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(54) **Gas mixing enhancement for self-blast circuit breakers**

(57) The self blast circuit breaker or puffer circuit breaker (10) according to the invention has at least a first and a second contact (11a, 11b) for coupling and decoupling an electric circuit, an arc volume (9) inside of which an electric arc (11c) between the first and the second contact (11a, 11b) develops and a heating volume (8). It further comprises, concentrically to the longitudinal axis (z) an insulating nozzle (1), a heating channel (16) connecting the arc volume (9) to the heating volume (8), and the heating channel (16) comprises at least one gas guide surface (4a), which has a first end section (12a) guiding gas into said arc volume (9) being radial to the longitudinal axis (z) of the circuit breaker (10), and has a second end section (12b) guiding gas into the heating volume (8) being arranged transversally to the longitudinal axis (z).

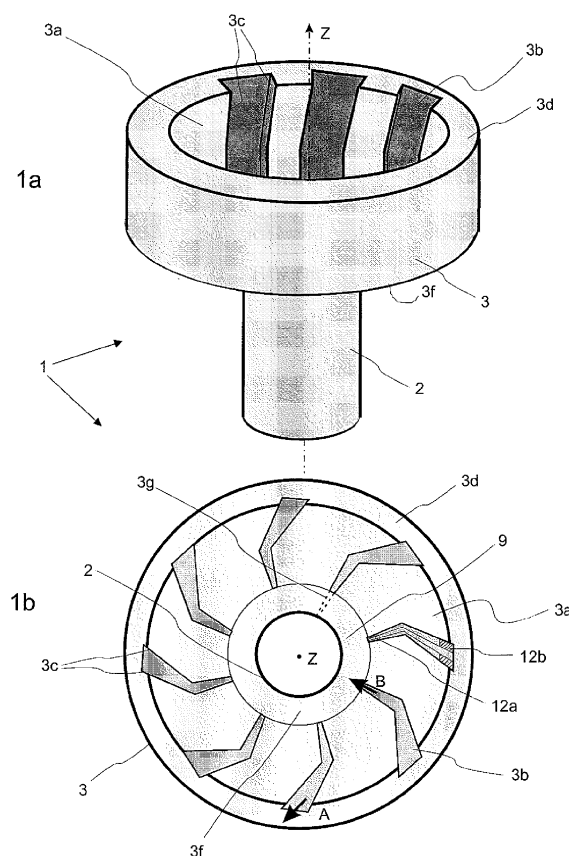


Fig. 1

Description

Background

[0001] The invention is related to the field of medium and high voltage technologies and concerns a self blast circuit breaker or a puffer circuit breaker according to the independent claim, particularly for a use as power switch in power distribution systems.

Prior art

[0002] Such self blast circuit breakers, puffer circuit breakers or gas blast circuit breakers are particularly used in high voltage switching technologies for electric current interruption. When disconnecting two contacts, an electric arc develops between the contacts. It is a task of said circuit breakers to quench the arc. This is done in such a way that a gas is blown into the arc in order to extinguish it. The gas usually used for this task is typically SF₆ (sulphur hexafluoride) because of its excellent quenching characteristics. It also has very good dielectric properties.

[0003] A widespread method of suppressing the arc will be broadly explained in the following, however without elaborating on all components of a circuit breaker.

[0004] The circuit breaker comprises a heating volume and an arc volume connected to one another by a heating channel. Both volumes are filled with the gas. The arc volume designates the space around the two contacts. As soon as the contacts are separated, an arc develops between them and starts heating up the gas in the arc volume. Because of the expansion of the gas volume caused by the heating up, a gas pressure difference between the arc volume and the heating volume occurs. A second cause for the pressure rise in the arc volume is an ablation of Teflon® from the surface of a nozzle due to electric arc radiation. The gas starts to flow from the arc volume through the heating channel into the heating volume, where it mixes with the "cold" gas stored therein and causes a pressure rise inside said heating volume. Particularly at the zero-crossing of the current, the pressure in the heating volume has to be higher than the pressure in the arc volume. The mixed, cooled gas flows from the heating volume back into the arc volume and quenches the arc.

[0005] It is an aim of self blast circuit breaker embodiments to quench the arc at the next possible zero crossing of the current in order to minimize erosions of the contacts and to limit the energy input into the circuit breaker. Amongst others, it is important that the gas temperature is low, when the gas flows back from the heating volume into the arc volume, in order to extinguish the electric arc efficiently. In ordinary circuit breakers it has been observed that the flow of hot gas has a substantially toroidal form inside the heating volume.

[0006] The patent CH 662 443 A5 discloses a circuit breaker with a heating volume and an arc volume which

are connected by a gas guiding device which comprises at least three channels arranged in different azimuthal positions around the axis. The channels have radial sections entering the arc volume. This embodiment acts as a whirl breaker.

Description of the invention

[0007] It is an objective of the present invention to provide a self blast circuit breaker or a puffer circuit breaker with enhanced mixing of the hot gas with cold gas in the heating volume.

[0008] This is achieved according to the invention by providing a self blast circuit breaker or a puffer circuit breaker according to the independent claim.

[0009] According to the independent claim, a self blast circuit breaker or a puffer circuit breaker is provided, which has at least a first and a second contact for coupling and decoupling an electric circuit, which are movable relatively to one another in a parallel direction to a longitudinal axis of the circuit breaker. The contacts are meeting each other in an arc volume inside of which an electric arc between the first and the second contact can develop as soon as the first and the second contact are separated.

The circuit breaker according to the invention comprises an insulating nozzle, a heating volume and a heating channel. The heating channel connects the arc volume with the heating volume, which both are filled with an insulating gas, preferably SF₆. The heating channel comprises at least one gas guide surface having a first and a second end section. The first end section guides gas into said arc volume. The second end section guides gas into the heating volume. The first end section is guiding gas into said arc volume and has first means for guiding a gas flow into the arc volume without an azimuthal component with respect to said longitudinal axis. The second end section is guiding gas into said heating volume and has second means for generating an azimuthal, i.e. tangential, component with respect to the longitudinal axis in a gas flow entering the heating volume. In other words, the second end section or its second means, respectively provide a swirling flow of gas into the heating chamber for enhanced hot-cold gas mixing in the heating chamber, whereas the first end section or its first means, respectively, provide quenching gas directly towards the longitudinal axis of the circuit breaker for highly efficient arc extinction, with minimal gas rotation inside the arc volume or around the arc.

[0010] The advantage of the circuit breaker according to the invention, particularly of the specific design of the end sections, is on one hand that the hot gas develops a flow pattern with azimuthal momentum within the heating volume, thus enhancing the gas mixing therein, and on the other hand that the mixed gas flows onto the arc in a more focused way and without azimuthal momentum when flowing back into the arc volume, thus quenching the arc more efficiently.

[0011] In embodiments, the first means comprise a

shape and/or arrangement and/or element of the first end section, that have no azimuthal gas-flow-guiding component with respect to said longitudinal axis. In particular, the first end section can be oriented radially with respect to the longitudinal axis.

[0012] In other embodiments, the second means comprise an at least partially azimuthal shape and/or arrangement and/or element of the second end section. In particular, the second end section can be oriented at least partially transversely with respect to the longitudinal axis. The term azimuthal (or transversal) shall mean gas-flow-guidance with net azimuthal (or net transversal) orientation, i.e. shall include local and/or temporal deviations from azimuthal (or transversal) orientation, as long as an overall at least partial azimuthal (or overall at least partial transversal) gas flow results.

[0013] In further embodiments, the insulating nozzle and the heating volume may be arranged concentrically to the longitudinal axis. In particular, the heating volume can be arranged beyond an end face of the insulating nozzle around the first contact.

[0014] In an embodiment, the azimuthal component introduced by the second end section(s) in the gas flow entering the heating volume can result in a full rotation of gas in the heating volume, which full rotating gas flow may in addition be broken up into smaller turbulences, e. g. by additional structural element(s) arranged inside the heating volume, preferably on a wall opposing the entrance side of the heating channel.

Short description of the drawings

[0015] Further embodiments, advantages and applications of the invention result from the dependent claims and from the now following description by the figures. It is shown in:

Fig. 1 in section 1a of the figure a perspective view of an embodiment of an insulating nozzle and in section 1b the embodiment in a top perspective view;
 Fig. 2 in section 2a of the figure a perspective view of an auxiliary nozzle used in an embodiment of the invention and in section 1b the auxiliary nozzle in an unfolded view;
 Fig. 3 an exemplary schematic view of another embodiment of the insulating nozzle within a coordinate system;
 Fig. 4 a section of a part of a self blast circuit breaker;
 Fig. 5 in sections 5a - 5d four embodiments of a combination of an insulating and an auxiliary nozzle; and
 Fig. 6 in sections 6a - 6b two further embodiments of such combination.

[0016] The reference numerals used in the figures are summarized in a list. Elements which are not necessary for the understanding of the invention may partly be not shown. The explained embodiments are exemplary for the subject of the invention and have no limiting effect;

the invention may be executed in different ways within the scope of the claims.

Ways of carrying out the invention

[0017] First, individual components which are relevant for the invention is explained. Subsequently, a short description of geometrical aspects is given, an exemplary embodiment of a part of a self blast circuit breaker comprising the already mentioned components is described along with the effect of the components for solving the objective of the invention, and finally a number of embodiments of the components are shown.

[0018] Fig. 1 shows in section 1a of the figure a perspective view of an embodiment of an insulating nozzle 1. The longitudinal axis z is identical to a longitudinal axis of the self blast circuit breaker. The insulating nozzle is known and has the task of enhancing the arc extinction by channelling the gas and increasing the gas pressure in the vicinity of the arc. As can be seen, the insulating nozzle 1 is arranged concentrically around the longitudinal axis. In this embodiment, it has a narrow part 2 and a wide section 3, connected by a "bottom" part 3f. It is noted that the bottom part 3f is seen as part of an inner wall 3a of the insulating nozzle 1 and is not counted as a gas guide surface in the context of this invention as it substantially has the same purpose as the inner wall 3a and is therefore known. The notional difference is used here only for explanation purposes. Evidently, other shapes of the insulating nozzle 1 are possible. Within the circuit breaker, which is not shown here for reasons of clarity, the insulating nozzle 1 is arranged in such a way that its end face 3d faces a heating volume which is not shown here. An arc volume, also not seen here, is located in a transition area between the narrow part 2 and the wide section 3 of the insulating nozzle 1, on the inside of the same.

[0019] The already mentioned gas guide surface is arranged at an inner wall 3a of the insulating nozzle 1. Fig. 1a depicts an example of an arrangement with three gas guiding channels 3b, which are formed as grooves in the inner wall 3a of the insulating nozzle 1. Evidently, the grooves 3b may have other shapes than in the shown embodiment. Each of the gas guiding channels 3b comprises two gas guide surfaces 3c, formed by walls of the grooves 3b. In Fig. 1a only second end sections 12b (see Fig. 1b) of the grooves 3b are shown, first end sections 12a are not visible. They are shown in Fig. 1b and will be explained in the following.

[0020] In section 1b of Fig. 1, the insulating nozzle 1 of Fig. 1a is shown in a top perspective view from the z direction. However, here it comprises eight gas guiding channels or grooves 3b. In Fig. 1b, an embodiment of the insulating nozzle 1 is shown, which has the grooves 3b formed by the gas guide surfaces 3c arranged concentrically along the entire inner wall 3a of the insulating nozzle 1. This arrangement advantageously increases the gas guiding effect of the insulating nozzle.

[0021] From this perspective, the first end sections 12a of the gas guide surfaces 3c are also visible and indicated for one groove 3b as the inner, small dashed area. The outer dashed area shows the second end section 12b of that groove 3b. It is noted that the shown size of the first and the second end sections 12a, 12b of the grooves 3b are not a limiting factor for the present invention. For example the groove 3b may be seen as formed by the first and the second end sections 12a, 12b only; the only restriction is that the first end section 12a is oriented radially to the longitudinal axis z and the second end section 12b is transversal to (i.e. has at least a transversal component to) the longitudinal axis Z. This applies for the embodiments explained in the following. Furthermore, the width of the groove can be substantially constant, while Fig. 1b depicts the grooves 3b as tapering towards the middle, i.e. towards the longitudinal axis z. This is shown in this way because the grooves extend away from the viewer.

[0022] As broadly explained above, the gas may travel along the heating channel in both directions; from the heating volume into the arc volume and vice versa. Thus, it also travels in said both directions inside the grooves 3b formed by the gas guide surfaces 3c. The shape of the grooves 3b influences the flow of the gas, especially the angle at which the gas leaves the grooves 3b into either the heating volume 8 or arcing volume 9. The arrow B shows the flow direction of gas entering the arc volume the position of which is here indicated by the reference number 9. In this example, it indicates the direction of the exiting gas in case the grooves 3b extend along the inner wall 3a of the insulating nozzle 1 only, however, they may also extend into the bottom part 3f, as indicated by the dashed lines 3g. It is also possible to provide grooves 3b only in the bottom part 3f. Reversely, the arrow A shows the gas travelling direction when the gas exits from the groove 3b into the heating volume 8. As can be seen from the direction of the arrow A, the flow has an azimuthal component, thus a component which is tangential to the outline or inner mantle surface of the wide section 3. The geometrical arrangement of the gas guide surface and the azimuthal component is explained in further detail in Fig. 3.

[0023] In another embodiment of the insulating nozzle 1, which is not shown in Fig. 1, at least one gas guide surface 3c may be formed by a fin, instead of the groove 3b mentioned above. The fin may either be part of the inner wall 3a or it may be attached to it. The fin may be formed such that its gas guide surfaces have a substantially same shape as the gas guide surfaces 3c of the groove 3b. The use of fins will be explained next in the context of Fig. 2 within the scope of a further embodiment of the invention.

[0024] The insulating nozzle 1 in either embodiment may have one gas guide surface 3c or multiple gas guide surfaces 3c arranged at its inner wall 3a. Furthermore, not only the first and the second end sections 12a, 12b are formed as a groove 3b or as a fin, but the entire gas guide surface may be formed in the same way as its end

sections 12a, 12b as well. Still further, a combination of fins and grooves is also conceivable as an arrangement along the inner wall 3a of the insulating nozzle 1.

[0025] Fig. 2 shows in its section 2a a perspective view of an auxiliary nozzle 5. The auxiliary nozzle 5 is arranged concentrically around the longitudinal axis z between a first contact of the circuit breaker and the insulating nozzle 1, both not being shown here for reasons of clarity. In this further embodiment, the auxiliary nozzle 5 also comprises at least a gas guide surface 4a, which is arranged at an outer wall 6 of the auxiliary nozzle 5. Multiple gas guide surfaces may be arranged at the outer wall 6 of the auxiliary nozzle 5, as it is the case in the example of Fig. 2, where four fins 4 are arranged along said outer wall 6, thus yielding a total of eight gas guide surfaces 4a. A front face 4c of the auxiliary nozzle 5 substantially faces the aforementioned arc volume 9, which may be located in the area in front of the inner circle 4d which indicates the beginning of an inner wall of the auxiliary nozzle 5. An end face 4b of the auxiliary nozzle 5 faces the heating volume 8.

[0026] An overview of an embodiment of a self blast circuit breaker with an insulating nozzle 1 and an auxiliary nozzle 5 is explained in the context of Fig. 4. This will further clarify the arrangement of both nozzles 1, 5 and of further elements of the circuit breaker relatively to one another.

[0027] In Fig. 2, each fin 4 is divided into three parts: a front head part 4f located on the front face 4c, an elongated part 4e located on the outer wall 6 and a non-radial part 4g located on the outer wall 6 as well. Analogously to Fig. 1b, a first end section part 12a and a second end section part 12b of the gas guide surfaces of the fin 4 are shown by the dashed surfaces on the fin 4. The fins 4 are used for the same purposes as the grooves 3b of Fig. 1. The shape of the fins 4 influence the flow of the gas, especially the angle at which the gas is guided by the fins 4 into the arc volume 9 or into the heating volume 8 respectively. The arrow B shows the flow direction of gas entering the arc volume 9. The arrow A shows the gas travelling direction when the gas flows into the heating volume 8 deflected by the second end sections 12b. As can be seen from the direction of the arrow A, the flow direction also has an azimuthal component, thus a component which is tangential to the outline or outer mantle surface of the outer wall 6 of the auxiliary nozzle 5. The geometrical arrangement of the gas guide surface 4a is explained in further detail in the context of Fig. 3.

[0028] Section 2b of Fig. 2 shows the auxiliary nozzle 5 in an unwound view. The dashed arrows between section 2a and section 2b of Fig. 2 denote corresponding points of the two views. Dashed arrow 7a shows the correspondence of an edge point formed by the front head part 4f and the elongated part 4e. Dashed arrow 7b shows the edge of the outer wall 6 and the front face 4c of the auxiliary nozzle 5. Dashed arrow 7c shows the corresponding edge between the elongated part 4e and the oblique part 4g of the fin 4. Dashed arrow 7d shows the

edge of the oblique part 4g, in particular transverse part 4g, of the fin 4. Furthermore Fig. 2b shows the flow directions A and B of the gas in case the gas is flowing into the heating volume 8 or into the arc volume 9, respectively. These flow directions A and B are oblique, in particular transverse or orthogonal, to one another.

[0029] Analogously to the insulating main nozzle 1, the gas guide surfaces 4a of the fins 4 of the auxiliary nozzle 5 may be formed as grooves 3b in the outer wall 6 and may have substantially the same shape as the fins 4 of the current example of Fig. 2. Furthermore, only the first and the second end sections 12a, 12b may be formed as a fin 4 or a groove 3b, contrary to this example, in which the entire gas guide surface is formed as a fin 4. Still furthermore, a combination of fins 4 and grooves 3b is also possible as an arrangement along the outer wall 6 of the auxiliary nozzle 5.

[0030] Fig. 3 shows a simplified view of the main nozzle 1 in another embodiment comprising an exemplary fin 4 instead of the grooves 3b of Fig. 1. In Fig. 3 the geometrical arrangement of the fin 4 is explained in more detail. Of course, the arrangement is also applicable in case grooves 3b are used instead of the fin 4. In the context of this figure, also the notion of azimuthal component introduced above will further be explained.

[0031] Only the wide part 3 of the insulating or main nozzle 1 is shown in Fig. 3. The inside surface of the cylinder shown corresponds to the inner wall 3a of the insulating nozzle 1 of Fig. 1. A cylindrical coordinate system is used for the description of the arrangement of the fin 4. The cylindrical coordinate system has its origin O, a longitudinal axis z which is identical to the longitudinal axis of the self blast circuit breaker, radial axis ρ and an angle φ between the radial axis ρ and a vector ω pointing to an arbitrary point P. Thus, each point P is described by $P(\rho, \varphi, z)$. As can be seen from the figure, a first portion 14a of the fin 4 runs in z-direction at a constant angle φ , which is also called azimuth angle, whereas a second portion 14b of the fin 4 also runs in the z-direction, however the angles φ varies as a function of z for each point or longitudinal section of the fin 4. Again, the first and the second end sections 12a, 12b are shown as dashed surfaces, their sizes being exemplary only. It is also possible to see the first end section as corresponding to the first portion 14a and the second end section 12b as corresponding to the second portion 14b. A front part 4f, analogous to the front part 4f of Fig. 2, is also shown in order to clarify its location in the coordinate system. The front part 4f extends into the bottom part 3f of the insulating nozzle 1, as described as an option above (Fig. 1b). Both cases may be seen as a radial extension of fins 4 or grooves 3b.

[0032] As mentioned, the first end section 12a being "arranged radially" may also include the fact that the gas guide surfaces of the first end section 12a are "arranged parallel" to the longitudinal axis z of the circuit breaker. In contrast, the second end section 12b is "arranged transversally" to the longitudinal axis z. The meaning of

the terms "arranged parallel" and "arranged transversally" is defined as follows:

- A gas guide surface is "arranged parallel" to longitudinal axis z if, for substantially each point of said gas guide surface, the local tangential plane of said surface at said point is parallel to longitudinal axis z.
- A gas guide surface is "arranged transversally" to longitudinal axis z if, for substantially each point of said surface, the local tangential plane of said surface at said point is oblique or transversal to longitudinal axis z, i.e. longitudinal axis z and the local tangential plane intersect (i.e. intersect one another under an arbitrary non-vanishing angle).

[0033] This definition holds for flat as well as for non-flat sections of the gas guide surfaces 3c or 4a. For a flat section, the tangential plane is the same for all points on the section and coincides with the surface itself. For non-flat sections, each point has its own tangential plane.

[0034] The above definition is based on the assumption of geometrically perfect surfaces. In a real embodiment, where surfaces may have microscopic defects and suffer from machining tolerances, the above definitions may not hold for each and every point on the surface, but at least for a majority of the points.

[0035] The gas guide surfaces may also be concave or convex seen from the point of view of Fig. 3. The tangential planes satisfy the above criteria for this kind of surfaces as well.

[0036] In the above embodiments, the gas guide surfaces are perpendicular to the inner wall, whereas in another embodiment they are oblique to it, in other words non-radial.

[0037] Fig. 4 shows a section of a self blast circuit breaker 10. A first and a second contact 11a, 11b are arranged substantially parallel to the longitudinal axis z. At least one of the contacts 11a, 11b is movable relative to the other contact 11b, 11a, and may touch that contact. This arrangement is known and will not be described here in more detail. When the contacts 11a, 11b are separated, an electric arc 11c may develop between the contacts 11a, 11b in the arc volume 9.

[0038] An insulating (main) nozzle 1 as the one shown in Fig. 1 is arranged concentrically around the contacts 11a, 11b, wherein, in this exemplary embodiment, the narrow part 2 is arranged around the second contact 11b and the wide part 3 of the insulating nozzle 1 is arranged substantially around the first contact 11a and the arc volume 9. The inner wall 3a is facing the outer wall 6 of the auxiliary nozzle 5, which is arranged around the first contact 11a and which protrudes into the arc volume 9. The said heating channel 16 is formed between said walls 3a and 6 of the two nozzles 1 and 5. The auxiliary nozzle 5 differs from the auxiliary nozzle 5 of Fig. 2 only insofar, as it has an additional segment 13 pointing towards the longitudinal axis Z. The explanations related to Fig. 2 apply here as well; therefore the numeral of the auxiliary

nozzle 5 has been chosen the same. The additional segment has an outer wall 6a substantially facing the bottom part 3f of the insulating nozzle 1. This arrangement extends the heating channel "around the corner" and can be advantageous, because it faces the electric arc 11c substantially perpendicularly. This is explained later in the context of the gas flow pattern. In this example, the auxiliary nozzle 5 is attached to the first contact 11a, it may however be attached in a different way, according to embodiments of the prior art. Fins 4 are attached to or are part of the inner wall 3a of the insulating nozzle 1 and the outer wall 6 of the auxiliary nozzle 5, respectively. By comparing the front head part 4f of the fin 4 of Fig. 2 with the fin part arranged at the additional segment of the fin 4 of Fig. 4, it can be seen that their orientation and shape are analogous.

[0039] The end face 3d of the insulating nozzle 1 faces the heating volume 8, which can be chosen much larger than the arc volume 9, as known by the skilled person. Two arrows A illustrate the inflow of gas into the heating volume 8 and the arrow B shows the inflow of gas into the arc volume 9. It is noted that each inflow takes place in a different phase of the arc quenching process, as known from the prior art. The gas flow and its relation to the quenching of the arc will now be explained in more detail.

[0040] Among others, the efficiency of quenching the arc 11c depends on the temperature of the gas, namely the lower the temperature the more effective the quenching. Thus, as mentioned above, it is desirable to be able to cool down the gas as much as possible. This operation is done in the heating volume 8, where cold gas is mixed with incoming gas, which is hotter because it has already been heated up by the forming arc 11c. In present solutions, the gas flow is only channelled by the inner wall 3a and the outer wall 6. It flows in a substantially perpendicular way into the heating volume 8 where it mixes with the cool gas by forming, as has been observed previously, a toroidal swirl without an azimuthal component inside the heating volume 8. However, by using the gas guide surfaces of the present invention, with their second end sections 12b being transversal to the longitudinal axis z, a part of the gas receives a third directional component in substantially azimuthal direction. The result is an additional azimuthal flow inside of the heating volume 8, which speeds up the gas mixing process. On the other hand, when the gas flows back into the arc volume 9 after having been cooled, it has a more focused direction, substantially perpendicular to the arc 11c, in other words it forms more focused beams. The number of beams depends on the number of gas guide surfaces. These beams quench the arc faster because of their lower temperature and their "focused" shape.

[0041] In other words, the heating channel comprises at least one gas guide surface with the first end section 12a guiding gas into the arc volume 9 and the second end section 12b guiding gas into the heating volume 8, wherein the first and the second end sections 12a, 12b

are located at delimiting walls 3a, 6 of the heating channel 16 and are arranged in such a way that gas flows into the arc volume 9 in a substantially radial direction ρ and into the heating volume 8 in a partially azimuthal direction φ in respect to the longitudinal axis z, respectively.

[0042] Fig. 5 shows four embodiments of a combination of the insulating nozzle 1 and the auxiliary nozzle 5. The reference numerals in Fig. 5a are valid for Fig. 5b and those of Fig. 5c are valid for Fig. 5d. All embodiments of Fig. 5 are seen from "inside" the heating volume 8 against the direction of the longitudinal axis z. The embodiments of Fig. 5a and 5b are shown in a perspective view, wherein the dotted circles denote far ends of the respective nozzle and the solid lined circles close ends of the respective nozzle. Thus, the bigger grey ring represents the inner wall 3a of the insulating nozzle 1 and the smaller grey ring represents the outer wall 6 of the auxiliary nozzle 5. The white ring indicates the heating channel 16. Fig. 5c and 5d show for reasons of clarity only a sectional view of both nozzles 1, 5, wherein the white ring again denotes the heating channel 16.

[0043] In the embodiment of Fig. 5a, both the insulating or main nozzle 1 and the auxiliary nozzle 5 each comprise eight fins 4 and accordingly sixteen gas guide surfaces 3c. In the embodiment of Fig. 5b, both the insulating and the auxiliary nozzle 1, 5 each comprise eight grooves 3b and accordingly sixteen gas guide surfaces 3c. The arrows A and B again denote the exit direction of the insulating gas from the gas guiding channel into the respective volume.

[0044] It is useful to use multiple fins 4, arranged at the inner wall 3a around the wide section 3 of the insulating nozzle 1, which are alternately concave and convex. By this arrangement, a type of wind channel for the gas is created by two neighbouring fins. An example is shown in Fig. 5c or 5d.

[0045] In the embodiment of Fig. 5c, the insulating nozzle 1 comprises sixteen fins 4 with thirty-two rounded gas guide surfaces 3c and the auxiliary nozzle 5 comprises eight grooves 3b with sixteen rounded gas guide surfaces 3c. The embodiment of Fig. 5d shows a variant of the embodiment of Fig. 5c with oblique gas guide surfaces 3c. Here, only the direction of gas exiting into the heating volume 8 is indicated for reasons of clarity. It can be seen that the fins and the grooves of the embodiments of Fig. 5c, 5d have been grouped to form a wind-tunnel-like gas guiding channel.

[0046] In all embodiments of the invention with more than two fins and/or grooves, the fins or grooves, respectively, are arranged at predefined mutual distances, wherein each mutual distance may be different or the distances may be equal.

[0047] In the case of using fins 4, the height of a fin in a direction perpendicular to the wall it is attached to or it is a part of can be chosen on the heating volume 8 side such that a free gas tunnel is remaining, which is not delimited by the fins 4 and which can be located substantially in the middle of the heating channel 16. This advan-

tageously allows a portion of the gas to flow into the heating volume 8 in the usual direction, whereas the rest of the gas flows in with azimuthal momentum. On the other hand, on the arc volume 9 side the fins 4 may be as high as to completely tunnel the gas flowing into the arc volume in order to focus the entire gas amount. Thus, this embodiment leads to such a shape of the fins 4 that, when travelling from the heating volume 8 towards the arc volume 9, the height of the fins 4 increases. In other words, in terms of the coordinate system of Fig. 3, the ρ component of the upper fin edge decreases.

[0048] Fig. 6 shows two further embodiments. In the embodiment of Fig. 6a (section 6a of Fig. 6), the second portion 14b of the fin 4, or the second end section 12b, extends into the heating volume 8. This example only shows a single fin 4 arranged at the inner wall 3a of the insulating nozzle 1 which is shown here as a simple cylinder for clarity reasons, and another fin arranged at the outer wall 6 of the auxiliary nozzle 5. However, multiple fins 4 and/or grooves 3b may be used.

[0049] In the embodiment of Fig. 6b (section 6b of Fig. 6), the end face 3d of the insulating nozzle 1 facing the heating volume 8 is formed as or has attached to it at least one protrusion 15 which extends into a flow C of the insulating gas. Of course, this embodiment may be applied on the arc volume side of the insulating nozzle 1 and for both end faces of the auxiliary nozzle 5, as well. In this embodiment, the gas guide surface is not formed by gas guiding channels extending throughout the heating channel 16, but the gas guide surface is rather formed only at the end of the heating channel 16. This advantageously saves material for gas guide surfaces and makes it easier to build the respective nozzle (main nozzle 1 and/or auxiliary nozzle 5).

[0050] The present invention enhances the gas mixing in the heating volume and at the same time focuses the gas on the arc volume side such that a more effective quenching of electric arcs in self blast circuit breakers or puffer circuit breakers is obtained. In other words, the gas guide surfaces act at the same time as a whirl breaker on the arc volume side and as a whirl producer on the heating volume side. This leads to energy saving and slows down the wear of components, as for example the contacts, thus making the circuit breaker more reliable and easier to maintain.

Reference numeral list

[0051]

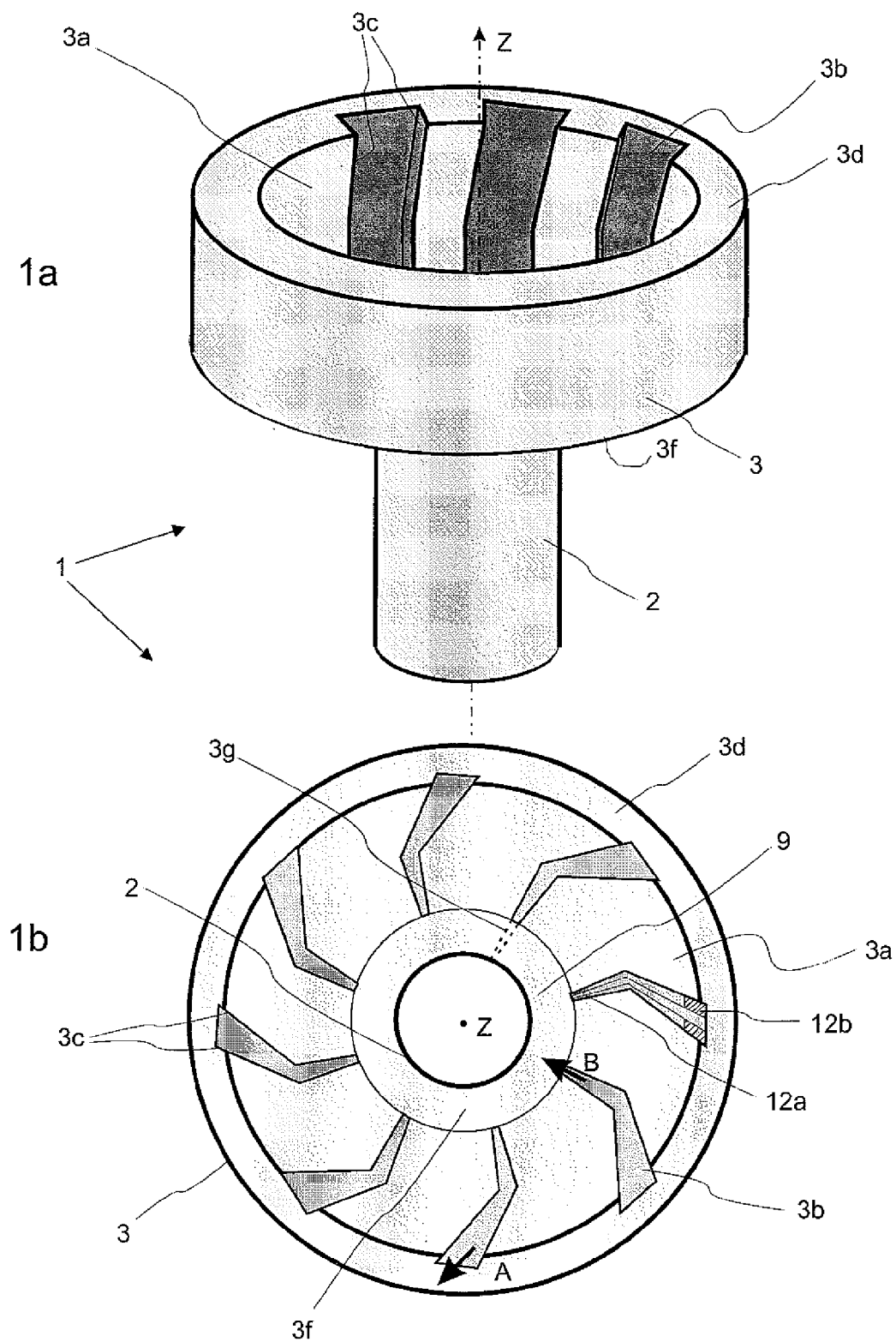
1	= insulating nozzle
2	= narrow part of insulating nozzle
3	= wide section of insulating nozzle
3a	= inner wall of insulating nozzle
3b	= gas guiding channel, gas guiding groove
3c	= gas guide surface of groove
3d	= end face of insulating or main nozzle
3f	= bottom part of insulating nozzle

3g	= groove extension
4	= fin
4a	= gas guide surface of fin
4b	= end face of auxiliary nozzle
5	4c = front face of auxiliary nozzle
4d	= inner circle
4e	= elongated part of fin
4f	= front head part of fin
4g	= oblique part of fin
10	5 = auxiliary nozzle
6	= outer wall of auxiliary nozzle
6a	= outer wall of additional fin segment
7a-7d	= correspondence arrows (dashed)
8	= heating volume
15	9 = arc volume
10	= self blast circuit breaker, puffer circuit breaker
11a	= first contact
11b	= second contact
11c	= electric arc
20	12a = first end section
12b	= second end section
13	= additional segment of auxiliary nozzle
14a	= first portion of fin
14b	= second portion of fin
25	15 = protrusion
16	= heating channel
A	= gas flow direction into heating volume
B	= gas flow direction into arc volume
30	C = flow of insulating gas
O	= origin of coordinate system
35	P = arbitrary point
Z	= longitudinal axis
ρ	= radial coordinate
40	φ = azimuth angle
ω	= vector

Claims

1. Self blast circuit breaker or puffer circuit breaker (10) with at least a first and a second contact (11a, 11b) for coupling and decoupling an electric circuit, which are movable relatively to one another in a direction parallel to a longitudinal axis (z) of the circuit breaker (10) and are meeting in an arc volume (9) inside of which an electric arc (11c) between the first and the second contact (11a, 11b) develops when the first and the second contact (11a, 11b) separate, comprising an insulating nozzle (1),

- a heating volume (8),
a heating channel (16) connecting the arc volume (9) to the heating volume (8),
wherein the arc volume (9) and the heating volume (8) are filled with an insulating gas,
wherein the heating channel (16) comprises at least one gas guide surface (3c, 4a) having
a first end section (12a) guiding gas into said arc volume (9), the first end section (12a) having first means for guiding a gas flow into the arc volume (9) without azimuthal component with respect to said longitudinal axis (z), and
a second end section (12b) guiding gas into said heating volume (8), the second end section (12b) having second means for generating an azimuthal component with respect to the longitudinal axis (z) in a gas flow entering the heating volume (8).
2. Circuit breaker according to claim 1, wherein the first means comprise a shape and/or arrangement and/or element of the first end section (12a) without azimuthal component with respect to said longitudinal axis (z).
 3. Circuit breaker according to any of the preceding claims, wherein the first end section (12a) is oriented radially with respect to the longitudinal axis (z).
 4. Circuit breaker according to any of the preceding claims, wherein the second means comprise an at least partially azimuthal shape and/or arrangement and/or element of the second end section (12b).
 5. Circuit breaker according any of the preceding claims, wherein the second end section (12a) is oriented at least partially transversely with respect to the longitudinal axis (z).
 6. Circuit breaker according any of the preceding claims, wherein the insulating nozzle (1) and the heating volume (8) are arranged concentrically to the longitudinal axis (z), and in particular wherein the heating volume (8) is arranged beyond an end face (3d) of the insulating nozzle (1) around the first contact (11a).
 7. Circuit breaker according to any of the preceding claims, wherein the gas guide surface (3c, 4a) is arranged at an inner wall (3a) of the insulating nozzle (1), and the first end section (12a) and/or the second end section (12b), in particular the entire gas guide surface (3c, 4a), is formed
as a groove (3b) in the inner wall (3a), and/or
by means of a fin (4), in particular wherein the fin (4) is either attached to or is part of the inner wall (3a).
 8. Circuit breaker according to claim 7, wherein multiple gas guide surfaces (3c, 4a) are arranged at the inner wall (3a) of the insulating nozzle (1).
 9. Circuit breaker according to any of the preceding claims, comprising an auxiliary nozzle (5) arranged concentrically around the longitudinal axis (z) between the first contact (11a) and the insulating nozzle (1), wherein the gas guide surface (4a) is arranged at an outer wall (6) of the auxiliary nozzle (5), and the first end section (12a) and/or the second end section (12b), in particular the entire gas guide surface (4a), is formed
as a groove (3b) in the outer wall (6), and/or
is delimited by means of a fin (4), in particular wherein the fin (4) is either attached to or is part of the outer wall (6).
 10. Circuit breaker according to claim 9, wherein multiple gas guide surfaces (4a) are arranged at the outer wall (6) of the auxiliary nozzle (5).
 11. Circuit breaker according to any of the preceding claims, wherein the second end section (12b) of the gas guide surface (4a) extends into the heating volume (8).
 12. Circuit breaker according to any of the preceding claims, wherein an end face (3d) of the insulating nozzle (1) facing the heating volume (8) is formed as or has attached to it at least one protrusion (15) which extends into a stream (C) of the insulating gas.
 13. Circuit breaker according to any of the preceding claims, wherein multiple gas guide surfaces (4a) are arranged at predefined mutual distances.
 14. Circuit breaker according to any of the preceding claims, wherein the gas guide surface (4a) is rounded, and/or the gas guide surface (4a) is non-radial.
 15. Circuit breaker according to any of the preceding claims, wherein the azimuthal component introduced by the second end section(s) in the gas flow entering the heating volume (8) generates a full rotation of gas in the heating volume (8), and additional structural elements are present in the heating volume (8) for breaking up the full rotation of gas into smaller turbulences.



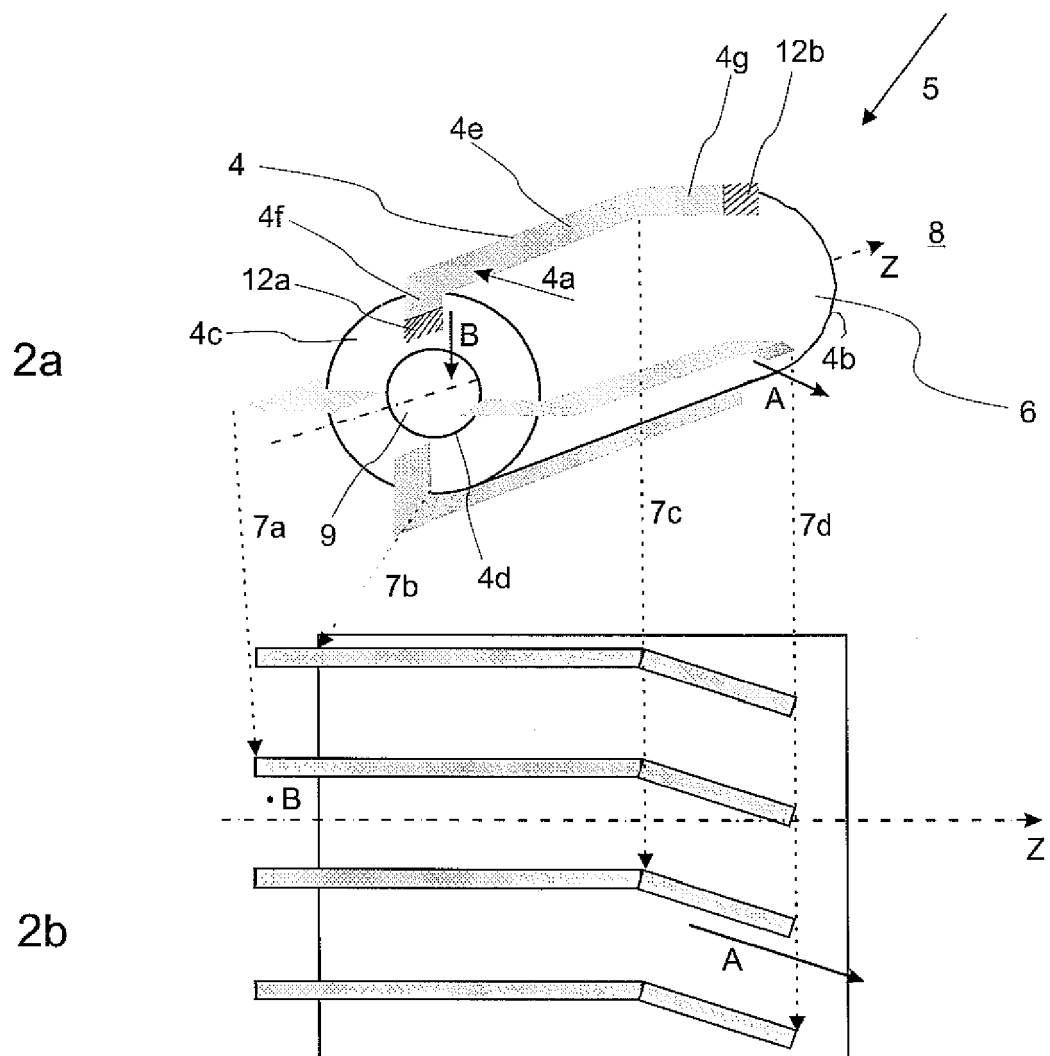


Fig. 2

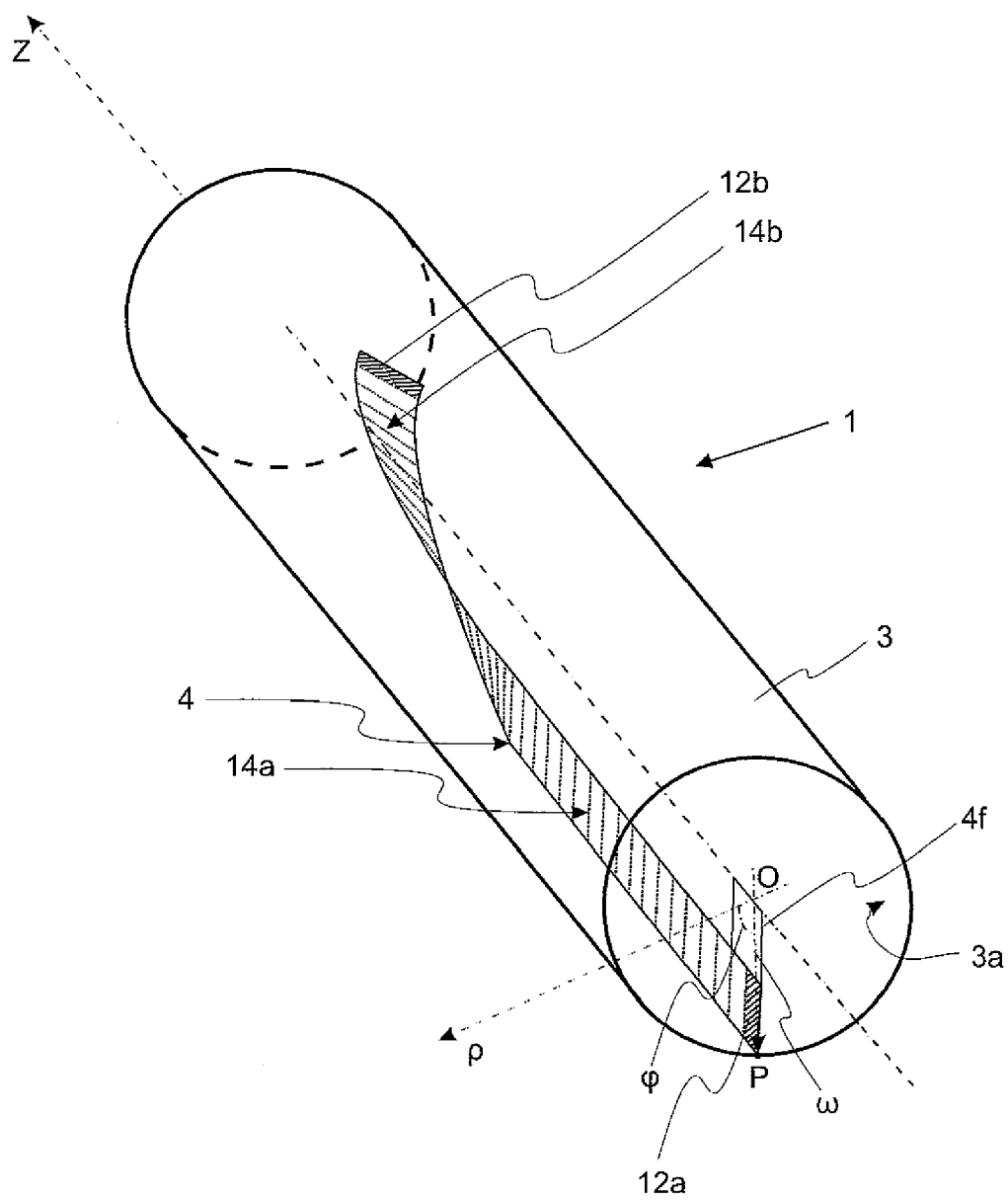


Fig. 3

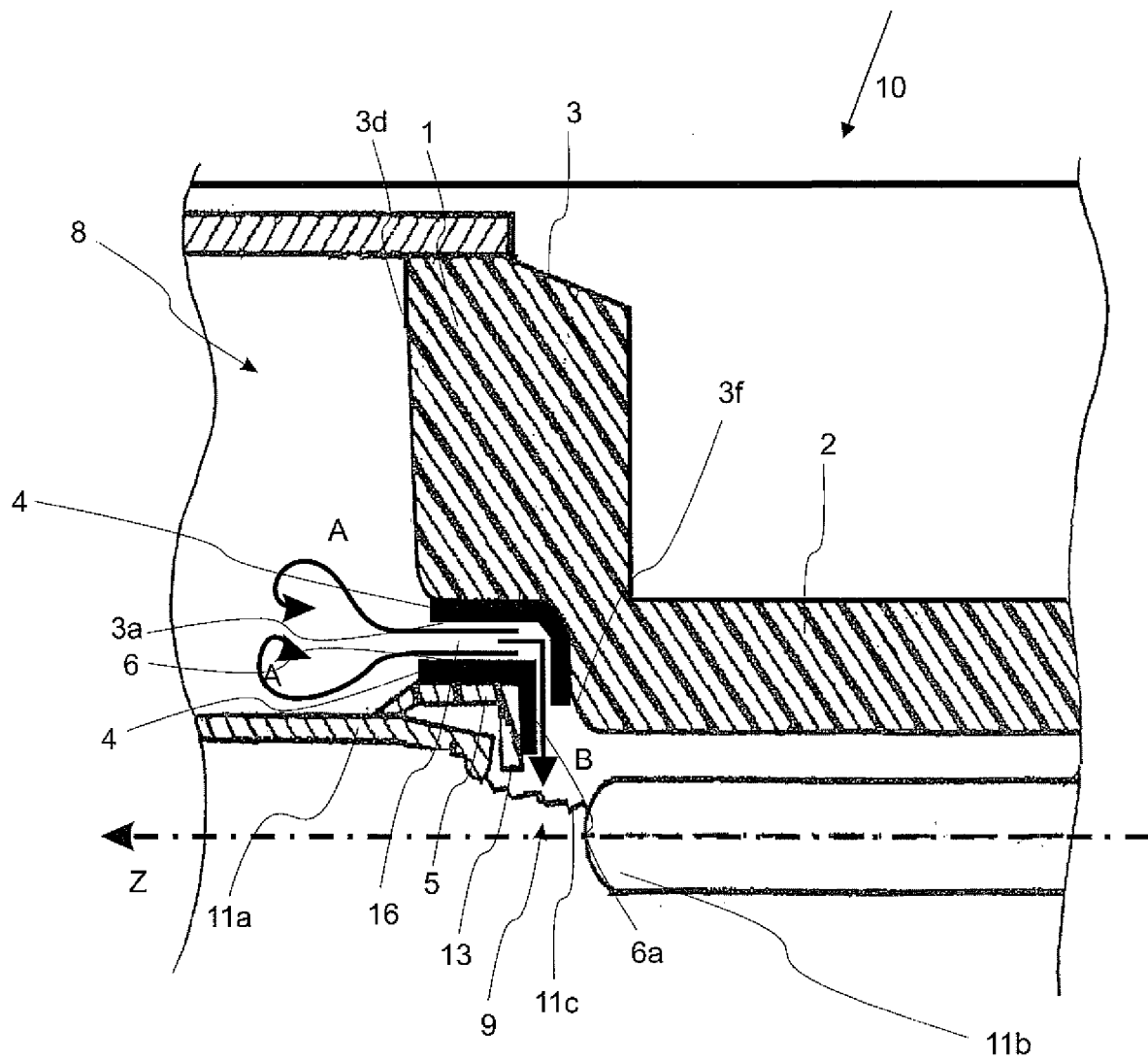


Fig. 4

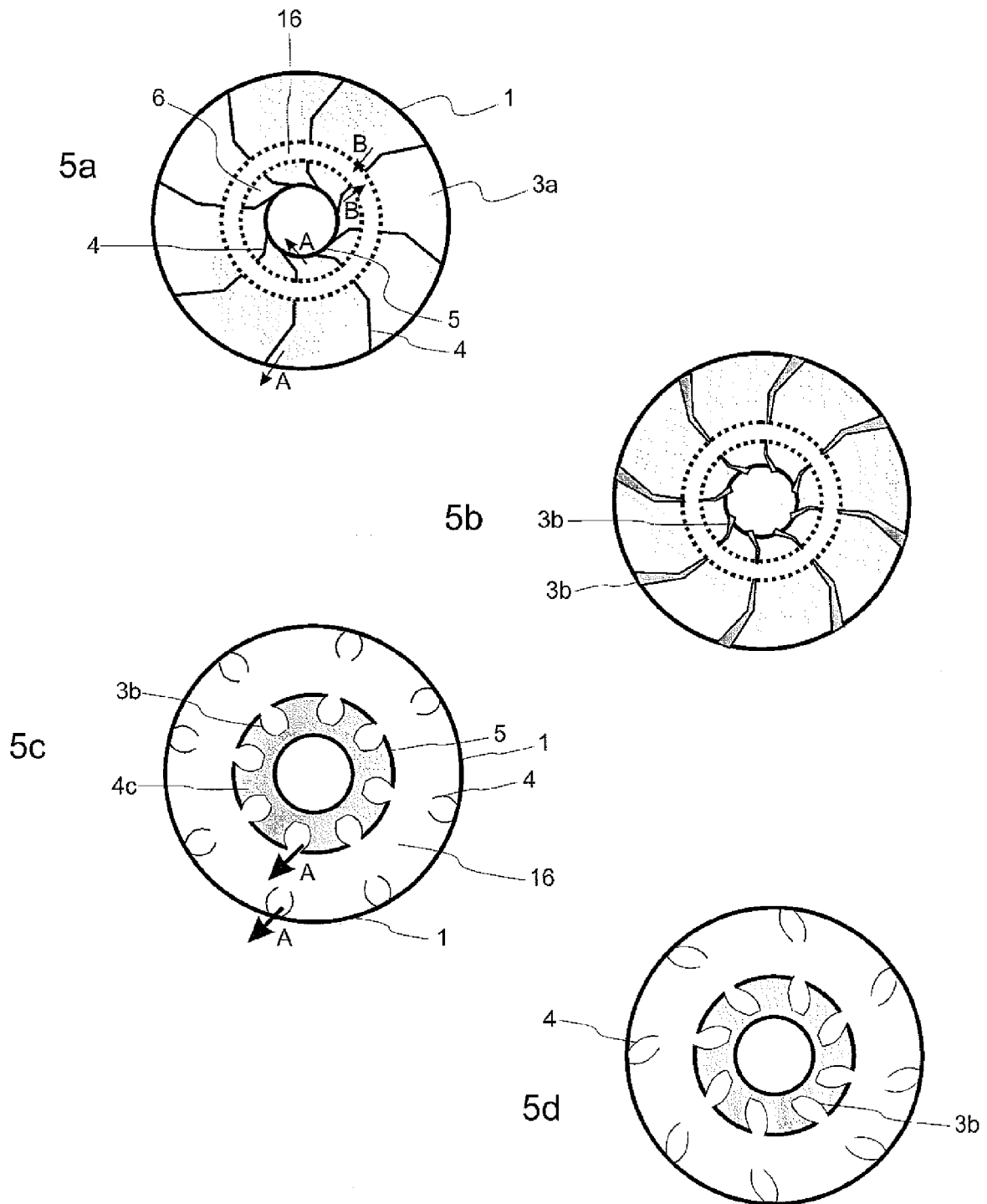


Fig. 5

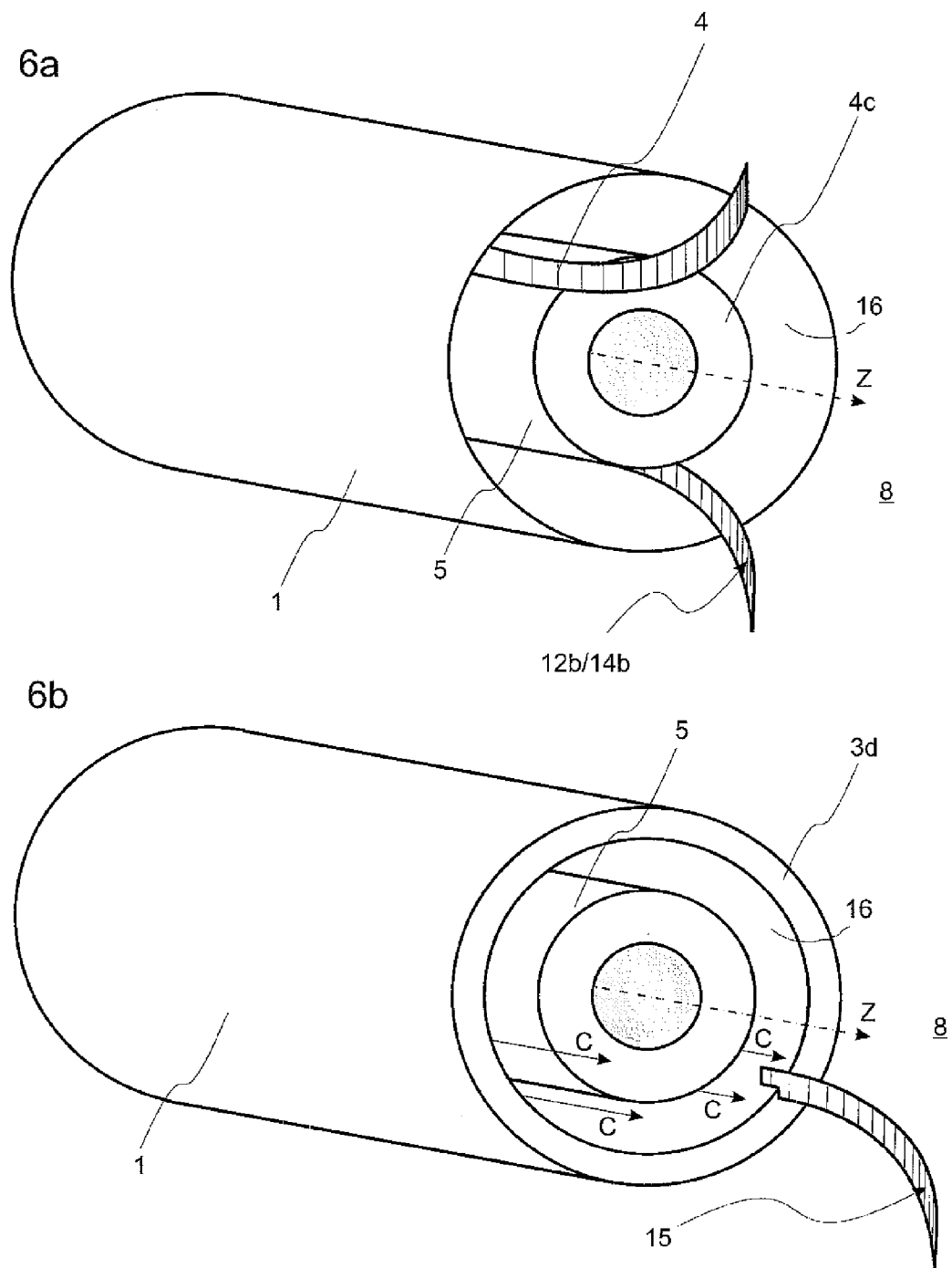


Fig. 6

Application Number
EP 10 15 3513

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)		
X,D A X	US 4 559 425 A (KIRCHESCH HEINZ-PETER [CH] ET AL) 17 December 1985 (1985-12-17) * column 2, lines 35-43; figures 1,2 * ----- JP 3 046939 U (-) 30 April 1991 (1991-04-30) * figures 1,2 * -----	1-6, 11-15 7-10 1	INV. H01H33/74		
			TECHNICAL FIELDS SEARCHED (IPC)		
			H01H		
The present search report has been drawn up for all claims					
Place of search Munich		Date of completion of the search 24 June 2010	Examiner Simonini, Stefano		
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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ON EUROPEAN PATENT APPLICATION NO.**

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24-06-2010

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