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(54) High voltage electrical switching device with supporting tube

(57) The electrical switching device (1) has at least a nominal contact arrangement, wherein the nominal contact arrangement comprises at least a first nominal contact comprising a plurality of contact fingers (3a) forming a finger cage concentric with respect to a longitudinal axis (z), and at least a mating second nominal contact (3b), wherein at least one of the nominal contacts (3a, 3b) is movable parallel to the longitudinal axis (z) and cooperates with the other nominal contact (3b, 3a) for closing and opening the electric switching device (1). The electrical switching device further comprises a supporting tube (6) fitted into the finger cage and contacting the contact fingers (3a). The supporting tube (6) carries a plurality of spacers (7), each of which extends into a gap between two adjacent contact fingers (3a).

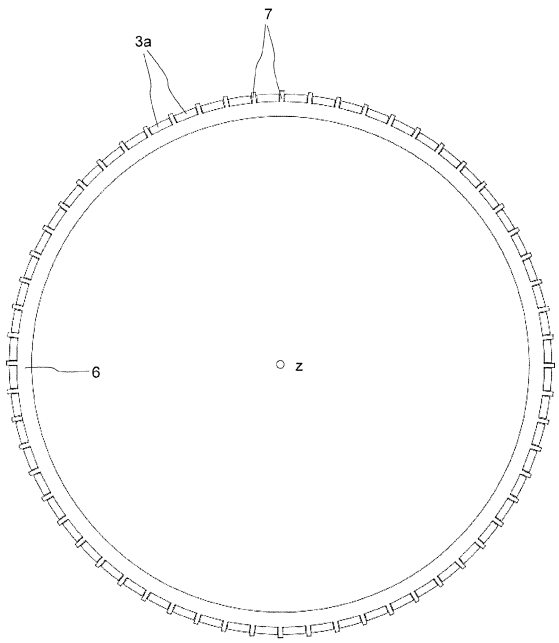

Fig. 5

EP 2 731 117 A1

Description

Background

[0001] The invention relates to the field of medium and high voltage switching technologies and concerns an electrical switching device according to the independent claim, particularly for a use as an earthing device, a fast-acting earthing device, a circuit breaker or a switch disconnector in power distribution systems.

Prior Art

[0002] Electrical switching devices are well known in the field of medium and high voltage switching applications. They are e.g. used for interrupting a current, when an electrical fault occurs. As an example for an electrical switching device, circuit breakers have the task of opening contacts and keeping them far apart from one another to avoid a current flow, even if high electrical potential is originating from the electrical fault itself. For the purposes of this document the term medium voltage refers to voltages from 1 kV to 72.5 kV and the term high voltage refers to voltages higher than 72.5 kV. The electrical switching devices, like the mentioned circuit breakers, may have to be able to carry high nominal currents of 5000 A to 6300 A and to switch very high short circuit currents of 63 kA to 80 kA at very high voltages of 550 kV to 1200 kV.

[0003] Because of the high nominal current, the electrical switching devices of today require many socalled contact fingers for the nominal current. In order to fit all the fingers in the electrical switching devices, the fingers have to be thinner.

[0004] When disconnecting a nominal or short circuit current in the electrical switching devices, the current commutates from the nominal contacts of the electrical switching device to its arcing contacts. An electric arc results for a short period of time, as soon as the arcing contacts have opened, as well.

[0005] EP 0 844 631 B1 discloses an electrical switching device with first contacts arranged in a cage formation and mating second contacts. Furthermore, the electrical switching device has a cylindrical support sleeve fitted into the finger cage as a support for the contact fingers in order to prevent the contact fingers from touching in the region of the contact surfaces. This would occur, because the electromagnetic forces act on the fingers in a radial direction, with radial being defined in respect to the longitudinal axis of the electrical switching device, in such a way that the contact fingers would be bent towards the longitudinal axis and would thus tend to touch one another. Thus, the solution proposed in EP 0 844 631 B1 prevents a damage of the contact fingers caused by radial electromagnetic forces by limiting their radial movement.

Description of the invention

[0006] It is an objective of the present invention to enhance an electrical switching device in terms of robustness by preventing damage of its contact fingers.

[0007] The objective is solved by the features of the independent claims. The electrical switching device has at least a nominal contact arrangement. The nominal contact arrangement comprises at least a first nominal contact with a plurality of contact fingers forming a finger cage. The finger cage is concentric with respect to a longitudinal axis. The nominal contact arrangement further comprises at least a mating second nominal contact. At least one of the contacts is movable parallel to the longitudinal axis and cooperates with the other nominal contact for closing and opening the electric switching device. The electrical switching device further comprises a supporting tube fitted into the finger cage and contacting the contact fingers. The supporting tube carries a plurality of spacers, each of which extends into a gap between two adjacent contact fingers.

[0008] The invention is based on the understanding that a high short circuit current results in high electromagnetic forces acting on the electrical switching device. These electromagnetic forces tend to bend the breaking chamber of the electrical switching device.

[0009] As known, the nominal current contact fingers are arranged around a longitudinal axis of the electrical switching device, e.g. at a constant distance from the axis. Thus, if the breaking chamber is bent, the contact fingers tend to be non-symmetrically displaced in the breaking chamber. Therefore, not all nominal current contacts are separated simultaneously. The contact fingers on one side separate from the mating contact later than the contact fingers on the opposite side and are therefore loaded with a higher current. Consequently, the unsymmetrical current distribution causes non-radial (with respect to the longitudinal axis) electromagnetic forces which can bend the contact fingers in non-radial directions and can therefore damage them.

[0010] In the claimed arrangement the spacers are located between each two adjacent contact fingers and thus act as a supporting means to prevent the contact fingers from being bent laterally, i.e. tangentially with respect to the longitudinal axis, as a result of the non-radial electromagnetic forces acting upon them.

[0011] Hence, the electrical switching device according to the invention provides a supporting tube which not only provides support for the contact fingers against radial electromagnetic forces but also against tangential or in general non-radial electromagnetic forces.

[0012] In an embodiment, the supporting tube is made of plastic resisting to temperatures up to 105° C, preferably Teflon.

[0013] In another embodiment the supporting tube is made of metal, particularly aluminium.

[0014] The spacers can also be made of plastic resisting to temperatures up to 105° C, preferably Teflon, in

one embodiment and of metal, preferably aluminium, in another embodiment.

[0015] Using a supporting tube and/or spacers of a plastic material is particularly advantageous, because, if these components are insulated, spark generation is avoided when the supporting tube touches the fingers.

[0016] It is particularly advantageous, if the supporting tube and the spacers are made of the same material, in particular if the spacers are formed in one piece with the supporting tube. However, in another embodiment they may also be attached to the supporting tube by attachment means, e.g. screws.

Short description of the drawings

[0017] Further embodiments, advantages and applications of the invention result from the dependent claims and from the now following description by means of the figures. It is shown in:

Fig. 1 a partial sectional view of a simplified basic embodiment of a high voltage circuit breaker;
Fig. 2 a perspective simplified schematic view of contact fingers of a finger cage of the high voltage circuit breaker of Fig. 1 with electromagnetic forces acting upon them;
Fig. 3 a partial sectional view of a first embodiment of a high voltage circuit breaker according to the invention;
Fig. 4 a partial sectional view of a second embodiment of a high voltage circuit breaker according to the invention; and
Fig. 5 a front view of a part of the embodiment of the circuit breaker of Fig. 3 or 4.

Ways of carrying out the invention

[0018] The invention is described for the example of a high voltage circuit breaker, but the principles described in the following also apply for the usage of the invention in other switching devices, e.g. of the type mentioned in the "Background"-section, such as in an earthing switch, fast-acting earthing switch, disconnector, combined disconnector and earthing switch, load break switch, generator circuit breaker, and generally in any switch for high voltage, medium voltage or even lower voltages. The most preferred use is in switches for high voltage and medium voltage.

[0019] Fig. 1 shows a partial sectional view of a simplified basic embodiment of a high voltage circuit breaker 1a in a closed configuration. In Fig. 1 "partial section view" means that only a part of the upper half of the circuit breaker is shown for reasons of clarity. The device is rotationally symmetric about a longitudinal axis z. Only the elements of the circuit breaker 1a which are related to the present invention are described in the following, and other elements present in the figures need not be relevant for understanding the invention and are known by the skilled person in high voltage electrical engineering.

[0020] A "closed configuration" as used herein means that nominal contacts of the circuit breaker are closed, thus conducting a nominal current or a short circuit current in case of a short circuit.

[0021] The circuit breaker 1a comprises a chamber enclosed by a shell or enclosure 5 which normally is cylindrical around the longitudinal axis z. It further comprises a nominal contact arrangement formed by a first nominal contact comprising a plurality of contact fingers 3a, of which only one is shown here for reasons of clarity. The nominal contact arrangement is formed as a finger cage around the longitudinal axis z. A shielding 9 can be arranged around the finger cage. The nominal contact arrangement further comprises a second mating contact 3b which normally is a metal tube. The contact fingers 3a and the second contact 3b are movable relatively to one other from the closed configuration shown in Fig. 1, in which they are in electrical contact to one another, into an opened configuration, in which they are apart from one another, and vice versa. It is also possible that only one of the contacts 3a, 3b moves parallel to the longitudinal axis z and the other contact 3b, 3a is stationary.

[0022] The contact fingers 3a are attached to or can be a part of a finger support 2, particularly a metal support cylinder 2.

[0023] The circuit breaker 1a furthermore comprises an arcing contact arrangement formed by a first arcing contact 4a and a second arcing contact 4b.

[0024] In one embodiment of the switching device the first nominal contact and the first arcing contact 4a may be movable with respect to one another, as well as the second nominal contact 3b and the second arcing contact 4b. In another embodiment of the switching device the first nominal contact and the first arcing contact 4a are not movable relatively to one another. In the same way, the second nominal contact 3b and the second arcing contact 4b are not movable with respect to one another. For the explanatory purposes of the present invention the latter embodiment is assumed and it is assumed that only the second nominal contact 3b and the arcing contact 4b are movable and the finger cage is stationary along the z-axis.

[0025] When the closed circuit of Fig. 1 shall be disconnected, the second nominal contact 3b and the second arcing contact 4b are moved parallel to the direction of the z-axis into the direction indicated by the z-arrow, such that the nominal contact arrangement disconnects first. Thereafter, the current commutates to the arcing contact arrangement, which is still closed. With further movement of the second nominal contact 3b and the second arcing contact 4b into the direction of the z-arrow, the arcing contact arrangement also disconnects, thereby creating an electric arc between the arcing contacts 4a, 4b, which is normally blasted out in a very short time. These principles are known and are therefore not explained in more detail here.

[0026] Fig. 2 shows a perspective simplified schematic view of contact fingers 3a of a finger cage of the high voltage circuit breaker 1a of Fig. 1 with electromagnetic forces acting upon them. The fingers 3a are shown as dots in Fig. 2. The mating second contact 3b and the arcing contact arrangement are not shown in Fig. 2. The longer arrows f1 denote radial electromagnetic forces and the shorter arrows f2 denote non-radial electromagnetic forces acting upon the contact fingers 3a. It has to be noted that the directions of the arrows f2 are chosen for illustrative purposes and they may vary in a practical arrangement. The shell or enclosure 5 of the circuit breaker 1a is shown as being bent by the electromagnetic forces in order to visualize that the contact fingers 3a are driven apart from eacho other on the bottom side and are compressed towards each other on the top side of the finger cage. This is due to the fact that the contact fingers 3a are firmly attached to the structure of the chamber shell of the circuit breaker 1a and thus are also moved when the chamber shell 5 bends.

[0027] It is assumed that the nominal contact arrangement is in the course of being opened. Because of the bending of the shell 5, the contact fingers 3a located in the figure below the longitudinal axis z are not in contact with the second nominal contact 3b anymore, whereas the contact fingers 3a located in the figure above the longitudinal axis z are still in contact with the second nominal contact 3b and therefore still conduct a current. Thus, the electromagnetic forces act upon them, which is illustrated by the arrows f1, denoting radial force components, and f2, denoting non-radial force components. As can be seen from Fig. 2, the radial forces f1 tend to bend the contact fingers 3a in directions towards the axis z, in other words they tend to reduce the diameter of the finger cage. The non-radial forces f2 tend to bend the fingers in a non-radial direction. These forces may be high enough to bend at least a part of the contact fingers 3a irreversibly and thus deform them and damage the circuit breaker 1a.

[0028] Fig. 3 shows a solution to this problem illustrated in Fig. 2 and presents a partial sectional view of a first embodiment of a high voltage circuit breaker 1 according to the invention. The setup is similar to the one already explained with regard to Fig. 1, but it comprises additional elements. A supporting tube 6 is additionally arranged inside the finger cage and is concentric with respect to the longitudinal axis z. It is arranged in such a way that it preferably has contact with all contact fingers 3a of the finger cage. In this embodiment the supporting tube 6 is made of metal, preferably aluminium. Furthermore, spacers 7 are arranged on the outer surface of the supporting tube 6. In Fig. 3 they extend into a region radially outside the finger cage.

[0029] In this embodiment, the supporting tube 6 made of metal is attached to the finger support 2. At their ends facing away from second nominal contact 3b, the contact fingers 3a are attached to the outer surface of the supporting tube 6. Thus, in an attachment area, the contact fingers 3a, the supporting tube 6 and the finger support 2 are arranged in a sandwich-like manner and are secured by e.g. bolts or screws extending through all of them. Other attachment means are also possible. It is e.g. possible to attach the contact fingers 3a, alternatively or additionally to the attachment configuration, directly to the finger support 2. If the contact fingers 3a are attached directly to the finger support 2, it is also possible to provide a thin insulating layer between the outer surface of the supporting tube 6 and the inner surface of the contact fingers 3a in order to avoid undefined current transfers via the attachment area of the supporting tube 6.

[0030] Fig. 4 shows also a solution to the problem illustrated in Fig. 2 and presents a partial sectional view of a second embodiment of a high voltage circuit breaker 1 according to the invention. This embodiment is similar to the embodiment of Fig. 3 with some modifications. In this embodiment the supporting tube 6 is made of plastic, preferably Teflon. As in the embodiment of Fig. 3 the contact fingers 3a are mounted to the finger support 2 and the supporting tube 6 is also attached to the finger support 2. However, in this embodiment the contact fingers 3a are attached directly to the finger support 2 and not via the supporting tube 6. The supporting tube 6 is attached to the front side, i.e. the side that faces the second nominal contact 3b, of the finger support 2, e.g. by means of a screw 8.

[0031] In the embodiments of Fig. 3 and 4 the contact fingers 3a extend beyond the supporting tube 6 in longitudinal direction z by a length L that exceeds a maximum insertion length of the second nominal contact 3b into the finger cage when the second nominal contact 3b is in the final closed position. This length L is for example between 1 cm and 3 cm, and in particular is about 2 cm.

[0032] Fig. 5 shows a front view of the embodiment of the circuit breaker of Fig. 3 or 4. The different ways of attaching the supporting tube 6 to the finger support 2 are not shown in Fig. 5. The supporting tube 6 with the spacers 7 is inserted into the finger cage such that the outer surface of the supporting tube supports the inner surfaces of the contact fingers 3a, and the spacers 7 support the lateral surfaces of the contact fingers 3a, that is, the spacers 7 are inserted into gaps between two adjacent contact fingers 3a. In embodiments, each of the gaps receives a spacer 7. As can be seen, the spacers 7 project radially outwards from the supporting tube 6 and away from the longitudinal axis z. In embodiments, the thickness of each spacer 7 is at most equal to a distance between two adjacent contact fingers 3a, particularly with a clearance between the spacer 7 and each of its adjacent contact fingers 3a. For example, in an opened state of the circuit breaker this clearance can be chosen between 0.1 mm and 0.2 mm. The clearance allows a better insertion of the spacers 7 between the contact fingers 3a. Furthermore, it allows the contact fingers 3a to flexibly bend radially outwards with respect to the longitudinal axis z when the first nominal contact receives the second nominal contact 3b while inserting it into the finger

cage. The second nominal contact 3b, which is formed as a tube, has such a diameter that the contact fingers 3a are elastically deformed in a radial direction upon closing the switching device, that is, closing the first and the second nominal contacts. Thereby a good electrical contact is achieved between the two nominal contacts.

[0033] In embodiments, the supporting tube is force-fitted into the finger cage. In the present context, force-fitted means that the outer diameter of the supporting tube is slightly greater, for example in the range of a few millimeters and preferably not more than 2 mm, than the inner diameter of the finger cage, such that the contact fingers 3a are bent outwards. In other words the supporting tube 6 can be dimensioned to impinge on the contact fingers 3a such that they are pre-opened when the first and the second contact are not closed. This is advantageous, because it minimizes the risk of damaging the fingers during the closing process of the switch due to the impact of the second nominal contact 3b onto the contact fingers 3a.

[0034] The arrangement of the supporting tube 6 with the spacers 7 inside the finger cage of the first nominal contact prevents the contact fingers 3a to be damaged by deformations caused by electromagnetic forces acting on them. Radial forces are accounted for by the cylinder body of the supporting tube 6, which supports the fingers against a deformation in radial direction, and the spacers 7 prevent that non-radial or tangential deformations, respectively, can occur because of non-radial electromagnetic forces. Thus, the contact fingers 3a can be designed to be thinner with the result that their number in the finger cage can be increased, thus permitting the usage of the electrical switching device for higher nominal currents.

[0035] In another aspect, the invention relates to a supporting tube 6 for being fitted into a finger cage and for contacting contact fingers 3a of an electrical switching device as claimed in any of the appended claims, wherein the supporting tube 6 carries a plurality of spacers 7, each of which is designed to extend into a gap between two adjacent contact fingers 3a.

[0036] While there are shown and described presently preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may otherwise variously be embodied and practised within the scope of the following claims. Therefore, terms like "preferred" or "in particular" or "particularly" signify optional and exemplary embodiments only.

List of reference numerals

[0037]

1a = basic switch, basic circuit breaker
1 = basic switch or basic circuit breaker according to the invention
2 = finger support
3a = contact finger of first nominal contact
3b = second nominal contact
4a = first arcing contact
4b = second arcing contact
5 = enclosure, shell
6 = supporting tube
7 = spacer
8 = screw
9 = shielding
f1 = radial force
f2 = non-radial force
z = longitudinal axis
L = contact finger extension length beyond supporting tube

Claims

1. Electrical switching device (1) having a longitudinal axis (z) and at least a nominal contact arrangement, wherein the nominal contact arrangement comprises at least a first nominal contact comprising a plurality of contact fingers (3a) forming a finger cage, which is concentric with respect to the longitudinal axis (z), and at least a mating second nominal contact (3b), wherein at least one of the nominal contacts is movable parallel to the longitudinal axis (z) and cooperates with the other nominal contact for closing and opening the electric switching device (1),
further comprising a supporting tube (6) fitted into the finger cage and contacting the contact fingers (3a),
characterized in that the supporting tube (6) carries a plurality of spacers (7), each of which extends into a gap between two adjacent contact fingers (3a).

2. The electrical switching device according to claim 1, wherein the thickness of each spacer (7) is at most equal to a distance between two adjacent contact fingers (3a), and in particular wherein a clearance of each spacer (7) from each one of its adjacent contact fingers (3a) is in an opened state of the electrical switching device (1) between 0.1 mm and 0.2 mm.

3. Electrical switching device according to claim 1 or 2, wherein the spacers (7) are made of temperature-resistant plastic, particularly Teflon.

4. Electrical switching device according to claim 1 or 2, wherein the spacers (7) are made of metal, particularly aluminium.

5. Electrical switching device according to any of the preceding claims, wherein the supporting tube (6) is made of temperature-resistant plastic, particularly Teflon.

6. Electrical switching device according to any of the claims 1 to 4, wherein the supporting tube (6) is made of metal, particularly aluminium.

7. Electrical switching device according to claim 6, wherein an insulating layer is provided between an outer surface of the supporting tube (6) and an inner surface of the contact fingers (3a).

8. Electrical switching device according to any of the preceding claims, wherein the spacers (7) are formed in one piece with the supporting tube (6).

9. Electrical switching device according to any of the preceding claims, wherein the contact fingers (3a) extend beyond the supporting tube (6) in the longitudinal direction (z) by a length (L) exceeding a maximum insertion length of the second nominal contact (3b) into the first nominal contact when the electric circuit is electrically connected, in particular wherein the length (L) is equal to or smaller than 3 cm.

10. Electrical switching device according to any of the preceding claims, wherein the supporting tube (6) is force-fitted into the finger cage.

11. Electrical switching device according to any of the preceding claims, further comprising a finger support (2), wherein the contact fingers (3a) are mounted to the finger support (2), and wherein the supporting tube (6) is attached to the finger support (2).

12. Electrical switching device according to any of the preceding claims, wherein the spacers (7) project outwards from the supporting tube (6) away from the longitudinal axis (z).

13. Electrical switching device according to any of the preceding claims, wherein each of the gaps receives a spacer (7).

14. Electrical switching device according to one of the preceding claims, wherein the contact fingers (3a) are elastically deformed in a radial direction upon closing the switching device (1).

15. Electrical switching device according to one of the preceding claims, it being an earthing device, a fast-acting earthing device, a circuit breaker, a generator circuit breaker, a switch disconnector, a combined disconnector and earthing switch, or a load break switch.

16. Supporting tube (6) for being fitted into a finger cage and for contacting contact fingers (3a) of an electrical switching device as claimed in any of the preceding claims 1-15, wherein the supporting tube (6) carries a plurality of spacers (7), each of which is designed to extend into a gap between two adjacent contact fingers (3a).

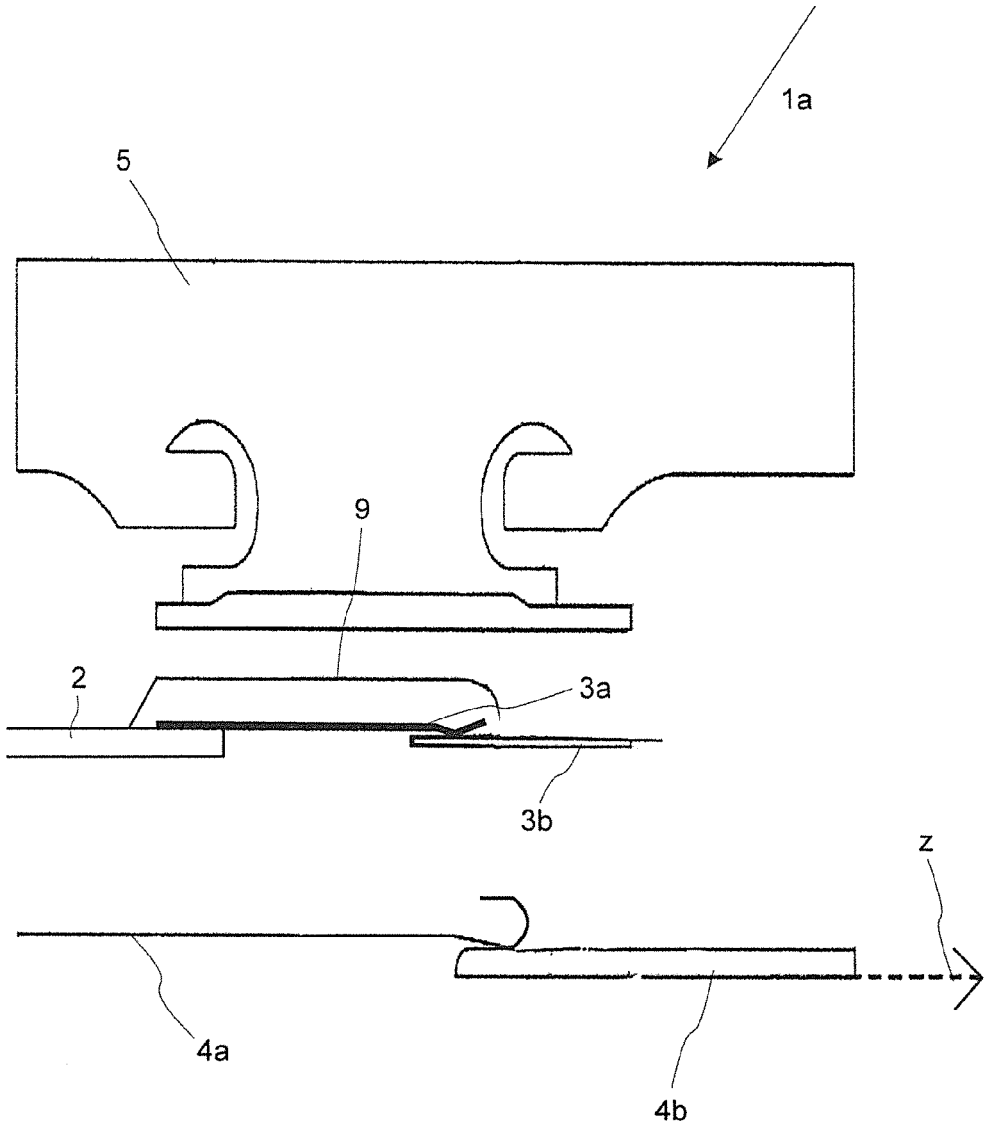

Fig. 1

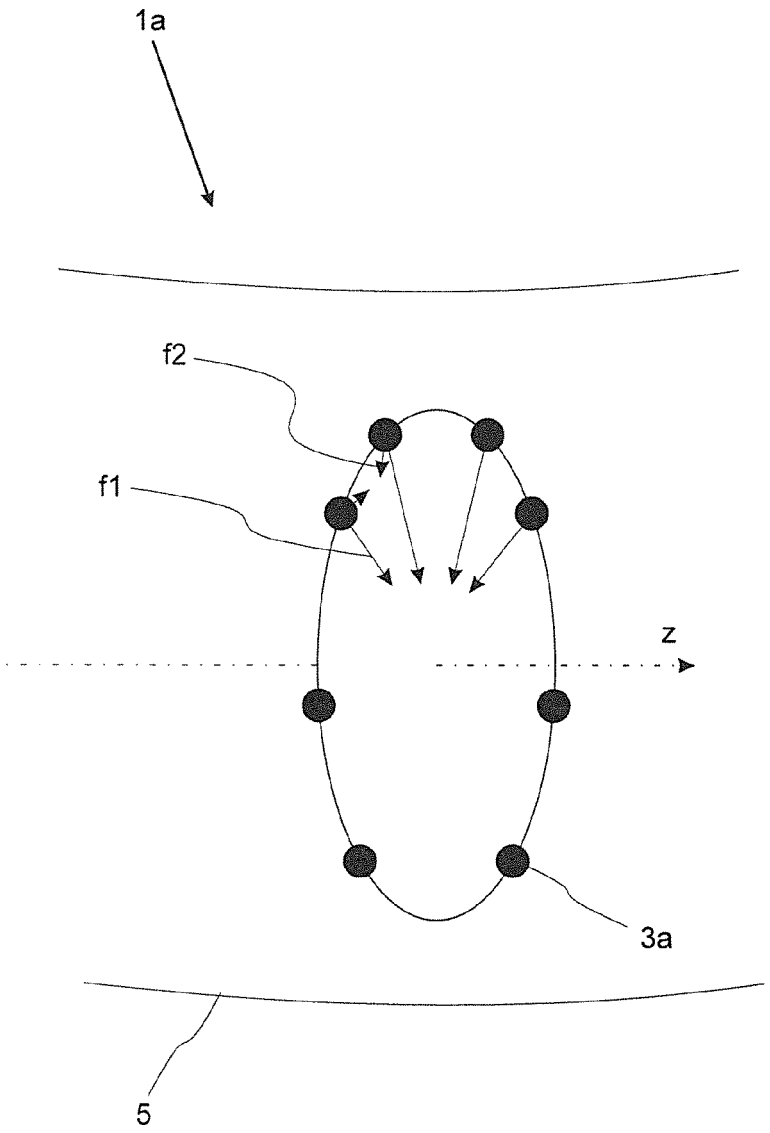

Fig. 2

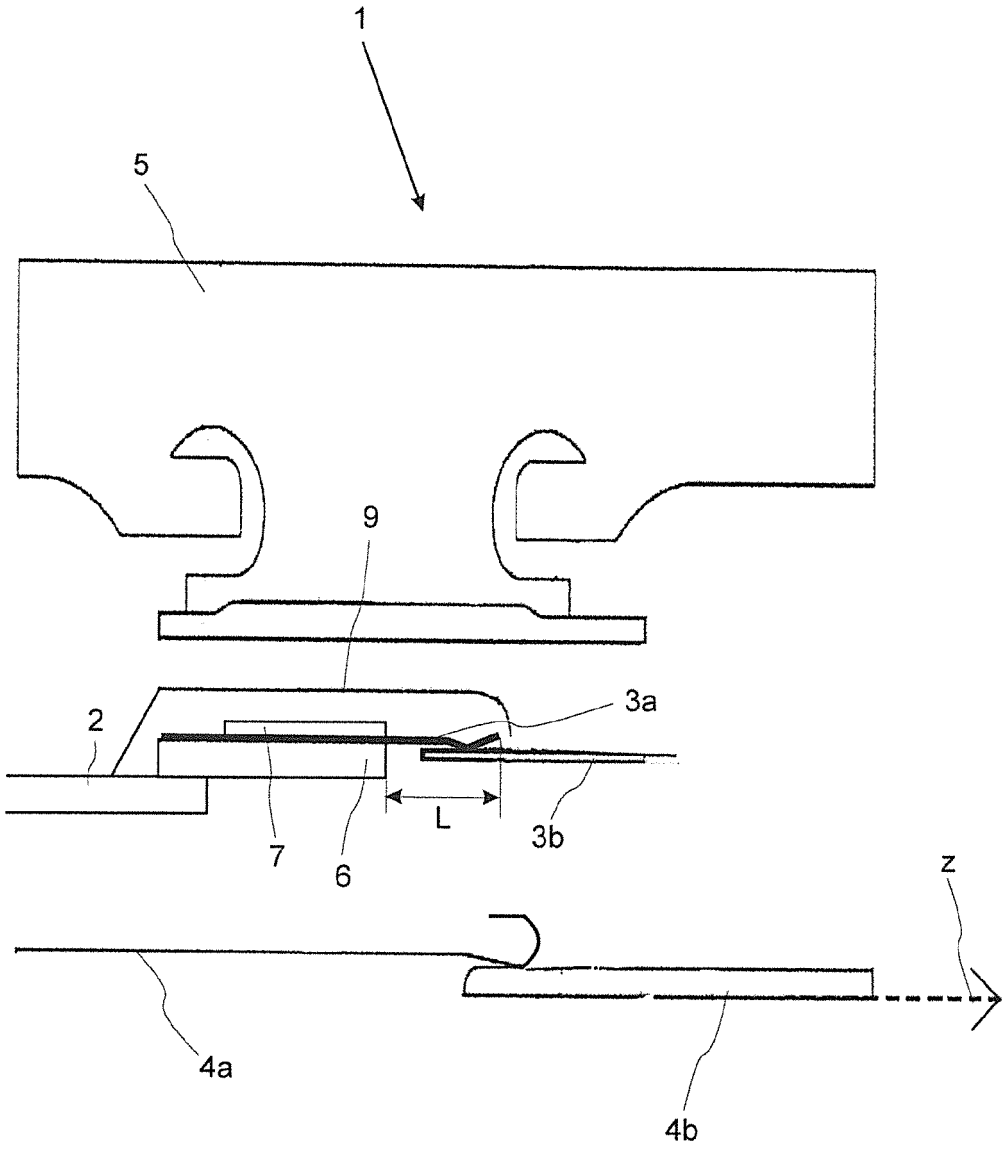

Fig. 3

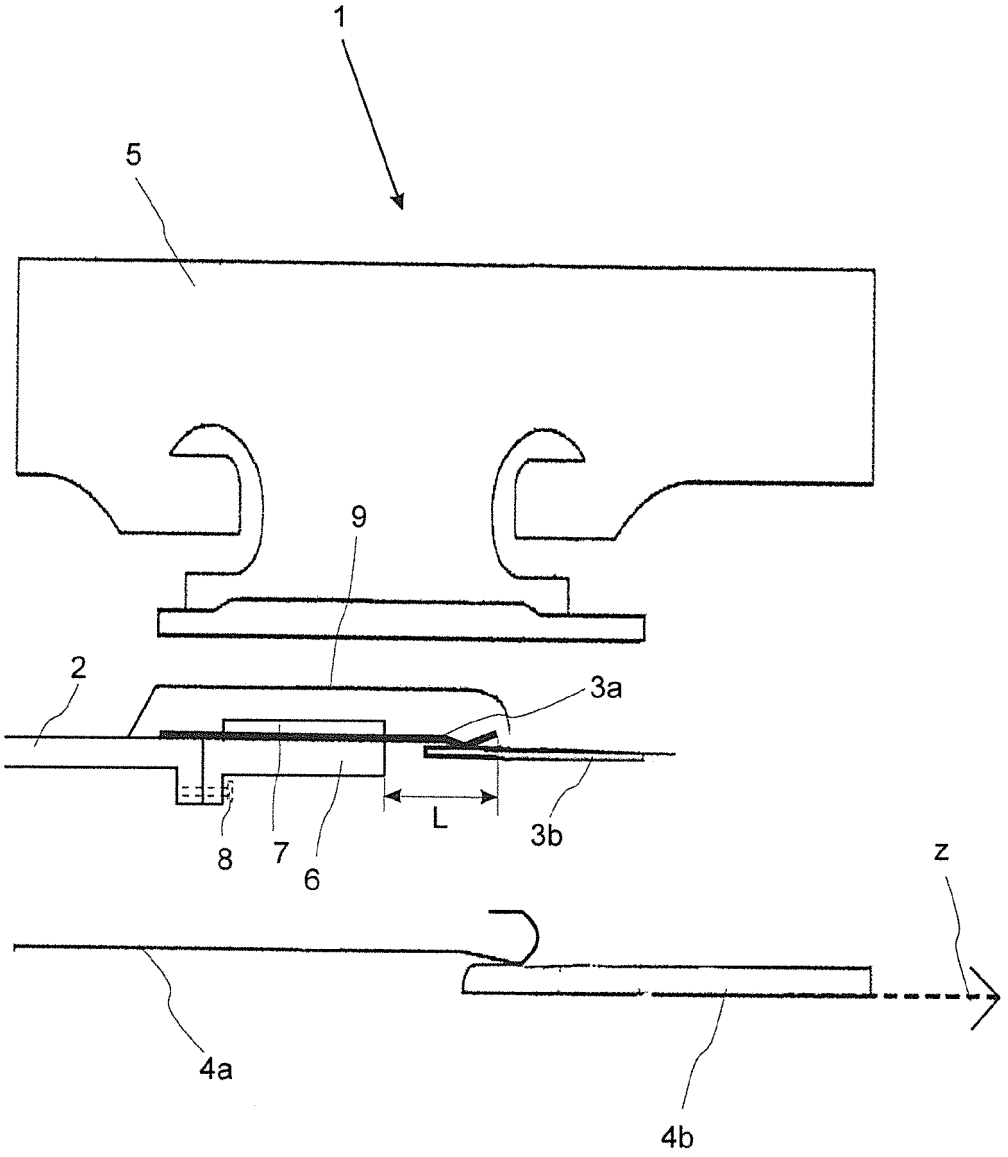

Fig. 4

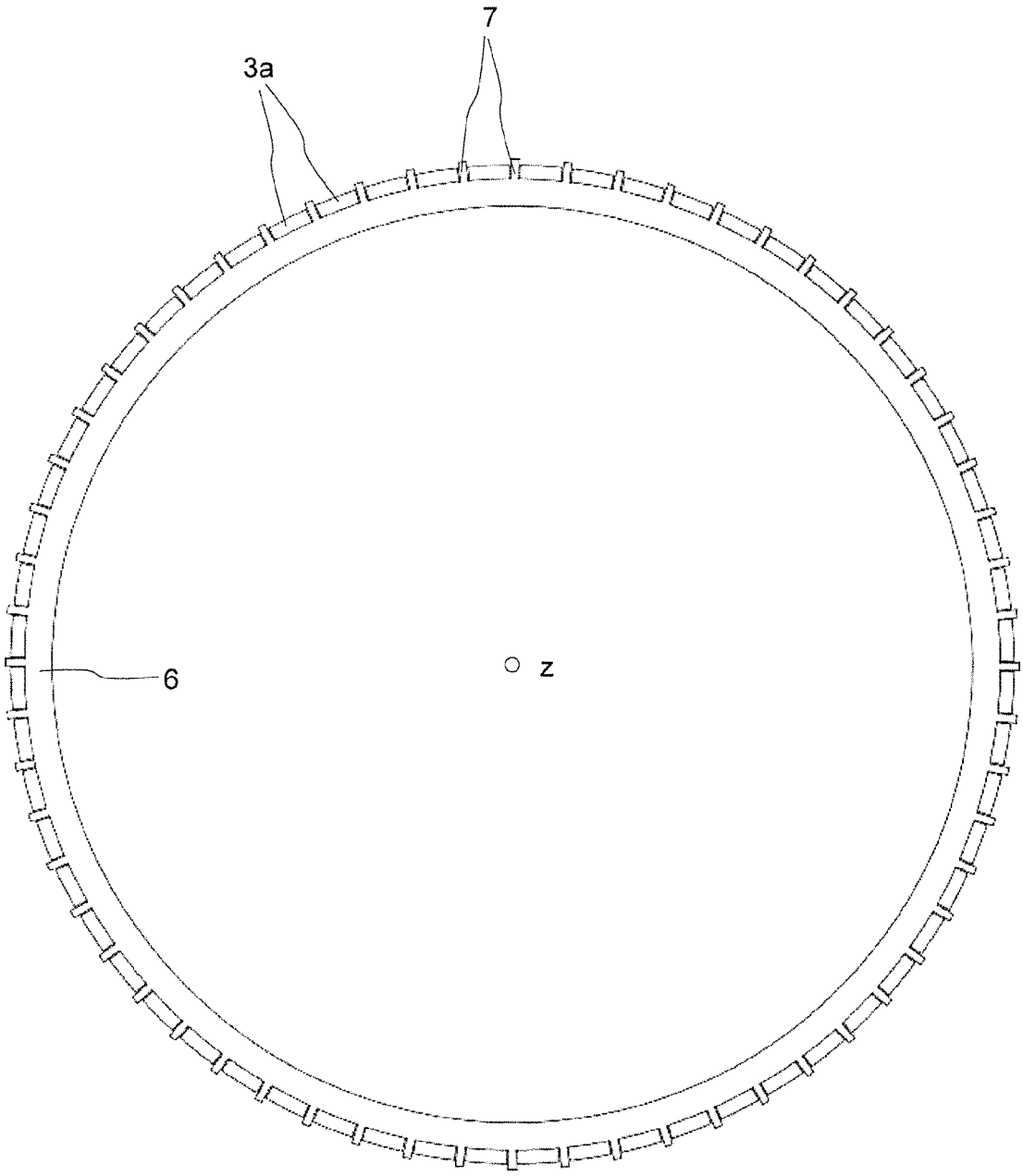

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 12 19 2469

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H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 April 2013	Fribert, Jan

CATEGORY OF CITED DOCUMENTS

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