordinate ρ a point located on the surface of a splitter plate 200-i becomes more distant from the adjacent splitter plate 200-(i+1) and/or 200-(i-1). This arrangement leads to a better cooling of the arc and also prevents the arc from moving sideways and bridge along the edges of the splitter plates.

[0131] According to some embodiments of the present disclosure, all the splitter plates interact with the electric arc as the distance between the arc and the splitter plates is maintained constant. The distance between the splitter plates and the moving contact may remain the same even if the number of splitter plates is increased. As a direct consequence of the higher number of splitter plates, the current interruption performance is augmented.

[0132] Beneficial effects have been assessed experimentally.

[0133] According to some embodiments of the present invention, a stabilization of the flow pattern and of the arc inside the splitter plate pack is obtained. The mixing at zero current is increased. Non-conducting side walls 500 along the splitter plate pack are present and also the legs of the splitter plate are surrounded with the same non-conducting material, for example plastic. The sidewalls, for example the side walls 500, are also used as a holder for the splitter plates.

[0134] A gas insulated switches according to the present disclosure may include a knife contact that swivels through a splitter plate arrangement during a current breaking operation. The ferromagnetic properties of the splitter plates in the plurality 200 of splitter plates attracts the electric arc 110, which enters the splitter plate pack formed by the plurality of splitter plates.

[0135] When the splitter plates are only held at the top and no side walls are present, the electric arc can move outside of the splitter plate pack. The arc may burn on the side of the splitter plates and may short circuit many splitter plates and therefore the current may fail to interrupt. The failure is observed in particular when a gas different from SF₆ is present between the splitter plates. Without the side walls 500 of the present disclosure, the gas is poorly mixed in particular at zero current. The hot gas flows out in upwards, side-ways, as for example parallel to rotation axis, and downwards direction, flowing in all directions from the central arcing region. A large flow cross section leads to lower flow velocity. The gas can

flow in all directions, for example in particular parallel to the rotation axis, and there is therefore no specific direction for the flow. The exterior side walls 500 of some embodiments of the present disclosure align the gas flow in a radial direction, for example parallel to the ρ axis as exemplarily illustrated by the flow of gas 520. The flow flows in one direction and away from the hot arcing region.

[0136] For example, a splitter plate holder, that is held from the fix contact side, for example the side of the first electric contact 102, having a plastic part that blocks the arc from moving upwards, may allow the electric arc to burn the plastic, which produces hot gas that is pushed back between the two contacts.

[0137] With side covers around the splitter plates a set of benefits is achieved.

[0138] For example with the exterior side walls 500 as side covers according to the present disclosure no obstruction of the arc is produced and hot gases move upwards and away from the arcing region. The sidewalls 500 may further act as a holder for the splitter plate pack 200. The presence of the side walls 500 prevents the arc to burn along the edges of the splitter plates. The inner surfaces of the side-walls also have groves in them to prevent the splitter plate to bend and touch each other. This prevents the arc from bridging along the edge of the splitter plates which may otherwise lead to failed interruption of the electric current.

[0139] The presence of side walls helps to cool the arc in multiple ways. Different mechanism improve a cooling of the arc in the presence of side-walls according to the present disclosure.

[0140] With the presence of side walls, the flow is blocked in the direction of the z axis and the flow can only pass through the top, top which is left open to increase the outlets. In embodiments of the present disclosure, the flow is constantly going from the contact area and through the splitter plates. A chimney effect is created with a defined flow pattern inside the splitter plate pack. Furthermore a vortex is created to increase the mixing at zero current.

[0141] The legs of the splitter plates may be surrounded by a wall. There are no outlets at the bottom of the legs of the splitter plates and therefore the flow is reflected to the center creating a vortex. If the arc goes to the legs of the splitter plates, a pressure builds up which will take place for example in the region 230 and at zero current the arc will be pushed back to the center of the splitter plate 200-i.

[0142] At the top of the sidewalls 500, the plastic may detach from the splitter plates with a 60° angle in order to create an outlet that disperse the hot gas forming an angled surface 550.

[0143] In some embodiments one exterior side wall 500 may be at least partially oblique corresponding to an angled segment 560 of the splitter plate 200-i, with an angle of for example 60° or 40° with respect to a segment having constant radial distance from the rotation axis

122. The insulating extension 506 may be smaller than the lower part of the splitter plate, the insulating extension 506 being located substantially radially outwardly and further away from the rotation axis. Accordingly also the splitter plate 200-i may have a substantially trapezoidal shape with a bigger extension closer to the rotation axis. In other embodiments the angled segment 560 of the splitter plate 200-i may form an angle of 60° or of 40° with respect to a segment perpendicular to the rotation axis 122 extending radially away from the rotation axis and intersecting the splitter plate 200-i. In yet other embodiment the angle may be different. The angle may facilitate a vortex of the hot gas.

[0144] The upper part of the exterior side walls 500 may also be angled, for example with an angle of 60° with respect to a segment having constant radial coordinate, forming angled surfaces 550, the angle extending away from the region 230 for the transit of the second electric contact in order to create an outlet that better disperse the hot gas, for example facilitating a chimney effect that disperses the gas substantially radially away from the rotation axis 122. In other embodiments the angled surfaces 550 may form an angle of 60° or of 40° with a radial axis perpendicular to the rotation axis and intersecting the splitter plate 200-i, such that the angled surfaces 550 extend outwardly away from the region 230 for the transit of the second electric contact. The angle may facilitate a chimney effect to disperse the hot gas substantially vertically upwardly and/or radially away from the rotation axis.

[0145] The side walls 500 of the present disclosure are designed to match perfectly the splitter plates 200-i on the lower part leaving only the place for the arc to enter the splitter plate. The top is left open. The sidewalls 500 may serve as a holder for the splitter plate and are attached to the fix contact 102 on the side. In this way the arc does not burn against any plastic part. The material of the sidewalls may be non-conducting plastic, like for example POM, PTFE, Pa6.

[0146] Embodiments of the present disclosure may have sidewalls for producing a chimney effect and to prevent arc bridging along the edges of the splitter plates. The splitter plates may be held at the bottom, with the outlet at the top far away from the contact. The bottom may be for example characterized by low radial coordinates ρ whereas the top is characterized by higher radial coordinates. An angle at the top of the plastic outlet may make it harder for the arc to attach and short circuit.

[0147] The legs of the splitter plates may be surrounded by plastic and in this way a vortex is created.

[0148] Groves to hold the splitter plates prevent the splitter plates to touch each other.

[0149] An attachment of the splitter plate holder on the side of the fix contact, for example on the sides of the first electric contact 102, prevents the arc from burning nearby plastic.

[0150] Embodiments of the present disclosure provide a medium voltage gas insulated switch 100 comprising

a first electric contact 102; and a second electric contact 104 that is moveable with respect to the first electric contact and a plurality 200 of splitter plates 200-1, 200-2, ... configured to interrupt an electric arc 110 between the first electric contact 102 and the second electric contact 104 during the switching operation of the switch; a splitter plate holder 510 that holds the plurality of splitter plates; some of which are ferromagnetic; exterior side walls 500 of the splitter plate holder 510; wherein the splitter plate holder electrically insulates different splitter plates in the plurality of splitter plates; and wherein the exterior side walls 500 of the splitter plate holder 510 are configured to block a flow of gas perpendicular to the side walls and to prevent a bridging of the electric arc 110 around splitter plates 200-1, 200-2, ... in the plurality 200 of splitter plates; and wherein the exterior side walls 500 are further configured to facilitate an evacuation of a hot gas by directing a flow of the hot gas in a direction parallel to the exterior side walls.

[0151] The evacuation of the hot gas is also facilitated by the presence of the side walls leaving open an upper area such that the gas can escape, like exemplarily illustrated by the flow 520.

[0152] The hot gas may be produced by the electric arc, e.g. by the electric arc ionizing the gas of the gas insulated switch.

[0153] In some embodiments, the medium voltage gas insulated switch may further include an extension of the splitter plates configured to prevent bridging of the electric arc around a side of a splitter plate extending between the exterior side walls.

[0154] The extension may be for example the insulating extension 506 that extends the splitter plate 200-i, formed at least in part by electrically insulating material.

[0155] In some embodiments, the splitter plates are provided with two legs and a leg cover that covers the legs of the splitter plates to prevent a bridging of the arc around the legs of a splitter plate. For example the cover may be formed by the inner leg insulating walls 502 that cover the legs of the generic splitter plate 200-i.

[0156] The exterior side walls (500) of the splitter plate holder (510) may be configured to block a side flow of gas and to prevent a bridging of the electric arc (110) around the splitter plates (200-1, 200-2, ...).

[0157] For example the exterior side walls 500 may prevent a bridging of the electric arc 110 from splitter plate 200-(i-1) to splitter plate 200-(i+1) bypassing the splitter plate 200-i in the plurality 200 of splitter plates.

[0158] The insulating extension 506 may not block a flow of gas 520, but may block a propagation of the electric arc 110.

[0159] The switch may operate in a background gas, in particular in air or in a CO_2/O_2 mixture or in SF_6 .

[0160] In some embodiments, the exterior side walls have a divergent profile to enhance the characteristics of the flow of the hot gas.

[0161] In some embodiments, the exterior side walls have a convergent-divergent inner profile to enhance the

characteristics of the flow of hot gas.

[0162] In some embodiments the medium voltage gas insulated switch further includes a casing that encloses the first electric contact, the second electric contact and the splitter plate holder containing an electrically insulating gas; and the splitter plate holder is substantially suspended and configured to prevent a current flowing on a surface of the casing of the medium voltage gas insulated switch, in particular wherein the splitter plate holder is fixed to the first electric contact.

[0163] In some embodiments, the electrically insulating gas does not include SF_6 and/or the electrically insulating gas comprises at least one gas component selected from the group consisting of CO_2 , O_2 , N_2 , H_2 , air, N_2O , a hydrocarbon, in particular CH_4 , a perfluorinated or partially hydrogenated organofluorine compound, and mixtures thereof or wherein the insulation gas comprises a background gas, in particular selected from the group consisting of CO_2 , O_2 , N_2 , H_2 , air, in a mixture with an organofluorine compound selected from the group consisting of fluoroether, oxirane, fluoramine, fluoroketone, fluoroolefin, fluoronitrile, and mixtures and/or decomposition products thereof.

[0164] The splitter plate holder 510 may not move with respect to the first electric contact (102).

[0165] In some embodiments, as exemplarily illustrated by FIG. 6, at least a part of the plurality 200 of splitter plates 200-1, 200-2, ... may be arranged in a non-parallel manner to each other.

[0166] In some embodiments, as exemplarily illustrated by FIG. 7, the splitter plates 200-1, 200-2, ... in the plurality 200 of splitter plates may be arranged substantially parallel to each other.

[0167] The second electric contact 104 may be rotatable with respect to the first electric contact 102 around a rotational axis 122, z of the second electric contact 104, the second electric contact 104 being configured to rotate away from the first electric contact 102 around the rotational axis 122, z during a switching operation for interrupting a current flow between the electric contacts.

[0168] In some embodiments, at least a portion of the splitter plates are ferromagnetic and configured to attract the electric arc (110) by Lorentz force, in particular where all the splitter plates are ferromagnetic or ferromagnetic splitter plates alternate with non-ferromagnetic splitter plates.

[0169] In some embodiments, each splitter plate of the plurality of splitter plates may lie in a plane containing the rotational axis 122, z of the second electric contact such that a radial distance between each splitter plate of the plurality of splitter plates and the rotational axis may be substantially constant.

[0170] In some embodiments, the splitter plate holder (300, 510) has substantially the form of a circular arc.

[0171] The gas insulated switch may be configured such that during the switching operation electrons of the electric arc 110 between the first electric contact 102 and the second electric contact 104 are attracted in a space

between adjacent splitter plates by a force acting substantially radially 212 with respect to the rotational axis 122, z of the second electric contact 104, the force moving the electrons away from the rotational axis 122, z;

[0172] In some embodiments, the splitter plate holder (300, 510) is fixed with respect to the first electric contact 102 and for each splitter plate 200-i in the plurality 200 of splitter plates a distance between a trajectory of the moveable second electric contact 104 and the splitter plate 200-i is substantially constant.

[0173] The splitter plates may be ferromagnetic and configured to attract the electric arc 110 by Lorentz force.

[0174] In some embodiments, the splitter plate holder 300, 510 may have substantially the form of a circular arc.

[0175] For example, FIG. 5 and FIG. 4 exemplarily show splitter plate holders 300 having the form of a circular arc.

[0176] For example, as shown in FIG. 7 the splitter plate holder 510 may extend substantially along the x axis having an extension forming a segment substantially parallel to the x axis. The splitter plate holder 510 of FIG. 7 in particular includes the exterior side walls 500, inner leg insulating walls 502 and includes upper extensions 506 of the splitter plates.

[0177] In some embodiments splitter plates arranged in a non-parallel manner to each other are configured such that the electric arc during a switching operation travels radially away from the rotational axis (122) and the gas insulated switch is further configured such that a length of the electric arc between adjacent splitter plates increases during the switching operation.

[0178] In some embodiments, the splitter plates of the plurality of splitter plates are aligned along a curved line, in particular along a circular arc.

[0179] In some embodiments, the splitter plates of the plurality of splitter plates are aligned along a straight line.

[0180] Embodiments of the present disclosure provide an improved gas insulated switch, which facilitates the extinction of the electric arc during a circuit breaking operation, for example increasing a resistance of the electric arc and/or a distance of the electric arc due e.g. to a nonparallel arrangement of the splitter plates and/or preventing a bridging of the arc and/or improving a flow of gas in order for example to create a vortex that facilitates the extinction of the arc.

[0181] In embodiments of the present disclosure the electric arc 110 is kept in the space between adjacent splitter plates by side walls 500. An improved extinction of the electric arc is therefore provided.

Claims

1. A medium voltage gas insulated switch (100) comprising

a first electric contact (102);

and a second electric contact (104) that is moveable with respect to the first electric contact and a plurality (200) of splitter plates (200-1, 200-2, ...) configured to interrupt an electric arc (110) between the first electric contact (102) and the second electric contact (104) during the switching operation of the switch;

a splitter plate holder (510) that holds the plurality of splitter plates; some of which are ferromagnetic;

exterior side walls (500) of the splitter plate holder (510);

wherein the splitter plate holder electrically insulates different splitter plates in the plurality of splitter plates;

and wherein the exterior side walls (500) of the splitter plate holder (510) are configured to block a flow of gas perpendicular to the side walls and to prevent a bridging of the electric arc (110) around splitter plates (200-1, 200-2, ...) in the plurality (200) of splitter plates;

and wherein the exterior side walls (500) are further configured to facilitate an evacuation of a hot gas by directing a flow of the hot gas in a direction parallel to the exterior side walls;

and wherein the splitter plates are provided with two legs and wherein inner leg insulating walls (502) are configured to cover the legs of the splitter plates to prevent a bridging of the arc around the leg of a splitter plate;

characterised in that the medium voltage gas insulated switch further comprises an insulating extension (506) of the splitter plates configured to prevent bridging of the electric arc around a side of a splitter plate extending between the exterior side walls.

2. The medium voltage gas insulated switch of claim 1, wherein the exterior side walls have a divergent profile to enhance the characteristics of the flow of the hot gas.

3. The medium voltage gas insulated switch of claim 1, wherein the exterior side walls have a convergent-divergent inner profile to enhance the characteristics of the flow of hot gas.

4. The medium voltage gas insulated switch of any of claims from 1 to 3, further comprising a casing that encloses the first electric contact, the second electric contact and the splitter plate holder containing an electrically insulating gas; and wherein the splitter plate holder is substantially suspended and configured to prevent a current flowing on a surface of the casing of the medium voltage gas insulated switch, in particular wherein the splitter plate holder is fixed to the first electric contact.

5. The medium voltage gas insulated switch of claim 4, wherein the electrically insulating gas does not include SF₆ and/or wherein the electrically insulating gas comprises at least one gas component selected from the group consisting of CO₂, O₂, N₂, H₂, air, N₂O, a hydrocarbon, in particular CH₄, a perfluorinated or partially hydrogenated organofluorine compound, and mixtures thereof or wherein the insulation gas comprises a background gas, in particular selected from the group consisting of CO₂, O₂, N₂, H₂, air, in a mixture with an organofluorine compound selected from the group consisting of: fluoroether, oxirane, fluoramine, fluoroketone, fluoroolefin, fluoronitrile, and mixtures and/or decomposition products thereof. 5
6. The medium voltage gas insulated switch of any of claims from 1 to 5, wherein the splitter plate holder (510) does not move with respect to the first electric contact (102). 10
7. The medium voltage gas insulated switch of any of claims from 1 to 6 wherein at least a part of the plurality (200) of splitter plates (200-1, 200-2, ...) is arranged in a non-parallel manner to each other. 15
8. The medium voltage gas insulated switch of any of claims from 1 to 6 wherein the splitter plates (200-1, 200-2, ...) in the plurality (200) of splitter plates are arranged substantially parallel to each other. 20
9. The medium voltage gas insulated switch of any of claims from 1 to 8, wherein at least a portion of the splitter plates are ferromagnetic and configured to attract the electric arc (110) by Lorentz force, in particular where all the splitter plates are ferromagnetic or ferromagnetic splitter plates alternate with non-ferromagnetic splitter plates. 25
10. The medium voltage gas insulated switch of any of claims from 1 to 9 wherein the splitter plate holder (510) has substantially the form of a circular arc. 30
11. The medium voltage gas insulated switch of any of claims from 1 to 10 wherein the splitter plate holder (510) is fixed with respect to the first electric contact (102) and wherein for each splitter plate (200-i) in the plurality (200) of splitter plates a distance between a trajectory of the moveable second electric contact (104) and the splitter plate (200-i) is substantially constant. 35
12. The medium voltage gas insulated switch of any of claims from 1 to 11, wherein the splitter plates of the plurality of splitter plates are aligned along a curved line, in particular along a circular arc. 40
13. The medium voltage gas insulated switch of any of 45

claims from 1 to 11, wherein the splitter plates of the plurality of splitter plates are aligned along a straight line.

Patentansprüche

1. Gasisolierter Mittelspannungsschalter (100), Folgendes umfassend

einen ersten elektrischen Kontakt (102);
und einen zweiten elektrischen Kontakt (104),
der in Bezug auf den ersten elektrischen Kontakt beweglich ist, und eine Vielzahl (200) von Teilerplatten (200-1, 200-2, ...), die eingerichtet sind, um einen Lichtbogen (110) zwischen dem ersten elektrischen Kontakt (102) und dem zweiten elektrischen Kontakt (104) während der Schaltoperation des Schalters zu unterbrechen; einen Teilerplattenhalter (510), der die Vielzahl von Teilerplatten hält; von denen einige ferromagnetisch sind;
Außenseitenwände (500) des Teilerplattenhalters (510); wobei der Teilerplattenhalter verschiedene Teilerplatten in der Vielzahl von Teilerplatten elektrisch isoliert;
und wobei die Außenseitenwände (500) des Teilerplattenhalters (510) eingerichtet sind, um einen Gasstrom senkrecht zu den Seitenwänden zu blockieren und eine Überbrückung des Lichtbogens (110) um Teilerplatten (200-1, 200-2, ...) in der Vielzahl (200) von Teilerplatten herum zu verhindern;
und wobei die Außenseitenwände (500) ferner eingerichtet sind, um eine Evakuierung eines heißen Gases zu erleichtern, indem eine Strömung des heißen Gases in eine Richtung parallel zu den Außenseitenwänden gelenkt wird; und wobei die Teilerplatten mit zwei Schenkeln versehen sind und wobei innere Schenkelsolierwände (502) eingerichtet sind, um die Schenkel der Teilerplatten zu bedecken, um eine Überbrückung des Lichtbogens um den Schenkel einer Teilerplatte herum zu verhindern;
dadurch gekennzeichnet, dass der gasisolierte Mittelspannungsschalter ferner eine isolierende Verlängerung (506) der Teilerplatten umfasst, die eingerichtet ist, um eine Überbrückung des Lichtbogens um eine Seite einer Teilerplatte herum zu verhindern, die sich zwischen den Außenseitenwänden erstreckt.

2. Gasisolierter Mittelspannungsschalter nach Anspruch 1, wobei die Außenseitenwände ein divergentes Profil aufweisen, um die Strömungseigenschaften des heißen Gases zu verbessern.

3. Gasisolierter Mittelspannungsschalter nach An-

spruch 1, wobei die Außenseitenwände ein konvergent-divergentes Innenprofil aufweisen, um die Strömungseigenschaften von heißem Gas zu verbessern.

4. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 3, ferner ein Gehäuse umfassend, das den ersten elektrischen Kontakt, den zweiten elektrischen Kontakt und den Teilerplattenhalter umschließt und das ein elektrisch isolierendes Gas enthält; und wobei der Teilerplattenhalter im Wesentlichen hängend ist und eingerichtet ist, um zu verhindern, dass ein Strom auf einer Oberfläche des Gehäuses des gasisolierten Mittelspannungsschalters fließt, wobei der Teilerplattenhalter insbesondere an dem ersten elektrischen Kontakt befestigt ist. 5
5. Gasisolierter Mittelspannungsschalter nach Anspruch 4, wobei das elektrisch isolierende Gas kein SF_6 umfasst und/oder wobei das elektrisch isolierende Gas mindestens eine Gaskomponente umfasst, die aus der Gruppe ausgewählt ist, bestehend aus CO_2 , O_2 , N_2 , H_2 , Luft, N_2O , einem Kohlenwasserstoff, insbesondere CH_4 , einer perfluorierten oder teilweise hydrierten Organofluor-Verbindung und Mischungen davon, oder wobei das Isolationsgas ein Hintergrundgas, das insbesondere aus der Gruppe ausgewählt ist, bestehend aus CO_2 , O_2 , N_2 , H_2 , Luft, in einer Mischung mit einer Organofluor-Verbindung umfasst, die aus der Gruppe ausgewählt ist, bestehend aus: Fluorether, Oxiran, Fluoramin, Fluorketon, Fluorolefin, Fluornitril und Mischungen und/oder Zersetzungsprodukten davon. 10
6. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 5, wobei sich der Teilerplattenhalter (510) in Bezug auf den ersten elektrischen Kontakt (102) nicht bewegt. 15
7. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 6, wobei mindestens ein Teil der Vielzahl (200) von Teilerplatten (200-1, 200-2, ...) in einer nicht parallelen Weise zueinander angeordnet ist. 20
8. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 6, wobei die Teilerplatten (200-1, 200-2, ...) in der Vielzahl (200) von Teilerplatten im Wesentlichen parallel zueinander angeordnet sind. 25
9. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 8, wobei mindestens ein Abschnitt der Teilerplatten ferromagnetisch ist und eingerichtet ist, um den Lichtbogen (110) durch Lorentzkraft anzuziehen, wobei insbesondere alle Teilerplatten ferromagnetisch sind oder ferromagnetische Teilerplatten mit nicht ferromagnetischen Tei- 30

lerplatten abwechseln.

10. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 9, wobei der Teilerplattenhalter (510) im Wesentlichen die Form eines Kreisbogens aufweist. 35
11. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 10, wobei der Teilerplattenhalter (510) in Bezug auf den ersten elektrischen Kontakt (102) fixiert ist und wobei für jede Teilerplatte (200-i) in der Vielzahl (200) von Teilerplatten ein Abstand zwischen einer Trajektorie des beweglichen zweiten elektrischen Kontakts (104) und der Teilerplatte (200-i) im Wesentlichen konstant ist. 40
12. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 11, wobei die Teilerplatten der Vielzahl von Teilerplatten entlang einer gekrümmten Linie, insbesondere entlang eines Kreisbogens, ausgerichtet sind. 45
13. Gasisolierter Mittelspannungsschalter nach einem der Ansprüche 1 bis 11, wobei die Teilerplatten der Vielzahl von Teilerplatten entlang einer geraden Linie ausgerichtet sind. 50

Revendications

1. Commutateur moyenne tension isolé au gaz (100) comprenant 55
 - un premier contact électrique (102) ;
 - et un deuxième contact électrique (104) qui est mobile par rapport au premier contact électrique et une pluralité (200) de plaques de séparation (200-1, 200-2, ...) configurées pour interrompre un arc électrique (110) entre le premier contact électrique (102) et le deuxième contact électrique (104) pendant l'opération de commutation du commutateur ;
 - un support de plaques de séparation (510) qui supporte la pluralité de plaques de séparation, dont certaines sont ferromagnétiques ;
 - des parois latérales extérieures (500) du support de plaques de séparation (510) ;
 - dans lequel le support de plaques de séparation isole électriquement différentes plaques de séparation dans la pluralité de plaques de séparation ;
 - et dans lequel les parois latérales extérieures (500) du support de plaques de séparation (510) sont configurées pour bloquer un écoulement de gaz perpendiculaire aux parois latérales et pour empêcher un pontage de l'arc électrique (110) autour de plaques de séparation (200-1, 200-2, ...) dans la pluralité (200) de plaques de

- séparation ;
 et dans lequel les parois latérales extérieures (500) sont également configurées pour faciliter l'évacuation d'un gaz chaud en dirigeant un écoulement du gaz chaud dans une direction parallèle aux parois latérales extérieures ;
 et dans lequel les plaques de séparation sont pourvues de deux branches et dans lequel des parois isolantes de branche intérieure (502) sont configurées pour recouvrir les branches des plaques de séparation pour empêcher un pontage de l'arc autour de la branche d'une plaque de séparation ;
caractérisé en ce que le commutateur moyenne tension isolé au gaz comprend en outre un prolongement isolant (506) des plaques de séparation configuré pour empêcher un pontage de l'arc électrique autour d'un côté d'une plaque de séparation s'étendant entre les parois latérales extérieures.
2. Commutateur moyenne tension isolé au gaz selon la revendication 1, dans lequel les parois latérales extérieures ont un profil divergent pour améliorer les caractéristiques de l'écoulement du gaz chaud.
 3. Commutateur moyenne tension isolé au gaz selon la revendication 1, dans lequel les parois latérales extérieures ont un profil intérieur convergent-divergent pour améliorer les caractéristiques de l'écoulement du gaz chaud.
 4. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 3, comprenant en outre un boîtier qui renferme le premier contact électrique, le deuxième contact électrique et le support de plaques de séparation contenant un gaz électriquement isolant ; et dans lequel le support de plaques de séparation est sensiblement suspendu et configuré pour empêcher une circulation de courant sur une surface du boîtier du commutateur moyenne tension isolé au gaz, en particulier dans lequel le support de plaques de séparation est fixé au premier contact électrique.
 5. Commutateur moyenne tension isolé au gaz selon la revendication 4, dans lequel le gaz électriquement isolant ne comporte pas de SF₆ et/ou dans lequel le gaz électriquement isolant comprend au moins un composant gazeux choisi dans le groupe constitué par CO₂, O₂, N₂, H₂, l'air, N₂O, un hydrocarbure, en particulier CH₄, un composé organofluoré perfluoré ou partiellement hydrogéné, et les mélanges de ceux-ci, ou dans lequel le gaz d'isolation comprend un gaz de fond, en particulier choisi dans le groupe constitué par CO₂, O₂, N₂, H₂, l'air, en mélange avec un composé organofluoré choisi dans le groupe constitué par : un fluoroéther, un oxirane, une fluoramine, une fluorocétone, une fluorooléfine, un fluoronitrile, et les mélanges et/ou produits de décomposition de ceux-ci.
 6. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 5, dans lequel le support de plaques de séparation (510) ne se déplace pas par rapport au premier contact électrique (102).
 7. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 6 dans lequel au moins une partie des plaques de la pluralité (200) de plaques de séparation (200-1, 200-2, ...) sont disposées d'une manière non parallèle les unes par rapport aux autres.
 8. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 6 dans lequel les plaques de séparation (200-1, 200-2, ...) dans la pluralité (200) de plaques de séparation sont disposées de façon sensiblement parallèle les unes par rapport aux autres.
 9. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 8, dans lequel au moins une partie des plaques de séparation sont ferromagnétiques et configurées pour attirer l'arc électrique (110) par la force de Lorentz, en particulier dans lequel toutes les plaques de séparation sont ferromagnétiques ou des plaques de séparation ferromagnétiques en alternance avec des plaques de séparation non ferromagnétiques.
 10. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 9 dans lequel le support de plaques de séparation (510) a sensiblement la forme d'un arc circulaire.
 11. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 10 dans lequel le support de plaques de séparation (510) est fixe par rapport au premier contact électrique (102) et dans lequel, pour chaque plaque de séparation (200-i) dans la pluralité (200) de plaques de séparation, une distance entre une trajectoire du deuxième contact électrique mobile (104) et la plaque de séparation (200-i) est sensiblement constante.
 12. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 11, dans lequel les plaques de séparation de la pluralité de plaques de séparation sont alignées le long d'une ligne courbe, en particulier le long d'un arc circulaire.
 13. Commutateur moyenne tension isolé au gaz selon l'une quelconque des revendications 1 à 11, dans lequel les plaques de séparation de la pluralité de

plaques de séparation sont alignées le long d'une ligne droite.

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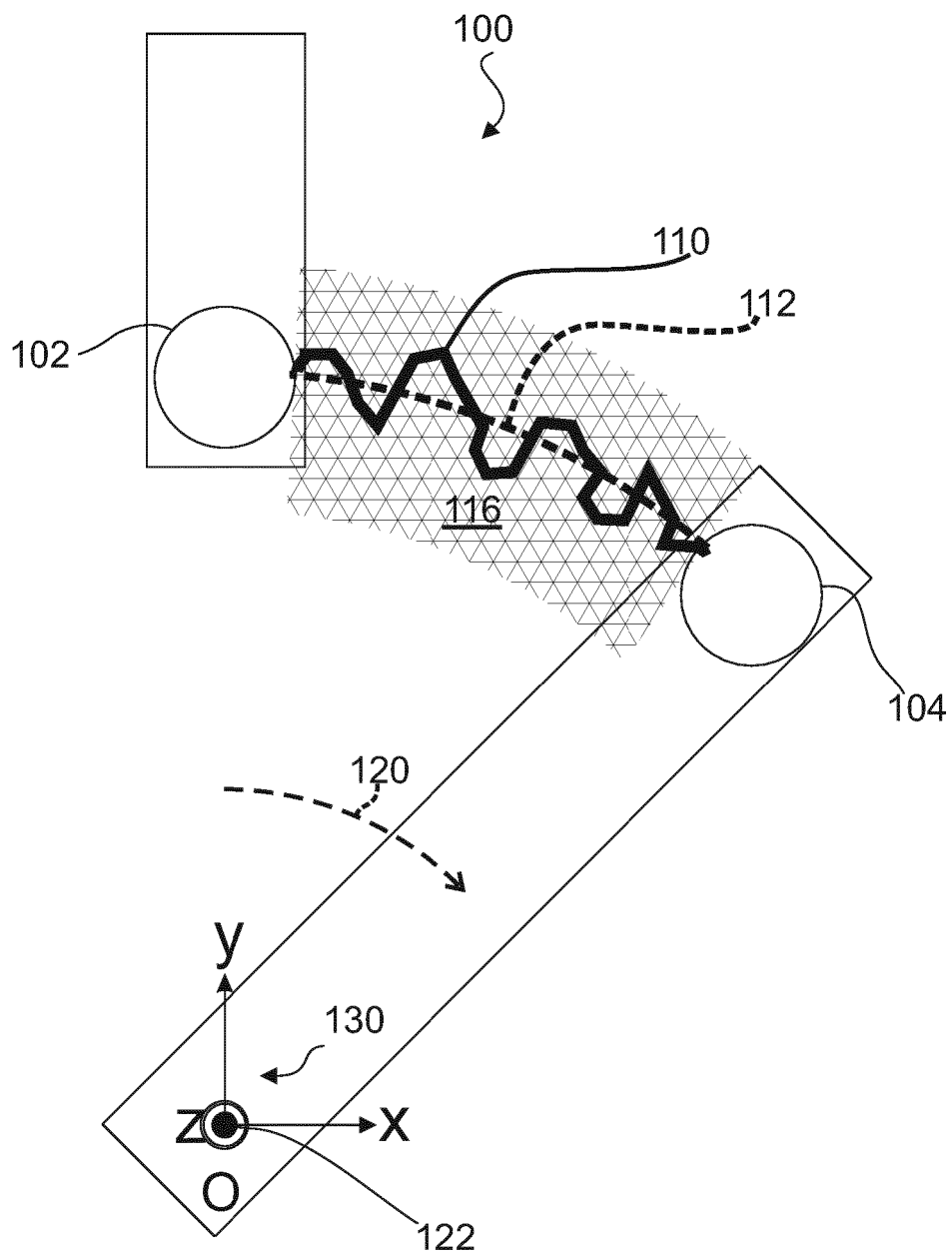


FIG. 1

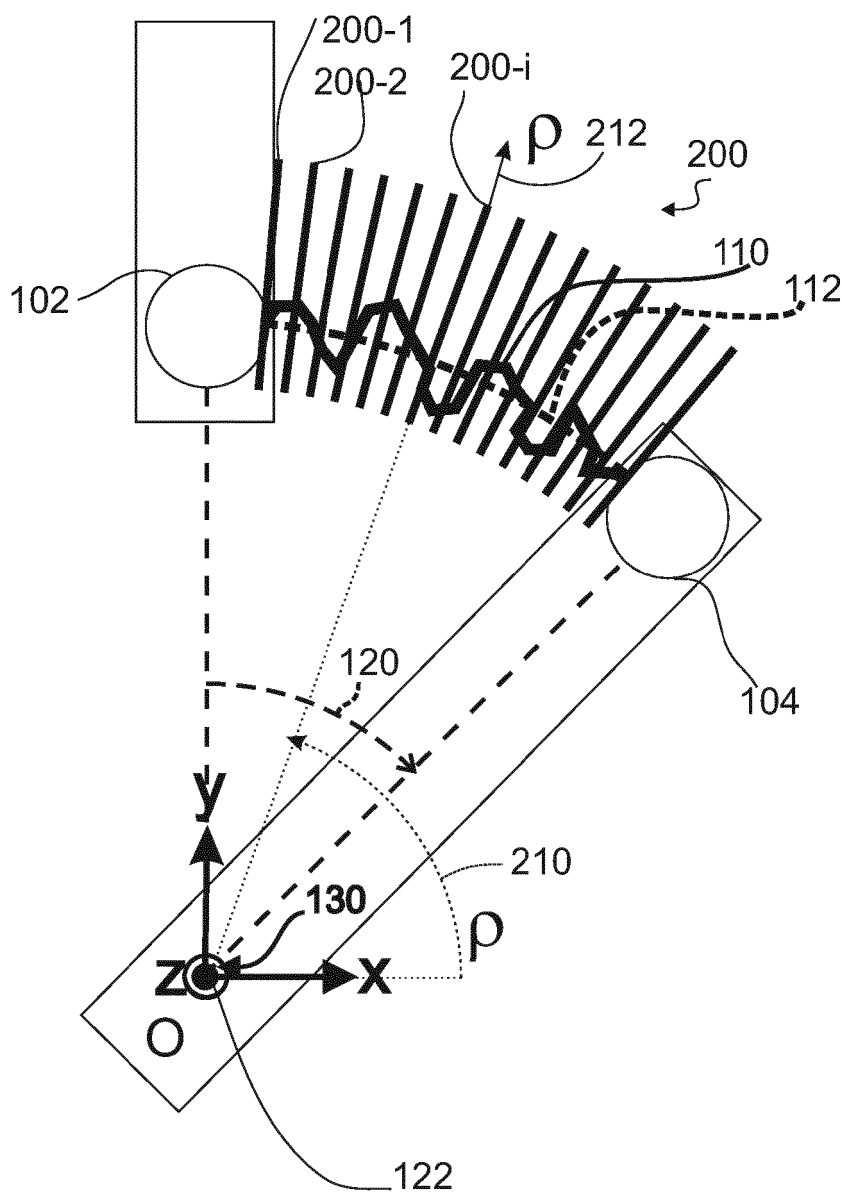


FIG. 2A

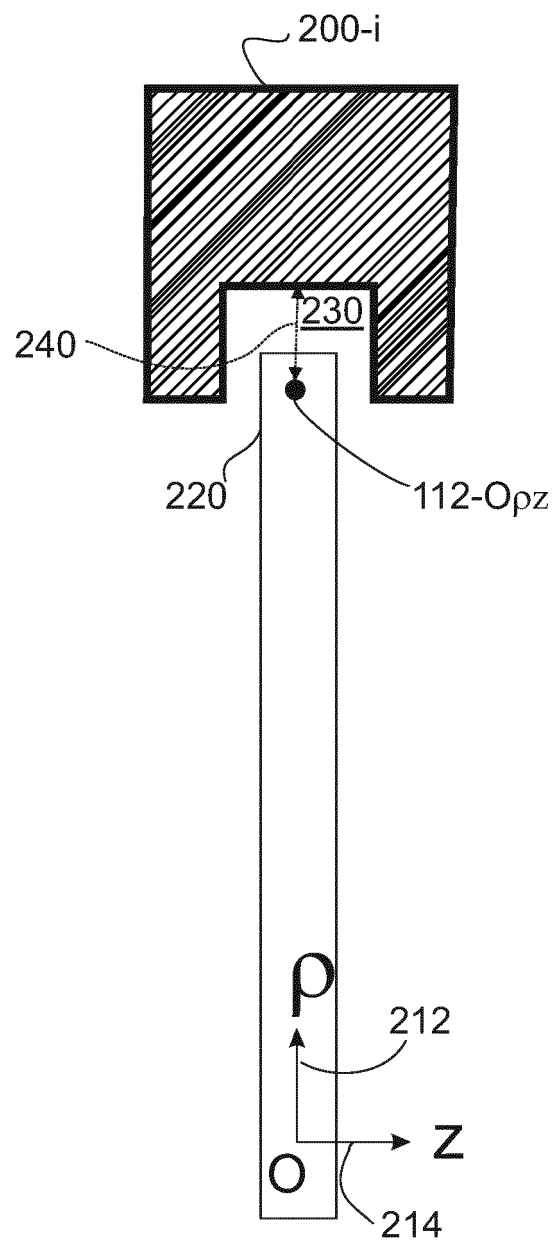


FIG. 2B

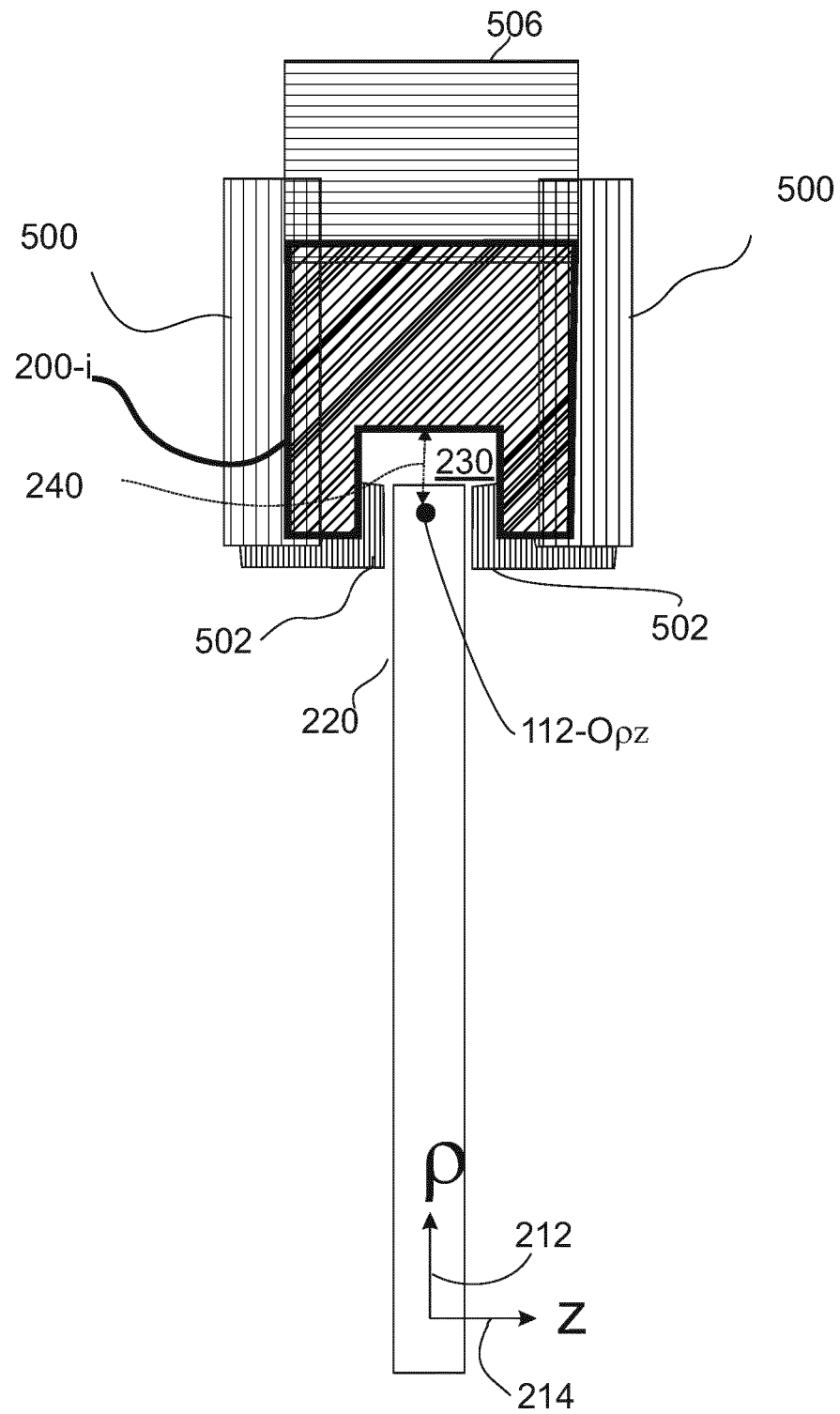


FIG. 3A

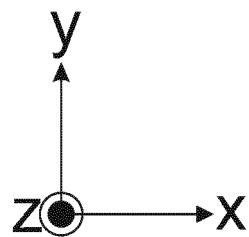
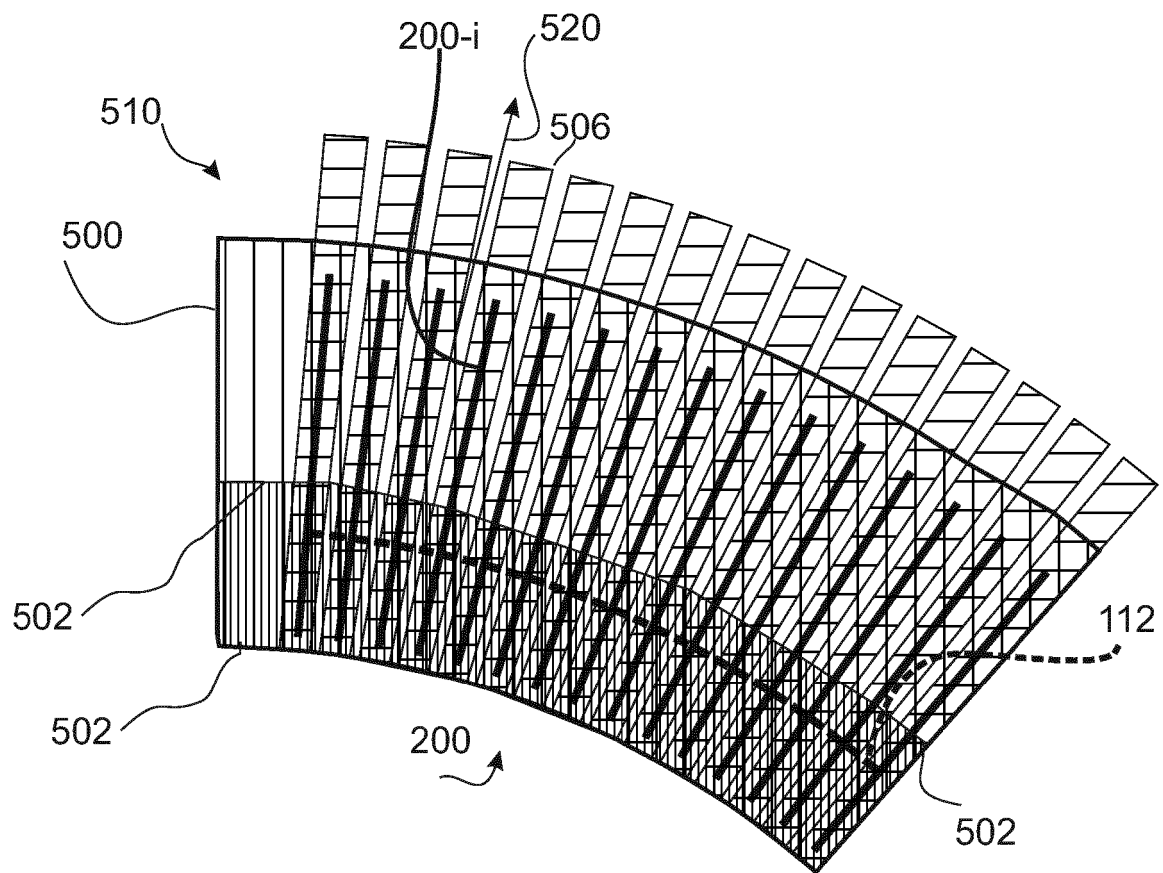


FIG. 3B

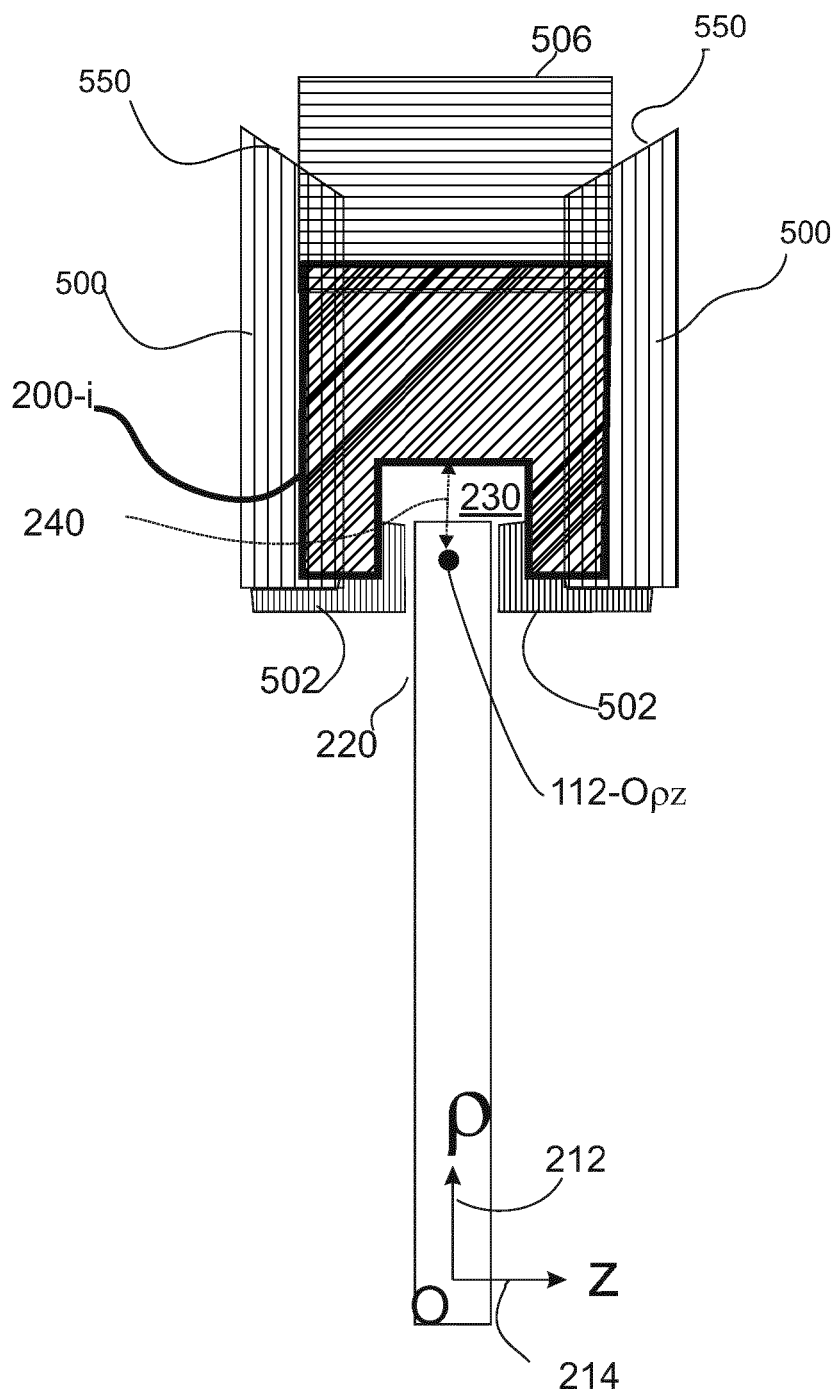


FIG. 3C

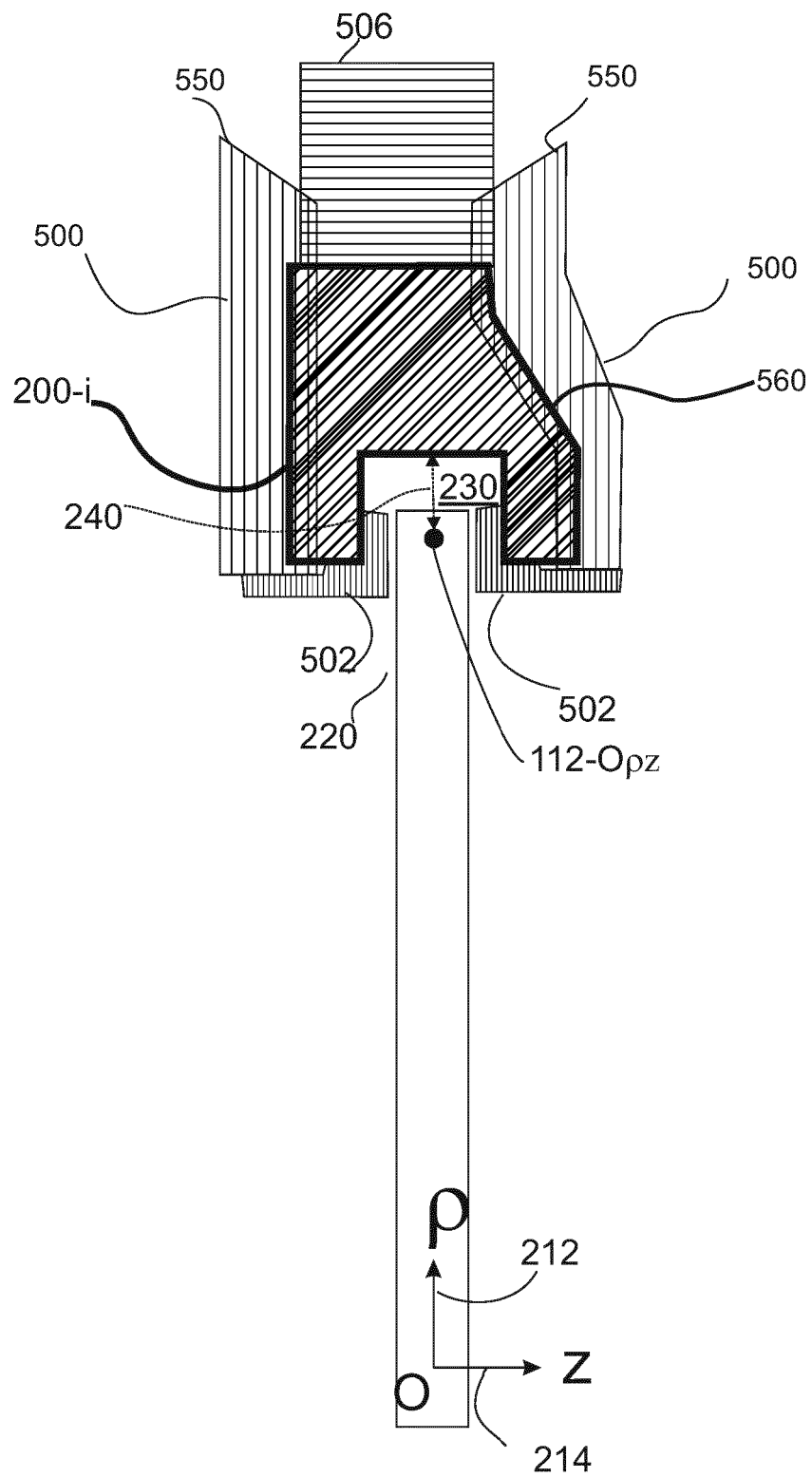


FIG. 3D

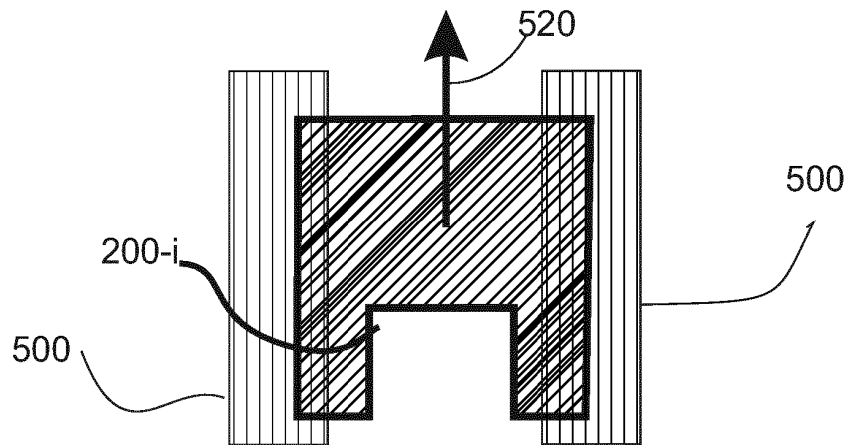


FIG. 3E

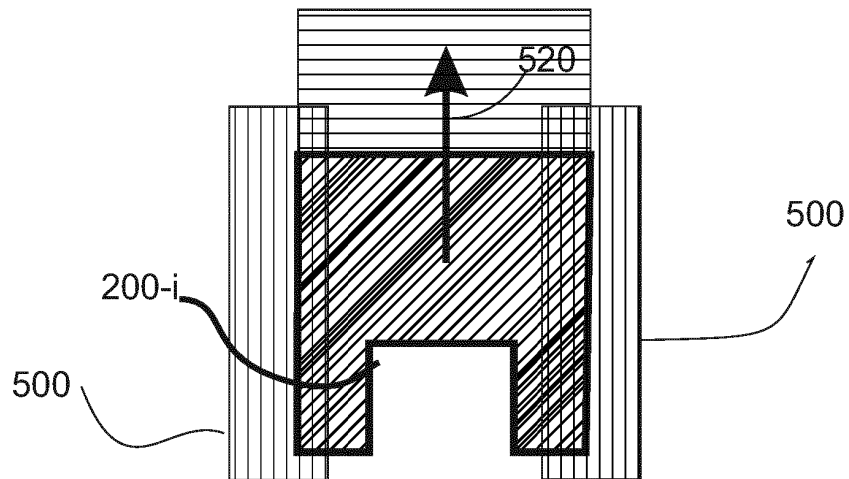


FIG. 3F

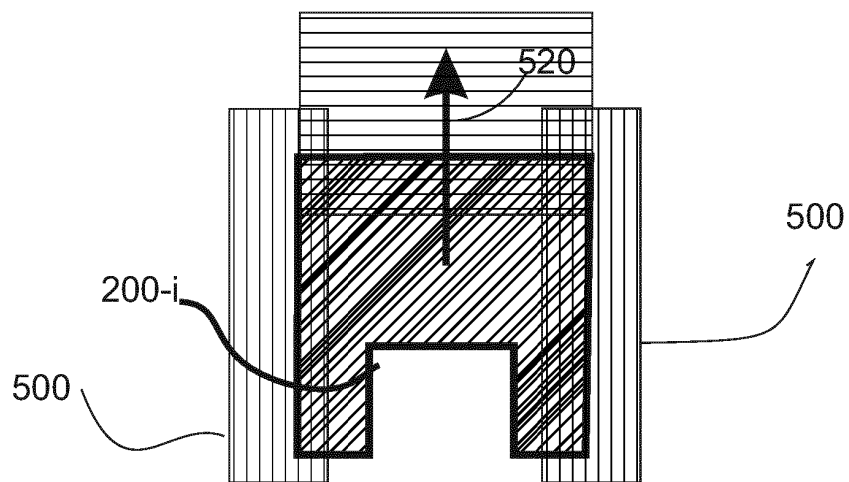


FIG. 3G

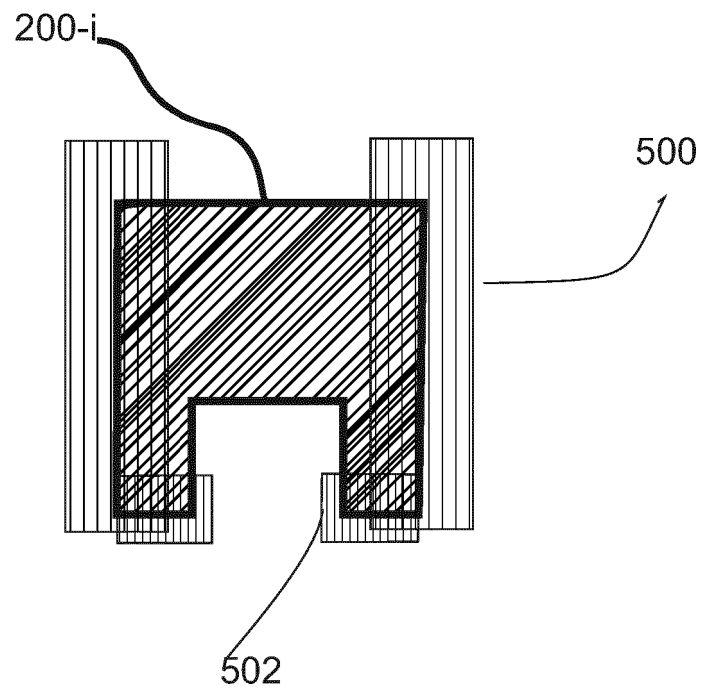


FIG. 3H

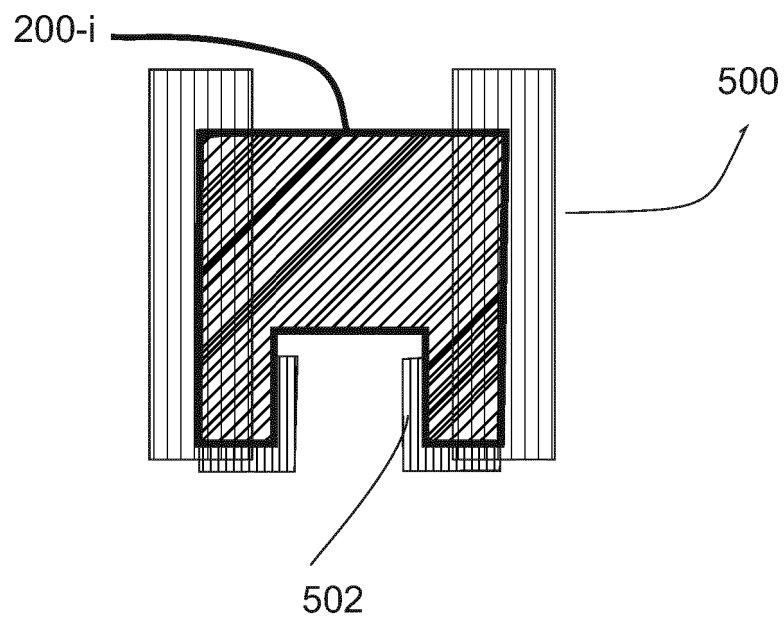


FIG. 3I

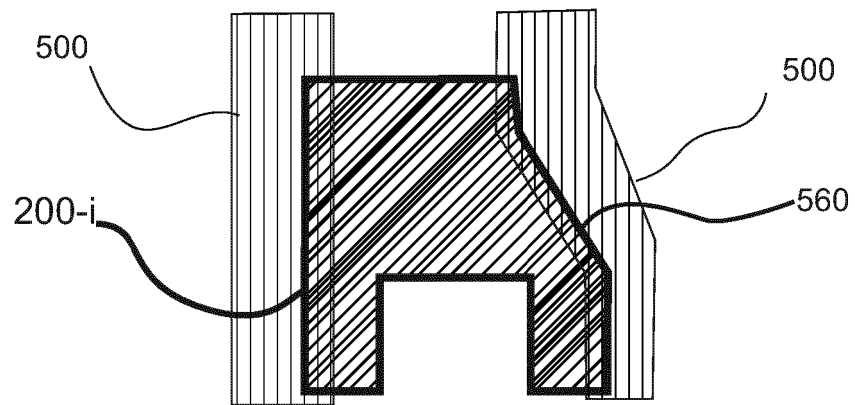
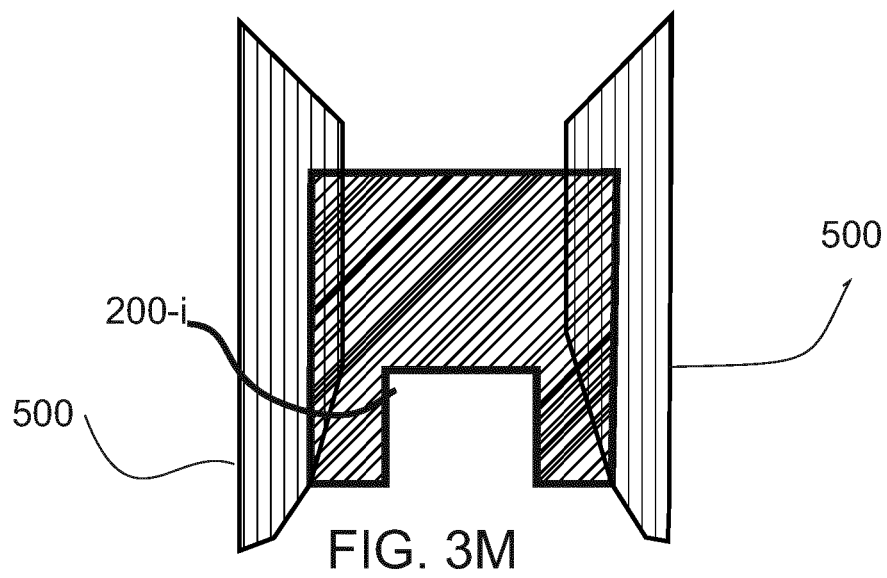
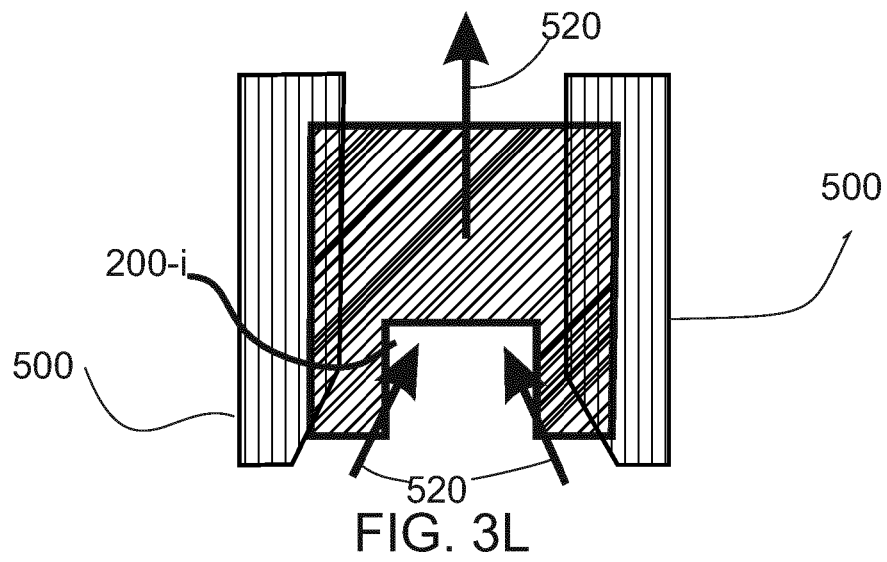
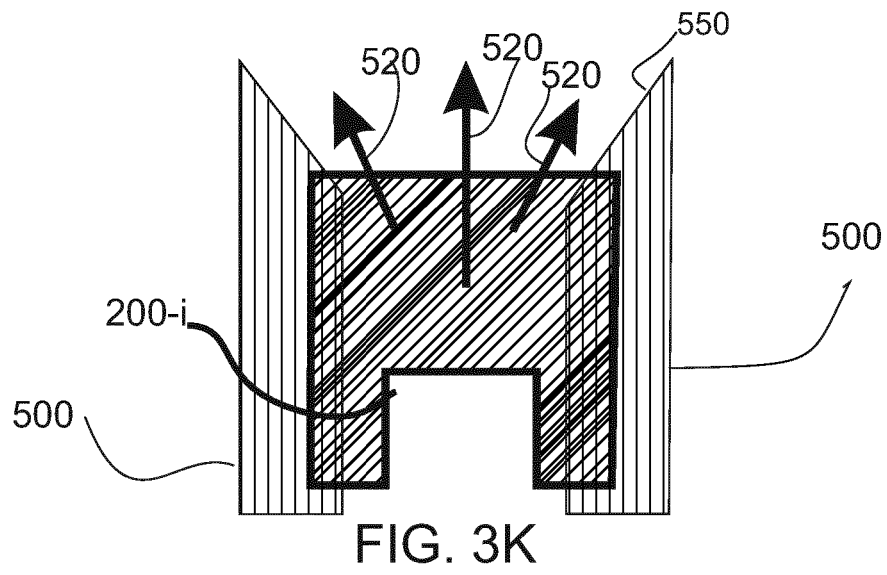


FIG. 3J



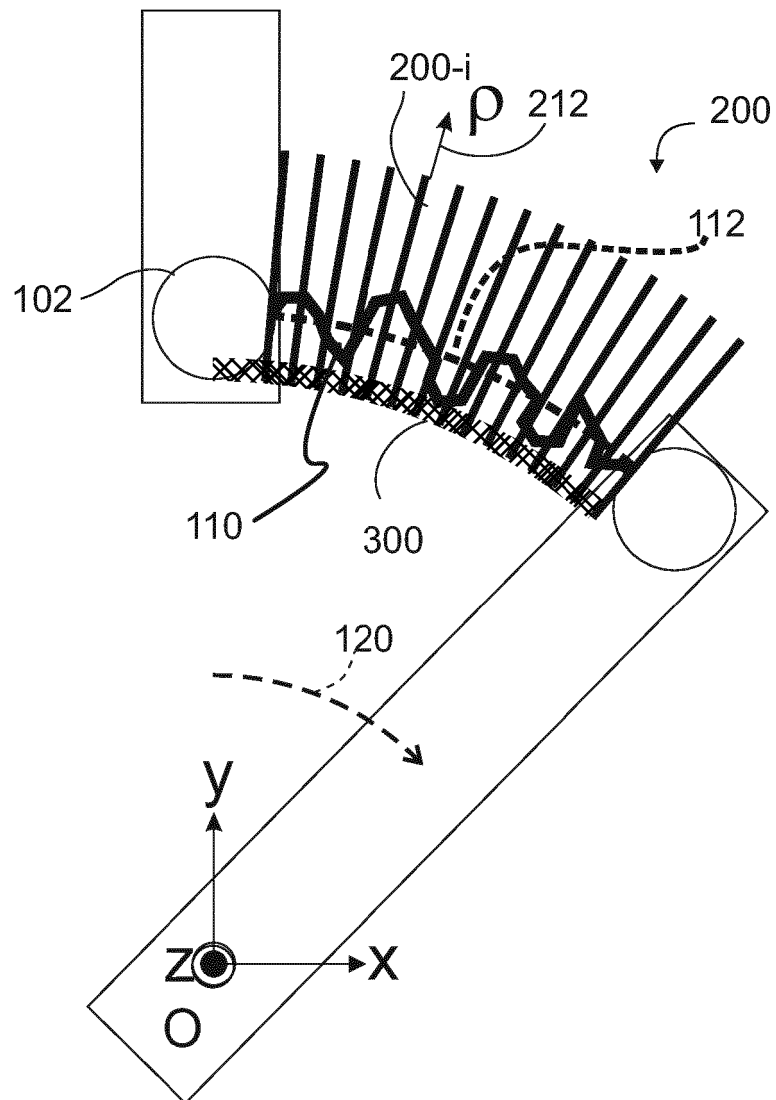


FIG. 4

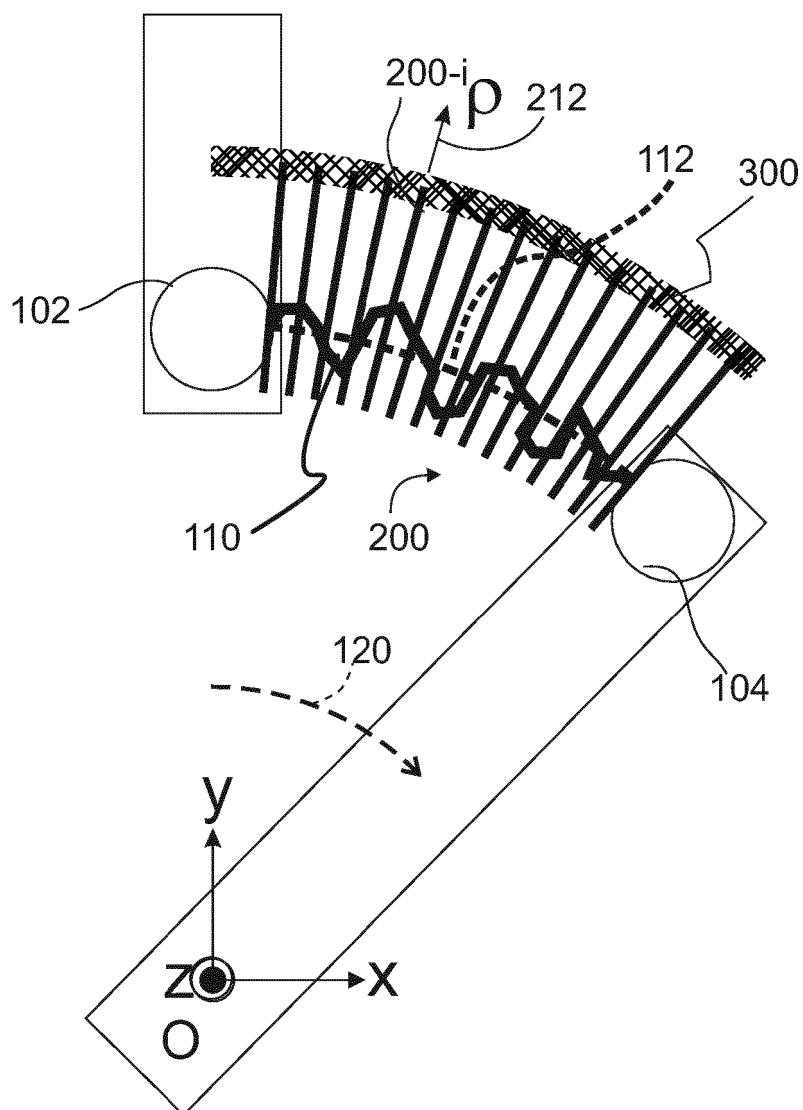
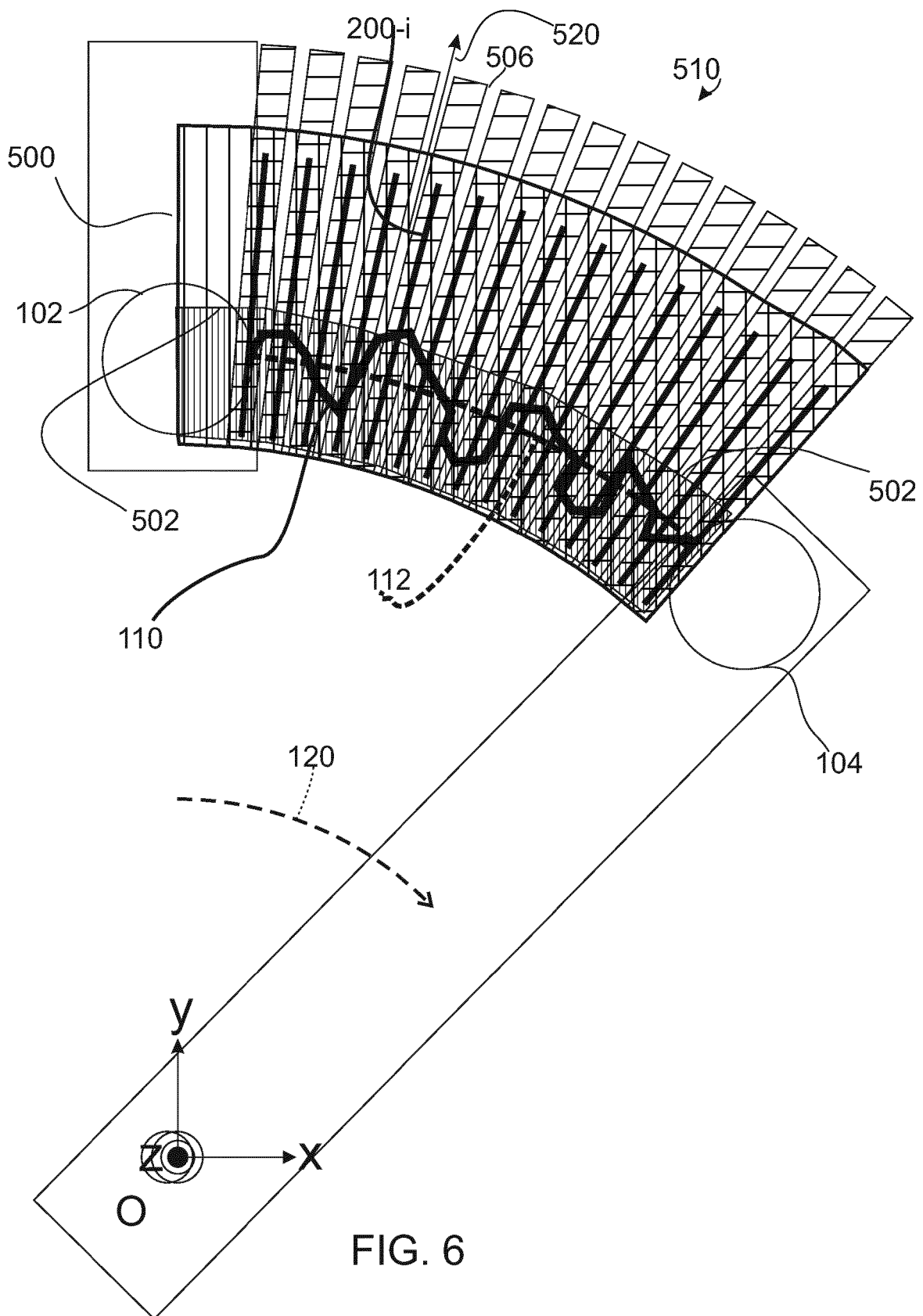
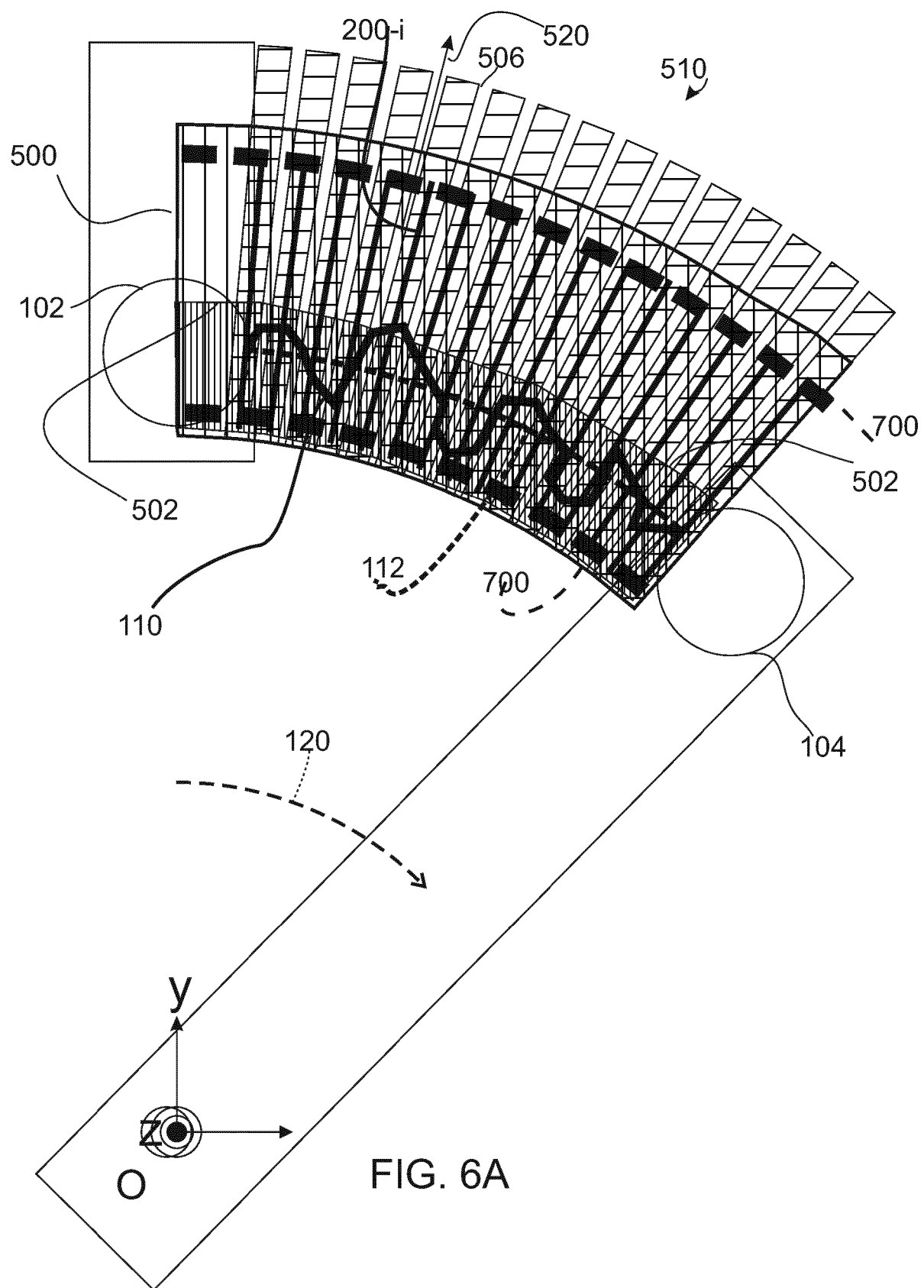


FIG. 5





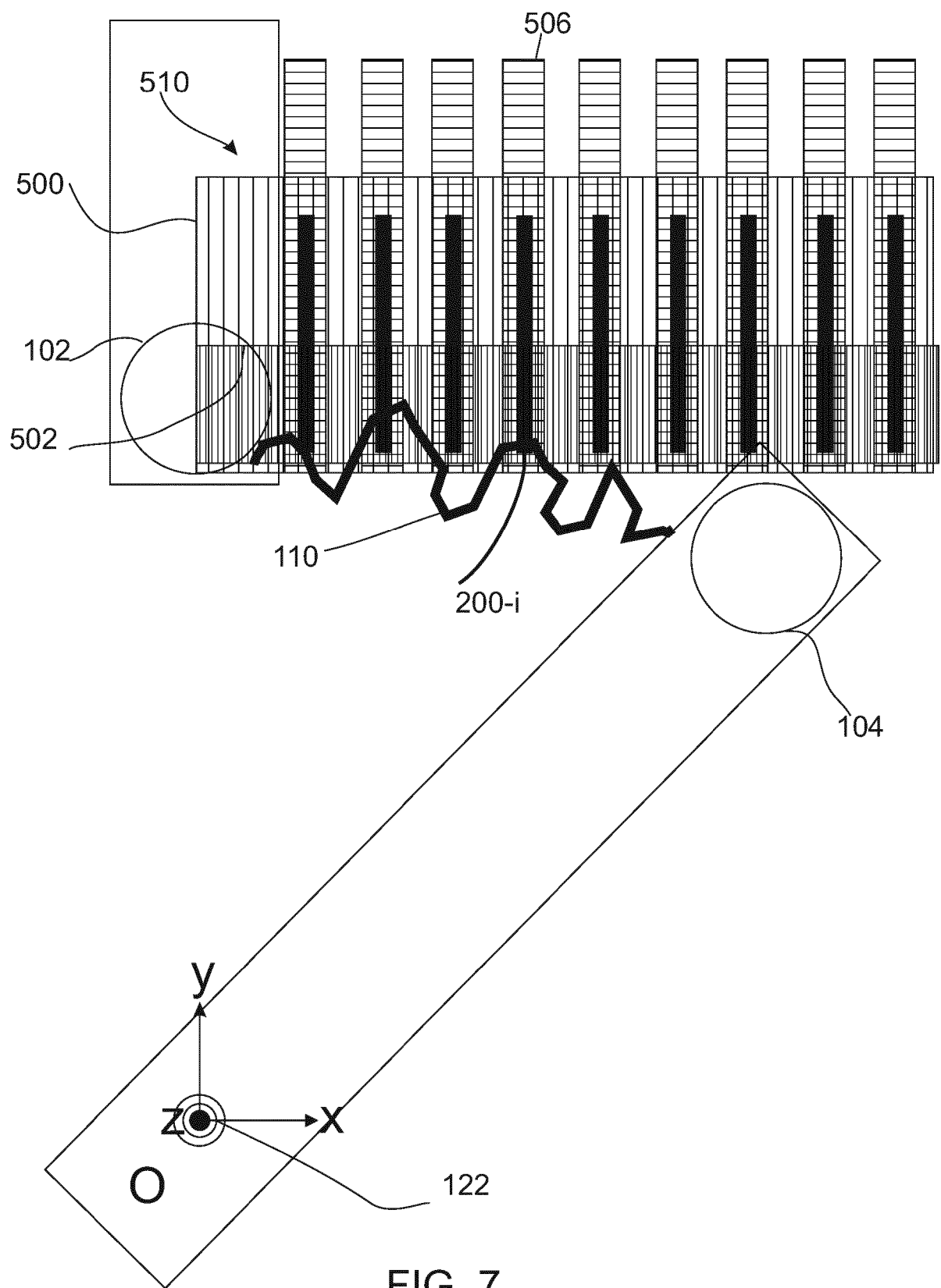


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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