

(19)



(11)

**EP 2 645 378 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:

**02.10.2013 Bulletin 2013/40**

(51) Int Cl.:

**H01B 17/42** (2006.01)**H01H 33/662** (2006.01)**H01H 33/666** (2006.01)(21) Application number: **12161172.7**(22) Date of filing: **26.03.2012**

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:

**BA ME**(71) Applicant: **ABB Technology AG****8050 Zürich (CH)**

(72) Inventors:

- **Cortinovis, Gianluca**  
**24021 Albino (BG) (IT)**

- **Moriconi, Giorgio**  
**24020 Torre Boldone (BG) (IT)**

(74) Representative: **De Santis, Giovanni****ABB S.p.A.****Via L. Lama, 33****20099 Sesto San Giovanni (MI) (IT)**(54) **Electric device with insulators**

(57) An electric device for an electric circuit having at least a first insulator with a first main insulating body and a second insulator with a second main insulating body. The first and second main insulating bodies protrude from corresponding portions of the electric device along a first longitudinal axis and a second longitudinal axis, respectively, with said first and second longitudinal axes lying parallel to each other in a common plane.

The first insulator comprises at least a first insulating fin and at least a second insulating fin which protrude from the first main insulating body so as to lie in a respective first plane and a second plane, respectively, perpendicular with respect to said common plane. The first fin and the second fin have a first distance  $D_1$  and a second distance  $D_2$ , respectively, between their delimiting ends nearer to the second longitudinal axis and the first longitudinal axis, wherein  $D_1 > D_2$ .

The second insulator comprises at least a third insulating fin and at least a fourth insulating fin which protrude from the second main insulating body so as to face the first fin and the second fin, respectively. The third and fourth fins have a third distance  $D_3$  and a fourth distance  $D_4$ , respectively, between their delimiting ends nearer to the first longitudinal axis and the second longitudinal axis.

The first, second, third and fourth distances  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$  satisfy the following relationships:

$$D_1 > D_3; D_4 > D_2; D_4 > D_3; \text{ and } D_4 < D_1 + (D_1 - D_2).$$

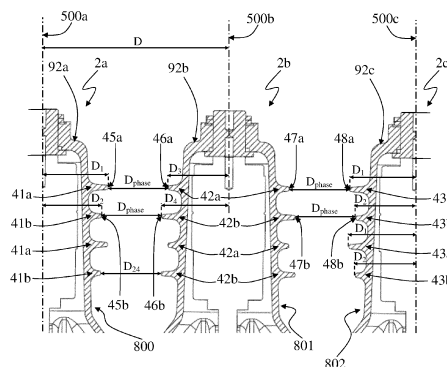


Fig. 8

## Description

**[0001]** The present invention relates to an electric device having a plurality of insulators with improved characteristics.

**[0002]** As known, insulators, such as for example bushings or insulating rods, are widely used in electric devices, associated to corresponding powered parts of such devices. In particular, the insulator has a main insulating body suitable for housing the corresponding powered parts, in such a way as to isolate them from the environment outside the insulator.

**[0003]** Generally, a phase of the electric device is associated to an insulator which contributes to the electrical isolation between the electric phase itself and the other adjacent electric phases of the electric device.

**[0004]** For example, insulators can be associated to the electric phases, or poles, of known switching devices, such as circuit breakers, disconnectors or contactors.

**[0005]** For example, insulators can be associated to the electric phases of known electric transformers, such as in the case where a feedthrough insulator is provided for allowing the passage of a conductor under voltage through an obstacle, e.g. thorough the tank of the transformer.

**[0006]** The insulator generally comprises a plurality of circular fins which protrude from its main insulating body in order to increase the creepage distance of the insulator itself (i.e. the distance covered by a leakage current flowing along the peripheral surface of the main insulating body, between its upper and lower ends).

**[0007]** In particular, fins having a greater radius (greater fins) and fins having a smaller radius (smaller fins) protrude from the main insulating body alternated to each other.

**[0008]** The greater fins of insulating bodies placed side by side are faced to each other, and the smaller fins of such insulating bodies are faced to each other.

**[0009]** For example, figure 1 shows a first insulator 700 and a second insulator 701 according to the state of the art, having a first main insulating body 702 and a second main insulating body 703, respectively.

**[0010]** The insulating body 702 and the insulating body 703 protrude and extend from corresponding portions of a known electric device, such as for example a switching device, along a first longitudinal axis 80 and a second longitudinal axis 81, respectively. The first and second longitudinal axes 80 and 81 lie parallel to each other in a common plane in such a way that the main insulating bodies 702 and 703 are aligned to each other and placed side by side.

**[0011]** The insulators 700 and 701 are associated to a first electric phase and a second adjacent electric phase of the electric device, respectively.

**[0012]** The greater circular fins 710 of the insulator 700 protrude from the main insulating body 702, each one faced to a corresponding greater circular fin 711 protruding from the main insulating body 703; in particular, the

faced greater fins 710 and 711 have the same radius.

**[0013]** The smaller circular fins 712 of the insulator 700 protrude from the main insulating body 702, each one faced to a corresponding one of the smaller fins 713 protruding from the second main insulating body 703; the smaller fins 712 and 713 faced to each other have the same radius.

**[0014]** The clearance distance between the first and second electric phases depends on the minimum distance in air  $D_{\text{phase}}$  between insulators 700, 701. In particular, such distance  $D_{\text{phase}}$  corresponds to the minimum distance between the greater fins 710 of the insulator 700 and the corresponding faced greater fins 711 of the insulator 701.

**[0015]** The distance  $D_{\text{phase}}$  is particularly critical, since that the dielectric stress between adjacent phases (and the undesired effects of the dielectric stress), strongly depends on such distance  $D_{\text{phase}}$ .

**[0016]** At the current state of the art, although known solutions perform in a rather satisfying way, there is still reason and desire for further improvements.

**[0017]** Such desire is fulfilled by an electric device suitable for being installed in an electric circuit and comprising at least a first insulator having a first main insulating body and a second insulator having a second main insulating body, wherein the first main insulating body and the second main insulating body protrude from corresponding portions of the electric device along a first longitudinal axis and a second longitudinal axis, respectively, with the first and second longitudinal axes lying parallel to each other in a common plane.

**[0018]** The first insulator has a plurality of insulating fins comprising:

- at least a first insulating fin protruding from the first main insulating body so as to lie in a respective first plane perpendicular with respect to the common plane, such first insulating fin having a first distance  $D_1$  between its delimiting end nearer to the second longitudinal axis and the first longitudinal axis; and
- at least a second insulating fin protruding from the first main insulating body so as to lie in a respective second plane perpendicular with respect to the common plane, the second insulating fin having a second distance  $D_2$  between its delimiting end nearer to the second longitudinal axis and the first longitudinal axis, wherein the first distance  $D_1$  is greater than the second distance  $D_2$ .

**[0019]** The second insulator has a plurality of insulating fins comprising:

- at least a third insulating fin protruding from the second main insulating body so as to face the first insulating fin, the third insulating fin having a third distance  $D_3$  between its delimiting end nearer to said first longitudinal axis and the second longitudinal axis; and

- at least a fourth insulating fin protruding from the second main insulating body so as to face the second insulating fin, the fourth insulating fin having a fourth distance  $D_4$  between its delimiting end nearer to the first longitudinal axis and the second longitudinal axis.

**[0020]** The first, second, third and fourth distances  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$  satisfy the following relationships:

$$D_1 > D_3; D_4 > D_2; D_4 > D_3; \text{ and } D_4 < D_1 + (D_1 - D_2).$$

**[0021]** Another aspect of the present disclosure is to provide a switchgear comprising at least an electric device such as the electric device defined by the annexed claims and disclosed in the following description.

**[0022]** In the following description particular reference will be made for example to an electric switching device; in particular, reference will be made for example to an electric switching device suitable for being used in medium voltage applications.

**[0023]** For the purpose of the present disclosure the term "medium voltage" is referred to applications with operating voltages in the range from 1 kV to some tens of kV, e.g. 30kV or 40 kV.

**[0024]** It is to be set forth that the principles and technical characteristics introduced in the following description are applicable to switching devices of different type and/or used in applications with a voltage range different to the one indicated above, e.g. in applications having a voltage greater than 40kV.

**[0025]** Furthermore, the introduced solutions and technical characteristics, in particular those related to the disclosed insulators, are also applicable to any type of electric device, such as for example an electric transformer.

**[0026]** Further characteristics and advantages will be more apparent from the description of exemplary, but non-exclusive, embodiments of an electrical device according to the present disclosure, illustrated in the accompanying drawings, wherein:

- figure 1 shows two insulating bodies placed aligned to each other, side by side, in an electric device according to the state of the art;
- figure 2 shows an electric scheme of an electric phase in a switching device according to the present invention;
- figure 3 is a perspective view of a switching device according to present invention;
- figure 4 is an exploded view of the components of the switching device of figure 3;
- figure 5 is a perspective view of the metal shell of the switching device of figure 3, also showing the components housed and/or supported by such metal shell;
- figure 6 is a section lateral view of the switching device of figure 3;
- figure 7 is a sectional front view of an electric phase

of the switching device of figure 3;

- figure 8 is a lateral section view showing at least partially the three aligned main insulating bodies of the switching device in figure 3;
- figure 9 is a lateral sectional view of a switchgear having a switching device installed therein according to the present invention.

**[0027]** It should be noted that in the detailed description that follows, identical or similar components, either from a structural and/or functional point of view, have the same reference numerals, regardless of whether they are shown in different embodiments of the present disclosure; it should also be noted that in order to clearly and concisely describe the present disclosure, the drawings may not necessarily be to scale and certain features of the disclosure may be shown in somewhat schematic form.

**[0028]** The present disclosure is related to an electric device 1 suitable for being installed in an electric circuit; the electric device 1 comprises at least a first insulator 800 having a first main insulating body 92a and a second insulator 801 having a second main insulating body 92b. The main insulating body 92a and the main insulating body 92b protrude from corresponding portions of the electric device 1 along a first longitudinal axis 500a and a second longitudinal axis 500b, respectively; in particular, the first and second longitudinal axes 500a and 500b lie parallel to each other in a common plane 900 (which is schematically depicted by dot lines in figure 3 and which practically coincides to the sheet of figure 8), in such a way that the main insulating bodies 92a and 92b are aligned to each other.

**[0029]** In practice, the longitudinal axes 500a and 500b cross centrally the respective insulators 800 and 801 along the longitudinal extension of their main insulating bodies 92a and 92b.

**[0030]** With reference to the exemplary non limiting embodiment of figures 2-9, the electric device 1 according to the present disclosure can be a switching device 1 suitable for being installed in an electric circuit 102, for instance in a medium voltage electric circuit 102.

**[0031]** The switching device 1 illustrated for example in figures 2-9 comprises: a first electrical phase 2a associated to the first insulator 800 (having the main insulating body 92a), a second electric phase 2b associated to the second insulator 801 (having the main insulating body 92b); and a third electric phase 2c associated to a third insulator 802 (having the main insulating body 92c).

**[0032]** The three electric phases 2a, 2b and 2c operatively electrically connect a first part 100 and a second part 101 of the electric circuit 102 (as illustrated for example in figure 2 which is related to the electric phase 2a). For instance, the first part 100 of the electric circuit 102 can be a distribution, or line, part 100 suitable for distributing power, and the second part 101 can be a load part 101 drawing power from the distribution part 101.

**[0033]** In particular, each of the three illustrated electric

phases 2a, 2b, 2c comprises at least a switching unit 10 having a movable contact 11, which can be actuated, during the operation of the switching unit 10 itself, to be coupled/decoupled to/from a corresponding fixed contact 12, as will be disclosed in more detail in the following description.

**[0034]** In the exemplary embodiment illustrated in figures 3-4, 6 and 8-9 the main insulating bodies 92a, 92b, 92c of the three insulators 800, 801, 802 protrude from a corresponding portion 90 of the switching device 1 along the longitudinal axis 500a, the longitudinal axis 500b and the third longitudinal axis 500c, respectively, which lie parallel to each other in the common plane 900.

**[0035]** The three main insulating bodies 92a, 92b, 92c are aligned to each other; in particular, the main insulating body 92a is placed side by side to the main insulating body 92b, which in turn is placed side by side to the main insulating body 92c.

**[0036]** It is to be set forth that the switching device 1 according to the present disclosure can have, according to specific requirements, a number of phases and associated insulators different to the illustrated one, e.g. two or four electric phases and associated insulators.

**[0037]** With reference to the exemplary embodiment of figures 3-9 (in particular to figures 6 and 8), the first insulator 800 of the electric device 1 according to the present disclosure has a plurality of insulating fins comprising:

- at least a first insulating fin 41a (hereinafter indicated for sake of simplicity as "fin 41a") protruding from the main insulating body 92a so as to lie in a respective first plane 901 (schematically viewable as a dot line in figure 6) which is perpendicular with respect to the common plane 900; the fin 41a has a first distance  $D_1$  between its delimiting end 45a nearer to the longitudinal axis 500b of the main insulating body 92b and the longitudinal axis 500a of the main insulating body 92a; and
- at least a second insulating fin 41b (hereinafter indicated for sake of simplicity as "fin 41b") protruding from the main insulating body 92a so as to lie in a respective second plane 902 (schematically viewable as a dot line in figure 6) which is perpendicular with respect to the common plane 900; the fin 41b has a second distance  $D_2$  between its delimiting end 45b nearer to the longitudinal axis 500b and the longitudinal axis 500a.

**[0038]** The second insulator 801 of the electric device 1 has a plurality of insulating fins comprising:

- at least a third insulating fin 42a (hereinafter indicated for sake of simplicity as "fin 42a") protruding from the main insulating body 92b so as to face the fin 41a; the fin 42a has a third distance  $D_3$  between its delimiting end 46a nearer to the longitudinal axis 500a of the main insulating body 92a and the longitudinal axis 500b of the main insulating body 92b; and

and

- at least a fourth insulating fin 42b (hereinafter indicated for sake of simplicity as "fin 42b") protruding from the main insulating body 92b so as to face the fin 41b; the fin 42b has a fourth distance  $D_4$  between its delimiting end 46b nearer to the longitudinal axis 500a of the main insulating body 92a and the longitudinal axis 500b of the main insulating body 92b.

**[0039]** In particular, the insulating fins 41a and 42a lie in the same plane 901 so as to be faced to each other; in the same way, the insulating fins 41a and 41b lie in the same plane 902 so as to be faced to each other.

**[0040]** The distances  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$  advantageously satisfy the following relationships:

$$D_1 > D_2; D_1 > D_3; D_4 > D_2; D_4 > D_3; \text{ and } D_4 < D_1 + (D_1 - D_2).$$

**[0041]** In order to better explain how satisfying the above mentioned relationships provides an improvement with respect to known solutions, firstly it is considered the case in that the fins 41a, 41b, 42a, 42b are dimensioned according to the state of the art, i.e. by dimensioning the fins 41a, 41b, 42a, 42b so as:

$$D_1 = D_3; D_2 = D_4;$$

wherein  $D_1 > D_2$ .

**[0042]** In this case, considering  $D$  the distance between the longitudinal axes 500a and 500b of the main insulating bodies 92a and 92b, the minimum distance in air  $D_{p_{\text{phase}}}$  between the insulators 800 and 801 would be equal to  $D - 2D_1$ .

**[0043]** Secondly, it is considered the case of having already dimensioned the insulating fins 41a, 41b and 42a according to the present invention, so as:

$$D_1, > D_2 \text{ and } D_1, > D_3.$$

**[0044]** The remaining fin 42b, in addition to be dimensioned so as  $D_4$  is greater than  $D_2$  and greater than  $D_3$ , has to be dimensioned imposing an upper limit to the value of  $D_4$ . Such upper limit is chosen so as the distance  $D_{24}$  between the delimiting ends 45b and 46b of the faced fins 41b and 42b (see figure 4) is greater than the minimum distance in air  $D_{p_{\text{phase}}}$  that would be present by dimensioning the fins 41a, 41b, 42a, 42b according to the state of the art.

**[0045]** Therefore, it is imposed that:

$$D_{24} > D - 2D_1, \text{ wherein } D_{24} = D - D_2 - D_4.$$

**[0046]** This leads to the following dimensional constrain for the fin 42b:

$$D_4 < D_1 + (D_1 - D_2).$$

**[0047]** According to a preferred but not limiting embodiment, the fins 41a, 41b and 42a, 42b have a circular shape; in this case the distances  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$  correspond to the radius of the circumference delimiting the peripheral edge of the respective fins 41a, 41b, 42a, 42b. According to an exemplary embodiment, the distance  $D_4$  is equal to the distance  $D_1$ , and the distance  $D_3$  is equal to the distance  $D_2$ . In this way the same distance  $D_{p_{hase}}$  is present between the delimiting ends 45a-46a of the faced fins 41a-42a and between the delimiting ends 45b-46b of the faced fins 41b-42b.

**[0048]** In such a case, the ratio between the distance  $D_3$  (equal to the distance  $D_2$ ) and the distance  $D_1$  (equal to the minimum distance  $D_4$ ) is comprised for instance between 0.5 and 0.9, e.g. is equal to 0.8.

**[0049]** According to a preferred but not limiting embodiment, the insulator 800 comprises a plurality of fins 41a and a plurality of fins 41b, wherein the fins 41a and 41b protrude from the main insulating body 92a alternated to each other, as illustrated in the exemplary embodiment of figures 3-4, 6 and 8-9.

**[0050]** Accordingly, the insulator 801 comprises a plurality of fins 42a and a plurality of fins 42b, wherein the fins 42a and 42b protrude from the main insulating body 92b alternated to each other. In particular, each fin 42a is faced to a corresponding one of the plurality of fins 41a (i.e. it lies in the same plane 901 of the corresponding fin 41a), and each fin 42b is faced to a corresponding one of the plurality of fins 41b (i.e. it lies in the same plate 902 of the corresponding fin 42b).

**[0051]** In the exemplary embodiment of figures 3-9, the main insulating bodies 92a, 92b and 92c of the insulators 800, 801 and 802 have a substantially cylindrical shape.

**[0052]** Two circular-shaped insulating fins 41a and two circular-shaped insulating fins 41b protrude from the main insulating body 92a alternated to each other; two circular-shaped insulating fins 42a and two ring-shaped insulating fins 42b protrude from the main insulating body 92b alternated to each other, so as each of the two insulating fins 42a face a corresponding one of the two insulating fins 41a (i.e. they lie in the same plane 901), and each of the two insulating fins 42b face a corresponding one of the two insulating fins 42b (i.e. they lie in the same plane 902).

**[0053]** It is to be set forth that the number of alternated insulating fins 41a and 41b, and of the corresponding insulating fins 42a and 42b can be different to the illustrated one.

**[0054]** Each of the two insulating fins 41a has the distance  $D_1$  between its delimiting end 45a nearer to the longitudinal axis 500b of the main insulating body 92b and the longitudinal axis 500a of the main insulating body 92a (such distance  $D_1$  corresponding to the radius of the circumference delimiting the peripheral edge of the fin 41a).

**[0055]** Each of the two insulating fins 41b has the distance  $D_2$  between its delimiting end 45b nearer to the longitudinal axis 500b and the longitudinal axis 500a

(such distance  $D_2$  corresponding to the radius of the circumference delimiting the peripheral edge of the fin 41b).

**[0056]** Each of the two insulating fins 42a has the distance  $D_3$  between its delimiting end 46a nearer to the longitudinal axis 500a and the longitudinal axis 500b (such distance  $D_3$  corresponding to the radius of the circumference delimiting the peripheral edge of the fin 42a).

**[0057]** Each of the two insulating fins 42b has the distance  $D_4$  between its delimiting end 46b nearer to the longitudinal axis 500a and the longitudinal axis 500b (such distance  $D_4$  corresponding to the radius of the circumference delimiting the peripheral edge of the fin 42b).

**[0058]** In the exemplary embodiment of figure 8, the distance  $D_1$  is equal to the distance  $D_4$  and the distance  $D_2$  is equal to the distance  $D_3$ , wherein the distance  $D_1$  is greater than the distance  $D_2$ . In particular the ratio between  $D_3$  and  $D_1$  (and therefore between  $D_2$  and  $D_4$ ) is substantially equal to 0.8.

**[0059]** In this way, the same distance in air  $D_{p_{hase}}$  is present between the delimiting ends 45a-46a of the faced fins 41a-42a, and between the delimiting ends 45b-46b of the faced fins 41b-42b.

**[0060]** Alternatively to the illustrated exemplary embodiment of figure 8, the minimum distance  $D_4$  (greater than the minimum distance  $D_2$  and than the minimum distance  $D_3$ ) could be dimensioned minor with respect to the minimum distance  $D_1$ , or could be dimensioned according to the following relationship:

$$D_1 + (D_1 - D_2) > D_4 > D_1.$$

**[0061]** In the exemplary embodiment of figures 3-9 the insulator 802 also comprises two circular-shaped fins 43a and two circular-shaped fins 43b, wherein the fins 43a and 43b protrude from the main insulating body 92c alternated to each other, so as each of the two fins 43a is faced to a corresponding one of the two fins 42a (i.e. it lies in the same plane 901 of the corresponding fin 42a), and each one of the two insulating fins 43b is faced to a corresponding one of the two insulating fins 42b (i.e. it lies in the same plane 902 of the corresponding fin 42b).

**[0062]** Each of the two insulating fins 43a has a distance between its delimiting end 48a nearer to the longitudinal axis 500b of the main insulating body 92b and the longitudinal axis 500c of the main insulating body 92c; such distance is equal to the distance  $D_1$  and corresponds to the radius of the circumference delimiting the peripheral edge of the fin 43a.

**[0063]** Each of the two insulating fins 43b has a distance between its delimiting end 48b nearer to the longitudinal axis 500b and the longitudinal axis 500c which is equal to the distance  $D_2$  (such distance corresponding to the radius of the circumference delimiting the peripheral edge of the fin 43b).

**[0064]** In this way, the same distance in air  $D_{p_{hase}}$  is present between the delimiting ends 47a-48a of the faced fins 42a-43a, and between the delimiting ends 47b-48b

of the faced fins 42b-43b.

**[0065]** Each of the two insulating fins 42a having the distance  $D_3$  is faced to the corresponding fins 41a and 43a having the greater distance  $D_1$ ; and each of the two fins 42b having the distance  $D_4$  (equal to the radial distance  $D_1$ ) is faced to the corresponding fins 41b and 43b having the smaller distance  $D_2$ .

**[0066]** The switching device 1 according to the exemplary embodiment of figures 2-9 comprises a casing 50 having at least a portion 51 made of insulating material. Preferably, the casing 50 defines a gas-tight internal space which can be filled with insulating gas, such as for example SF6 or alternatively, in applications for smaller voltages, with air.

**[0067]** The casing 50 houses the switching unit 10 of each of its electric phases 2a, 2b, 2c, and its insulating portion 51 comprises the insulators 800, 801 and 802 associated to such electric phases 2a, 2b and 2c.

**[0068]** Preferably, the casing 50 advantageously comprises also a metal portion 52. In the exemplary embodiment of figures 3- 9, the insulating portion 51 and the metal portion 52 of the casing 50 comprise an insulating shell 51 and a metal shell 52, respectively, which are coupled to each other.

**[0069]** The insulating shell 51 can be made for example of polymeric material (e.g. a thermoplastic or a thermosetting material). Among the thermosetting polymers, epoxy resin or polyester can be cited for example. In case of outdoor installation of the switching device 1, the insulating shell 51 can be entirely made of or comprise at least a covering layer of a polymeric material that is resistant to the external environment, e.g. epoxy cycloaliphatic resin or silicon coated material.

**[0070]** The metal shell 52 can be made for example of steel, such as stainless steel or pre-galvanized steel.

**[0071]** Preferably, each of the main insulating bodies 92a, 92b and 92c of the insulators 800, 801 and 802 defines an internal chamber 93 housing the switching unit 10 of the corresponding electric phase 2a, 2b, 2c.

**[0072]** In the exemplary embodiment of figures 2-9 the switching unit 10 is a circuit breaker unit 10, wherein its movable contact 11 can be actuated, during the operation of the circuit breaker unit 10 itself, between a closed position where it is coupled to the corresponding fixed contact 12 and an open position where it is spaced away from the fixed contact 12 so as to be electrically separated from such contact 12.

**[0073]** With reference to the example of figure 2, the actuation from the open position to the closed position of the movable contact 11 of the circuit breaker unit 10 of the electric phase 2a allows the flowing of a current  $I_{p_{hase}}$  between the first and second parts 100, 101 of the electric circuit 102, through the electrically coupled movable and fixed contacts 11, 12.

**[0074]** The actuation of the movable contact 11 from the closed position to the open position causes the interruption of such current  $I_{p_{hase}}$  by means of the electrical separation between the movable and fixed contacts 11,

12. Such actuation can be caused by the manual intervention of an operator, or automatically (by means of actuators) at the occurrence of an electric fault, e.g. an overload or a short-circuit.

**[0075]** In the exemplary embodiment of figures 3-9, the circuit breaker unit 10 comprises a bulb 15 defining an internal sealed environment where the electrical connection/separation between the movable and fixed contacts 11, 12 can occur. Preferably, the internal space of the bulb 15 is in vacuum; alternatively, such internal space may be filled with insulating gas. Accordingly, the circuit breaker chamber 93 is defined so as to house the bulb 15 of the corresponding circuit breaker unit 10. A through hole 95 is defined in the upper end of the insulating bodies 92a, 92b and 92c to allow the free passage into the respective circuit breaker chamber 93 of an electric terminal 3.

**[0076]** The electric terminal 3 is connected to the circuit breaker unit 10 housed in the circuit breaker chamber 53 (in particular it is connected to the fixed contact 12 into the bulb 15) and is suitable for electrically connecting the circuit breaker unit 10 to the corresponding portion 100 of the electric circuit 102.

**[0077]** The switching device 1 comprises actuating means (schematically depicted and indicated with numeral reference 200 in figure 2) which are operatively connected to and adapted to actuate the movable contact 11 of each circuit breaker unit 10 of the switching device 1 itself.

**[0078]** For example, the actuating means 200 comprise a kinematic chain (overall indicated with numeral reference 201) and driving means 203 operatively connected to each other. The kinematic chain 201 is operatively connected to the movable contact 11 of each circuit breaker unit 10 housed in a corresponding circuit breaker chamber 93 and is adapted to be driven by the driving means 203 to cause the actuation of the movable contacts 11 between the open and closed positions.

**[0079]** In the exemplary embodiment of figures 2-3 and 6, the driving means 203 comprise a driving shaft 203 which can rotate about an axis of rotation 204 and which is operatively connected (through conventional linkage means 205) to the kinematic chain 201. The kinematic chain 201 is in turn operatively connected to and adapted to cause the actuation of the movable contact 11 of each circuit breaker unit 10, upon the rotation of the driving shaft 203 about the axis 204.

**[0080]** The insulating shell 51 of the switching device 1 comprises a central portion 90 defining an internal main chamber 91 housing at least a portion of the actuating means 200, wherein the main insulating bodies 92a, 92b and 92c protrude from such central portion 90 along the respective longitudinal axes 500a, 500b and 500c.

**[0081]** In the exemplary embodiment of figures 3-4 and 6-8, the internal main chamber 91 houses the kinematic chain 201, wherein each circuit breaker chamber 93 can be accessed from the main chamber 91 so as the kinematic chain 201 can operatively interact to the associated

movable contacts 11 of the circuit breaker units 10.

**[0082]** An access opening 59 is defined in the central portion 90 of the insulating shell 51; the switching device 1 comprises a cover 400 which is operatively coupled to the central portion 90 to cover the access opening 59, and which is adapted to cover and support the driving shaft 203 in such a way that it can rotate about the axis 204. The access opening 59 allows the free access into the main chamber 91 of the linkage means 205 in order to operatively connect the driving shaft 203 and the kinematic chain 201. Preferably, the cover 400 is made of metal material to better support the driving shaft 203 and withstand the forces generated during the rotation of the shaft 203 itself.

**[0083]** According to a preferred embodiment, the insulating shell 51 is advantageously manufactured in a single piece, i.e. the central portion 90, the main insulating body 90a (with the associated insulating fins 41a, 41b), the main insulating body 92b (with the associated insulating fins 42a, 42b) and the main insulating body 92c (with the associated insulating fins 43a, 43b) are all integral-made during the manufacturing process.

**[0084]** In the exemplary embodiment of figures 3-9, the central portion 90 of the insulating shell 51 1 comprises: a base portion 53; a first front wall 96 and a second front wall 97 which protrude transversally from opposed ends of the base portion 53 in such a way to be faced to each other; first and second parallel lateral walls 98 and 99 which protrude transversally from the base portion 53 in such a way to link transversally the first and second front walls 96 and 97; and an upper wall 25 linking transversally the first and second lateral walls 98 and 99 (and the first and second faced front walls 96 and 97).

**[0085]** The base portion 53 is coupled to a corresponding flanged portion 54 of the metal shell 52 and the access opening 59 is defined in the first front wall 96, with the cover 400 fixed to such wall 96 so as to cover such opening 59 and to support the driving shaft 203. The main insulating bodies 92a, 92b and 92c protrude from the upper wall 25 along their respective longitudinal axes 500a, 500b and 500c.

**[0086]** The central portion 90 further advantageously comprises: at least a support tab 110 connecting the first lateral wall 98 to the based portion 53; and at least a second support tab 111 (viewable for example in figure 7) connecting the second lateral wall 99 to the based portion 53. Such support tabs 110, 111 are suitable for reinforcing the overall structure of the insulating shell 51.

**[0087]** In the exemplary embodiment of figure 3 said at least a tab 110 comprises:

- a support tab 110a lying in a plane 450 comprising the longitudinal axis 500a;
- a support tab 110b lying in a plane 451 comprising the longitudinal axis 500b;
- a support tab 110c lying in a plane 452 comprising the longitudinal axis 500c;
- a support tab 100d placed between the support tabs

110a and 110b; and

- a support tab 100e placed between the support tabs 100b and 110c.

**[0088]** Said at least a support tab 111 comprises:

- a support tab aligned to the support tab 110a (i.e. lying in the same plane 450 of the support tab 110a);
- a support tab aligned to the support tab 110b (i.e. lying in the same plane 451 of the support tab 110b);
- a support tab aligned to the support tab 110c (i.e. lying in the same plane 452 of the support tab 110c);
- a support tab aligned to the support tab 110d (i.e. lying in the same plane of the support tab 100d); and
- a support tab aligned to the support tab 110e (i.e. lying in the same plane of the support tab 110e).

**[0089]** According to the exemplary embodiment of figures 2-9, each of the electric phase 2a, 2b and 2c of the switching device 1 comprises a further switching unit 20 associated to the switching unit 10 disclosed in the above description. Such switching unit 20 comprises at least movable contact 21 which can be actuated, during the operation of the switching unit 20 itself, to be coupled/separated to/from a corresponding fixed contact 22.

**[0090]** An electric terminal 4 is connected to each switching unit 20 and is suitable for electrically connecting the switching unit 20 to the corresponding portion 101 of the electric circuit 102. The overall casing 50 also houses the switching unit 20 of each electric phase 2a, 2b, 2c.

**[0091]** In the exemplary embodiment of figures 2-9, the switching unit 20 is a disconnecter unit 20 wherein the movable contact 21 can be actuated, during the operation of the disconnecter unit 20 itself, between a connection position where it is coupled and connected to the corresponding fixed contact 22, and at least a disconnection position where it is spaced away from from the fixed contact 22, so as to be disconnected from such contact 22.

**[0092]** The switching device 1 comprises actuating means (schematically depicted and indicated with numeral reference 300 in figure 2) operatively connected to and adapted to cause the actuation of the movable contact 21 of each disconnecter unit 20. Preferably, the casing 50 houses at least a portion of the actuating means 300.

**[0093]** With reference to figure 2, the connection between the movable and fixed contacts 21, 22 is suitable for realizing an electrical connection between the first and second parts 100, 101 of the electric circuit 102. The actuation of the movable contact 21 from the connection position to the disconnection position causes a physical separation between the first and second parts 100, 101 (in order to interrupt the electrical connection between them).

**[0094]** Preferably, the disconnecter unit 20 and the circuit breaker unit 10 of each phase 2a, 2b, 2c are connected in series between the first and second parts 100, 101 of the electric circuit 102

**[0095]** In particular, in the exemplary embodiment of figure 2 the movable contact 11 is electrically connected to the fixed contact 22 so as to realized the connection in series between the associated circuit breaker unit 10 and the disconnecter unit 20; alternatively, such connection can be realized by connecting the fixed contact 12 of the circuit breaker unit 10 to one among the movable and fixed contacts 21 and 22 of the associated disconnecter unit 20.

**[0096]** With reference to the example of figure 2, under normal operation conditions of the switching device 1, the current  $I_{p_{hase}}$  flows between the first and second parts 100, 101 through the current path realized by the electrically coupled movable and fixed contacts 11, 12 of the circuit breaker unit 10 and by the connected movable and fixed contacts 21, 22 of the disconnecter unit 20.

**[0097]** After that the movable contact 11 of the circuit breaker unit 10 has been actuated from the closed to the open position to interrupt the current  $I_{p_{hase}}$ , the movable contact 21 of the disconnecter unit 20 can be also actuated from the connection position to the disconnection position so as to provide a further physical interruption in the electrical connection between the first and second parts 100, 101.

**[0098]** According to a preferred but not limitative embodiment, the disconnecter unit 20 is advantageously arranged to realize also the functionality of earthing means, i.e. the disconnecter unit 20 is arranged in such a way that it can connect, during its operation, the associated part 101 of the electric circuit 102 to electric earth.

**[0099]** In the exemplary embodiment of figures 2-9, the disconnecter unit 20 comprises an earthing contact 23, i.e. a contact 23 electrically connected to earth, and the movable contact 21 of such disconnecter unit 20 can be actuated between the connection position and:

- a first disconnection position, where the movable contact 21 is disconnected from the corresponding fixed contact 22 and the earthing contact 23;
- a second disconnection position, or earthing position, where the movable contact 21 is disconnected from the corresponding fixed contact 22 and connected to the earthing contact 23.

**[0100]** When the movable contact 21 is in the earthing position, the associated part 101 of the electric circuit 102 is electrically connected to the earthing contact 23 by means of the electric connection provided by the movable contact 21 and the electric terminal 4.

**[0101]** Preferably, the metal shell 52 of the casing 50 is earthed, i.e. it is connected to electric earth, so as to perform a metal earthed segregation between the first and second parts 100, 101 of the electric circuit 102. In such a case, the earthing contact 23 is preferably connected to the metal shell 52; for instance, the earthing contact 23 can be mounted on a corresponding portion of the metal shell 52 (as shown in the exemplary embodiment of figure 5) .

**[0102]** According to the exemplary embodiment of figures 3-9 the metal shell 52 is suitable for: supporting the movable contact 21 and housing the earthing contact 23 of each disconnecter unit 20; and housing the actuating means 300.

**[0103]** In particular, the actuating means 300 of the illustrated exemplary embodiment comprise a driving shaft 301. The driving shaft 301 is operatively connected to each movable contact 21, through conventional linking means, in such a way that the rotation of the driving shaft 301 about the axis 302 causes the actuation of each movable contact 21 between the connected position, the first disconnection position and the earthing position.

**[0104]** The metal shell 52 comprises at least: a base wall 71; a front wall 72 and a rear wall 73 protruding transversally from two opposed ends of the base wall 71; first and second parallel lateral walls 74, 75 protruding transversally from the base wall 71 so as to link the first and second front walls 72, 73. The upper ends of the front walls 72, 73 and of the lateral walls 74, 75 are configured to define an overall flanged upper edge (globally indicated by the numeral reference 76) which is coupled to the flanged portion 54 (which in turn is coupled to the insulating shell 51).

**[0105]** The ends of the driving shaft 301 are operatively coupled to a front wall 72 and a rear wall 73 of the metal shell 52, in such a way that the driving shaft 301 is able to rotate about the axis of rotation 302.

**[0106]** The driving shaft 301 is positioned inside the metal shell 52 between the movable contacts 21 and the second lateral wall 75. The earthing contacts 23 are fixed to the first lateral wall 74, each one aligned to the movement direction of a corresponding contact 21. The metal shell 52 is connected to electric earth together with the earthing contacts 23 fixed thereto.

**[0107]** The present disclosure is also related to an electric unit 1000, or switchgear 1000, comprising at least an electric device 1 according to the present disclosure.

**[0108]** In the exemplary embodiment of figure 9, the switchgear 1000 comprises a housing 1001 inside which the switching device 1 according to previous disclosure is installed. Such switching device 1 is placed between an upper compartment 1002, or power distribution compartment 1002, containing the power distribution bars, and a lower compartment 1003, or load compartment 1003, containing the load cables or connections associated to one or more electric loads drawing power from the distribution bars.

**[0109]** In particular, the insulating shell 51 of the casing 50 is placed at the power distribution compartment 1002, so as the electric terminal 3 associated to each circuit breaker unit 10 can be connected to a corresponding distribution bar. The metal shell 52 of the casing 50 is placed at the load compartment 1003, so as the electric terminal 4 associated to each disconnecter unit 20 can be connected to a corresponding load cable or connector.

**[0110]** In this way, the casing 50 (in particular the earthed metal shell 52) realizes an earthed metal segre-



gation between the distribution and load compartments 1002, 1003.

**[0111]** In practice, it has been seen how electric device 1 according to the present invention allows achieving the intended object offering some improvements over known solutions.

**[0112]** In particular, a greater minimum distance in air  $D_{p_{phase}}$  between insulators 800-801, 801-802 placed side by side is achieved with respect to known solution, such as the solution illustrated in figure 1. By having a greater minimum distance in air  $D_{p_{phase}}$ , the dielectric stress between the insulators 800-801, 801-802 (and hence between the associated adjacent electric phases 2a-2b, 2b-2c) is reduced with respect to known solutions.

**[0113]** Further, the disclosed switching device 1 carries out at least the current interruption functionality between parts 100, 101 of the associated electric circuit 102 (through the circuit breaker units 10) and the disconnection functionality between such parts 100, 101 (through the disconnecter units 20). Preferably, the switching device 1 itself also carries out the earthing functionality on one of the parts 100, 101 of the associated electric circuit 102, namely the part associated to one or more electric loads.

**[0114]** By integrating more functionalities in a single device, the overall space occupied into the housing 1001 of a corresponding electric unit, such as the switchgear 1000, is drastically reduced.

**[0115]** The one or more circuit breaker units 10 (carrying out the interruption functionality) and the one or more disconnecter units 20 (carrying out the disconnection functionality) are all housed in the single casing 50 having a compact and at the same time sturdy structure.

**[0116]** It is particularly advantageous defining the casing 50 by coupling the insulating shell 51 and the metal shell 52 (realizing a metal earthed segregation).

**[0117]** The insulating shell 51 realizes an economical and compact size of the overall casing 50. Since such size is made of insulating material, it is possible to reduce its electrical distance with respect to live parts (i.e. energized parts) in the switchgear 1000, such as the bars in the distribution compartment 1002, thereby further reducing the waste of space into the housing 1001 of the switchgear 1000.

**[0118]** The compact insulating shell 51 is configured to house the circuit breaker units 10 (and at least the associated kinematic chain 201) according to a practice and economic solution. By manufacturing the insulating shell 51 in a single piece such advantages are further improved. In particular, the circuit breaker units 10 are housed in the corresponding circuit breaker chambers 93 defined by the aligned main insulating bodies 92a-92c. The disclosed configuration of the insulating fins 41a-43a, 42a-42c and 43a-43c allows to reduce the dielectric stress between the main insulating bodies 92a-92b and 92b-92c, and hence between the circuit breaker units 10 housed into the circuit breaker chambers 93 of such main insulating bodies 92a-92c.

**[0119]** The metal shell 52, connected to ground, realizes a size of the overall casing 50 which ensures the respect of relevant Standards (e.g. the required metal earthed segregation between the distribution compartment 1002 and the load compartment 1003 of the switchgear 100), even if only a single, multifunctional and very compact device, as the switching device 1, is placed between the distribution bars of the distribution compartment 1002 and the load compartment, and even if the insulating shell 51 of such device 1 is placed very close to the distribution bars. Moreover, all parts/components can be replaced with other technically equivalent elements; in practice, the type of materials, and the dimensions, can be any according to needs and to the state of the art.

## Claims

1. An electric device (1) suitable for being installed in an electric circuit (102), said electric device (1) comprising at least a first insulator (800) having a first main insulating body (92a) and a second insulator (801) having a second main insulating body (92b), wherein said first main insulating body (92a) and said second main insulating body (92b) protrude from corresponding portions (90) of said electric device (1) along a first longitudinal axis (500a) and a second longitudinal axis (500b), respectively, with said first and second longitudinal axes (500a, 500b) lying parallel to each other in a common plane (900), said first insulator (800) having a plurality of insulating fins (41a, 41b) comprising:

- at least a first insulating fin (41a) protruding from said first main insulating body (92a) so as to lie in a respective first plane (901) perpendicular with respect to said common plane (900), said first insulating fin having a first distance  $D_1$  between its delimiting end (45a) nearer to said second longitudinal axis (500b) and said first longitudinal axis (500a); and
- at least a second insulating fin (41b) protruding from said first main insulating body (92a) so as to lie in a respective second plane (902) perpendicular with respect to said common plane (900), said second insulating fin having a second distance  $D_2$  between its delimiting end (45b) nearer to said second longitudinal axis (500b) and said first longitudinal axis (500a), wherein said first distance  $D_1$  is greater than said second distance  $D_2$ ;

said second insulator (801) having a plurality of insulating fins (42a, 42b) comprising:

- at least a third insulating fin (42a) protruding from said second main insulating body (92b) so

as to face said first insulating fin (41a), said third insulating fin having a third distance  $D_3$  between its delimiting end (46a) nearer to said first longitudinal axis (500a) and said second longitudinal axis (500b); and

- at least a fourth insulating fin (42b) protruding from said second main insulating body (92b) so as to face said second insulating fin (41b), said fourth insulating fin having a fourth distance  $D_4$  between its delimiting end (46b) nearer to said first longitudinal axis (500a) and said second longitudinal axis (500b);

**characterized in that** said first, second, third and fourth distances  $D_1$ ,  $D_2$ ,  $D_3$  and  $D_4$  satisfy the following relationships:

$$D_1 > D_3; D_4 > D_2; D_4 > D_3; \text{ and } D_4 < D_1 + (D_1 - D_2).$$

2. The electric device (1) according to claim 1, **characterized in that** said fourth distance  $D_4$  is equal to said first distance  $D_1$ , and said third distance  $D_3$  is equal to said second distance  $D_2$ .

3. The electric device (1) according to claim 2, **characterized in that** the ratio between the third distance  $D_3$  and the first distance  $D_1$  is comprised between 0.5 and 0.9.

4. The electric device (1) according to one or more of the preceding claims, **characterized in that**:

- said at least a first insulating fin (41a) comprises a plurality of first insulating fins (41a) and said at least a second insulating fin (41b) comprises a plurality of second insulating fins (41b), wherein said first and second insulating fins (41a, 41b) protrude from said first main insulating body (92a) alternated to each other;

- said at least a third insulating fin (42a) comprises a plurality of third insulating fins (42a) each faced to a corresponding one of said plurality of first insulating fins (41a), and said at least a fourth insulating fin (42b) comprises a plurality of fourth insulating fins (42b) each faced to a corresponding one of said plurality of second insulating fins (41b).

5. The electric device (1) according to one or more of the preceding claims, **characterized in that** it comprises at least:

- a first electric phase (2a) comprising at least a first switching unit (10), wherein said first switching unit (10) comprises at least a first movable contact (11) which can be actuated, during the operation of the first switching unit (10), to be coupled/separated to/from a corresponding first

fixed contact (12);

- a second electric phase (2b) comprising at least a second switching unit (10), wherein said second switching unit (10) comprises at least a second movable contact (11) which can be actuated, during the operation of the second switching unit (10), to be coupled/decoupled to/from a corresponding second fixed contact (12); said first insulator (800) and said second insulator (801) being associated to said first electric phase (2a) and to said second electric phase (2b), respectively.

6. The electric device (1) according to claim 5, **characterized in that** it comprises a casing (50) having at least an insulating portion (51), wherein said casing (50) houses said first switching unit (10) and said second switching unit (10), and wherein said at least an insulating portion (52) of the casing (50) comprises said first and second insulators (800, 801).

7. The electric device (1) according to claim 6, **characterized in that** said first main insulating body (92a) defines a first internal chamber (93) housing said first switching unit (10) and said second main insulating body (92b) defines a second internal chamber (93) housing said second switching unit (10).

8. The electric device (1) according to claim 7, **characterized in that** it comprises actuating means (200) which are operatively connected to and adapted to actuate said at least a first movable contact (11) and said at least a second movable contact (11), wherein said at least an insulating portion (52) of the casing (50) comprises a central portion (90) defining a main chamber (91) housing at least a portion of said actuating means (200), and wherein said first and second main insulating bodies (92a, 92b) protrude from said central portion (90).

9. The electric device (1) according to claim 8, **characterized in that** said central portion (90) comprises:

- a base portion (53);  
- first and second parallel lateral walls (98, 99) protruding transversally from said base portion (53);  
- at least a support tab (110) connecting said first lateral wall (98) to said base portion (53);  
- at least a support tab (111) connecting said second lateral wall (99) to said base portion (53).

10. The electric device (1) according to claim 9, **characterized in that**:

- said central portion (90) comprises an upper wall (25) linking transversally said first and second lateral walls (98, 99), wherein said first and

- second main insulating bodies (92a, 92b) protrude from said upper wall (25);  
 - said at least a tab (110) connecting said first lateral wall (98) to said base portion (53) comprises: a first support tab (110a) lying in a plane (450) comprising said first longitudinal axis (500a); a second support tab (110b) lying in a plane (451) comprising said second extension axis (500b); a third support tab (110c) placed between the first support tab (110a) and the second support tab (110b);  
 - said at least a support tab (111) connecting said second lateral wall (99) to said base portion (53) comprises: a fourth support tab aligned to said first support tab (110a); a fifth support tab aligned to said second support tab (110b), and a sixth support tab aligned to said third support tab (110c).
11. The electric device (1) according to one or more of the preceding claims 6-10, **characterized in that** said casing (50) comprises a metal portion (52).
12. The electric device (1) according to claim 11, **characterized in that** said at least an insulating portion (51) of the casing (50) comprises an insulating shell (51), and said metal portion (52) comprises a metal shell (52) coupled to said insulating shell (51).
13. The electric device (1) according to claim 11 or 12, **characterized in that:**
- said first electric phase (2a) comprises a third switching unit (20) associated to said first switching unit (10), wherein said third unit (20) comprises at least a third movable contact (21) which can be actuated, during the operation of said third switching unit (20), to be coupled/separated to/from a corresponding third fixed contact (22);
  - said second electric phase (2b) comprises a fourth switching unit (20) associated to said second switching unit (10), wherein said fourth unit (20) comprises at least a fourth movable contact (21) which can be actuated, during the operation of said fourth unit (20), to be coupled/separated to/from a corresponding fourth fixed contact (22);
- said casing (50) housing said third and fourth switching units (20).
14. The electric device (1) according to claim 13, **characterized in that** said first and second switching units (10) are first and second circuit breaker units (10), respectively, and said third and fourth switching units (20) are third and fourth disconnecter units (20), respectively.
15. A switchgear (1000) comprising at least an electric device (1) according to one or more of the preceding claims 1-14.

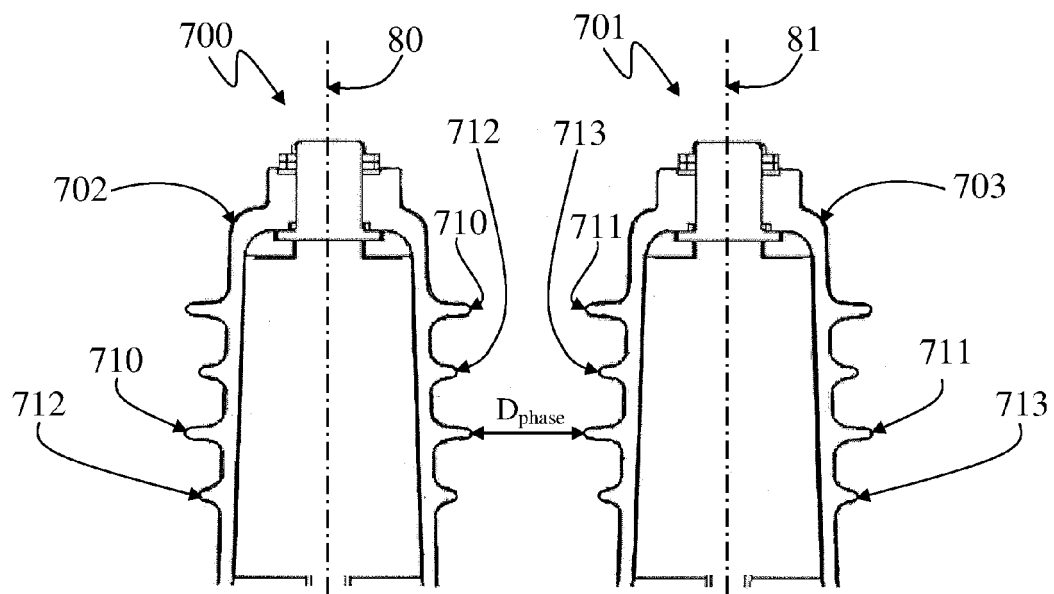


Fig. 1

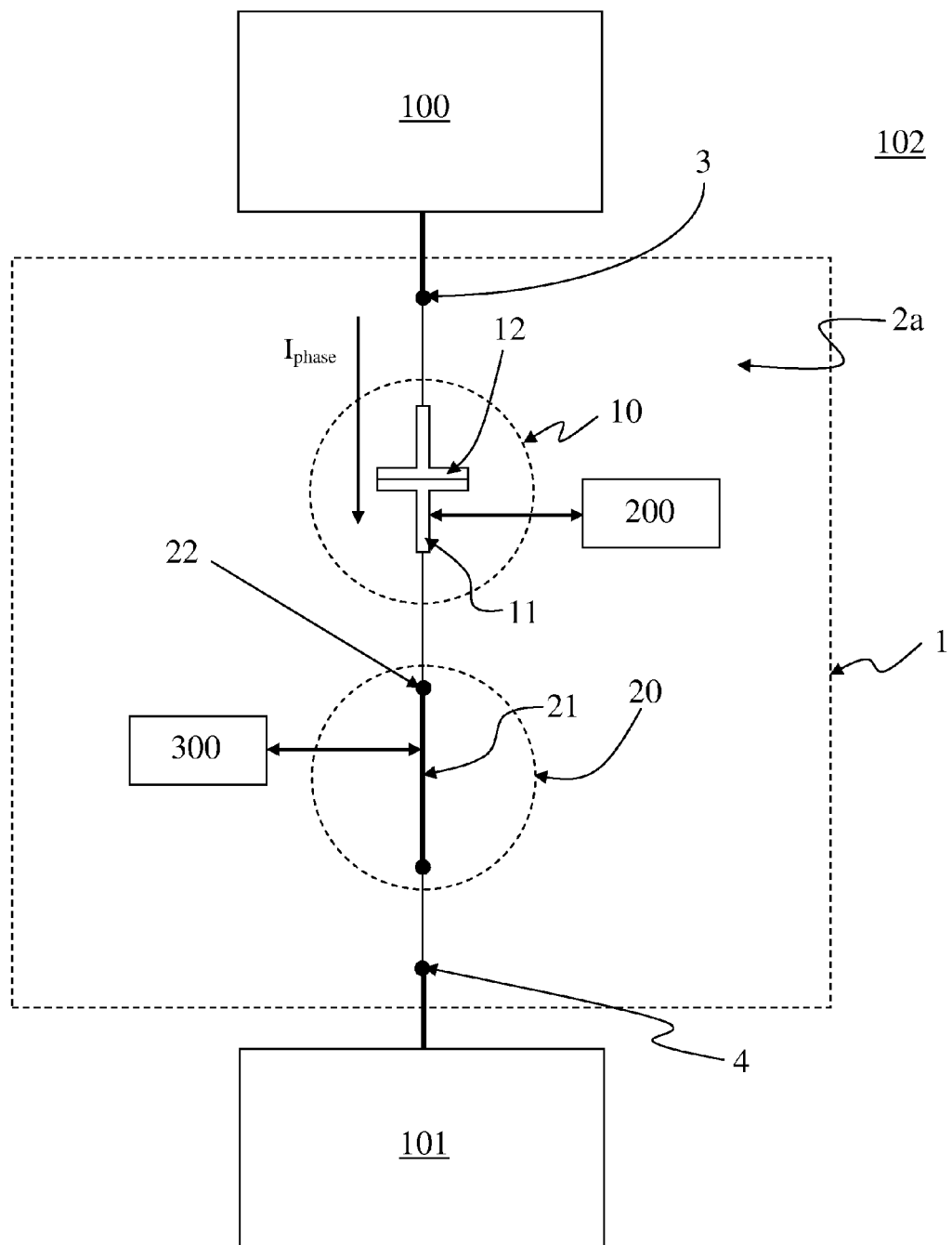


Fig. 2

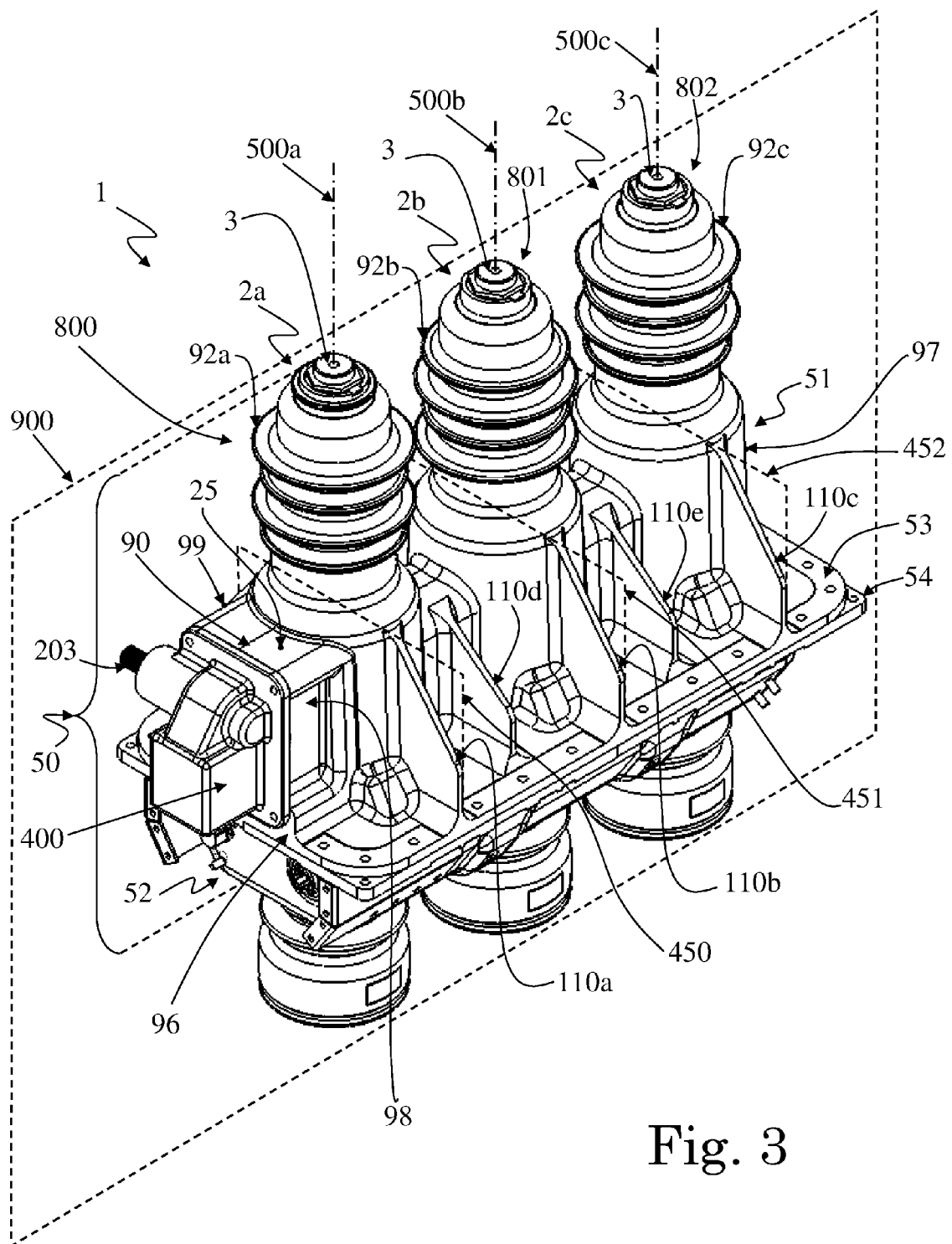


Fig. 3

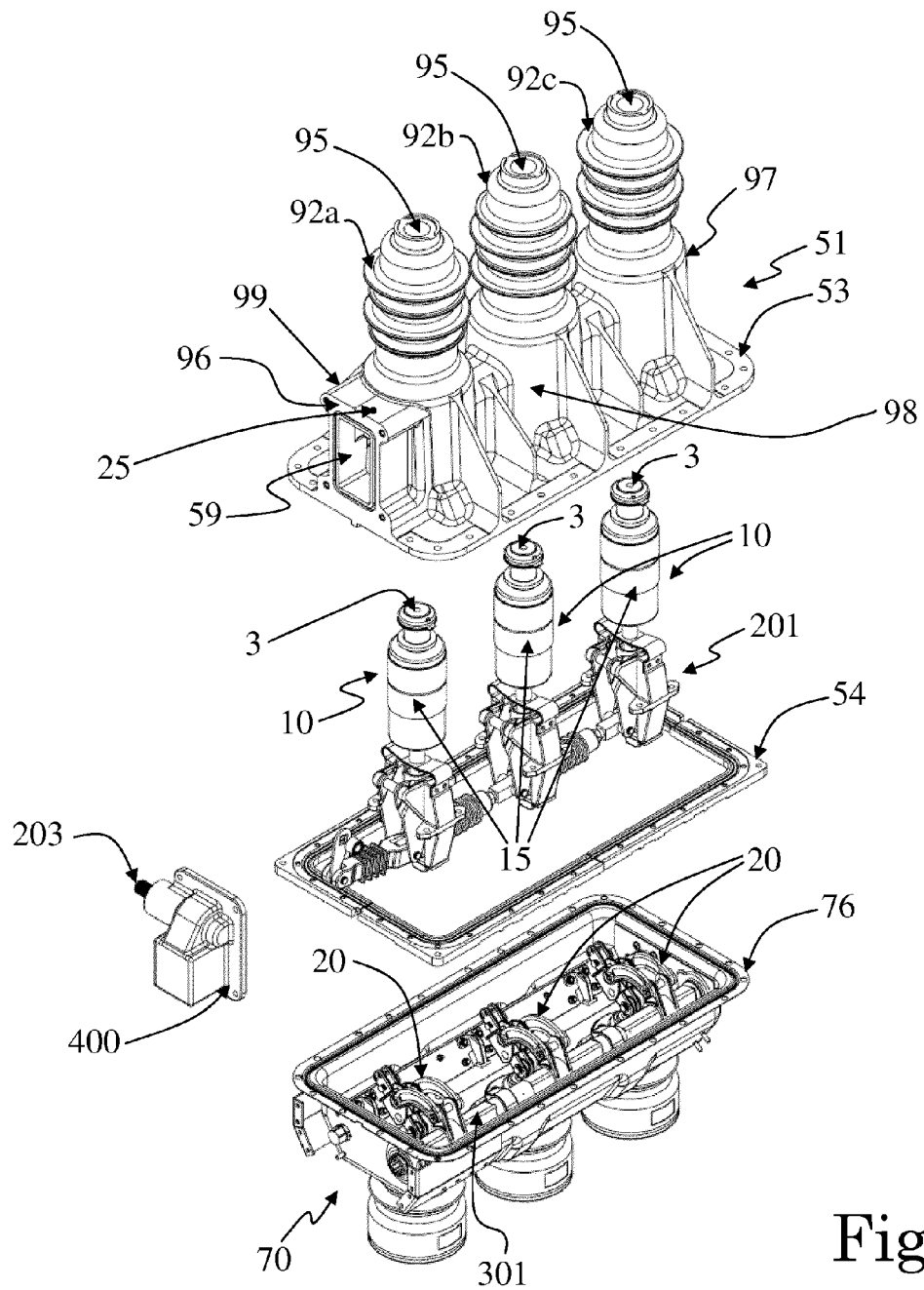


Fig. 4

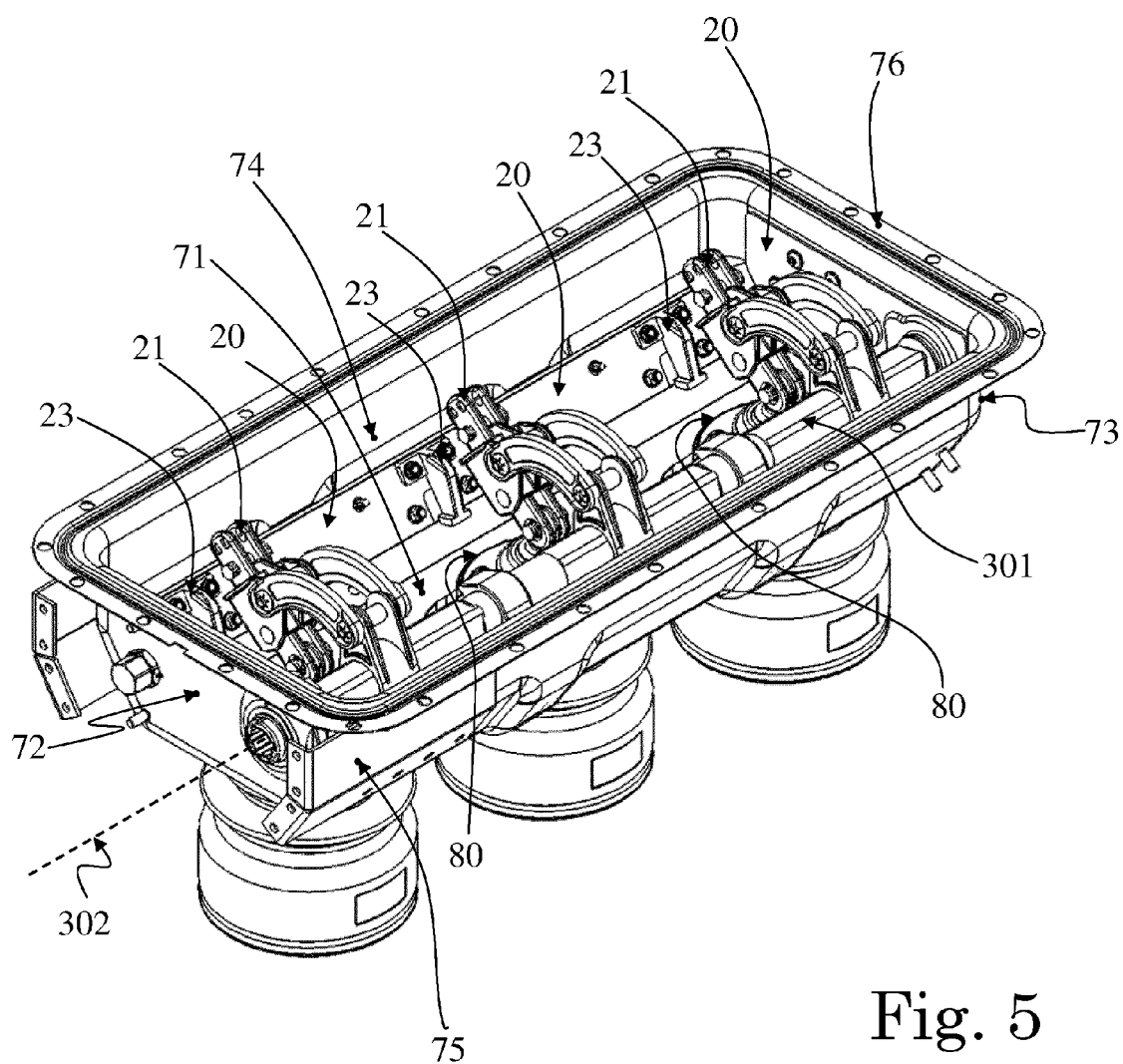


Fig. 5



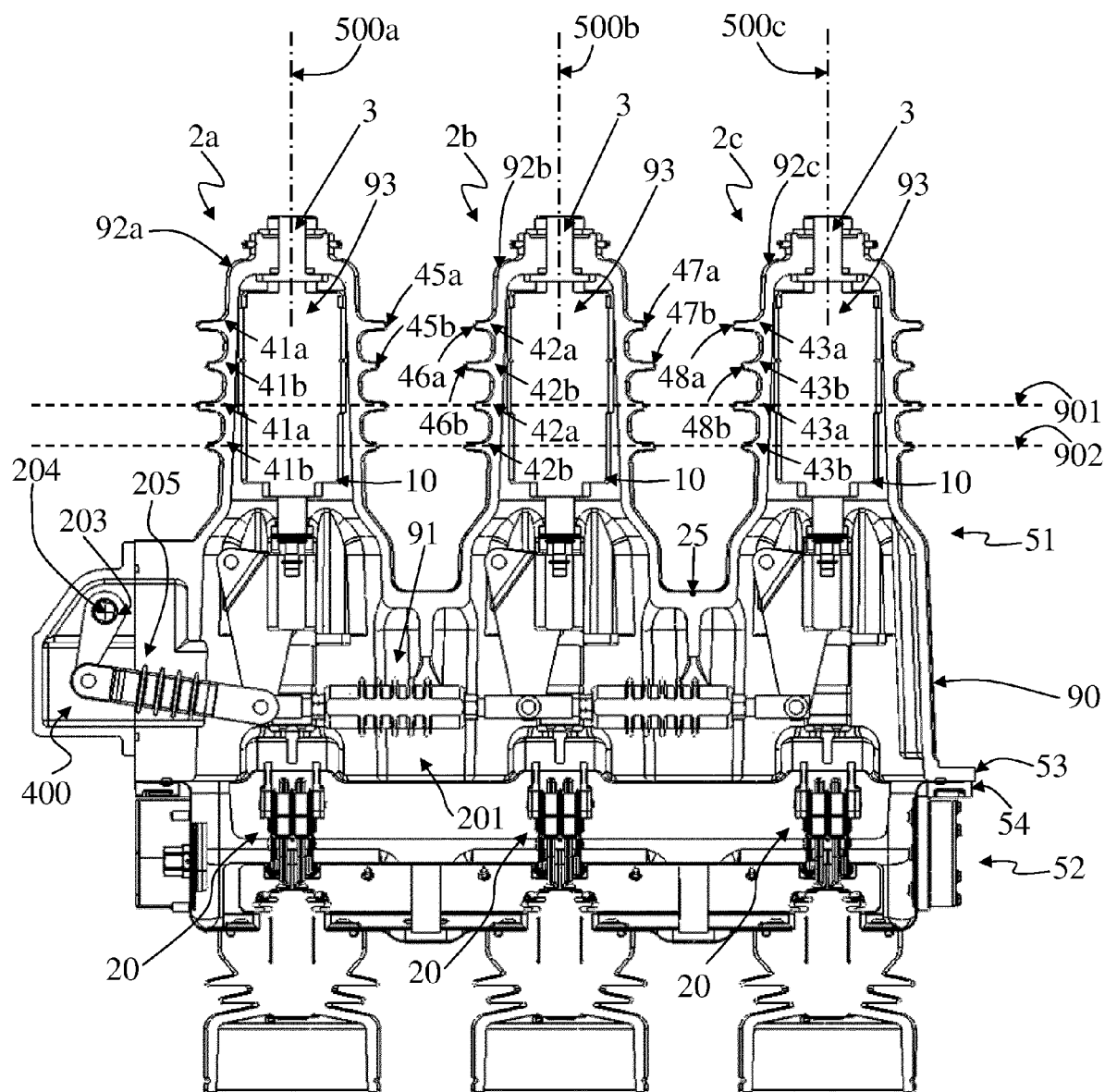


Fig. 6

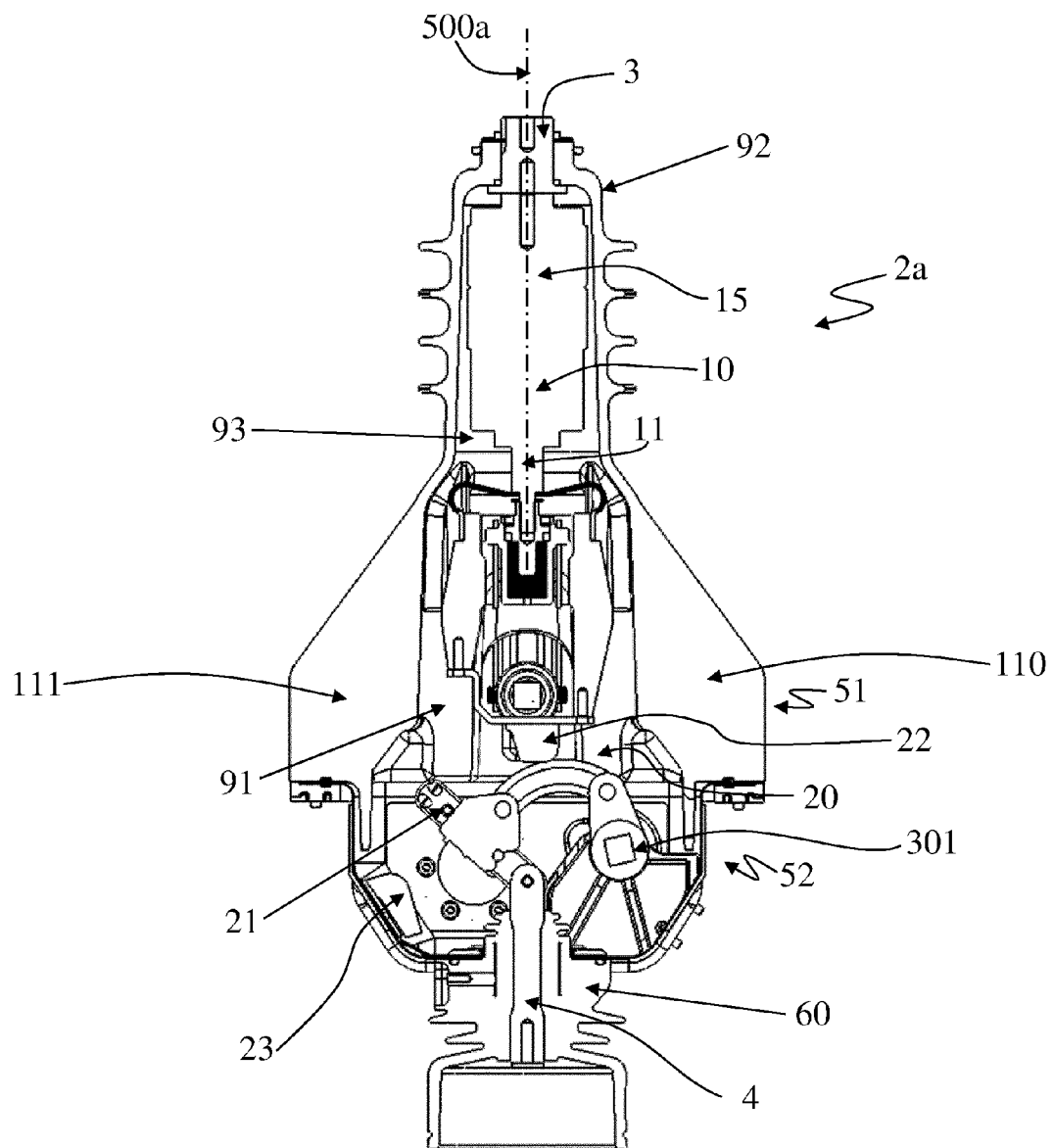


Fig. 7

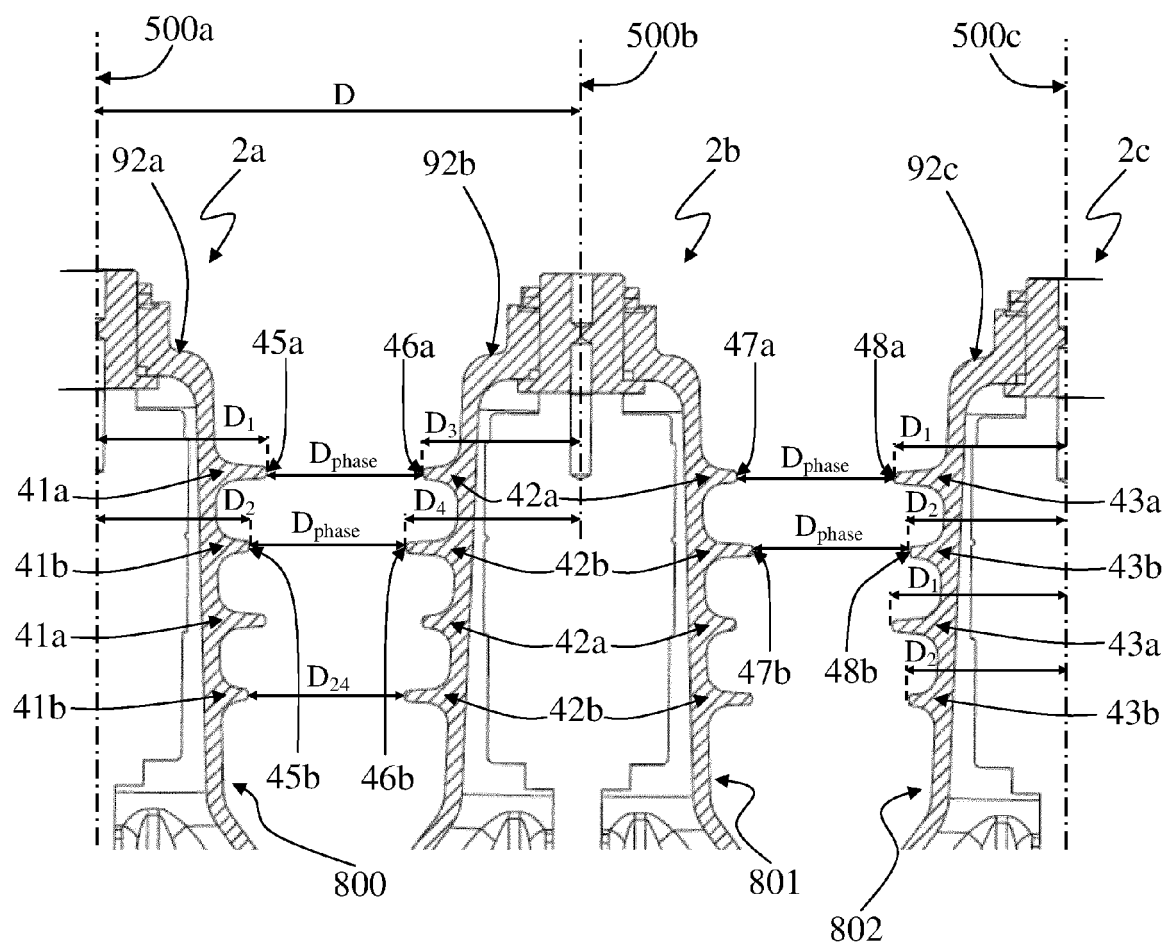


Fig. 8

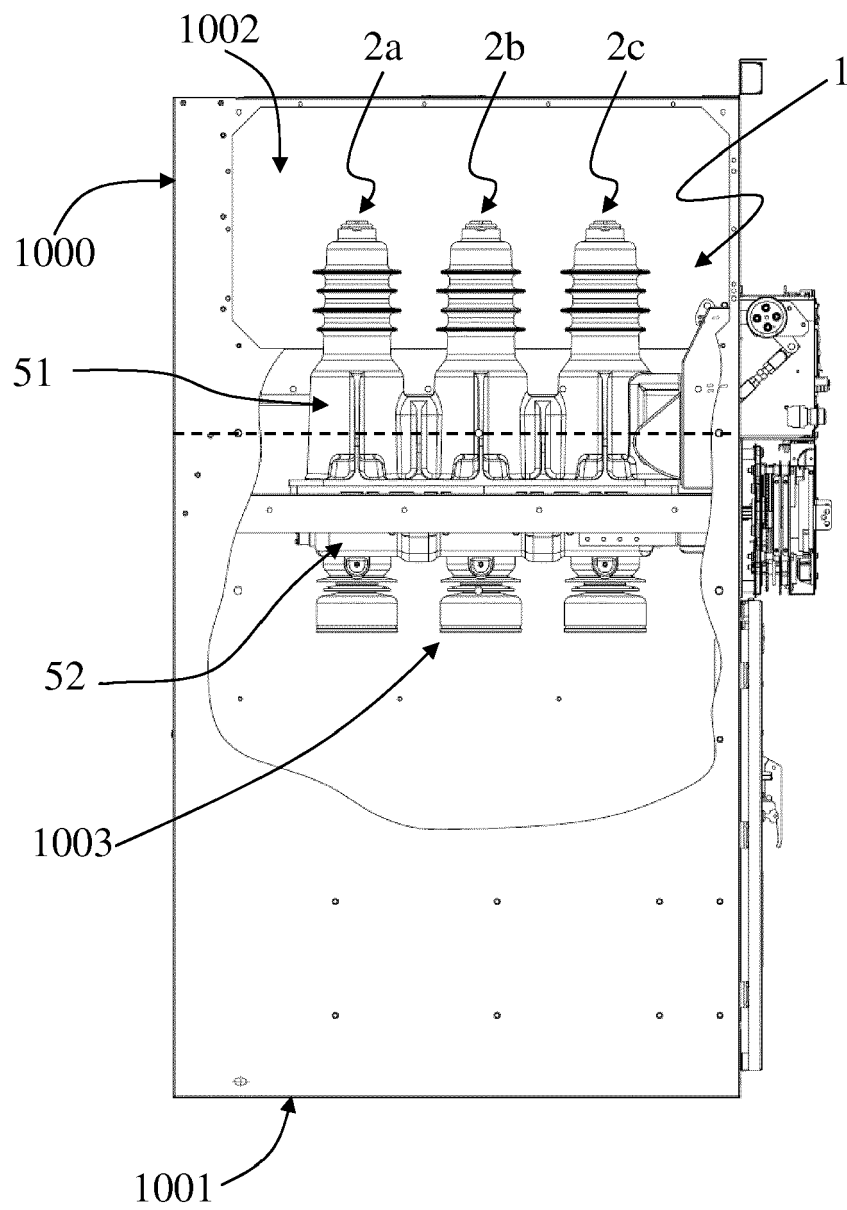


Fig. 9



## EUROPEAN SEARCH REPORT

Application Number  
EP 12 16 1172

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                     |                                  |                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                                       | Relevant to claim                | CLASSIFICATION OF THE APPLICATION (IPC)       |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 5 821 486 A (PAW KACEY J [US] ET AL)<br>13 October 1998 (1998-10-13)<br>* column 2, line 30 - column 3, line 9;<br>figures 1,2 * | 1-5,15                           | INV.<br>H01B17/42<br>H01H33/662<br>H01H33/666 |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -----<br>EP 1 928 065 A1 (ABB TECHNOLOGY AG [CH])<br>4 June 2008 (2008-06-04)<br>* the whole document *                             | 6                                |                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -----<br>DE 10 2007 042041 B3 (SIEMENS AG [DE])<br>12 February 2009 (2009-02-12)<br>* the whole document *                          | 1                                |                                               |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | -----<br>EP 1 226 596 B1 (VEI POWER DISTRIB S P A [IT])<br>29 January 2003 (2003-01-29)<br>* the whole document *                   | 6                                |                                               |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                     |                                  | TECHNICAL FIELDS SEARCHED (IPC)               |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                     |                                  | H01B<br>H01H                                  |
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                     | Date of completion of the search | Examiner                                      |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                     | 29 August 2012                   | Ramírez Fueyo, M                              |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                     |                                  |                                               |

1

EPO FORM 1503 03.82 (P04C01)

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

EP 12 16 1172

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

29-08-2012

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                                           | Publication<br>date                                                                                                        |
|-------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| US 5821486 A                              | 13-10-1998          | CA 2213671 A1<br>US 5821486 A                                                                                                                        | 26-02-1998<br>13-10-1998                                                                                                   |
| EP 1928065 A1                             | 04-06-2008          | CN 201163710 Y<br>EP 1928065 A1                                                                                                                      | 10-12-2008<br>04-06-2008                                                                                                   |
| DE 102007042041 B3                        | 12-02-2009          | DE 102007042041 B3<br>WO 2009030721 A1                                                                                                               | 12-02-2009<br>12-03-2009                                                                                                   |
| EP 1226596 B1                             | 29-01-2003          | AT 232012 T<br>AU 1721501 A<br>DE 60001334 D1<br>DE 60001334 T2<br>EP 1226596 A1<br>ES 2190993 T3<br>IT PC990038 A1<br>PT 1226596 E<br>WO 0133593 A1 | 15-02-2003<br>14-05-2001<br>06-03-2003<br>25-03-2004<br>31-07-2002<br>01-09-2003<br>03-05-2001<br>30-06-2003<br>10-05-2001 |