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(54) **Gas-insulated disconnecter with shield**

Gasisolierter Trennschalter mit Schutz

Sectionneur à isolation gazeuse avec écran

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Description

TECHNICAL FIELD

[0001] The present invention in general relates to gas-insulated disconnectors. In particular, the present invention relates to a gas-insulated disconnector having a pair of contact units and an electrically conductive shield.

BACKGROUND OF THE INVENTION

[0002] Electrical disconnectors often are used to open (or close) circuits by the separation (or connection) of conductive members. Often, a disconnector is used for isolation of a circuit.

[0003] Generally, an electrical disconnector is intended to be opened only when no current or only a small current is flowing through it, e.g. after current has been interrupted. This distinguishes a disconnector from a circuit breaker which is opened to interrupt large currents. Electrical disconnectors conform to standards of the International Electrotechnical Commission (IEC), in particular IEC 62271-102.

[0004] During opening and closing of an electrical disconnector, it is possible for an electrical arc (i.e. an electrical discharge accompanied by ionization of the insulation gas) to form between contact members or between contact members and the housing of the disconnector. Since the arc of a disconnector cannot be compared to the much more powerful arcs formed in a circuit breaker, a disconnector has, in contrast to a circuit breaker, no special blast system or the like for extinguishing an arc. Nevertheless, also in a disconnector, an arc can wear off the contacts and may even damage the disconnector, especially if the arc forms between one of the contact members and the housing of the disconnector. A shielded switch of the prior art is disclosed in GB-A-1544333.

SUMMARY

[0005] Thus, there is a need for reducing the probability of arcing in a disconnector, particularly of arcing between the housing and a contact member, especially during opening and/or closing of the circuit. This object is achieved by the gas-insulated disconnector according to independent claim 1. Further aspects, advantages, and features of the present invention are apparent from the claims, the claim combinations, the description, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Typical embodiments are depicted in the drawings and are detailed in the description which follows. The drawings illustrate in

Fig. 1 a cross-section of a disconnector in an open position according to an embodiment,

Fig. 2 a cross-section of a disconnector in a non-closed position according to an embodiment,

Fig. 3 a cross-section of contact units of a disconnector in a closed position according to an embodiment,

Fig. 4 a cross-section of contact units of a disconnector in a closed position according to an embodiment,

Fig. 5 a cross-section of contact units of a disconnector in a closed position according to an embodiment,

Fig. 6 a cross-section of a disconnector in a closed position according to an embodiment,

Fig. 7 a first contact unit and mechanical coupler of a disconnector in a non-closed position according to an embodiment,

Fig. 8 a first and second contact unit and mechanical coupler of a disconnector, according to an embodiment,

Fig. 9 the second contact unit in a non-closed position according to an embodiment, and

Fig. 10 a cross-section of a disconnector according to an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0007] Reference will now be made in detail to the various embodiments of the invention, one or more examples of which are illustrated in the figures. Within the following description of the drawings, the same reference numbers refer to same or functionally similar components. Typically, only the differences with respect to individual embodiments and/or configurations are described. Each example is provided by way of explanation of the invention and is not meant as a limitation of the invention. Furthermore, features illustrated or described as part of one embodiment and/or configuration can be used on or in conjunction with other embodiments and/or configurations to yield yet a further embodiment and/or configuration. It is intended that the description includes such modifications and variations.

[0008] Herein, flush is intended to mean substantially flush, such as flush within a margin of error normally associated with mechanical elements, e.g. within 0.25 mm, or at most 1 mm. Herein, curvature is defined as the reciprocal of radius of curvature.

[0009] Fig. 1 shows, according to an embodiment, a cross-section of a disconnector 1 comprising a housing 100, a first contact unit 110, and a second contact unit 120. The disconnector 1 is depicted in an open-disconnector position, in which the first and second contact units 110, 120 are separated; more specifically in this example the inner contact element 130 of the second contact unit 120 is separated from the first contact unit 110. At least one of the first and second contact units 110, 120 are movable with respect to the other to enable opening and closing of a circuit, i.e. are movable between an open-disconnector position and a closed-disconnector position.

tion. Here, the second contact unit 130 is movable along the axis 160 which extends between the first contact unit 110 and the second contact unit 120.

[0010] More particularly, the inner contact element 130 is movable relative to the housing 100 along the axis 160, and is movable between the closed-disconnector position, in which the inner contact element 130 contacts the first contact unit 110, and the open-disconnector position depicted in Fig. 1, in which the inner contact element 130 is separated from the first contact unit 110. Herein, a position in which the inner contact element 130 is separated from the first contact unit 110 is referred to as a "non-closed position," e.g. positions such as the open-disconnector position, a fully open position, and between fully open and closed position.

[0011] The second contact unit 120 has, in addition to the inner contact element 130, an electrically conductive shield 180 arranged radially outside of the inner contact element 130 for electrically shielding the inner contact element 130. The shield 180 is movable along the axial direction (direction of axis 160) relative to the housing 100 and relative to the inner contact element 130.

[0012] Herein, a shield 180 is defined as a conductive structure which reduces an electric field magnitude. A shield 180 has at least a coating of a conductive material, and may be made of a conductive material. This does a priori not exclude some additional non-conductive elements attached to it, although in some embodiments the shield 180 may even be entirely made of a conductive material without any non-conductive element attached to it. Herein, the term conductive means electrically conductive unless otherwise specified. For example, the conductive material may be a metal. The shield 180 operates by the movement of charges (electrons) on the surface of the conductive material in response to an applied field; and the movement (or distribution) of the charges acts to cancel at least partially the applied field. Herein, the shield 180 is arranged such that it reduces an electric field, in particular a radial electrical field component, in a region between the first contact unit 110 and the inner contact element 130. Typically, the shield 180 is conductively coupled to the inner contact element 130 so that it is adapted to have substantially the voltage of the inner contact element 130. Typically, the shield 180 is positioned such that the shield 180 does not carry a nominal current.

[0013] In the following, some further general aspects are mentioned which are illustrated by Fig. 1 and some of the other Figures, but each of which may also be included in other embodiments.

[0014] Generally, the disconnecter 1 is rated for switching bus-charging currents with equipment rated 72.5 kV and/or above, and is designed to be compliant with IEC standards such as specific values of current given in IEC 62271-102 Annex F.

[0015] As a general aspect, the first contact unit 110 and the inner contact element 130 may be substantially cylindrically symmetric about the axis 160. Alternatively

or additionally, an electrically conductive shield 180 may be substantially cylindrically symmetric about the axis 160.

[0016] The shield 180 is optionally annularly shaped and/or substantially cylindrically symmetric about the axis 160. Typically, the shield 180 is conductively coupled to the inner contact element 130 for bringing the shield 180 substantially to the electrical potential of the inner contact element 130. The shield 180 can electrically shield the inner contact element 130.

[0017] The shield 180 substantially reduces a radial electrical field component, particularly in a region between the first contact unit 110 and the inner contact element 130. This reduction is particularly pronounced in an intermediate (not fully open and not fully closed) position, for example as depicted in Fig. 2, described in more detail below, in which the conductive shield 180 substantially reduces the radially directed electrical field (E_r). In some embodiments, the reduction of radial field component in an intermediate position can be more than 30%, more than 50% or even more than 75 % of the electrical field that would be present in the absence of the shield 180. Alternatively or additionally, the shield 180 reduces the ratio of radial to axial electric field, i.e. the magnitude of radial to axial electric field (E_r/E_a). In an embodiment, the shield 180 is designed in a way to decrease the field strength toward the housing 100. An effect of reducing the radial electric field or field strength toward the housing is to reduce the probability of arcing from at least one of the first and second contacts to the housing 100.

[0018] Typically, the shield 180 is movable along the axial direction 160 relative to the housing 100 and relative to the inner contact element 130. For example, the shield 180 can be moved to reduce and/or minimize E_r/E_a and/or E_r in the open-disconnector position and/or non-closed positions.

[0019] Typically, the shield 180 is arranged such that it does not carry a nominal current when the disconnecter 1 is closed and the nominal current flows through the disconnecter 1.

[0020] In an embodiment, the disconnecter 1 is a gas-insulated disconnecter 1 comprising an insulation gas contained in the housing 100; typically the housing 100 provides a volume for containing the gas, i.e. a dielectric insulation gas. In an embodiment, an insulation gas contained in the housing 100 comprises a gas component selected from the group consisting of: sulfur hexafluoride, nitrogen, oxygen, carbon dioxide, nitric oxide, nitrogen dioxide, nitrous oxide, argon, methanes (in particular partially or fully halogenated methanes, in particular tetrafluoromethane or trifluoroiodomethane), air (in particular technical air or synthetic air), partially or fully fluorinated ethers (in particular hydrofluoro monoethers, hydrofluoro monoethers containing at least 3 carbon atoms, perfluoro monoethers, or perfluoro monoethers containing at least 4 carbon atoms), partially or fully fluorinated ketones (in particular hydrofluoro monoketones, per-

fluoro monoketones, perfluoro monoketones comprising at least 5 carbon atoms, or perfluoro monoketones comprising exactly 5 or 6 or 7 or 8 carbon atoms), olefines (e.g. HFO-1234ze, HFO-1234yf), and mixtures thereof.

[0021] Embodiments relate to: the insulation gas being a gas mixture containing at least two different gas components or even at least three different gas components selected from the group of the gas components mentioned above, thus the insulation gas being a binary or ternary gas mixture; and/or the insulation gas contained in the housing 100 not consisting of pure sulfur hexafluoride; and/or the insulation gas having a filling pressure higher than a hypothetical filling pressure would be, if pure sulfur hexafluoride was used (for same or similar electrical ratings). In preferred embodiments, a component of the insulation gas is at least one of the above-mentioned partially fluorinated ketones.

[0022] Fig. 2 depicts a cross-section of a disconnecter 1 in a non-closed position. For example, as a disconnecter 1 is closed (i.e. moved from an open-disconnector position toward a closed position), the second contact 120 is moved toward the first contact 110 typically along a line such as the axis 160, and the disconnecter 1 passes through a non-closed position such as that depicted in Fig. 2. The shield 180 and inner contact element 130 may move together in going from an open position to the non-closed position during at least part of the movement toward a closed position. Fig. 3 depicts a cross-section of a disconnecter 1 in a closed position, such that the first and second contact units 110, 120 are in contact. In the closed disconnecter position, at least one of the inner contact element 130 and the shield 180 of the second contact unit 120 contact the first contact unit 110.

[0023] Opening of a disconnecter 1 may be regarded as going from Fig. 3 to Fig. 2 to Fig. 1, and may be the reverse process of the closing of the disconnecter. As the first contact unit 110 and second contact unit 120 separate, a gap develops between them, as illustrated in going from Fig. 3 to Fig. 2. Typically the separation is along a line, e.g. the axis 160. During opening, the shield 180, which is radially arranged outside of the inner contact element 130, reduces the likelihood of arcing toward the housing 100 by electrically shielding the inner contact element 130. This may reduce E_f in the region between the first and second contact units 110, 120, particularly between the first contact unit 110 and the inner contact element 130.

[0024] Fig. 4 illustrates a disconnecter 1 in a closed-disconnector position, according to an embodiment which may be combined with any other embodiment. The first contact unit 110 may have a cavity 145. The inner contact element 130 may be adapted to enter the cavity 145 at least partially when the second contact unit 120 is in the closed-disconnector position. The first contact unit 110 optionally has a holding portion 140 on which the cavity 145 is formed. For example, the cavity 145 is formed on the side of the holding portion 140 facing the second contact unit 120.

[0025] According to yet another option, the first contact unit 110 has a retractable portion 190, as shown in Fig. 4. For example, in the closed-disconnector position, the retractable portion 190 resides within the cavity 145, as depicted in Fig. 4. In yet another embodiment, which may be combined with any other embodiment, the retractable portion 190 is at least partially retractable into the cavity 145 and arranged to be pushed into the cavity when the second contact unit 120 is in the closed-disconnector position (e.g. the second contact unit 120 pushes the retractable portion 190 against a spring). For example, the inner contact element 130 pushes the retractable portion 190 into the cavity 145 during a closing of the disconnecter. During opening, optionally, a releasing mechanism such as a spring can release and/or push the retractable portion 190 toward the direction of the second contact unit 120; during opening, optionally, a gap (i.e. a separation) develops between the first and second contact units 110, 120, such as between the retractable portion 190 and the inner contact element 130. If one side of a disconnecter 1 is under even a small AC load, an arc is expected to form during an opening of the disconnecter 1.

[0026] Fig. 5 illustrates the disconnecter 1 in a closed-disconnector position, according to an embodiment. The housing 100, for example, is not shown. In an embodiment which may be combined with any other embodiment, the first contact unit 110 has a first nominal-contact portion 148, and the second contact unit 120 has a second nominal-contact portion 128. For example, the first and second nominal contact portions 148, 128 are adapted to contact each other when the second contact unit 120 is in the closed-disconnector position. Typically, a path of minimum electrical resistance between the first and second contact unit 110, 120 is defined through the first and second nominal contact portions 148, 128, particularly in the closed-disconnector position. In an embodiment (general optional aspect of the invention), the first nominal-contact portion 148 is arranged at a side wall of the cavity 145. The first nominal contact portion 148 may be a resilient element such as a spiral spring. The second nominal contact portion 128 may be a surface of the second contact unit 120 arranged such as to contact the first nominal contact portion 148 in a closed-disconnector configuration. The first and second nominal contact portions 148, 128 may be silver coated (optionally together with other parts of the disconnecter, such as a larger portion of the the inner contact element's surface).

[0027] Fig. 6 illustrates the disconnecter 1, according to an embodiment described herein. In an embodiment, which may be combined with any other embodiment, the disconnecter 1 includes a drive mechanism 200 for driving the shield 180 and/or the inner contact element 130. For example, the drive mechanism 200 drives the shield 180 and the inner contact element 130 linearly, i.e. along a linear direction, along the axis 160, between the closed disconnecter position and the open-disconnector position. The drive mechanism 200 may drive the shield 180 and inner contact 130 separately (e.g. with two separate

drives, gears, or the like) or together, with or without a coupling mechanism. For example, the movement of the shield and/or inner contact occurs at speeds up to about 10 m/s, up to about 6 m/s, or up to about 0.2 m/s. The drive mechanism 200 can include a leadscrew type gear such as a ball screw or roller screw gear. Alternatively or additionally, the drive mechanism 200 includes a spring.

[0028] Fig. 7 illustrates the second contact unit 120 and a mechanical coupler 300 of the disconnecter 1 in a non-closed position, according to an embodiment which may be combined with other embodiments. The mechanical coupler 300 can couple the movement of the inner contact element 130 with the shield 180. The mechanical coupler 300 can include a spring 350 (shown in cross-section in Fig. 7) for pushing the shield 180 towards the first contact unit 110 (not shown, to the right of Fig. 7). The spring 350 can be coupled at one end to the inner contact element 130, and at the other end the shield 180, for example a shield-stopper 450 which is fixed to the shield 180.

[0029] In embodiments, the spring 350 can be coupled at one end to the inner contact element 130 or to an element jointly movable with the inner contact element 130, such as the rod shown in Fig. 7. Preferably the element jointly movable with the inner contact element 130 is rigidly connected to the inner contact element 130. At the other end, the spring 350 can be coupled to the shield 180 or to an element jointly movable with the shield (and preferably rigidly connected to the shield). In Fig. 7, for example, the other end of the spring 350 is coupled to a shield-stopper 450 which is fixed to the shield 180.

[0030] For example, as consistent with the illustration of Fig. 7, the spring 350 is in a slightly compressed state so that its force on the shield 180 pushes the shield 180 toward the right (toward the first contact unit 110, not shown). Further consistent with the illustration of Fig. 7 is the presence of a contact force, or normal force, between a stopper 400 fixed directly (as shown) or indirectly to the inner contact element 130 and a stopper on the shield 180, i.e. a shield-stopper 450. Thus the stopper 400 stops the shield 180 from moving farther toward the first contact unit 110 than a stopping position relative to the inner contact element 130. Generally, according to an embodiment which can be combined with any other embodiment, the mechanical coupler 300 includes a spring 350 and at least one stopper (400 and/or 450) fixed to the second contact unit 120 for stopping the conductive shield 180 from moving farther toward the first contact unit 110 than a stopping position (e.g. a stopping position of the shield 180) relative to the inner contact element 130.

[0031] In an embodiment, the mechanical coupler 300 also includes a stopper 400 fixed to the second contact unit 120 (e.g., as depicted in Fig. 7, more specifically, the inner contact element 130). The stopper 400 stops the shield 180 from moving farther toward the first contact unit 110 than the stopping position relative to the inner contact element 130. As depicted in Fig. 7, the stopper

400 can be fixed to the inner contact element 130; for example the stopper 400 is a protrusion, e.g. a radial protrusion, on the inner contact element 130. Furthermore, as depicted in Fig. 7, the stopping position of the shield 180 relative to the inner contact element 130 may be such that the shield 180 is flush with the second contact element 130 or retracted (e.g. slightly retracted, by less than e.g. 20 mm) from the contact-side edge 132 of the inner contact element 130 away from the first contact element or unit 110. The retracted configuration has the advantage of reducing the risk of an arc moving to the shield 180. On the other hand, the flush configuration is advantageous because sharp edges are avoided. Therefore, the flush configuration may be advantageously accompanied by an arc termination structure 125 as shown in Fig. 10 (described below); and the slightly retracted configuration is preferred especially in embodiments which lack such an arc termination structure.

[0032] The spring 350 can be coupled at one spring end to the second contact unit 120 (or, as depicted in Fig. 7, more specifically, the inner contact element 130), and at another spring end to the shield 180. In another embodiment, combinable with other embodiments described herein, an end of the mechanical coupler 300 is fixed directly or indirectly to the housing 100 and/or drive mechanism 200 and the other end is fixed directly or indirectly to the shield 180. In another embodiment, combinable with other embodiments described herein, an end of the spring 350 is fixed relative to the shield 180, and the spring 350 is arranged so as to exert a force on the shield 180 directed toward the first contact unit 110; such an embodiment is consistent with the depiction of Fig. 7.

[0033] Fig. 8 illustrates the first 110 and second contact units 120 and mechanical coupler 300 of the disconnecter 1 in a closed-disconnector position, according to an optional embodiment which may be combined with other embodiments. Generally the mechanical coupler 300 couples the movement of the inner contact element 130 with the shield 180. As depicted, in one example of a closed position, the second contact unit 120 is in contact with the first contact unit 110, and the contact force between the first contact element 110 and the shield 180 is such that the second contact unit 120 is pushed against the force of the mechanical coupler 300 (particularly, e.g. the spring 350). Thus, as depicted in Fig. 8, the stopper 400 may be separated from the shield stopper 450, and the shield 180 may be pushed back from the inner contact element 130, i.e. the position of the shield 180 with respect to the inner contact element 130 is different than that depicted in Fig. 7, e.g. no longer flush.

[0034] During closing of the disconnecter, for example, the drive mechanism 200 (not shown) can engage the inner contact element 130 (and directly or indirectly the shield 180 for example through the coupler 300, or the spring 350) to induce the closed disconnecter position. For example, the drive mechanism 200 pushes the inner contact element 130 which is coupled to the shield 180 by the mechanical coupler 300. While in a non-closed

position, for example, as illustrated in Fig. 7, the mechanical coupler 300 causes the motion of the shield 180 to match that of the inner contact element 130. When contact is made, the first contact element 110 can oppose the mechanical coupler 300 (particularly, for example by compressing the spring 350).

[0035] As illustrated in Fig. 8, when the disconnecter is in the closed configuration, the mechanical coupler 300 may be such that the spring 350 is compressed by the shield-stopper 450 and the inner contact element 130 (compare to Fig. 7). Therefore, in this example, although the spring 350 exerts a force pushing the shield 180 toward the first contact unit 110 in both the closed position of the disconnecter (Fig. 8) and the non-closed position (Fig. 7); in the closed position, the first contact unit 110 exerts a force on the shield 180 which opposes the force of the mechanical coupler 300. In the example of a closed configuration depicted in Fig. 8, the inner contact element 130 resides in a cavity 145 of the first contact unit 110. For instance, as is depicted in Fig. 8 which illustrates an embodiment of a closed-position disconnecter 1, the end of the inner contact element 130 extends beyond the shield 180, the stopper 400 and the shield-stopper 450 are disengaged and/or separated.

[0036] A further option is that a retractable portion 190 (for example as illustrated in Fig. 5) also resides in the cavity 145. It follows that, in the closed disconnecter position, the retractable portion 190, which is movable, can be positioned so that the end of the inner contact element 130 extends beyond the shield 180, and also be positioned to allow the stopper 400 and the shield-stopper 450 to disengage and/or separate. The engaged, abutted, and/or non-separated arrangement of the stopper 400 and shield-stopper 450 in the non-closed disconnecter position is depicted in Fig. 7, in contrast.

[0037] For example, the drive mechanism 200 can cause the inner contact element 130 to make contact with the retractable portion 190 of the first contact unit 110. Thereby, in order to ensure that the arc originates between the inner contact element 130 and the retractable portion 190, within the cavity.

[0038] In another embodiment, the face of the inner contact element 130 which faces the first contact unit (right of Fig. 8) contacts the first contact unit 110 (which may not have a cavity 145). The mechanical coupler 300 (e.g. particularly the spring 350) pushes the shield 180 toward the first contact unit 110. In the closed-disconnector position, the stopper 400 is not engaged with the shield-stopper 450, and a gap lies between them; and the inner contact element 130 is in contact with the first contact unit 110.

[0039] Fig. 9 illustrates the second contact unit 120 according to an embodiment, in a non-closed position, for example during opening or closing of the circuit. The shield 180 comprises, optionally, a forward surface portion 185, which is located at a radially inner portion of the conductive shield 180 and oriented toward the first contact unit 110 (not shown, to the right of Fig. 9). The inner

contact element 130 has an optional contact-side edge 132 which is the radially outer edge of the face of the inner contact 130 which faces the first contact unit 110. In an embodiment that may be combined with other embodiments, the forward surface 185 of the shield is substantially flush with the inner contact element 130, particularly its contact-side edge 132 when the second contact unit 120 is in a non-closed position. For example, the forward surface 185 of the shield is substantially flush with the contact-side edge 132 of the inner contact element 130 when the circuit is not fully closed, or not at least partially closed, or not more than partially closed.

[0040] In another embodiment, which may be combined with other embodiments, when the stopper 400 (not shown) is engaged, the shield 180, in particular its forward surface portion 185, is flush with the inner contact element 130, particularly its contact-side edge 132. For example, the stopper 400 stops the shield from moving farther toward the first contact unit than a stopping position, the stopping position being such that the shield 180, in particular its forward surface portion 185, is flush with the inner contact element 130, particularly its contact-side edge 132. In an embodiment which may be combined with other embodiments, the face of the inner contact element 132, in the region near its contact-side edge 132, is substantially coplanar with the forward surface portion 185 of the shield 180.

[0041] An additional optional embodiment has an intermediate portion 186 of the conductive shield 180 extending between the forward 185 and the outward 187 surface portions. A further option is that the curvature of the intermediate portion 186 is increasing in the radial direction, i.e.: the radius of curvature of the intermediate portion 186 of the conductive shield 180, which extends between the forward surface portion 185 and the outward surface portion 187, is decreasing when moving in an outward radial direction (i.e. away from a central longitudinal axis 160).

[0042] In yet another option, the radius of curvature of the intermediate portion 186 is approximately more than 10 mm. Alternatively or additionally, the radius of curvature of the intermediate portion 186 is from approximately 20% of the radius of the housing 100 to 50% of the radius of the housing 100. Alternatively or additionally, the radius of curvature of the intermediate portion 186 is from approximately 60% to 150% or from about 80% to 120% of the radius of the inner contact unit 130.

[0043] As another optional general aspect of the invention, the minimum radius of curvature of the exposed surface of the shield 180 is more than 10 mm.

[0044] Other optional geometries are such that the average radius of curvature of the forward surface 185 and the intermediate portion 186 is approximately more than 10 mm. Alternatively or additionally, the average radius of curvature of the forward surface 185 and the intermediate portion 186 is from approximately 20% of the radius of the housing 100 to 50% of the radius of the housing 100. Alternatively or additionally, the average radius of

curvature of the forward surface 185 and the intermediate portion 186 is from approximately 60% to 150% or from about 80% to 120% of the radius of the inner contact unit 130.

[0045] Fig. 10 illustrates a disconnecter in cross-section, according to an embodiment. In an embodiment which may be combined with any other embodiment, at least one of the first contact unit 110 and the second contact unit 120 comprise(s) an arc termination structure. For example, the first contact unit 110 comprises a first arc termination structure 115, and the second contact unit 120 (or more specifically the inner contact element 130) comprises a second arc termination structure 125. The arc termination structures 115, 125 are shaped and arranged such that, in the event an arc is formed, the arc is probabilistically formed between the arc termination structures 115, 125 when the second contact unit 120 is opened (closed) from the closed (open)-disconnecter position towards the open (closed)-disconnecter position in the presence of a current (the current being from the first to second contact unit or vice versa). Alternatively or additionally, the arc termination structures 115, 125 are shaped and arranged such that, in the event an arc is formed, it is formed so that it probabilistically terminates at at least one of the arc termination structures 115, 125, especially when the second contact unit 120 is opened or closed (i.e. undergoing an opening or closing action), e.g. when the disconnecter 1 is closed from an open-disconnector position towards a closed disconnecter position, such as in the presence of a voltage difference between the first and second contact units 110, 120.

[0046] The arc termination structures 115, 125 may be the surfaces of the first and second contact units 110, 120, respectively, which are closest together when the first and second contact units 110, 120 are in a non-closed position. Accordingly, at least one of the arc termination structures 115, 125 may be a mesa structure, such as shown for each arc termination structure 115, 125 of Fig. 10. The arc termination structures 115, 125 may be shaped as a protrusion protruding in an axial direction towards the respective other contact element and being delimited by a step-shaped edge. The arc termination structures 115, 125 may be arranged on a center axis 160 of the disconnecter 1 and may be facing each other.

[0047] The arc termination structures 115, 125 can, for example, be located so as to (in combination with the shield 180) decrease the electric field strength toward the housing 100, and/or decrease the radial component of the field strength (E_r), and/or decrease the ratio of radial to axial field strength (E_r/E_a). For example, the second arc termination structure 125 is, as depicted in Fig. 10, the edge of a mesa, plateau, and/or cylindrical plateau located on the face of the inner contact element 130 which faces the first contact unit 110.

[0048] In an embodiment, a first arc termination structure 115 localizes the arc by providing a surface of the first contact unit 110 which is closest to the second con-

tact unit 120 when the disconnecter 1 is in a non-closed position. In another embodiment, a second arc termination structure 125 localizes the arc by providing a surface of the second contact unit 120 which is closest to the first contact unit 110 when the disconnecter 1 is in a non-closed position. In yet another embodiment, each of the first and second contact units 110, 120 have arc termination structures 115, 125 which provide surfaces of the first and second contact units 110, 120 which are closest to each other. The arc termination structures 115, 125 are typically near the center of symmetry of the disconnecter 1. As a general optional aspect of the invention, the first arc termination structure 115 may reside on the retractable portion 190 (as it is depicted in Fig. 10). However, this is not mandatory, and the first arc termination structure 115 may also be located at other parts of the first contact unit 110. It is possible for there to be 0, 1 (on either of the first or second contact units 110, 120), or more arc termination structures.

[0049] In another possible working aspect, which may be combined with any other embodiment regarding arc termination structures, the curvature of at least one of the arc termination structures 115, 125 contributes to the localization of the arc. In this working aspect, it is regarded that electric fields are strongest where a surface is most curved, i.e. at or on an arc termination structure. Regions where electrical field lines are crowded (i.e. fields are greatest) are sometimes regarded to have a greater probability of providing a conductive path, such as providing a conductive path to or from a gas which is subject to dielectric breakdown. Therefore, in an embodiment, at least one arc termination structure of the first or second contact unit localizes (or increases the probability of localization of) the arc termination on the surface of the respective first or second contact unit 110, 120 by providing a surface of high curvature. Thus, the arc termination structures 115, 125 may localize and/or increase the probability of localizing an arc termination (in the event an arc occurs), especially arc termination occurring at or near the arc termination structures 115, 125, for example on the oppositely facing sides of the inner contact element 130 and the first contact unit 110.

[0050] For example, the arc termination structures 115, 125 are angular structures and/or structures of high curvature, i.e. relatively angular and/or relative highly curved; particularly in comparison to the shield 180. For example, at least one of and preferably each of the first and second arc termination structures 115, 125 has greater curvature than the shield 180.

[0051] Optionally, given the radius, r , of the inner contact element 130 (its radius being in the radial direction), the second arc termination structure 125 is located about $r/1.5$ or less from the center axis of the inner contact element 110. Optionally, the second arc termination structure 125 is located about $r/2$ or less, $r/2.5$ or less, or $r/3$ or less from the center axis of the inner contact element 110. In yet another option, given the radius, s , of the inner radius of the shield (e.g. the shield having an

annular shape), the second arc termination structure 125 is located about $s/1.5$ or less from the center axis of the inner contact element 110. Optionally, the second arc termination structure 125 is located about $s/2$ or less, $s/2.5$ or less, or $s/3$ or less from the center axis of the inner contact element 110. (The center axis of the inner contact element 110 is collinear with the axis 160 depicted in Fig. 10.) The arc termination structures 115, 125 are not necessarily located at equal distances, radially as measured from the axis 160 (i.e. from the axis of symmetry), on the respective first 110 and second 120 contact units. In the case that first and/or second arc termination structures 115, 125 are present, they may be on the first contact unit 110 and retractable portion 190 of the second contact unit 120, respectively. The arc termination structures 115, 125, when present, can be located near the axis of symmetry.

[0052] In an embodiment which can be combined with other embodiments, the arc termination structures are relatively angular and/or relative highly curved; particularly in comparison to at least one of the forward surface portion 185, intermediate portion 186, and outward 187 portion of the shield 180. The arc termination structures 115, 125 can (e.g. in synergy with the shield 180) increase the probability of localizing an arc termination and/or decrease the radial component of the field strength (E_r), and/or decrease the ratio of radial to axial field strength (E_r/E_a), especially in a non-closed position.

[0053] In moving from the open-disconnector position to a non-closed disconnector position and/or in moving through a plurality of non-closed disconnector positions, it is possible that the forward surface 185 of the shield 180 is substantially flush with the contact-side edge 132 of the inner contact element 130, for example, in geometries that include an open-disconnector position, and/or some or all non-closed disconnector positions. For example, each of the shield 180 and inner contact element 130 is movable with respect to the housing 100. It is also possible that, during closing, the shield 180 and inner contact element 130 move substantially together at least through part of the closing. It is also possible that after the first and second contact units 110 and 120 make contact during closing, that the shield 180 and inner contact element 130 move with respect to each other (e.g. the shield 180 stops moving as the inner contact element 130 continues to move). In the reverse movement, it is possible that during opening, until the first and second contact units are separated (or begin to separate), the inner contact element 130 moves with respect to the shield 180; and after the first and second contact units 110, 120 are separated (or are partially separated), the shield 180 and the inner contact element 130 move in synchronicity.

[0054] A variation is such that the second contact unit 120 has two structures, an arc termination structure 125 and a nominal contact. 128 Possibly, the inner contact element 130 has two structures, an arc termination structure 125 and a nominal contact 128. Alternatively, the

inner contact element 130 has an arc termination structure 125 and the shield 180 has a nominal contact 128.

[0055] Another variation consistent with the disclosure herein has the shield 180 driven by a gear rather than or in addition to a spring. Alternatively or additionally, a gear and/or lever couples the motion of the shield 180 and the inner contact element 130. A further optional feature of the disconnector 1 is a shield support 170, which may support the shield 180 when in the open position.

[0056] In a further variation additional shields may be provided in addition to the shield 180. For example, a further shield - which may be movable with respect to the shield 180 - may be provided radially outwards of the shield 180, thereby forming a combined shield. In the case that the further shield is non-movable with respect to the shield 180, the shield 180 may in this case be viewed as the combined shield which comprises two separate shield parts.

Claims

1. A gas-insulated disconnector (1) comprising:

- a housing (100),
- a first contact unit (110),
- a second contact unit (120) which comprises an electrically conductive shield (180) and an inner contact element (130), wherein

the inner contact element (130) is movable relative to the housing (100) along an axis (160) between a closed-disconnector position in which the inner contact element (130) contacts the first contact unit (110) and an open-disconnector position in which the inner contact element (130) is separated from the first contact unit (110), the axis (160) extending between the first contact unit (110) and the second contact unit (120), and wherein the electrically conductive shield (180) is arranged radially outside of the inner contact element (130) for electrically shielding the inner contact element (130) thereby reducing a radial electrical field component in a region between the first contact unit (110) and the inner contact element (130), and

wherein the electrically conductive shield (180) is movable along the axial direction (160) relative to the housing (100) and relative to the inner contact element (130),

the gas-insulated disconnector (1) further comprising a mechanical coupler (300) for coupling the movement of the inner contact element (130) to the electrically conductive shield (180), **characterised in that** the mechanical coupler (300) includes

- a spring (350) for pushing the electrically conductive shield (180) towards the first contact unit (110), and

- a stopper (400 and/or 450) fixed to the second contact unit (120) for stopping the electrically conductive shield (180) from moving farther towards the first contact unit (110) than a stopping position defined relative to the inner contact element (130)..
2. The gas-insulated disconnecter (1) of any one of the preceding claims, wherein the electrically conductive shield (180) is arranged radially outside of the inner contact element (130) for electrically shielding the inner contact element (130) thereby substantially reducing a radial electrical field component in a region between the first contact unit (110) and the inner contact element (130); and/or wherein the first contact unit (110), the inner contact element (130), and the electrically conductive shield (180) are substantially cylindrically symmetric, in particular are cylindrically symmetric, about the axis (160).
 3. The gas-insulated disconnecter (1) of any one of the preceding claims, wherein the electrically conductive shield (180) is positioned such that it does not carry a nominal current.
 4. The gas-insulated disconnecter (1) of claim 1, wherein the electrically conductive shield (180) is movable along the axial direction (160) relative to the first contact unit (110); and/or the gas-insulated disconnecter (1) further comprising a drive mechanism (200) for driving the electrically conductive shield (180) and the inner contact element (130) in a linear direction along the axis (160) between the closed-disconnector position and the open-disconnector position.
 5. The gas-insulated disconnecter (1) of any one of the preceding claims, wherein the electrically conductive shield (180) reduces a ratio of radial to axial electric field; and/or the electrically conductive shield (180) is designed to decrease the field strength toward the housing (100); and/or wherein the electrically conductive shield (180) is movable to reduce and/or minimize the magnitude of the radial to axial electric field E_r/E_a and/or of the radially directed electrical field E_r in the open-disconnector position and/or non-closed positions.
 6. The gas-insulated disconnecter (1) of any one of the preceding claims, wherein the surface of the electrically conductive shield (180) comprises an outward surface portion (187) which is located at a radially outer portion of the electrically conductive shield (180) and is oriented radially outwardly; and/or wherein the electrically conductive shield (180) is conductively coupled to the inner contact element (130) for bringing the electrically conductive shield (180) substantially to the electrical potential of the inner contact element (130); and/or wherein the gas-insulated disconnecter (1) is rated for switching bus-charging currents with equipment rated 72.5 kV and above.
 7. The gas-insulated disconnecter (1) of any of the preceding claims, further comprising an insulation gas contained in the housing (100), the insulation gas comprising a gas component selected from the group consisting of:
 - sulfur hexafluoride,
 - nitrogen,
 - oxygen,
 - carbon dioxide,
 - nitric oxide,
 - nitrogen dioxide,
 - nitrous oxide,
 - argon,
 - methanes, in particular partially or fully halogenated methanes, in particular tetrafluoromethane or trifluoroiodomethane,
 - air, in particular technical air or synthetic air,
 - partially or fully fluorinated ethers, in particular hydrofluoro monoethers, hydrofluoro monoethers containing at least 3 carbon atoms, perfluoro monoethers, or perfluoro monoethers containing at least 4 carbon atoms,
 - partially or fully fluorinated ketones, in particular hydrofluoro monoketones, perfluoro monoketones, perfluoro monoketones comprising at least 5 carbon atoms, or perfluoro monoketones comprising exactly 5 or 6 or 7 or 8 carbon atoms,
 - olefines, e.g. HFO-1234ze, HFO-1234yf,
 - and mixtures thereof.
 8. The gas-insulated disconnecter (1) of claim 7, with the insulation gas being a gas mixture containing at least two different gas components or even at least three different gas components selected from the group of the gas components of claim 7; and/or the insulation gas contained in the housing (100) not consisting of pure sulfur hexafluoride; and/or the insulation gas having a filling pressure higher than a hypothetical filling pressure would be, if pure sulfur hexafluoride was used.
 9. The gas-insulated disconnecter (1) of any of the preceding claims, wherein a forward surface (185) of the electrically conductive shield (180) is substantially flush with or is retracted in an axial direction away from the first contact unit (110), in particular is substantially flush with or is retracted in an axial direction away from a contact-side edge (132) of the inner contact element (130) when the second contact unit (120) is not in the closed-disconnector position.

10. The gas-insulated disconnecter (1) of any of the preceding claims, wherein the first contact unit (110) comprises a first arc termination structure (115) and the inner contact element (130) comprises a second arc termination structure (125), the first and second arc termination structure (115, 125) being shaped and arranged such that an arc is formed between the first and second arc termination structure (115, 125), when the second contact unit (120) is opened from the closed-disconnector position towards the open-disconnector position in the presence of a current and/or when closing the second contact unit (120); and/or wherein the first contact unit (110) has a first nominal-contact portion (148) and the second contact unit (120) has a second nominal-contact portion (128), wherein the first and second nominal contact portions (148, 128) are adapted to contact each other when the second contact unit (120) is in the closed-disconnector position, and wherein a path of minimum electrical resistance between the first contact unit (110) and the second contact unit (120) is defined through the first and second nominal contact portions (148, 128).
11. The gas-insulated disconnecter (1) of any of the preceding claims, wherein the surface of the electrically conductive shield (180) comprises:
- a or the forward surface portion (185) which is located at a radially inner portion of the electrically conductive shield (180) and is oriented toward the first contact unit (110); and
 - an intermediate surface portion (186) extending between and connecting smoothly the forward surface portion (185) and a or the outward surface portion (187);
 - in particular wherein the intermediate surface portion (186) has a radius of curvature of more than 10 mm.
12. The gas-insulated disconnecter (1) of claim 11, wherein the radius of curvature of the intermediate portion (186) of the electrically conductive shield (180) extending between the forward surface portion (185) and the outward surface portion (187) is decreasing when moving in an outward radial direction.
13. The gas-insulated disconnecter (1) of claim 1, wherein the mechanical coupler (300) comprises at least one of: a gear, and a lever.
14. The gas-insulated disconnecter (1) of claim 13, wherein one end of the mechanical coupler (300) is attached to the inner contact element (130) or to an element jointly movable with the inner contact element (130), and wherein the other end of the mechanical coupler (300) is attached to the electrically conductive shield (180) or to an element jointly mov-

able with the electrically conductive shield (180).

Patentansprüche

1. Gasisolierter Trennschalter (1), der Folgendes umfasst:
 - ein Gehäuse (100),
 - eine erste Kontakteinheit (110),
 - eine zweite Kontakteinheit (120), die einen elektrisch leitenden Schirm (180) und ein inneres Kontaktelement (130) umfasst, wobei
 das innere Kontaktelement (130) relativ zu dem Gehäuse (100) entlang einer Achse (160) zwischen einer geschlossenen Trennschalterposition, in der das innere Kontaktelement (130) die erste Kontakteinheit (110) berührt, und einer offenen Trennschalterposition, in der das innere Kontaktelement (130) von der ersten Kontakteinheit (110) getrennt ist, bewegt werden kann, wobei sich die Achse (160) zwischen der ersten Kontakteinheit (110) und der zweiten Kontakteinheit (120) erstreckt, und wobei der elektrisch leitende Schirm (180) auf der Außenseite des inneren Kontaktelements (130) radial angeordnet ist, um das innere Kontaktelement (130) elektrisch abzuschirmen, wodurch eine radiale Komponente des elektrischen Feldes in einem Bereich zwischen der ersten Kontakteinheit (110) und dem inneren Kontaktelement (130) reduziert wird, und wobei der elektrisch leitende Schirm (180) entlang der axialen Richtung (160) relativ zu dem Gehäuse (100) und relativ zu dem inneren Kontaktelement (130) bewegt werden kann, wobei der gasisolierte Trennschalter (1) ferner einen mechanischen Koppler (300) zum Koppeln der Bewegung des inneren Kontaktelements (130) an den elektrisch leitenden Schirm (180) umfasst, **dadurch gekennzeichnet, dass** der mechanische Koppler (300) Folgendes enthält:
 - eine Feder (350), um den elektrisch leitenden Schirm (180) in Richtung der ersten Kontakteinheit (110) zu drücken, und
 - einen Anschlag (400 und/oder 450), der an der zweiten Kontakteinheit (120) befestigt ist, um den elektrisch leitenden Schirm (180) davon abzuhalten, sich weiter als eine Anschlagposition in Richtung der ersten Kontakteinheit (110) zu bewegen, die relativ zu dem inneren Kontaktelement (130) definiert ist.
2. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei der elektrisch leitende Schirm (180) auf der Außenseite des inneren Kontaktelements (130) radial angeordnet ist, um das innere Kontaktelement (130) elektrisch abzuschir-

men, wodurch eine radiale Komponente des elektrischen Feldes in einem Bereich zwischen der ersten Kontakteinheit (110) und dem inneren Kontaktelement (130) wesentlich reduziert wird; und/oder wobei die erste Kontakteinheit (110), das innere Kontaktelement (130) und der elektrisch leitende Schirm (180) im Wesentlichen zylindersymmetrisch um die Achse (160) sind, insbesondere zylindersymmetrisch um die Achse (160) sind.

3. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei der elektrisch leitende Schirm (180) derart positioniert ist, dass er keinen Nennstrom führt.

4. Gasisolierter Trennschalter (1) nach Anspruch 1, wobei der elektrisch leitende Schirm (180) entlang der axialen Richtung (160) relativ zu der ersten Kontakteinheit (110) bewegt werden kann; und/oder der gasisierte Trennschalter (1) ferner einen Antriebsmechanismus (200) umfasst, um den elektrisch leitenden Schirm (180) und das innere Kontaktelement (130) in einer linearen Richtung entlang der Achse (160) zwischen der geschlossenen Trennschalterposition und der offenen Trennschalterposition anzutreiben.

5. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei der elektrisch leitende Schirm (180) ein Verhältnis des radialen zu dem axialen elektrischen Feld reduziert; und/oder der elektrisch leitende Schirm (180) dafür ausgelegt ist, die Feldstärke in Richtung des Gehäuses (100) zu erniedrigen; und/oder wobei der elektrisch leitende Schirm (180) bewegt werden kann, um den Betrag des Verhältnisses E_r/E_a des radialen zu dem axialen elektrischen Feld und/oder des radial gerichteten elektrischen Feldes E_r in der offenen Trennschalterposition und/oder in nicht geschlossenen Positionen zu reduzieren und/oder zu minimieren.

6. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei die Oberfläche des elektrisch leitenden Schirms (180) einen nach außen gerichteten Oberflächenabschnitt (187) umfasst, der sich an einem radialen Außenabschnitt des elektrisch leitenden Schirms (180) befindet und radial nach außen ausgerichtet ist; und/oder wobei der elektrisch leitende Schirm (180) leitend an das innere Kontaktelement (130) gekoppelt ist, um den elektrisch leitenden Schirm (180) im Wesentlichen auf das elektrische Potential des inneren Kontaktelements (130) zu bringen; und/oder wobei der gasisierte Trennschalter (1) ausgelegt ist, um Sammelschienenladeströme mit Anlagen, die für 72, 5 kV und höher ausgelegt sind, zu schalten.

7. Gasisolierter Trennschalter (1) nach einem der vor-

hergehenden Ansprüche, der ferner ein in dem Gehäuse (100) enthaltenes Isoliergas umfasst, wobei das Isoliergas eine Gaskomponente umfasst, die aus der folgenden Gruppe ausgewählt wird:

- Schwefelhexafluorid,
- Stickstoff,
- Sauerstoff,
- Kohlenstoffdioxid,
- Stickstoffmonoxid,
- Stickstoffdioxid,
- Distickstoffmonoxid,
- Argon,
- Methane, insbesondere teilweise oder vollständig halogenierte Methane, insbesondere Tetrafluormethan oder Trifluoridmethan,
- Luft, insbesondere technische Luft oder synthetische Luft,
- teilweise oder vollständig fluorinierte Ether, insbesondere Hydrofluormonoether, Hydrofluormonoether, die mindestens 3 Kohlenstoffatome enthalten, Perfluormonoether oder Perfluormonoether, die mindestens 4 Kohlenstoffatome enthalten,
- teilweise oder vollständig fluorinierte Ketone, insbesondere Hydrofluormonoketone, Perfluormonoketone, Perfluormonoketone, die mindestens 5 Kohlenstoffatome umfassen, oder Perfluormonoketone, die genau 5 oder 6 oder 7 oder 8 Kohlenstoffatome umfassen,
- Olefine, z. B. HFO-1234ze, HFO-1234yf,
- und Mischungen daraus.

8. Gasisolierter Trennschalter (1) nach Anspruch 7, wobei das Isoliergas einer Mischung entspricht, die mindestens zwei verschiedene Gaskomponenten oder sogar mindestens drei verschiedene Gaskomponenten enthält, die aus der Gruppe der Gaskomponenten aus Anspruch 7 ausgewählt worden sind; und/oder wobei das in dem Gehäuse (100) enthaltene Isoliergas nicht aus reinem Schwefelhexafluorid besteht; und/oder wobei das Isoliergas einen Fülldruck aufweist, der größer ist als ein hypothetischer Fülldruck sein würde, wenn reines Schwefelhexafluorid verwendet werden würde.

9. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei eine vordere Oberfläche (185) des elektrisch leitenden Schirms (180) im Wesentlichen bündig mit der ersten Kontakteinheit (110) ist oder in axialer Richtung von der ersten Kontakteinheit (110) zurückgezogen wird, insbesondere im Wesentlichen bündig mit einer kontaktseitigen Kante (132) des inneren Kontaktelements (130) oder in einer axialen Richtung von einer kontaktseitigen Kante (132) des inneren Kontaktelements (130) weg zurückgezogen wird, wenn die zweite Kontakteinheit (120) nicht in der geschlossenen

Trennschalterposition ist.

10. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei die erste Kontakteinheit (110) eine erste Lichtbogenabschlußstruktur (115) umfasst und das innere Kontaktelement (130) eine zweite Lichtbogenabschlußstruktur (125) umfasst, wobei die erste und die zweite Lichtbogenabschlußstruktur (115, 125) derart geformt und angeordnet sind, dass ein Lichtbogen zwischen der ersten und der zweiten Lichtbogenabschlußstruktur (115, 125) gebildet wird, wenn die zweite Kontakteinheit (120) in Anwesenheit eines Stromes aus der geschlossenen Trennschalterposition in Richtung der offenen Trennschalterposition geöffnet wird und/oder wenn die zweite Kontakteinheit (120) geschlossen wird; und/oder wobei die erste Kontakteinheit (110) einen ersten Soll-Kontaktabschnitt (148) aufweist und die zweite Kontakteinheit (120) einen zweiten Soll-Kontaktabschnitt (128) aufweist, wobei der erste und der zweite Soll-Kontaktabschnitt (148, 128) dafür ausgelegt sind, einander zu berühren, wenn die zweite Kontakteinheit (120) in der geschlossenen Trennschalterposition ist, und wobei ein Pfad des elektrischen Mindestwiderstands zwischen der ersten Kontakteinheit (110) und der zweiten Kontakteinheit (120) durch den ersten und den zweiten Soll-Kontaktabschnitt (148, 128) definiert ist.

11. Gasisolierter Trennschalter (1) nach einem der vorhergehenden Ansprüche, wobei die Oberfläche des elektrisch leitenden Schirms (180) Folgendes umfasst:

- einen oder den vorderen Oberflächenabschnitt (185), der sich bei einem radial inneren Abschnitt des elektrisch leitenden Schirms (180) befindet und in Richtung der ersten Kontakteinheit (110) ausgerichtet ist; und
- einen Zwischenoberflächenabschnitt (186), der sich zwischen dem vorderen Oberflächenabschnitt (185) und einem oder dem nach außen gerichteten Oberflächenabschnitt (187) erstreckt und diese glatt verbindet;
- wobei insbesondere der Zwischenoberflächenabschnitt (186) einen Krümmungsradius von mehr als 10 mm hat.

12. Gasisolierter Trennschalter (1) nach Anspruch 11, wobei der Krümmungsradius des Zwischenabschnitts (186) des elektrisch leitenden Schirms (180), der sich zwischen dem vorderen Oberflächenabschnitt (185) und dem nach außen gerichteten Oberflächenabschnitt (187) erstreckt, in einer nach außen gerichteten radialen Richtung kleiner wird.

13. Gasisolierter Trennschalter (1) nach Anspruch 1,

wobei der mechanische Koppler (300) ein Zahnrad und/oder einen Hebel umfasst.

14. Gasisolierter Trennschalter (1) nach Anspruch 13, wobei ein Ende des mechanischen Kopplers (300) an dem inneren Kontaktelement (130) oder an einem Element, das gemeinsam mit dem inneren Kontaktelement (130) bewegt werden kann, angebracht ist, und wobei das andere Ende des mechanischen Kopplers (300) an dem elektrisch leitenden Schirm (180) oder an einem Element, das gemeinsam mit dem elektrisch leitenden Schirm (180) bewegt werden kann, angebracht ist.

Revendications

1. Sectionneur à isolation gazeuse (1) comprenant :

- une enveloppe (100),
- une première unité de contact (110),
- une seconde unité de contact (120) qui comprend un écran électriquement conducteur (180) et un élément de contact interne (130), où

l'élément de contact interne (130) est mobile par rapport à l'enveloppe (100) le long d'un axe (160) entre une position de sectionnement fermé dans laquelle l'élément de contact interne (130) est en contact avec la première unité de contact (110) et une position de sectionnement ouvert dans laquelle l'élément de contact interne (130) est séparé de la première unité de contact (110), l'axe (160) s'étendant entre la première unité de contact (110) et la seconde unité de contact (120), et où l'écran électriquement conducteur (180) est agencé radialement à l'extérieur de l'élément de contact interne (130) pour blinder électriquement l'élément de contact interne (130), ce qui réduit ainsi la composante radiale de champ électrique dans une zone située entre la première unité de contact (110) et l'élément de contact interne (130), et

dans lequel l'écran électriquement conducteur (180) est mobile le long de la direction axiale (160) par rapport à l'enveloppe (100) et par rapport à l'élément de contact interne (130),

le sectionneur à isolation gazeuse (1) comprenant en outre un coupleur mécanique (300) permettant de coupler le mouvement de l'élément de contact interne (130) à l'écran électriquement conducteur (180),

caractérisé en ce que le coupleur mécanique (300) inclut :

- un ressort (350) permettant de pousser l'écran électriquement conducteur (180) vers la première unité de contact (110), et
- un arrêt (400 et/ou 450) fixé à la seconde unité

- de contact (120) pour stopper le déplacement de l'écran électriquement conducteur (180) vers la première unité de contact (110) plus loin qu'une position d'arrêt définie par rapport à l'élément de contact interne (130).
2. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel l'écran électriquement conducteur (180) est agencé radialement à l'extérieur de l'élément de contact interne (130) pour blinder électriquement l'élément de contact interne (130), ce qui réduit ainsi sensiblement une composante radiale de champ électrique dans une zone située entre la première unité de contact (110) et l'élément de contact interne (130) ; et/ou dans lequel la première unité de contact (110), l'élément de contact interne (130) et l'écran électriquement conducteur (180) sont pratiquement dans une symétrie cylindrique, et sont en particulier dans une symétrie cylindrique autour de l'axe (160).
 3. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel l'écran électriquement conducteur (180) est positionné de telle sorte qu'il ne transporte pas de courant nominal.
 4. Sectionneur à isolation gazeuse (1) selon la revendication 1, dans lequel l'écran électriquement conducteur (180) est mobile le long de la direction axiale (160) par rapport à la première unité de contact (110) ; et/ou le sectionneur à isolation gazeuse (1) comprend en outre un mécanisme d'entraînement (200) destiné à déplacer l'écran électriquement conducteur (180) et l'élément de contact interne (130) dans une direction linéaire le long de l'axe (160) entre la position de sectionnement fermé et la position de sectionnement ouvert.
 5. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel l'écran électriquement conducteur (180) réduit le rapport du champ électrique radial sur le champ électrique axial ; et/ou l'écran électriquement conducteur (180) est conçu pour diminuer l'intensité du champ vers l'enveloppe (100) ; et/ou dans lequel l'écran électriquement conducteur (180) est mobile dans le but de réduire et/ou de minimiser l'amplitude du rapport des champs électriques radial sur axial E_r / E_a et/ou du champ électrique dirigé radialement E_r dans la position de sectionnement ouvert et/ou les positions de sectionnement non refermé.
 6. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel la surface de l'écran électriquement conducteur (180) comprend une partie de surface vers l'extérieur (187) qui est située au niveau d'une partie radialement externe de l'écran électriquement conducteur (180) et qui est orientée radialement vers l'extérieur ; et/ou dans lequel l'écran électriquement conducteur (180) est couplé par conduction à l'élément de contact interne (130) pour amener l'écran électriquement conducteur (180) pratiquement au potentiel électrique de l'élément de contact interne (130) ; et/ou dans lequel le sectionneur à isolation gazeuse (1) est dimensionné pour commuter des courants de charge de bus avec des équipements dimensionnés nominalement à 72,5 kV et au-dessus.
 7. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, comprenant en outre un gaz isolant contenu dans l'enveloppe (100), le gaz isolant comprenant une composante de gaz sélectionnée à partir du groupe constitué par :
 - de l'hexafluorure de soufre,
 - de l'azote,
 - de l'oxygène,
 - du dioxyde de carbone,
 - de l'oxyde nitrique,
 - du dioxyde d'azote,
 - de l'oxyde nitreux,
 - de l'argon
 - des méthanes, en particulier des méthanes partiellement ou entièrement halogénés, en particulier du tétrafluorométhane ou du tétrafluoroiodométhane,
 - de l'air, en particulier de l'air technique ou de l'air synthétique,
 - des éthers partiellement ou entièrement fluorés, en particulier des hydrofluoro mono éthers, des hydrofluoro mono éthers contenant au moins 3 atomes de carbone, des perfluoro mono éthers, ou des perfluoro mono éthers contenant au moins 4 atomes de carbone,
 - des cétones partiellement entièrement fluorés, en particulier des hydrofluoro mono cétones, des perfluoro mono cétones comprenant au moins 5 atomes de carbone ou des perfluoro mono cétones comprenant exactement 5, 6, 7 ou 8 atomes de carbone,
 - des oléfines, par exemple HFO-1234ze ou HFO-1234yf,
 - et des mélanges de ceux-ci.
 8. Sectionneur à isolation gazeuse (1) selon la revendication 7, dont le gaz isolant est un mélange de gaz contenant au moins deux composantes de gaz différentes ou même au moins trois composantes de gaz différentes sélectionnées à partir du groupe des composantes de gaz de la revendication 7 ; et/ou un gaz isolant contenu dans l'enveloppe (100) qui n'est pas constitué de pur hexafluorure de soufre ; et/ou un gaz isolant présentant une pression de remplissage supérieure à ce que serait une pression hypo-

thétique de remplissage si de l'hexafluorure de soufre était utilisé.

9. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel la surface avant (185) de l'écran électriquement conducteur (180) se trouve pratiquement affleurant ou en retrait dans la direction axiale à distance de la première unité de contact (110), en particulier elle se trouve pratiquement affleurant ou en retrait dans la direction axiale à distance du bord de contact (132) de l'élément de contact interne (130) lorsque la seconde unité de contact (120) n'est pas en position de sectionnement fermé.

10. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel la première unité de contact (110) comprend une première structure d'extinction d'arc (115) et l'élément de contact interne (130) comprend une seconde structure d'extinction d'arc (125), les première et seconde structures d'extinction d'arc (115, 125) étant façonnées et agencées de sorte à ce qu'un arc soit formé entre les première et seconde structures d'extinction d'arc (115, 125) lorsque la seconde unité de contact (120) est ouverte à partir de la position de sectionnement fermé vers la position de sectionnement ouvert en présence d'un courant et/ou en refermant la seconde unité de contact (120) ; et/ou dans lequel la première unité de contact (110) possède une première partie de contact à puissance nominale (148) et la seconde unité de contact (120) possède une seconde partie de contact à puissance nominale (128), les première et seconde parties de contact à puissance nominale (148, 128) étant conçues pour entrer en contact l'une avec l'autre lorsque la seconde unité de contact (120) se trouve en position de sectionnement fermé, et dans lequel le chemin de résistance électrique minimale entre la première unité de contact (110) et la seconde unité de contact (120) est défini au travers des première et seconde parties de contact à puissance nominale (148, 128).

11. Sectionneur à isolation gazeuse (1) selon l'une quelconque des revendications précédentes, dans lequel la surface de l'écran électriquement conducteur (180) comprend :

- une ou la partie de surface avant (185) qui est située au niveau d'une partie radialement interne de l'écran électriquement conducteur (180) et qui est orientée vers la première unité de contact (110), et
- une partie de surface intermédiaire (186) s'étendant entre la partie de surface avant (185) et une ou la partie de surface vers l'extérieur (187) et les reliant sans à-coups,

- la partie de surface intermédiaire (186) présentant en particulier un rayon de courbure supérieur à 10 mm.

12. Sectionneur à isolation gazeuse (1) selon la revendication 11, dans lequel le rayon de courbure de la partie intermédiaire (186) de l'écran électriquement conducteur (180), s'étendant entre la partie de surface avant (185) et la partie de surface vers l'extérieur (187), diminue dans la direction radiale vers l'extérieur.

13. Sectionneur à isolation gazeuse (1) selon la revendication 1, dans lequel le coupleur mécanique (300) comprend au moins l'un d'un engrenage et d'un levier.

14. Sectionneur à isolation gazeuse (1) selon la revendication 13, dans lequel une extrémité du coupleur mécanique (300) est fixée à l'élément de contact interne (130) ou à un élément solidairement mobile avec l'élément de contact interne (130), et dans lequel l'autre extrémité du coupleur mécanique (300) est fixée à l'écran électriquement conducteur (180) ou à un élément solidairement mobile avec l'écran électriquement conducteur (180).

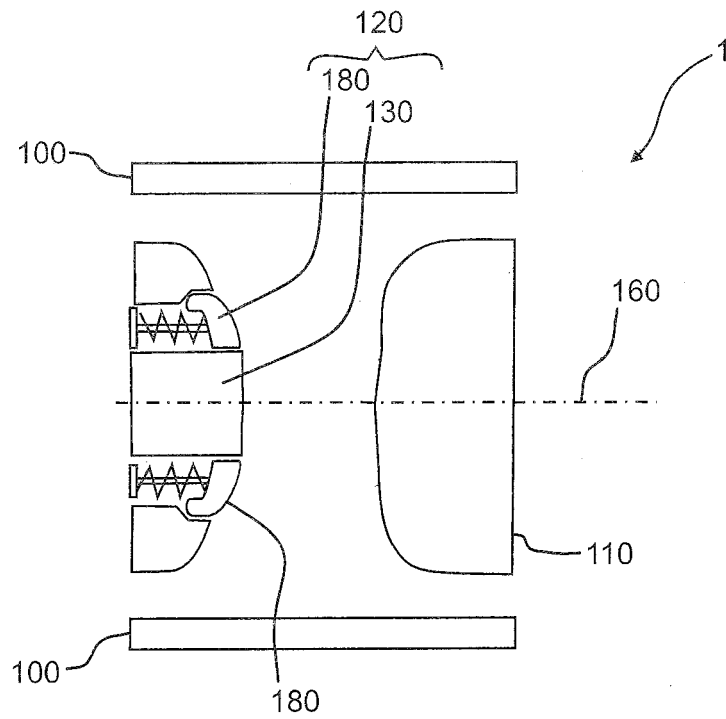


FIG. 1

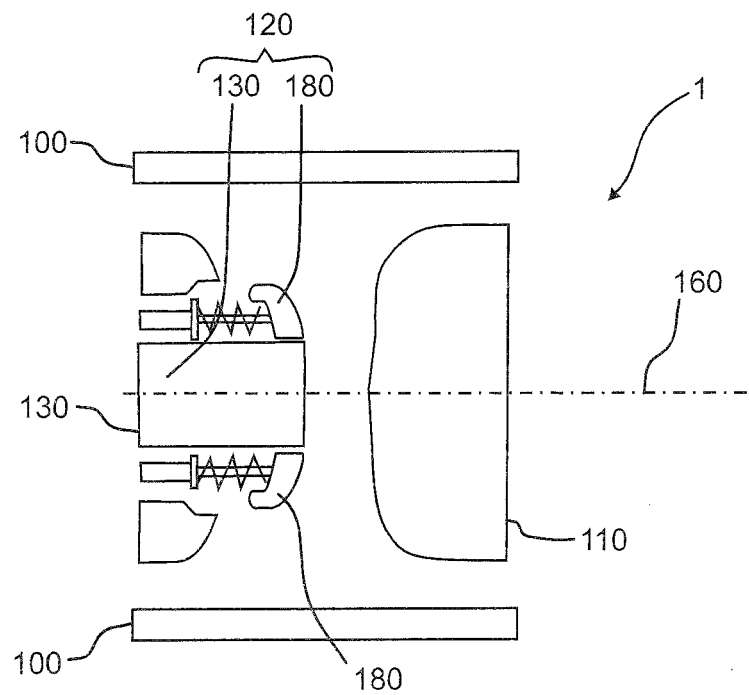


FIG. 2

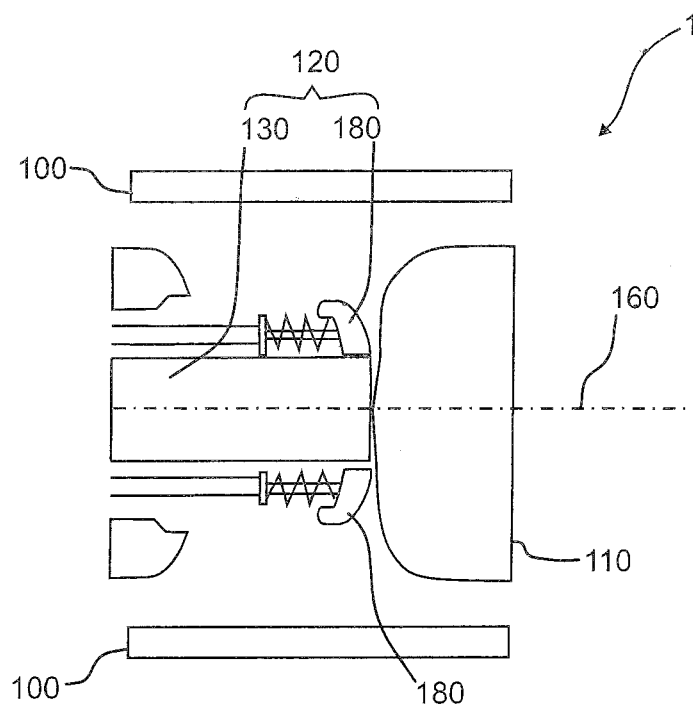


FIG. 3

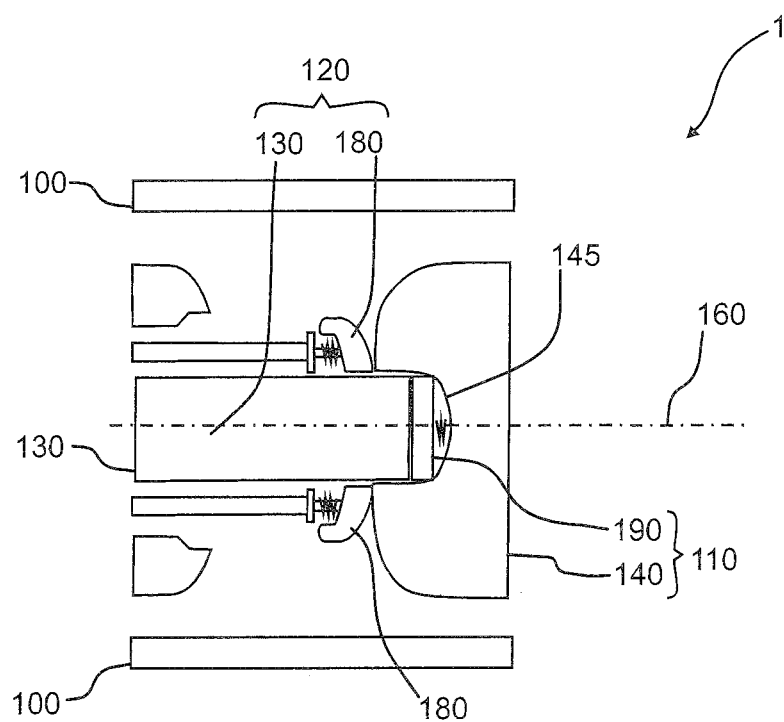


FIG. 4

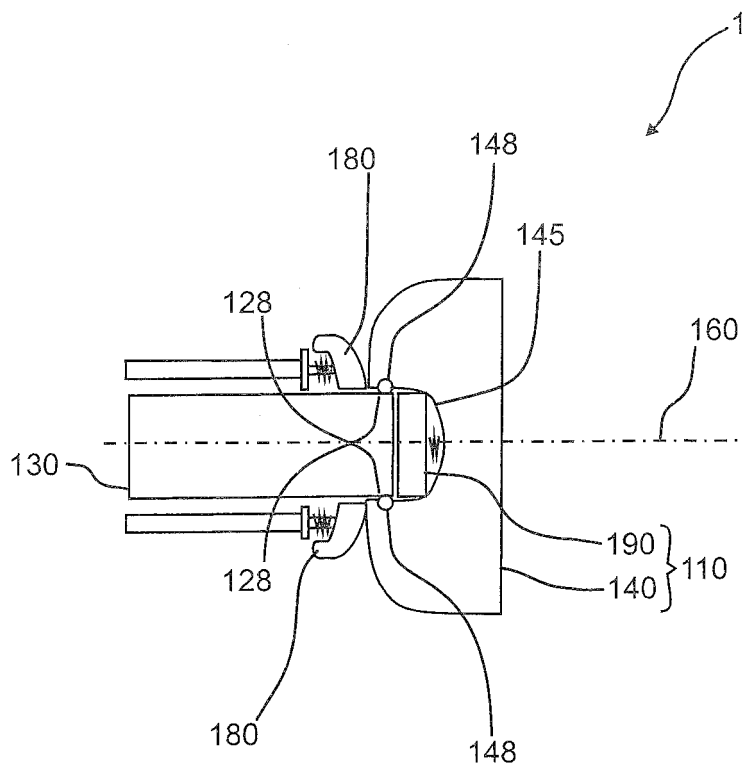


FIG. 5

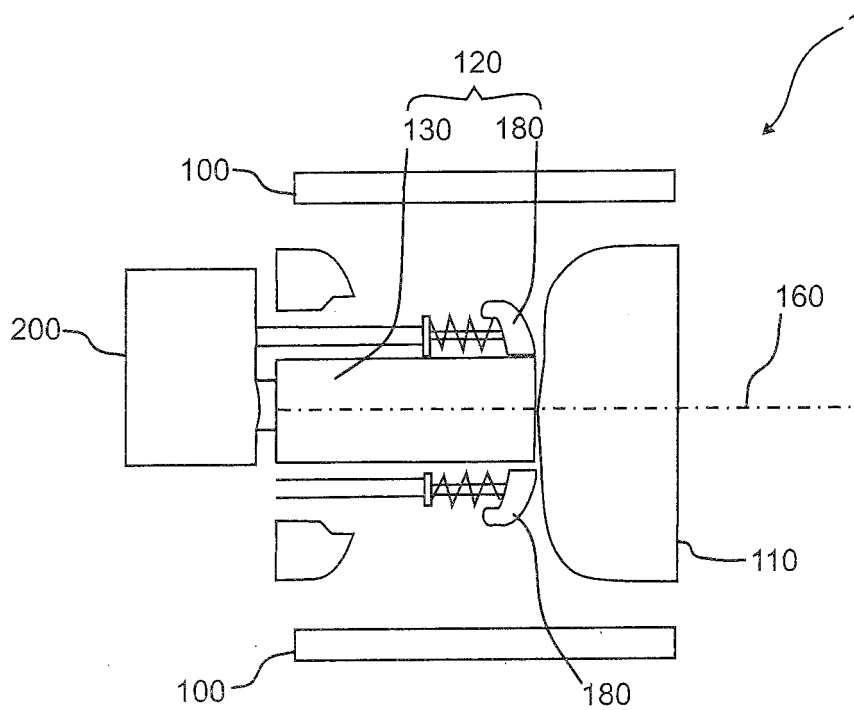


FIG. 6

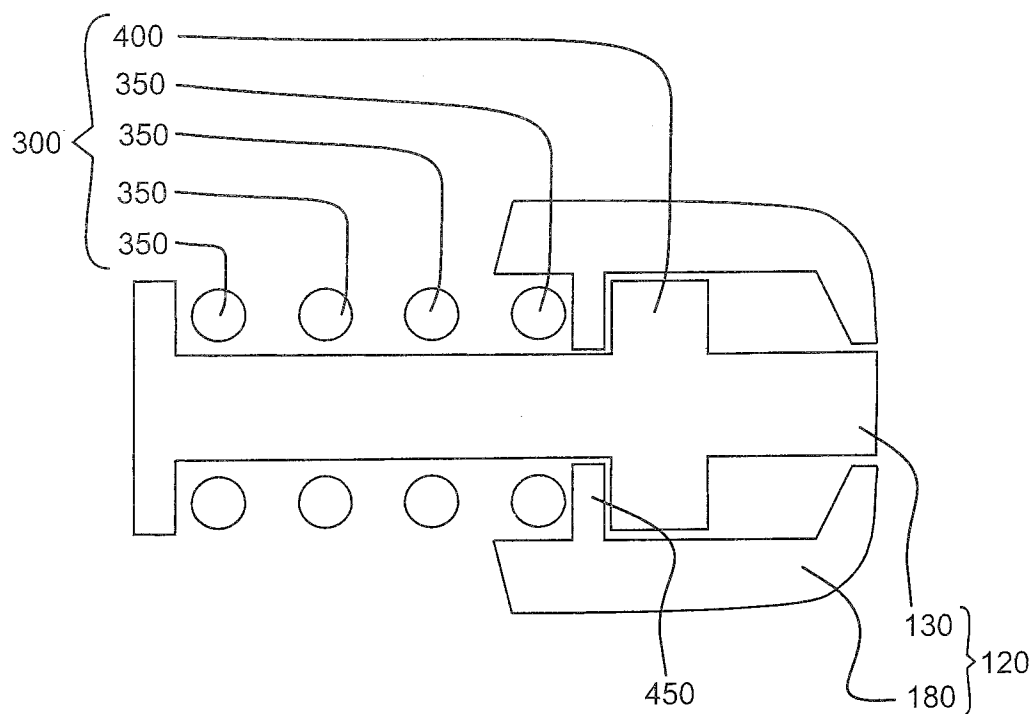


FIG. 7

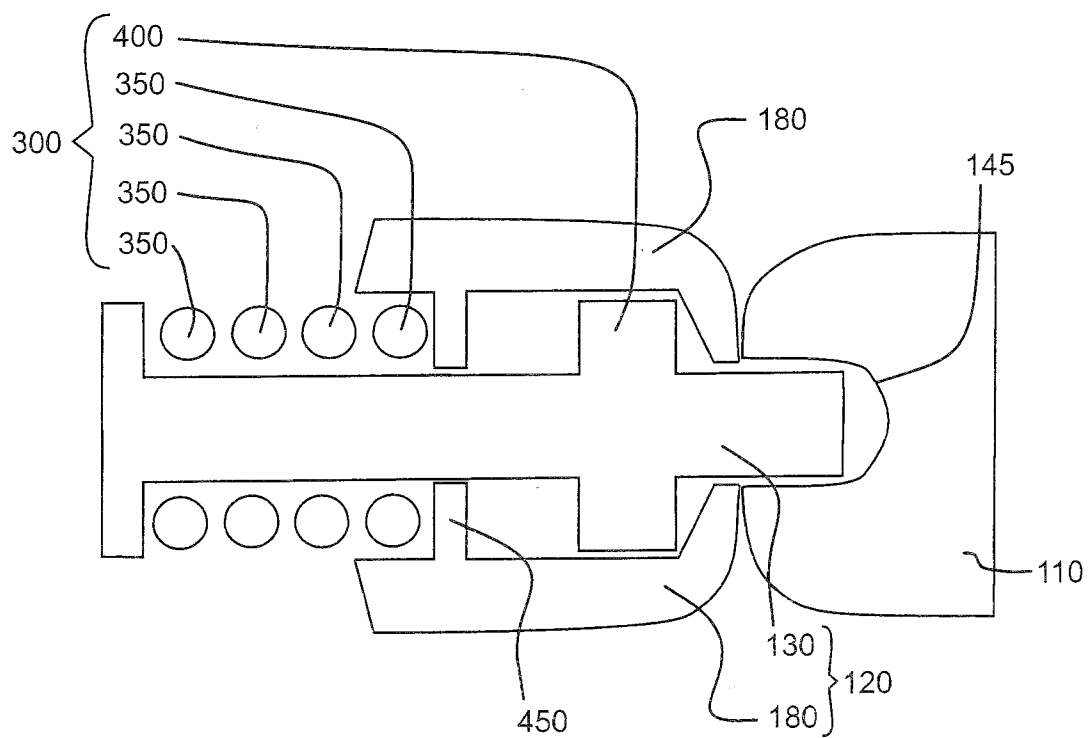


FIG. 8

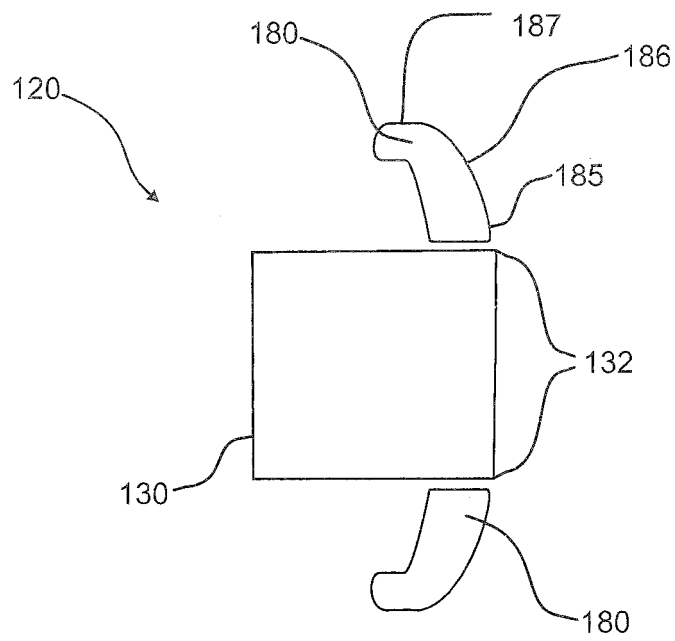


FIG. 9

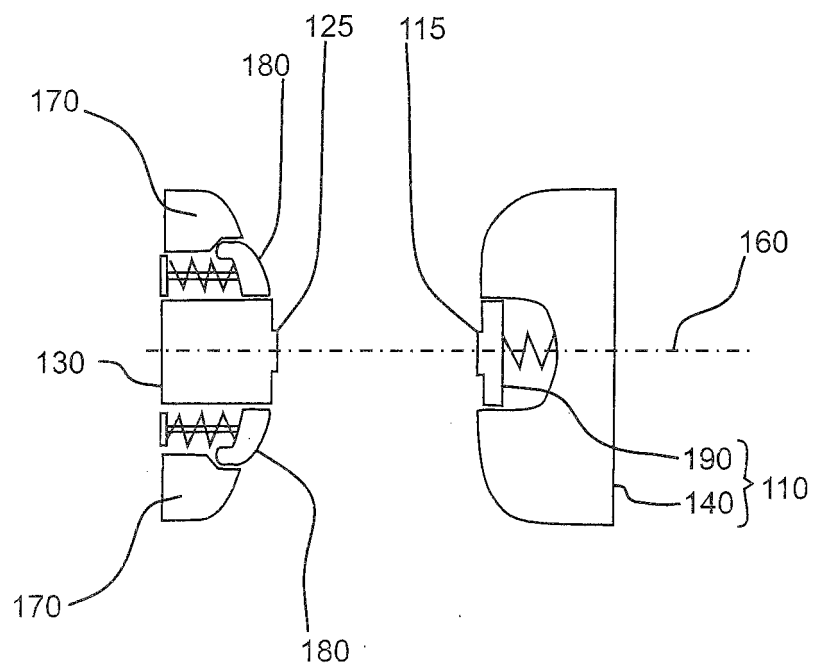


FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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