

(19)



(11)

EP 2 920 801 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

07.09.2016 Bulletin 2016/36

(21) Application number: **13789779.9**

(22) Date of filing: **12.11.2013**

(51) Int Cl.:

H01H 1/38 (2006.01)

(86) International application number:

PCT/EP2013/073528

(87) International publication number:

WO 2014/076040 (22.05.2014 Gazette 2014/21)

(54) **CONTACT SYSTEM**

KONTAKTSYSTEM

SYSTÈME DE CONTACT

(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**

(30) Priority: **13.11.2012 EP 12192470**

22.11.2012 EP 12193720

(43) Date of publication of application:

23.09.2015 Bulletin 2015/39

(73) Proprietor: **ABB Schweiz AG**

5400 Baden (CH)

(72) Inventors:

- **PISU, Franceso**
5413 Birmenstorf (CH)

• **KOSTOVIC, Jadran**
5430 Wettingen (CH)

• **KOTILAINEN, Sami**
5443 Niederrohrdorf (CH)

• **SUTHERLAND, Timothy**
8192 Zewidlen (CH)

(74) Representative: **ABB Patent Attorneys**

C/o ABB Schweiz AG
Intellectual Property (CH-LC/IP)
Brown Boveri Strasse 6
5400 Baden (CH)

(56) References cited:

EP-A1- 0 951 038 DE-A1- 2 935 202
DE-A1- 19 816 508

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 2 920 801 B1

Description

Background

[0001] The invention relates to the field of medium and high voltage switching technologies and concerns an electrical switching device, a contact arrangement for the electrical switching device and a method for closing the electrical switching system according to the independent claims, particularly for a use as an earthing switch, fast-acting earthing switch, disconnecter, combined disconnecter and earthing switch, load break switch, circuit breaker or generator circuit breaker, in power transmission or 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 in order to avoid a current flow, even in case of high electrical potential originating from the electrical fault itself. For the purposes of this disclosure 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 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 so-called nominal contact fingers for the nominal current. When disconnecting (opening) a nominal or short circuit current within the electrical switching devices, the current commutates from nominal contacts of the electrical switching device to its arcing contacts. Thus, when connecting (closing) the nominal contacts of the electric switching device, also the arcing contacts are connected. They normally comprise as a first arcing contact arcing contact fingers arranged around the longitudinal axis of the electrical switching device in a so-called arcing finger cage and, as a second arcing contact, a rod which is driven into the finger cage.

[0004] The opening and closing processes of the nominal and the arcing contacts have to be carried out with a predefined speed, according to the specification of the electrical switching device. During the closing of the electrical switching device particularly the arcing contact fingers are subjected to an impact caused by the incoming rod. The impact force acting on the arcing contact fingers depends on the closing speed of the rod. Thus, the higher the speed, the higher is the force acting on the arcing contact fingers. However, a high contact speed is desired because it improves the performance of the electrical

switching device when applying controlled switching in the sense that the switching device is closed or opened as accurate as possible in the instant of e.g. voltage or current zero-crossing. As a consequence of higher impact forces acting on the arcing contact fingers, the arcing contact fingers may experience a permanent deformation. For example, they may be deformed radially outward with respect to the longitudinal axis. A contact force between the arcing contact finger and the second arcing contact has to be high enough to ensure a good electrical contact. Eventually, requirements regarding the contact force are not met anymore because of the deformation.

[0005] EP 0 951 038 A1 (closest prior art) discloses an arcing contact arrangement in a generator circuit breaker having a support body for arcing contact fingers.

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. This objective is achieved by the subject-matter of the independent claims.

[0007] In a first aspect of the invention the objective is solved by the features of claim 1 by an electrical switching device having a longitudinal axis and comprising at least one contact arrangement. The contact arrangement comprises a first contact and a mating second contact, wherein the first contact comprises at least one contact finger. For closing and opening the electric switching device at least one of the contacts is movable parallel to the longitudinal axis and cooperates with the other contact. The electrical switching device further comprises a deflector elastically deflecting the at least one contact finger in a radial direction away from the axis prior to or while closing the electrical switching device. Furthermore, the deflector is movable parallel to the longitudinal axis z between a first position corresponding to a pre-deflection position of the contact finger, in which the contact finger is elastically deflected by the deflector radially outward with respect to the longitudinal axis z, when the electrical switching device is in an opened configuration, and a second position corresponding to an end position of the second arcing contact, in which the deflector does not deflect the contact finger, when the electrical switching device is in a closed configuration, and the deflector is adapted to be moved from the first position into the second position by the second arcing contact when the electrical switching device is being closed.

[0008] The advantage of designing the contact arrangement to have a deflector elastically deflecting the contact finger in the way mentioned above is that the impact stress is diminished while the required contact force between the two contacts is maintained.

[0009] In embodiments, the at least one contact arrangement is or comprises an arcing contact arrangement, the first contact is or comprises a first arcing contact comprising at least one arcing contact finger, and the

mating second contact is or comprises a mating second arcing contact. In particular, for closing and opening the electric switching device at least one of the arcing contacts is movable parallel to the longitudinal axis and cooperates with the other arcing contact.

[0010] In alternative or additional embodiments, the at least one contact arrangement is or comprises a nominal contact arrangement, the first contact is or comprises a first nominal contact comprising a plurality of nominal contact fingers and forming a finger cage concentric with respect to the longitudinal axis, and the mating second contact is or comprises a mating second nominal contact. In particular, for closing and opening the electric switching device at least one of the nominal contacts is movable parallel to the longitudinal axis and cooperates with the other nominal contact.

[0011] In a second aspect, the invention also relates to a contact arrangement for an electrical switching device as disclosed above. The contact arrangement has a longitudinal axis and comprises at least one contact finger. A deflector is provided, which elastically deflects the contact finger in a radial direction away from the axis prior to or while closing the electrical switching device.

[0012] In embodiments, the contact arrangement is further characterized by the features of any of the dependent claims.

[0013] In other embodiments, the contact arrangement is or comprises an arcing contact arrangement and the contact finger is or comprises an arcing contact finger, and/or the contact arrangement is or comprises a nominal contact arrangement and the contact finger is or comprises a nominal contact finger.

[0014] A third aspect of the invention concerns a method for closing a contact arrangement according to the second aspect of the invention of an electrical switching device according to the first aspect of the invention. The method comprises the steps of deflecting the contact finger radially outward by means of the deflector and connecting the second contact with the deflected first contact.

[0015] The advantage of closing the electrical switching device in the way is that a reduction of the mechanical strain exerted on the contact fingers is attained by pre-opening the contact fingers before their first impact with the second contact. By this, the contact fingers are subjected to less mechanical stress and consequently their lifetime is prolonged.

Short description of the drawings

[0016] 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 and 3 sectional side views of an arcing contact

finger of the first arcing contact of the circuit breaker of Fig. 1 with a first comparative embodiment of a deflector;

Fig. 4 and 5 sectional side views of an arcing contact finger of the first arcing contact of the circuit breaker of Fig. 1 with a second embodiment of a deflector; Fig. 6 and 7 sectional top views of the arcing contact fingers of the first arcing contact with the embodiment of the deflector of Fig. 4 and 5;

Fig. 8 a front view of the deflector of Fig. 4 and 5 as seen in the direction of the longitudinal axis z;

Fig. 9 to 12 sectional views of an arcing contact finger of the first arcing contact of the circuit breaker of Fig. 1 with a third embodiment of a deflector; and

Fig. 13 and 14 sectional views of an arcing contact finger of the first arcing contact of the circuit breaker of Fig. 1 with a deflection limiting element.

Ways of carrying out the invention

[0017] The invention is described for the example of a high voltage circuit breaker having nominal contacts and arcing contacts, 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 at the beginning, such as in an earthing switch, fast-acting earthing switch, disconnecter, combined disconnecter and earthing switch, load break switch, circuit breaker or generator circuit breaker, and generally in any switch for high voltage or medium voltage. In particular, the invention is fully applicable in switches having an arcing contact arrangement solely, a nominal contact arrangement solely, or both an arcing contact system and a nominal contact system. An arcing contact arrangement shall encompass a first arcing contact comprising at least one arcing contact finger 4a, and a mating second arcing contact 4b, both being movable relative to one another. A nominal contact arrangement shall encompass a first nominal contact comprising a plurality of nominal contact fingers 3a, and a mating second arcing contact 3b, both being movable relative to one another.

[0018] In the following same reference numerals denote structurally or functionally same elements of the various embodiments of the invention.

[0019] Fig. 1 shows a partial sectional view of a simplified basic embodiment of a high voltage circuit breaker 1 in a closed configuration. In Fig. 1 "partial section view" means that only the upper half of a section 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 1 which are related to the present invention are described in the following. Other elements present in the figures are not 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 the nominal contacts and/or the arcing contacts of the circuit breaker are closed. Particularly, a closed con-

figuration is interpreted as a motionless arrangement of said contacts. The term "being closed" or "closing process" refer to a moving state of the contact or contacts. Accordingly, an "opened configuration" as used herein means that the nominal contacts and/or the arcing contacts of the circuit breaker are opened. Particularly, an opened configuration is interpreted as a motionless arrangement of said contacts. The term "being opened" or "opening process" refer to a moving state of the contact or contacts.

[0021] The circuit breaker 1 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 with 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 along the longitudinal axis z.

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

[0023] The circuit breaker 1 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 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 it is assumed that only the second nominal contact 3b and the second arcing contact 4b are movable and the finger cage and the first arcing contact 4a are stationary along the z-axis.

[0025] Fig. 2 shows a sectional view of an arcing contact finger 4a of the first arcing contact with a first comparative embodiment of a deflector 6 in an idle position, in other words in an opened configuration of the electrical switching device 1. The deflector 6 is arranged radially between a longitudinal axis z of the electrical switching device 1 and the arcing contact finger 4a. Advantageously, the deflector 6 is a tube and has such a diameter that the arcing contact finger 4a is deflected outward with re-

spect to the longitudinal axis z by not more than 0.05 cm. In other words an inner diameter of the arcing contact finger cage increases up to 0.1 cm. Thus, the arcing contact finger 4a is pre-opened by the deflector 6. The arcing contact finger 4a normally has a curvature towards the longitudinal axis z at its free end, also called tulip, as can be seen in the figures. The arcing contacts 4a, 4b are shown in Fig. 2 in an opened configuration and in Fig. 3 in a closed configuration. Furthermore, in Fig. 2 and 3 the arcing contact finger is shown with dashed lines and denoted by the reference numeral 4c in a non-deflected position as it would be arranged without the deflector 6. This is assumed for the subsequent embodiments, as well, but the corresponding illustration is not shown in these embodiments because of clarity reasons.

[0026] Fig. 3 shows the sectional view of the arcing contact finger 4d of the first arcing contact of Fig. 2 with the deflector 6 in the closed configuration of the electrical switching device 1. In the closed configuration the deflector 6 has substantially no more contact to the arcing contact finger 4d, as the second arcing contact 4b now elastically deflects the arcing contact finger radially outward with respect to the longitudinal axis z. Thus, a first deflection of the arcing contact finger 4a is caused by the deflector 6, subsequently called pre-deflection, and a further deflection of the arcing contact finger 4d is caused by the second arcing contact 4b, subsequently called final deflection. Because of its elasticity, the arcing contact finger 4d in the final deflection position exerts a force on the second arcing contact 4b in the closed configuration, thus ensuring a good electrical contact. This is assumed for all embodiments of the invention as well. The end of the deflector 6 facing the tulip of the arcing contact finger 4a may have a rounded shape. The electrical switching device 1 further comprises a finger support 20 carrying the at least one contact finger 4a.

[0027] In this comparative embodiment of the electrical switching device 1 the deflector 6 is fixedly attached to the finger support 20 in a first position corresponding to the pre-deflection position of the arcing contact finger 4a, as shown in Fig. 2. Thus, in this embodiment the arcing contact finger 4c is positioned as pre-deflected arcing contact finger 4a in the opened configuration of the electrical switching device 1 and it is positioned in the final deflection position 4d in the closed configuration of the electrical switching device 1.

[0028] This advantageously simplifies the construction of the electrical switching device 1 because the deflector 6 has merely to be fixed only once to its support, advantageously to the finger support 20, when the electrical switching device 1 is being assembled.

[0029] Advantageously, the deflector 6 has a higher stiffness than the arcing contact finger 4a. By this it is made sure that the deflector deflects the arcing contact finger 4a and not vice versa. The stiffness of the deflector 6 is chosen such that the highest deflection effect is attained, in other words such that the bending of the deflector 6 itself is minimal.

[0030] Fig. 4 shows a sectional side view of an arcing contact finger 4a of the first arcing contact with a second embodiment of a deflector 7a in the opened configuration of the electrical switching device 1. The deflector 7a is also arranged between the longitudinal axis z and the arcing contact finger 4a, like in case of the first comparative embodiment of Fig. 2. A spring 7b is provided, which connects the finger support 20 carrying the at least one contact finger 4a and the deflector 7a. The deflector 7a is movable parallel to the longitudinal axis z between a first position and a second position. The first position corresponds to a pre-deflection position of the arcing contact finger 4a, in which the deflector 7a abuts against the arcing contact finger 4a, particularly against a tulip of the arcing contact finger 4a, and elastically deflects the arcing contact finger 4a radially outward with respect to the longitudinal axis z when the electrical switching device 1 is in an opened configuration. The second position corresponds to an end position of the second arcing contact 4b in the closed configuration of the electrical switching device 1. In other words, after the second arcing contact 4b has started entering the arcing finger cage, the arcing contact finger 4a is further deflected until it reaches its final deflection position, being denoted by 4d in this position. Already now the deflector 7a has substantially no more contact to the arcing contact 4a. When the second arcing contact 4b is further pushed in the direction opposite to the arrow z it eventually reaches the deflector 7a and pushes it until the second arcing contact 4b has reached its end position inside the arcing finger cage. Thus, in the second position the deflector 7a does not deflect the arcing contact finger 4d. In the final deflection position the arcing contact finger 4d is only deflected by the second arcing contact 4b. Thus, the deflector 7a is adapted to be moved from the first position into the second position by the second arcing contact 4b when the electrical switching device 1 is being closed. Advantageously, there is no additional element required for moving the deflector 7a from the first position into the second position, as this task is carried out by the second arcing contact 4b itself. The deflector 7a is adapted to be moved from the second position into the first position by the spring 7b when the electrical switching device 1 is being opened and reaches the first position before the second arcing contact 4b has left the arcing finger cage. This embodiment of the deflector 7a in connection with the spring 7b has a similar effect like the comparative embodiment of the fixed deflector 6 of Fig. 2 and 3, as the arcing contact finger 4a is always kept in a pre-deflected state in the opened configuration of the electrical switching device 1.

[0031] In one embodiment the deflector 7a is star-shaped and advantageously comprises Teflon or is made of Teflon. The advantage of the star shape is that an extinguishing medium inside the switching device 1, which cools down the electric arc forming between the two arcing contacts 4a, 4b when closing or opening the electrical switching device 1, can flow faster through the

deflector 7a and thus it can escape through the "channels" formed between the star teeth of the deflector 7a, which in this embodiment has a larger opening.

[0032] As can be seen in Fig. 4, the deflector 7a is guided on an inner surface of the arcing contact finger 4a. The inner surface denotes a surface facing the longitudinal axis z. The radial dimensions of the deflector 7a are chosen in such a way that its edge or edges opposed to the edge or edges sliding on the inner surface of the arcing contact finger 4a are closer to the longitudinal axis z than the lowermost extremity of the free end of the tulip of the arcing contact finger 4a. In the context of the present document the term "lower" or "lowermost" is interpreted as "closer" or "closest" to the longitudinal axis z. By choosing such dimensions of the deflector 7a it is made sure that, during the closing process of the electrical switching device 1, the second arcing contact 4b, which is shifted parallel to the longitudinal axis z in a contrary direction to the arrow of the axis z, is capable of pushing the deflector 7a back towards the finger support 20. The diameter of the deflector 7a is chosen to have such a value that the deflector 7a can move freely, in particular parallel to the longitudinal axis z, after a first contact of the first and the second arcing contacts 4a, 4b while closing the electrical switching device 1 or until a last contact of the first and the second arcing contacts 4a, 4b while opening the electrical switching device 1 respectively.

[0033] In an embodiment the spring 7b is arranged inside a protecting tube 7c, in particular inside a hollow protecting tube 7c, which is fixedly attached to the deflector 7a. Thus, the protecting tube 7c moves along with the deflector 7a when the deflector 7a is shifted between the first and the second positions. By providing the protecting tube 7c it is avoided that hot gases come into contact with the spring 7b and potentially damage it or affect its stiffness or elasticity, respectively. The deflector 7a can be supported by the finger support 20 in order to make sure that the finger support 20 moves substantially parallel to the longitudinal axis z. For this, a support element not shown here is movably supported by the finger support 20. For example, the support element may be shifted back and forth through a hole in the finger support 20.

[0034] Advantageously, like in comparative embodiment according to Fig. 2 and 3, the deflector 7a has a higher stiffness than the arcing contact finger 4a. By this it is made sure that the deflector 7c deflects the arcing contact finger 4a and not vice versa. The stiffness of the deflector 7a is chosen such that the highest deflection effect is attained, in other words such that the bending of the protecting tube 7c itself is minimal.

[0035] Fig. 5 shows the sectional side view of the arcing contact finger 4a of the first arcing contact of Fig. 4 with the second embodiment of the deflector 7a in the closed configuration of the electrical switching device 1, thus in the final deflection position of the arcing contact finger 4d. As can be seen from Fig. 4 and Fig. 5 and analogous

to the comparative embodiment of Fig. 2 and 3, the arcing contact finger 4a is positioned in a pre-deflection position, as a deflected arcing contact finger 4a, in the opened configuration of the electrical switching device 1, and it is positioned in the final deflection position in the closed configuration of the electrical switching device 1.

[0036] Fig. 6 shows a sectional top view of two arcing contact fingers 4a of the first arcing contact with the embodiment of the deflector 7a of Fig. 4 and 5 in a closed configuration of the electrical switching device 1. The deflector 7a has been pushed back by the tip of the second arcing contact 4b in an opposite direction with respect to the direction of the arrow z. A spring fixation tube 7d is coupled to the spring 7b and serves as a support for the spring 7b. In one embodiment the spring fixation tube 7d is made of Teflon.

[0037] The protecting tube 7c has a first section with a thick wall extending between the spring 7b and the deflector 7a, and a second section with a thin wall following the first section. The spring 7b is arranged outside the protecting tube 7c. In the first section, the protecting tube 7c has an outside radius, with respect to the longitudinal axis z, which is slightly smaller than the inside radius of the arcing contact finger 4a, such that it can be moved inside the finger cage of the arcing contact fingers 4a after a first contact between the arcing contact finger 4a and the second arcing contact 4b when the electrical switching device 1 is being closed. The protecting tube 7c may be made of or comprise steel and/or titanium and/or tungsten-copper.

[0038] Fig. 7 shows a sectional top view of the arcing contact fingers 4a of the first arcing contact with the embodiment of the deflector 7a of Fig. 4, 5 and 6 in an opened configuration of the electrical switching device 1. The second arcing contact 4b doesn't act on the deflector 7a in this position. During the opening process, starting from the position of the second arcing contact 4b shown in Fig. 6, the second arcing contact 4b is moved in the direction of the arrow z. The deflector 7a follows this movement together with the protecting tube 7c, being pushed by the spring 7b. As soon as the deflector 7a reaches the "tulip" section of the arcing contact fingers 4a, which has smaller diameters, it is stopped by the tulip section of the arcing contact fingers 4a, as can be seen in Fig. 7.

[0039] Fig. 8 shows a front view of the deflector 7a of Fig. 4 to 7 as seen in the direction of the plane AA of Fig. 6 and 7. In this figure the advantageous star shape of the deflector 7a can be seen well. The dashed surfaces are only illustrated in this way in order to differentiate them from the empty spaces in the middle. The empty spaces in the middle of the deflector 7a denote the "channels" mentioned above, formed between the star teeth. The hot extinguishing medium inside the electrical switching device 1 can escape faster through the channels from the contact area of the arcing contacts 4a, 4b when using this advantageous shape of the deflector 7a. It is understood that other shapes yielding the same effect are readily conceivable.

[0040] Fig. 9 to 12 show a sectional view of an arcing contact finger 4a of the first arcing contact with a third embodiment of a deflector 11, 12, 14 in different stages of a closing or opening process respectively. The electrical switching device 1 comprises a finger support 20 carrying the at least one arcing contact finger 4a. The deflector comprises a first deflection element 11. The arcing contact finger 4a is arranged between the first deflection element 11 and the longitudinal axis z. In this example the first deflection element 11 is arranged between the first nominal contact 3a (shown in Fig. 1) and the arcing contact finger 4a. Advantageously, the first deflection element 11 is arranged radially not more than 1 cm away from the arcing contact finger 4a in an opened configuration of the electrical switching device 1. The first deflection element 11 comprises a first and a second abutment member 11a, 11b. The deflector further comprises a second deflection element 14 located at one end of the arcing contact finger 4a. A stop element 12 is provided, which may be attached to a fixed part of the electrical switching device 1. This is not shown in Fig. 9 to 12 because of clarity reasons. The first deflection element 11 is movable substantially parallel to the longitudinal axis z between a first position in which the first abutment member 11a abuts against the stop element 12 (Fig. 10) and a second position in which the second abutment member 11b abuts against the stop element (Fig. 11, 12). Advantageously, the first and the second deflection elements 11, 14 are shaped to engage each other upon a mutual displacement along the longitudinal axis z, thereby urging the second deflection element 14 and the arcing contact finger 4a away from the longitudinal axis z.

[0041] In embodiments, the first deflection element 11 comprises at its free end a first protrusion 15 and the second deflection element 14 comprises at its free end a second protrusion 16. The first and the second protrusions 15, 16 are intermeshed in an opened configuration of the electrical switching device 1. The second protrusion 16 slides over the first protrusion 15 during a deflection of the arcing contact finger 4a. In other embodiments the protrusions 15, 16 may be replaced by other shapes which generate the same effect.

[0042] In embodiments, the first deflection element 11 and the second deflection element 14 have a higher stiffness than the arcing contact finger 4a. By this it is made sure, as also mentioned in conjunction with Fig. 3, that the deflector 11, 14 deflects the arcing contact finger 4a and not vice versa. The stiffness of the deflector 11, 14 is chosen such that the highest deflection effect is attained, in other words such that the bending of the deflector 11, 14 itself is minimal.

[0043] It is advantageous for all embodiments of the deflector explained above that the deflector comprises steel or titanium. This confers the required stiffness and durability to the deflector.

[0044] The embodiment of the deflector according to Fig. 9 to 12, is particularly suitable for full double motion interrupters, but it can also be implemented in other types

of interrupters. For the following explanation it is assumed that in the present example the first nominal contact 3a and the first arcing contact 4a are moved parallel to the longitudinal axis z towards the second nominal contact 3b and the second arcing contact 4b, respectively.

[0045] In Fig. 9 the electrical switching device 1 is in an opened configuration. In this state the first deflection element 11 is engaged with the second deflection element 14. Thus, the first and the second protrusions 15, 16 are intermeshed. During the closing process, the arcing contact finger 4a moves to the right in the figure, towards the second arcing contact 4b. During this movement the second deflection element 14 drags along the first deflection element 11 up to the point immediately before impacting the second arcing contact 4b by means of the first protrusion 15 being engaged with the second protrusion 16. This is shown in Fig. 10. At this point the first deflection element 11 is stopped by the stop element 12 which abuts against the first abutment member 11a. However, the arcing contact finger 4a moves further in the same direction. This causes the second protrusion 16 to start sliding up on the slope 15a of the first protrusion 15. By this, the entire arcing contact finger 4a is lifted up; in more general words it is radially displaced outwards with respect to the longitudinal axis z. Subsequently, the first and the second deflection elements 11, 14 are not engaged anymore, as can be seen in Fig. 11. The location of the stop element 12 in Fig. 11 reflects one step further, in which the electrical switching device 1 is being opened. In the opening process the arcing contact finger 4a is moved to the left in the figure, i.e. away from the second arcing contact 4b. In the course of this movement the second deflection element 14 pushes the first deflection element 11 to the left by means of the second protrusion 16 interacting with the first protrusion 15. As soon as the stop element 12 has reached the second abutment member 11b (Fig. 11), the first deflection element 11 cannot move further to the left, thus forcing the second protrusion 16 to slide over the first protrusion 15 and re-engage with it. This is shown in Fig. 12. The total distance of the shifting of the first and second deflection elements 11, 14 is given by the distance between the first and the second abutment members 11a, 11b. In one embodiment (not shown) the position of at least one of the first and the second abutment members 11a, 11b is changeable in order to provide a possibility of variation of the distance.

[0046] Fig. 13 shows a sectional view of an arcing contact finger 4a of the first arcing contact with a deflection limiting element 8, wherein the arcing contact finger 4a is arranged between the deflection limiting element 8 and the longitudinal axis z. In this example in conjunction with Fig. 1 the deflection limiting element 11 is arranged between the first nominal contact 3a and the arcing contact finger 4a. In one embodiment the deflection limiting element 8 is arranged not more than 0.5 cm radially away from the arcing contact finger 4a.

[0047] Fig. 14 shows a sectional view of an arcing con-

tact finger 4a of the first arcing contact with another embodiment of the deflection limiting element 8a. In this embodiment the deflection limiting element 8a is formed in such a way that it matches the outer surface, as seen with respect to the longitudinal axis z, of the arcing contact finger 4a.

[0048] The deflection limiting element 8 or 8a advantageously limits the radial deflection of the arcing contact finger 4a in order to minimize the risk of exceeding a yield stress of the finger material at the finger root. In a simple embodiment the deflection limiting element is a tube 8 or 8a around the arcing contact fingers, in other words around the arcing finger cage of the electrical switching device 1.

[0049] 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" or "advantageously" or the like signify optional and exemplary embodiments only.

List of reference numerals

[0050]

1	= basic circuit breaker
2	= finger support
3a	= contact finger of first nominal contact
3b	= second nominal contact
4a	= pre-opened first arcing contact, arcing contact finger
4b	= second arcing contact
4c	= arcing contact finger without deflector
4d	= arcing contact finger in the closed configuration
5	= enclosure, shell
6	= deflector according to a first comparative embodiment
7a	= deflector according to a second embodiment
7b	= spring
7c	= protecting tube
7d	= spring fixation tube
8	= deflection limiting element
9	= shielding
11	= first deflection element
11a	= first abutment member
11b	= second abutment member
12	= stop element
14	= second deflection element
15	= first protrusion
15a	= slope of first protrusion
16	= second protrusion
20	= finger support
z	= longitudinal axis (of switching device or of contact arrangement)

Claims

1. Contact arrangement for an electrical switching device (1) having a longitudinal axis (z), wherein the contact arrangement comprises a first contact (3a, 4a) and a mating second contact (3b, 4b), wherein the first contact comprises at least one contact finger (3a, 4a), wherein for closing and opening the electric switching device (1) at least one of the first contact and the mating second contact (3a, 3b; 4a, 4b) is movable parallel to the longitudinal axis (z) and cooperates with the other contact (3b, 3a; 4b, 4a), **characterized in that** a deflector (6; 7a; 11, 14) is provided, which elastically deflects the at least one contact finger (3a, 4a) in a radial direction away from the axis (z) prior to or while closing the electrical switching device (1), that further the deflector (7a) is movable parallel to the longitudinal axis (z) between a first position corresponding to a pre-deflection position of the contact finger (3a, 4a), in which the contact finger (3a, 4a) is elastically deflected by the deflector (7a) radially outward with respect to the longitudinal axis (z), when the electrical switching device (1) is in an opened configuration, and a second position corresponding to an end position of the second arcing contact (4b), in which the deflector (7a) does not deflect the contact finger (3a, 4a), when the electrical switching device is in a closed configuration, and that the deflector (7a) is adapted to be moved from the first position into the second position by the second arcing contact (4b) when the electrical switching device (1) is being closed.
2. Contact arrangement according to claim 1, wherein the at least one contact arrangement is or comprises an arcing contact arrangement, the first contact is or comprises a first arcing contact comprising at least one arcing contact finger (4a), in particular a plurality of arcing contact fingers (4a) forming an arcing contact finger cage concentrically with respect to the longitudinal axis (z), and the mating second contact is or comprises a mating second arcing contact (4b), in particular wherein for closing and opening the electric switching device (1) at least one of the arcing contacts is movable parallel to the longitudinal axis (z) and cooperates with the other arcing contact.
3. Contact arrangement according to any one of the preceding claims, wherein the at least one contact arrangement is or comprises a nominal contact arrangement, the first contact is or comprises a first nominal contact comprising a plurality of nominal contact fingers (3a) and forming a finger cage concentrically with respect to the longitudinal axis (z), and the mating second contact is or comprises a mating second nominal contact (3b), in particular wherein for closing and opening the electric switching device (1) at least one of the nominal contacts is movable parallel to the longitudinal axis (z) and cooperates with the other nominal contact.
4. Contact arrangement according to any one of the preceding claims, wherein the deflector (6) is arranged between the longitudinal axis (z) and the contact finger (3a, 4a), particularly wherein the deflector (6) is a tube having such a diameter that the contact finger (3a, 4a) is deflected outward with respect to the longitudinal axis (z) by not more than 0.05 cm.
5. Contact arrangement according to any one of the preceding claims, wherein the deflector (6; 7a) abuts against the contact finger (3a, 4a), particularly against a tulip of the contact finger (4a), and elastically deflects the contact finger (3a, 4a) radially outward with respect to the longitudinal axis (z), in particular when the electrical switching device (1) is in an opened configuration, particularly wherein the deflector (6; 7a) has a higher stiffness than the contact finger (3a, 4a).
6. Contact arrangement according to claim 5, further comprising a finger support (20) carrying the at least one contact finger (4a) and the deflector (7a).
7. Contact arrangement according to claim 1, wherein in the first position corresponding to the pre-deflection position of the contact finger (3a, 4a) the deflector (7) abuts against the arcing contact finger (4a) and elastically deflects the arcing contact finger (4a) radially outward with respect to the longitudinal axis z when the electrical switching device (1) is in the opened configuration, wherein further after the second arcing contact (4b) has started entering the arcing finger cage, the arcing contact finger (4a) is further deflected until it reaches its final deflection position (4d), and wherein further in the second position corresponding to the end position of the second arcing contact (4b) the deflector (7a) does not deflect the arcing contact finger (4d) and the arcing contact finger (4d) is only deflected by the second arcing contact (4b).
8. Contact arrangement according to claim 1 or 7, wherein a spring (7b) is provided, which connects a finger support (20) carrying the at least one contact finger (4a) and the deflector (7a), wherein the deflector (7a) is adapted to be moved from the first position into the second position by the second contact (3b, 4b) when the electrical switching device is being closed, and wherein the deflector (7a) is adapted to be moved from the second position into the first position by the spring (7b), when the electrical switching device is

being opened,
particularly wherein the deflector (7a) is star-shaped.

9. Contact arrangement according to claim 8, wherein the spring (7b) is arranged inside a protecting tube (7c) which is fixedly attached to the deflector (7a). 5
10. Contact arrangement for an electrical switching device (1) having a longitudinal axis (z), wherein the contact arrangement comprises a first contact (3a, 4a) and a mating second contact (3b, 4b), wherein the first contact comprises at least one contact finger (3a, 4a), wherein for closing and opening the electric switching device (1) at least one of the first contact and the mating second contact (3a, 3b; 4a, 4b) is movable parallel to the longitudinal axis (z) and cooperates with the other contact (3b, 3a; 4b, 4a), **characterized in that** a deflector (11, 14) is provided that elastically deflects the at least one contact finger (3a, 4a) in a radial direction away from the axis (z) prior to or while closing the electrical switching device (1), that the electrical switching device (1) further comprises a finger support (20) carrying the at least one contact finger (3a, 4a), wherein the deflector (11, 14) comprises:

(i) a first deflection element (11), wherein the contact finger (3a, 4a) is arranged between the first deflection element (11) and the longitudinal axis (z), particularly wherein the first deflection element (11) is arranged radially not more than 1 cm away from the contact finger (3a, 4a) in an opened configuration of the electrical switching device, wherein the first deflection element (11) comprises a first and a second abutment member (11a, 11b), and
(ii) a second deflection element (14) located at one end of the contact finger (3a, 4a), and that

the first and the second deflection elements (11, 14) are shaped to engage each other upon a mutual displacement along the longitudinal axis (z), thereby urging the second deflection element (14) and the contact finger (3a, 4a) away from the longitudinal axis (z). 10
15
20
25
30
35
40
45
11. Contact arrangement according to claim 10, further comprising a stop element (12), particularly attached to the finger support (20), wherein the first deflection element (11) is movable substantially parallel to the longitudinal axis (z) between a first position in which the first abutment member (11a) abuts against the stop element (12) and a second position in which the second abutment member (11b) abuts against the stop element (12). 50
55

12. Contact arrangement according to any one of the claims 10 to 11, wherein the first deflection element (11) comprises at its free end a first protrusion (15) and the second deflection element (14) comprises at its free end a second protrusion (16), wherein the first and the second protrusions (15, 16) are intermeshed in an opened configuration of the electrical switching device (1) and wherein the second protrusion (16) slides over the first protrusion (15) during a deflection of the contact finger (3a, 4a).
13. Contact arrangement according to any one of the claims 10 to 12, wherein the first deflection element (11) and/or the second deflection element (14) has or have a higher stiffness than the at least one contact finger (3a, 4a).
14. Contact arrangement according to any one of the claims 10 to 13, it being or comprising an arcing contact arrangement and the contact finger being or comprising an arcing contact finger (4a), and/or it being or comprising a nominal contact arrangement and the contact finger being or comprising a nominal contact finger (3a).
15. Contact arrangement according to any one of the preceding claims, wherein a deflection limiting element (8; 8a) is provided, wherein the contact finger (3a, 4a) is arranged between the deflection limiting element (8; 8a) and the longitudinal axis (z), particularly wherein the deflection limiting element (8; 8a) is arranged not more than 0.5 cm radially away from the at least one contact finger (3a, 4a), in particular wherein the deflection limiting element (8a) is formed in such a way that it matches the outer surface, as seen with respect to the longitudinal axis (z), of the contact finger (3a, 4a).
16. Contact arrangement according to any one of the preceding claim, wherein the deflector (6; 7a; 11, 14) comprises steel or titanium.
17. Contact arrangement according to any one of the preceding claims, wherein the contact arrangement comprises a plurality of contact fingers forming a contact finger cage (3a, 4a) concentrically to the longitudinal axis (z).
18. Electrical switching device (1) having a longitudinal axis (z) and comprising at least one contact arrangement according to any one of the preceding claims.
19. Electrical switching device (1) according to claim 18, 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.

20. Method for closing a contact arrangement according to one of the claims 1 to 17 of an electrical switching device (1) according to any one of the claims 18 to 19, comprising the steps of:

- deflecting the at least one contact finger (3a, 4a) radially outward by means of the deflector (6; 7a; 11, 14), and
- connecting the second contact (3b, 4b) with the deflected first contact (3a, 4a).

Patentansprüche

1. Kontaktanordnung für eine elektrische Schaltvorrichtung (1), die eine longitudinale Achse (z) aufweist, wobei die Kontaktanordnung einen ersten Kontakt (3a, 4a) und einen dazu passenden, zweiten Kontakt (3b, 4b) umfasst, wobei der erste Kontakt mindestens einen Kontaktfinger (3a, 4a) umfasst, wobei zum Schließen und Öffnen der elektrischen Schaltvorrichtung (1) mindestens der erste Kontakt und/oder der dazu passende, zweite Kontakt (3a, 3b; 4a, 4b) parallel zu der longitudinalen Achse (z) beweglich ist und mit dem anderen Kontakt (3b, 3a; 4b, 4a) zusammenwirkt, **dadurch gekennzeichnet, dass**

eine Ablenkeinrichtung (6; 7a; 11, 14) vorgesehen ist, die vor dem Schließen oder während des Schließens der elektrischen Schaltvorrichtung (1) den mindestens einen Kontaktfinger (3a, 4a) elastisch in eine radiale Richtung von der Achse (z) ablenkt, dass die Ablenkeinrichtung (7a) ferner parallel zu der longitudinalen Achse (z) beweglich ist zwischen einer ersten Position, die einer Vorablenkungsposition des Kontaktfingers (3a, 4a) entspricht, in der der Kontaktfinger (3a, 4a) von der Ablenkeinrichtung (7a) elastisch bezüglich der longitudinalen Achse (z) radial nach außen abgelenkt wird, wenn sich die elektrische Schaltvorrichtung (1) in einer geöffneten Konfiguration befindet, und einer zweiten Position, die einer Endposition des zweiten Lichtbogenkontakts (4b) entspricht, in der die Ablenkeinrichtung (7a) den Kontaktfinger (3a, 4a) nicht ablenkt, wenn sich die elektrische Schaltvorrichtung in einer geschlossenen Konfiguration befindet, und dass das Ablenkelement (7a) ausgelegt ist, durch den zweiten Lichtbogenkontakt (4b) von der ersten in die zweite Position bewegt zu werden, wenn die elektrische Schaltvorrichtung (1) geschlossen wird.

2. Kontaktanordnung nach Anspruch 1, wobei die mindestens eine Kontaktanordnung eine Lichtbogenkontaktanordnung ist oder umfasst, wobei der erste Kontakt ein erster Lichtbogenkontakt ist oder einen ersten Lichtbogenkontakt umfasst, der mindestens einen Lichtbogenkontaktfinger (4a), insbesondere mehrere Lichtbogenkontaktfinger (4a), die konzent-

risch bezüglich der longitudinalen Achse (z) einen Lichtbogenkontaktfingerkäfing bilden, umfasst, und wobei der dazu passende, zweite Kontakt ein dazu passender, zweiter Lichtbogenkontakt (4b) ist oder einen dazu passenden, zweiten Lichtbogenkontakt (4b) umfasst, wobei insbesondere zum Schließen und Öffnen der elektrischen Schaltvorrichtung (1) mindestens einer der Lichtbogenkontakte parallel zu der longitudinalen Achse (z) beweglich ist und mit dem anderen Lichtbogenkontakt zusammenwirkt.

3. Kontaktanordnung nach einem der vorhergehenden Ansprüche, wobei die mindestens eine Kontaktanordnung eine nominale Kontaktanordnung ist oder umfasst, wobei der erste Kontakt ein erster nominaler Kontakt ist oder einen ersten nominalen Kontakt umfasst, der mehrere nominale Kontaktfinger (3a) umfasst und konzentrisch bezüglich der longitudinalen Achse (z) einen Fingerkäfing bildet, und wobei der dazu passende, zweite Kontakt ein dazu passender, zweiter nominaler Kontakt (3b) ist oder einen dazu passenden, zweiten nominalen Kontakt (3b) umfasst, wobei insbesondere zum Schließen und Öffnen der elektrischen Schaltvorrichtung (1) mindestens einer der nominalen Kontakte parallel zu der longitudinalen Achse (z) beweglich ist und mit dem anderen nominalen Kontakt zusammenwirkt.

4. Kontaktanordnung nach einem der vorhergehenden Ansprüche, wobei die Ablenkeinrichtung (6) zwischen der longitudinalen Achse (z) und dem Kontaktfinger (3a, 4a) angeordnet ist, wobei die Ablenkeinrichtung (6) insbesondere ein Rohr ist, das einen Durchmesser aufweist, derart, dass der Kontaktfinger (3a, 4a) bezüglich der longitudinalen Achse (z) um nicht mehr als 0,05 cm nach außen abgelenkt wird.

5. Kontaktanordnung nach einem der vorhergehenden Ansprüche, wobei die Ablenkeinrichtung (6; 7a) gegen den Kontaktfinger (3a, 4a) stößt, insbesondere gegen eine Tulpe des Kontaktfingers (4a), und den Kontaktfinger (3a, 4a) elastisch bezüglich der longitudinalen Achse (z) radial nach außen ablenkt, insbesondere wenn sich die elektrische Schaltvorrichtung in einer geöffneten Konfiguration befindet, wobei die Ablenkeinrichtung (6; 7a) insbesondere eine höhere Steifigkeit als der Kontaktfinger (3a, 4a) aufweist.

6. Kontaktanordnung nach Anspruch 5, die ferner einen Fingerträger (20) umfasst, der den mindestens einen Kontaktfinger (4a) und die Ablenkeinrichtung (7a) trägt.

7. Kontaktanordnung nach Anspruch 1, wobei die Ab-

lenkeinrichtung (7) in der ersten Position, die der Vorablenkungsposition des Kontaktfingers (3a, 4a) entspricht, gegen den Lichtbogenkontaktfinger (4a) stößt und den Lichtbogenkontaktfinger (4a) elastisch bezüglich der longitudinalen Achse z radial nach außen ablenkt, wenn sich die elektrische Schaltvorrichtung (1) in der geöffneten Konfiguration befindet, wobei der Lichtbogenkontaktfinger (4a) ferner weiter abgelenkt wird, bis er seine endgültige Ablenkposition (4d) erreicht hat, nachdem der zweite Lichtbogenkontakt (4b) begonnen hat, sich in den Lichtbogenkontaktfingerkäfing zu bewegen, und wobei die Ablenkeinrichtung (7a) in der zweiten Position, die der Endposition des zweiten Lichtbogenkontakts (4b) entspricht, den Lichtbogenkontaktfinger (4d) nicht ablenkt und der Lichtbogenkontaktfinger (4d) lediglich durch den zweiten Lichtbogenkontakt (4b) abgelenkt wird.

8. Kontakthanordnung nach Anspruch 1 oder 7, wobei eine Feder (7b) vorgesehen ist, die einen Fingerträger (20), der den mindestens einen Kontaktfinger (4a) und die Ablenkeinrichtung (7a) trägt, verbindet, wobei die Ablenkeinrichtung (7a) ausgelegt ist, durch den zweiten Kontakt (3b, 4b) von der ersten Position in die zweite Position bewegt zu werden, wenn die elektrisch Schaltvorrichtung geschlossen wird, und wobei die Ablenkeinrichtung (7a) ausgelegt ist, durch die Feder (7b) von der zweiten Position in die erste Position bewegt zu werden, wenn die elektrische Schaltvorrichtung geöffnet wird, wobei die Ablenkeinrichtung (7a) insbesondere sternförmig ist.
9. Kontakthanordnung nach Anspruch 8, wobei die Feder (7b) innerhalb eines Schutzrohrs (7c) angeordnet ist, das feststehend an der Ablenkeinrichtung (7a) befestigt ist.
10. Kontakthanordnung für eine elektrische Schaltvorrichtung (1), die eine longitudinale Achse (z) aufweist, wobei die Kontakthanordnung einen ersten Kontakt (3a, 4a) und einen dazu passenden, zweiten Kontakt (3b, 4b) umfasst, wobei der erste Kontakt mindestens einen Kontaktfinger (3a, 4a) umfasst, wobei zum Schließen und Öffnen der elektrischen Schaltvorrichtung (1) mindestens der erste Kontakt und/oder der dazu passende, zweite Kontakt (3a, 3b; 4a, 4b) parallel zu der longitudinalen Achse (z) beweglich ist und mit dem anderen Kontakt (3b, 3a; 4b, 4a) zusammenwirkt, **dadurch gekennzeichnet, dass** eine Ablenkeinrichtung (11, 14) vorgesehen ist, die vor dem Schließen oder während des Schließens der elektrischen Schaltvorrichtung (1) den mindestens einen Kontaktfinger (3a, 4a) elastisch in einer radialen Richtung von der Achse (z) ablenkt, dass

die elektrische Schaltvorrichtung (1) ferner einen Fingerträger (20) umfasst, der den mindestens einen Kontaktfinger (3a, 4a) trägt, wobei die Ablenkeinrichtung (11, 14) Folgendes umfasst:

- (i) ein erstes Ablenkelement (11), wobei der Kontaktfinger (3a, 4a) zwischen dem ersten Ablenkelement (11) und der longitudinalen Achse (z) angeordnet ist, wobei das erste Ablenkelement (11) insbesondere in einer geöffneten Konfiguration der elektrischen Schaltvorrichtung radial nicht mehr als 1 cm von dem Kontaktfinger (3a, 4a) entfernt angeordnet ist, wobei das erste Ablenkelement (11) ein erstes und ein zweites Anstosselement (11a, 11b) umfasst, und
- (ii) ein zweites Ablenkelement (14), das an einem Ende des Kontaktfingers (3a, 4a) angeordnet ist, und dass

das erste und das zweite Ablenkelement (11, 14) derart geformt sind, dass sie als Antwort auf eine wechselseitige Verschiebung entlang der longitudinalen Achse (z) ineinandergreifen, wodurch sie das zweite Ablenkelement (14) und den Kontaktfinger (3a, 4a) von der longitudinalen Achse (z) abdrängen.

11. Kontakthanordnung nach Anspruch 10, die ferner ein Anschlagelement (12) umfasst, das insbesondere an dem Fingerträger (20) befestigt ist, wobei das erste Ablenkelement (11) im Wesentlichen parallel zu der longitudinalen Achse (z) zwischen einer ersten Position, in der das erste Anstosselement (11a) gegen das Anschlagelement (12) stößt, und einer zweiten Position, in der das zweite Anstosselement (11b) gegen das Anschlagelement (12) stößt, beweglich ist.
12. Kontakthanordnung nach einem der Ansprüche 10 bis 11, wobei das erste Ablenkelement (11) an seinem freien Ende einen ersten Vorsprung (15) umfasst und das zweite Ablenkelement (14) an seinem freien Ende einen zweiten Vorsprung (16) umfasst, wobei der erste und der zweite Vorsprung (15, 16) in einer geöffneten Konfiguration der elektrischen Schaltvorrichtung (1) ineinandergreifen und wobei der zweite Vorsprung (16) während einer Ablenkung des Kontaktfingers (3a, 4a) über den ersten Vorsprung (15) gleitet.
13. Kontakthanordnung nach einem der Ansprüche 10 bis 12, wobei das erste Ablenkelement (11) und/oder das zweite Ablenkelement (14) eine höhere Steifigkeit als der mindestens eine Kontaktfinger (3a, 4a) aufweisen oder aufweist.
14. Kontakthanordnung nach einem der Ansprüche 10 bis 13, wobei sie eine Lichtbogenkontakthanordnung ist

oder umfasst und wobei der Kontaktfinger ein Lichtbogenkontaktfinger (4a) ist oder einen Lichtbogenkontaktfinger (4a) umfasst und/oder wobei sie eine nominale Kontakthanordnung ist oder umfasst und der Kontaktfinger ein nominaler Kontaktfinger (3a) ist oder einen nominalen Kontaktfinger (3a) umfasst.

15. Kontakthanordnung nach einem der vorhergehenden Ansprüche, wobei ein Ablenkungsbegrenzungselement (8; 8a) vorgesehen ist, wobei der Kontaktfinger (3a, 4a) zwischen dem Ablenkungsbegrenzungselement (8; 8a) und der longitudinalen Achse (z) angeordnet ist, wobei das Ablenkungsbegrenzungselement (8; 8a) insbesondere radial nicht weiter als 0,5 cm von dem mindestens einen Kontaktfinger (3a, 4a) entfernt angeordnet ist, wobei das Ablenkungsbegrenzungselement (8a) insbesondere in einer solchen Weise ausgebildet ist, dass es gesehen in Richtung der longitudinalen Achse (z) zu der Außenfläche des Kontaktfingers (3a, 4a) passt. 10
16. Kontakthanordnung nach einem der vorhergehenden Ansprüche, wobei die Ablenkeinrichtung (6; 7a; 11, 14) Stahl oder Titan umfasst. 15
17. Kontakthanordnung nach einem der vorhergehenden Ansprüche, wobei die Kontakthanordnung mehrere Kontaktfinger umfasst, die konzentrisch zu der longitudinalen Achse (z) einen Kontaktfingerkäfig (3a, 4a) bilden. 20
18. Elektrische Schaltvorrichtung (1), die eine longitudinale Achse (z) aufweist und mindestens eine Kontakthanordnung nach einem der vorhergehenden Ansprüche umfasst. 25
19. Elektrische Schaltvorrichtung (1) nach Anspruch 18, wobei sie ein Erdungsschalter, eine Schnellerder, ein Leistungsschalter, ein Generatorleistungsschalter, ein Trenner, ein kombinierter Trenn- und Erdungsschalter oder ein Lastunterbrechungsschalter ist. 30
20. Verfahren zum Schließen einer Kontakthanordnung nach einem der Ansprüche 1 bis 17 einer elektrischen Schaltvorrichtung (1) nach einem der Ansprüche 18 bis 19, das die folgenden Schritte umfasst: 35
 - Ablenken des mindestens einen Kontaktfingers (3a, 4a) radial nach außen mittels der Ablenkeinrichtung (6; 7a; 11, 14), und 40
 - Verbinden des zweiten Kontakts (3b, 4b) mit dem abgelenkten, ersten Kontakt (3a, 4a). 45

Revendications

1. Agencement de contacts pour un dispositif (1) de commutation électrique présentant un axe longitudinal (z), l'agencement de contacts comportant un premier contact (3a, 4a) et un deuxième contact (3b, 4b) complémentaire, le premier contact comportant au moins un doigt (3a, 4a) de contact, au moins un contact parmi le premier contact et le deuxième contact (3a, 3b ; 4a, 4b) complémentaire pouvant, pour fermer et ouvrir le dispositif (1) de commutation électrique, être déplacé parallèlement à l'axe longitudinal (z) et coopérant avec l'autre contact (3b, 3a ; 4b, 4a), **caractérisé en ce que** un déflecteur (6 ; 7a ; 11, 14) est incorporé, qui déforme élastiquement le ou les doigts (3a, 4a) de contact dans une direction radiale s'écartant de l'axe (z) avant ou pendant la fermeture du dispositif (1) de commutation électrique, **en ce que** le déflecteur (7a) peut en outre être déplacé parallèlement à l'axe longitudinal (z) entre une première position correspondant à une position avant déformation du doigt (3a, 4a) de contact, dans laquelle le doigt (3a, 4a) de contact est déformé élastiquement par le déflecteur (7a) radialement vers l'extérieur par rapport à l'axe longitudinal (z), lorsque le dispositif (1) de commutation électrique est en configuration ouverte, et une deuxième position correspondant à une position d'extrémité du deuxième contact (4b) d'arc, dans laquelle le déflecteur (7a) ne déforme pas le doigt (3a, 4a) de contact, lorsque le dispositif de commutation électrique est en configuration fermée, et **en ce que** le déflecteur (7a) est prévu pour être déplacé de la première position dans la deuxième position par le deuxième contact (4b) d'arc lorsque le dispositif (1) de commutation électrique est en cours de fermeture. 5
2. Agencement de contacts selon la revendication 1, l'agencement ou les agencements de contacts étant ou comportant un agencement de contacts d'arc, le premier contact étant ou comportant un premier contact d'arc comportant au moins un doigt (4a) de contact d'arc, en particulier une pluralité de doigts (4a) de contact d'arc formant une cage de doigts de contact d'arc de manière concentrique par rapport à l'axe longitudinal (z), et le deuxième contact complémentaire étant ou comportant un deuxième contact (4b) d'arc complémentaire, en particulier, au moins un des contacts d'arc pouvant, pour fermer et ouvrir le dispositif (1) de commutation électrique, être déplacé parallèlement à l'axe longitudinal (z) et coopérant avec l'autre contact d'arc. 10
3. Agencement de contacts selon l'une quelconque des revendications précédentes, l'agencement ou les agencements de contacts étant ou comportant 15

un agencement de contacts nominaux, le premier contact étant ou comportant un premier contact nominal comportant une pluralité de doigts (3a) de contact nominal et formant une cage de doigts de manière concentrique par rapport à l'axe longitudinal (z), et le deuxième contact complémentaire étant ou comportant un deuxième contact nominal (3b) complémentaire,

en particulier, au moins un des contacts nominaux pouvant, pour fermer et ouvrir le dispositif (1) de commutation électrique, être déplacé parallèlement à l'axe longitudinal (z) et coopérant avec l'autre contact nominal.

4. Agencement de contacts selon l'une quelconque des revendications précédentes, le déflecteur (6) étant agencé entre l'axe longitudinal (z) et le doigt (3a, 4a) de contact, particulièrement le déflecteur (6) étant un tube présentant un diamètre tel que le doigt (3a, 4a) de contact est déformé vers l'extérieur par rapport à l'axe longitudinal (z) d'au plus 0,05 cm. 15
5. Agencement de contacts selon l'une quelconque des revendications précédentes, le déflecteur (6 ; 7a) prenant appui contre le doigt (3a, 4a) de contact, particulièrement contre une tulipe du doigt (4a) de contact, et déformant élastiquement le doigt (3a, 4a) de contact radialement vers l'extérieur par rapport à l'axe longitudinal (z), en particulier lorsque le dispositif (1) de commutation électrique est en configuration ouverte, particulièrement le déflecteur (6 ; 7a) présentant une raideur supérieure à celle du doigt (3a, 4a) de contact. 25
6. Agencement de contacts selon la revendication 5, comportant en outre un support (20) de doigt portant le ou les doigts (4a) de contact et le déflecteur (7a). 30
7. Agencement de contacts selon la revendication 1, dans la première position correspondant à la position avant déformation du doigt (3a, 4a) de contact, le déflecteur (7) prenant appui contre le doigt (4a) de contact d'arc et déformant élastiquement le doigt (4a) de contact d'arc radialement vers l'extérieur par rapport à l'axe longitudinal z lorsque le dispositif (1) de commutation électrique est en configuration ouverte, 40
en outre, après que le deuxième contact (4b) d'arc a commencé à pénétrer dans la cage de doigts d'arc, le doigt (4a) de contact d'arc étant encore déformé jusqu'à ce qu'il atteigne sa position de déformation finale (4d), et 45
en outre, dans la deuxième position correspondant à la position d'extrémité du deuxième contact (4b) d'arc, le déflecteur (7a) ne déformant pas le doigt (4d) de contact d'arc et le doigt (4d) de contact d'arc étant uniquement déformé par le deuxième contact (4b) d'arc. 50

8. Agencement de contacts selon la revendication 1 ou 7, un ressort (7b) étant incorporé, qui relie un support (20) de doigt portant le ou les doigts (4a) de contact et le déflecteur (7a), 5

le déflecteur (7a) étant prévu pour être déplacé de la première position dans la deuxième position par le deuxième contact (3b, 4b) lorsque le dispositif de commutation électrique est en cours de fermeture, et le déflecteur (7a) étant prévu pour être déplacé de la deuxième position dans la première position par le ressort (7b), lorsque le dispositif de commutation électrique est en cours d'ouverture, particulièrement le déflecteur (7a) étant en forme d'étoile. 10

9. Agencement de contacts selon la revendication 8, le ressort (7b) étant agencé à l'intérieur d'un tube protecteur (7c) qui en liaison compète avec le déflecteur (7a). 15

10. Agencement de contacts pour un dispositif (1) de commutation électrique présentant un axe longitudinal (z), l'agencement de contacts comportant un premier contact (3a, 4a) et un deuxième contact (3b, 4b) complémentaire, le premier contact comportant au moins un doigt (3a, 4a) de contact, au moins un contact parmi le premier contact et le deuxième contact (3a, 3b ; 4a, 4b) complémentaire pouvant, pour fermer et ouvrir le dispositif (1) de commutation électrique, être déplacé parallèlement à l'axe longitudinal (z) et coopérant avec l'autre contact (3b, 3a ; 4b, 4a), **caractérisé en ce que** un déflecteur (11, 14) est incorporé, qui déforme élastiquement le ou les doigts (3a, 4a) de contact dans une direction radiale s'écartant de l'axe (z) avant ou pendant la fermeture du dispositif (1) de commutation électrique, **en ce que** le dispositif (1) de commutation électrique comporte en outre un support (20) de doigt portant le ou les doigts (3a, 4a) de contact, le déflecteur (11, 14) comportant : 20

- (i) un premier élément (11) de déformation, le doigt (3a, 4a) de contact étant agencé entre le premier élément (11) de déformation et l'axe longitudinal (z), particulièrement le premier élément (11) de déformation étant agencé radialement à au plus 1 cm du doigt (3a, 4a) de contact en configuration ouverte du dispositif de commutation électrique, le premier élément (11) de déformation comportant un premier et un deuxième élément (11a, 11b) d'appui, et 25
- (ii) un deuxième élément (14) de déformation situé à une extrémité du doigt (3a, 4a) de contact, et **en ce que** les premier et deuxième éléments (11, 14) de déformation présentent une forme leur permettant d'interagir entre eux suite à un déplacement mutuel le long de l'axe longi- 30

tudinal (z), sollicitant ainsi le deuxième élément (14) de déformation et le doigt (3a, 4a) de contact en les écartant de l'axe longitudinal (z).

11. Agencement de contacts selon la revendication 10, comportant en outre un élément (12) de butée, particulièrement fixé au support (20) de doigt, le premier élément (11) de déformation pouvant être déplacé sensiblement parallèlement à l'axe longitudinal (z) entre une première position dans laquelle le premier élément d'appui (11a) prend appui contre l'élément (12) de butée et une deuxième position dans laquelle le deuxième élément d'appui (11b) prend appui contre l'élément (12) de butée. 5
12. Agencement de contacts selon l'une quelconque des revendications 10 à 11, le premier élément (11) de déformation comportant à son extrémité libre une première protubérance (15) et le deuxième élément (14) de déformation comportant à son extrémité libre une deuxième protubérance (16), la première et la deuxième protubérances (15, 16) étant imbriquées dans la configuration ouverte du dispositif (1) de commutation électrique et la deuxième protubérance (16) glissant pardessus la première protubérance (15) pendant une déformation du doigt (3a, 4a) de contact. 10 20 25
13. Agencement de contacts selon l'une quelconque des revendications 10 à 12, le premier élément (11) de déformation et/ou le deuxième élément (14) de déformation présentant une raideur supérieure à celle du ou des doigts (3a, 4a) de contact. 30
14. Agencement de contacts selon l'une quelconque des revendications 10 à 13, celui-ci étant ou comportant un agencement de contacts d'arc et le doigt de contact étant ou comportant un doigt (4a) de contact d'arc, et/ou celui-ci étant ou comportant un agencement de contacts nominaux et le doigt de contact étant ou comportant un doigt (3a) de contact nominal. 35 40
15. Agencement de contacts selon l'une quelconque des revendications précédentes, un élément limiteur (8 ; 8a) de déformation étant incorporé, le doigt (3a, 4a) de contact étant agencé entre l'élément limiteur (8 ; 8a) de déformation et l'axe longitudinal (z), particulièrement l'élément limiteur (8 ; 8a) de déformation étant agencé à au plus 0,5 cm radialement du ou des doigts (3a, 4a) de contact, en particulier l'élément limiteur (8a) de déformation étant formé de telle manière qu'il coïncide avec la surface extérieure, dans une vue par rapport à l'axe longitudinal (z), du doigt (3a, 4a) de contact. 45 50 55
16. Agencement de contacts selon l'une quelconque des revendications précédentes, le déflecteur (6 ;

7a ; 11, 14) comportant de l'acier ou du titane.

17. Agencement de contacts selon l'une quelconque des revendications précédentes, l'agencement de contacts comportant une pluralité de doigts de contact formant une cage (3a, 4a) de doigts de contact de manière concentrique à l'axe longitudinal (z).
18. Dispositif (1) de commutation électrique présentant un axe longitudinal (z) et comportant au moins un agencement de contacts selon l'une quelconque des revendications précédentes.
19. Dispositif (1) de commutation électrique selon la revendication 18, celui-ci étant un dispositif de mise à la terre, un dispositif de mise à la terre à action rapide, un disjoncteur, un disjoncteur de générateur, un interrupteur-sectionneur, un sectionneur combiné à un interrupteur de mise à la terre, ou un interrupteur à coupure de charge.
20. Procédé de fermeture d'un agencement de contacts selon l'une des revendications 1 à 17 d'un dispositif (1) de commutation électrique selon l'une quelconque des revendications 18 à 19, comportant les étapes consistant à :
 - déformer le ou les doigts (3a, 4a) de contact radialement vers l'extérieur au moyen du déflecteur (6 ; 7a ; 11, 14), et
 - connecter le deuxième contact (3b, 4b) avec le premier contact (3a, 4a) déformé.

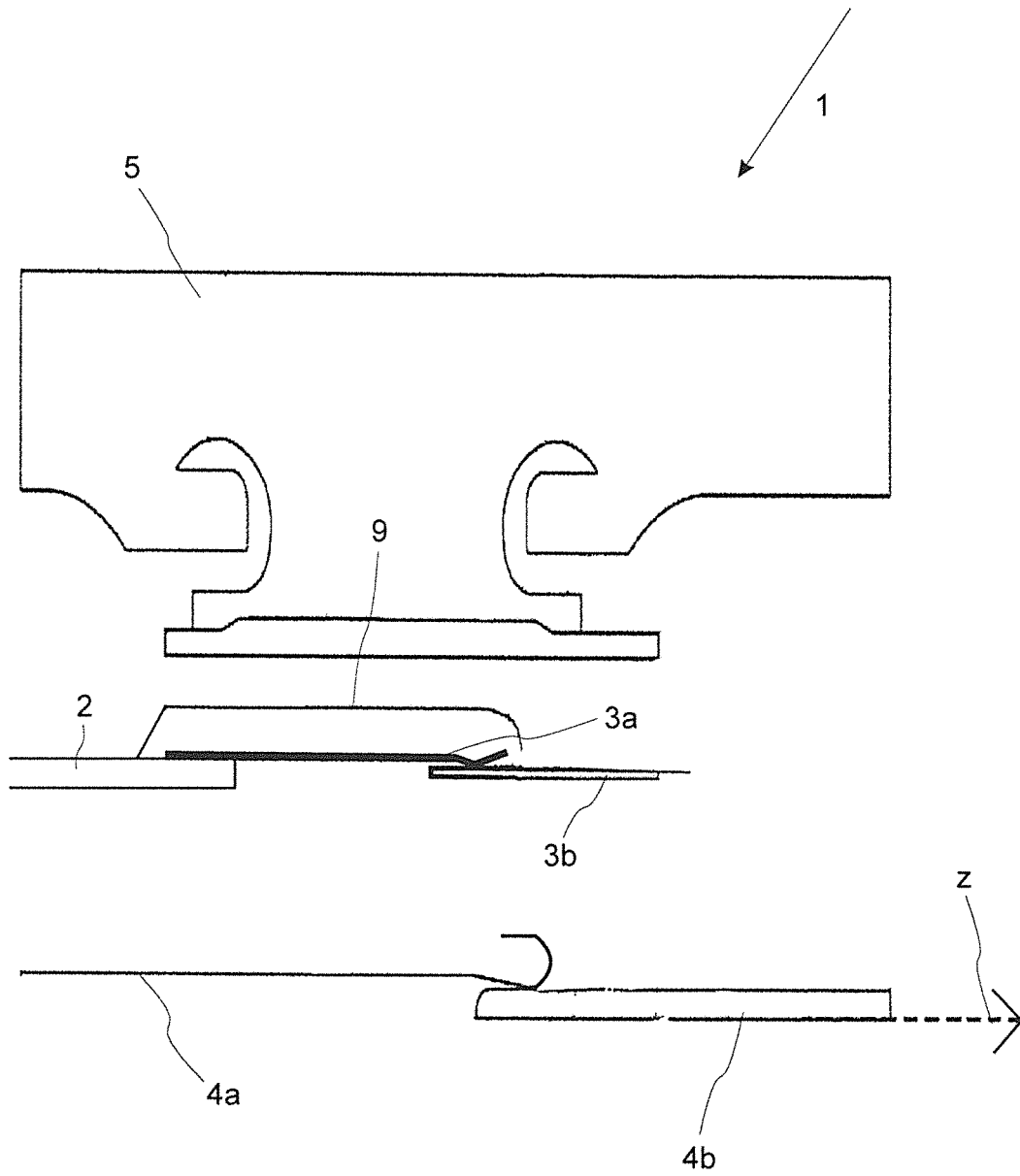


Fig. 1

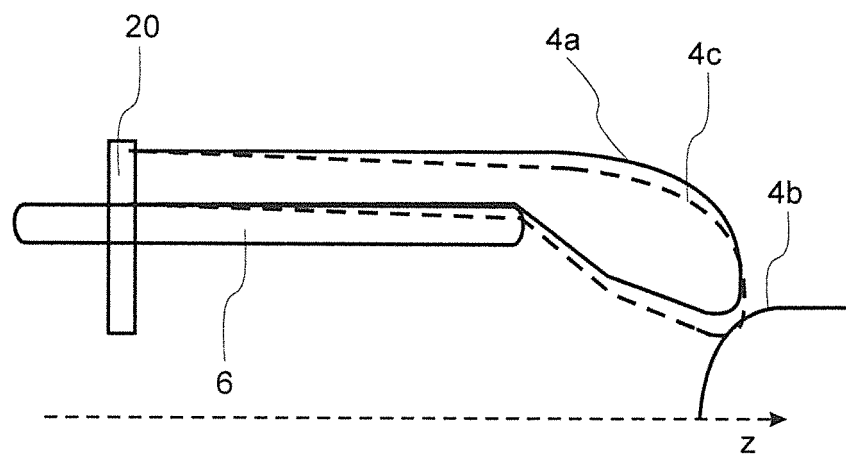


Fig. 2

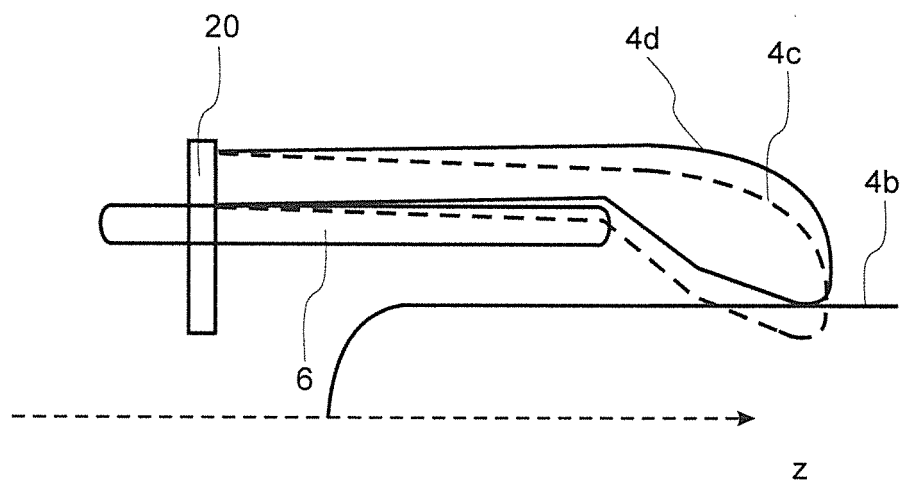


Fig. 3

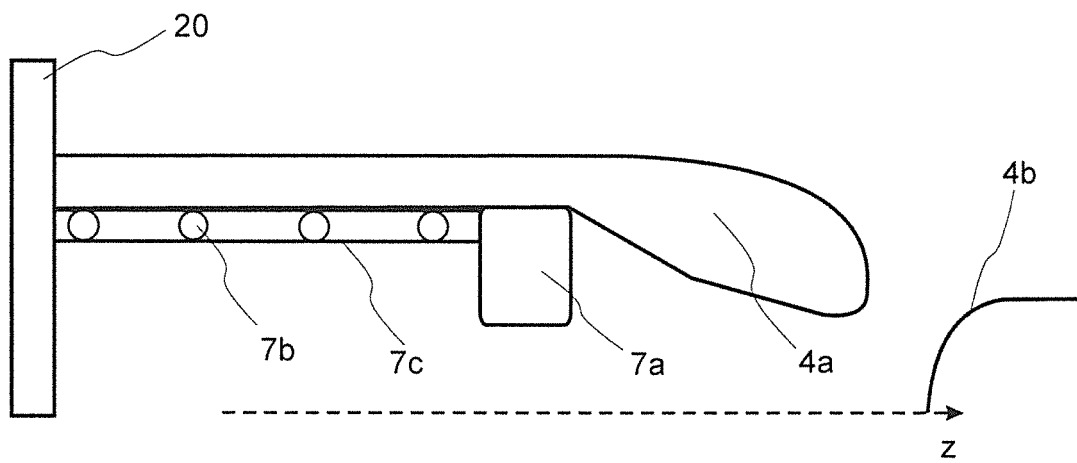


Fig. 4

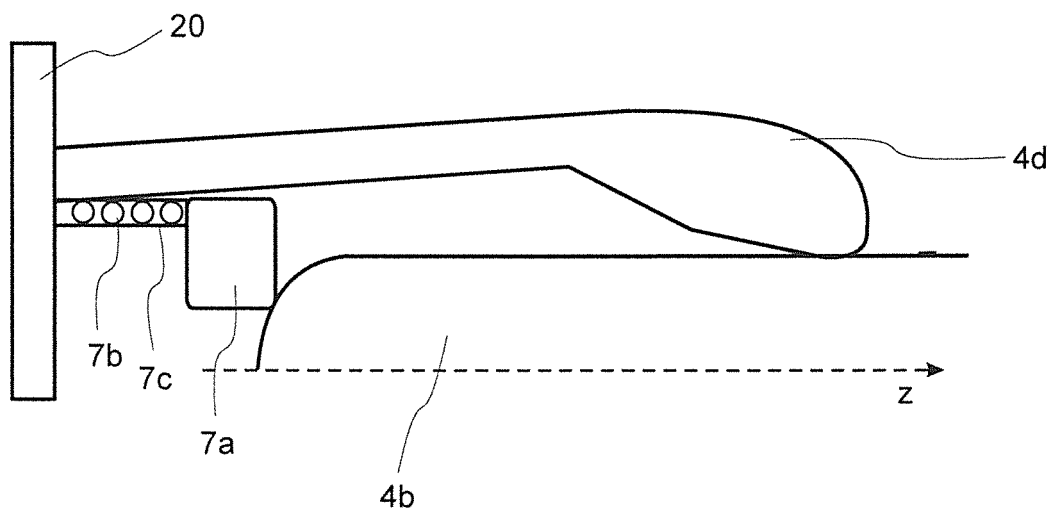


Fig. 5

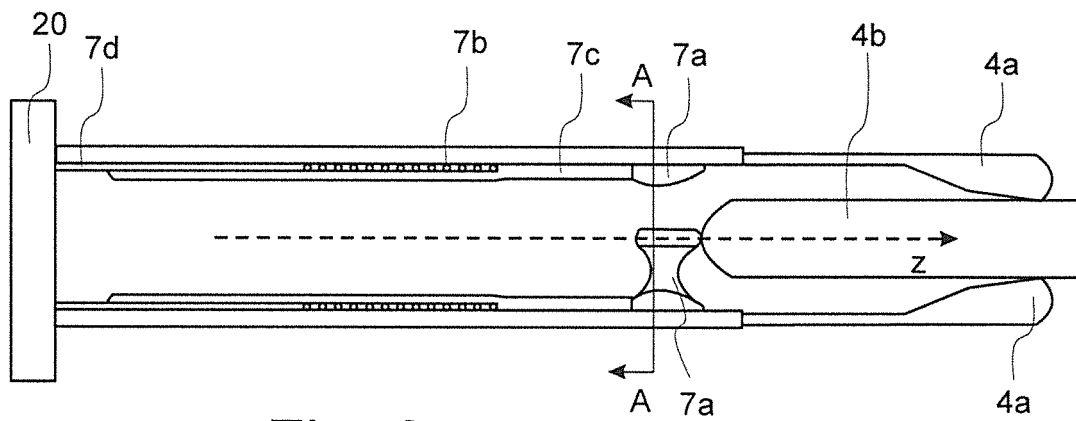


Fig. 6

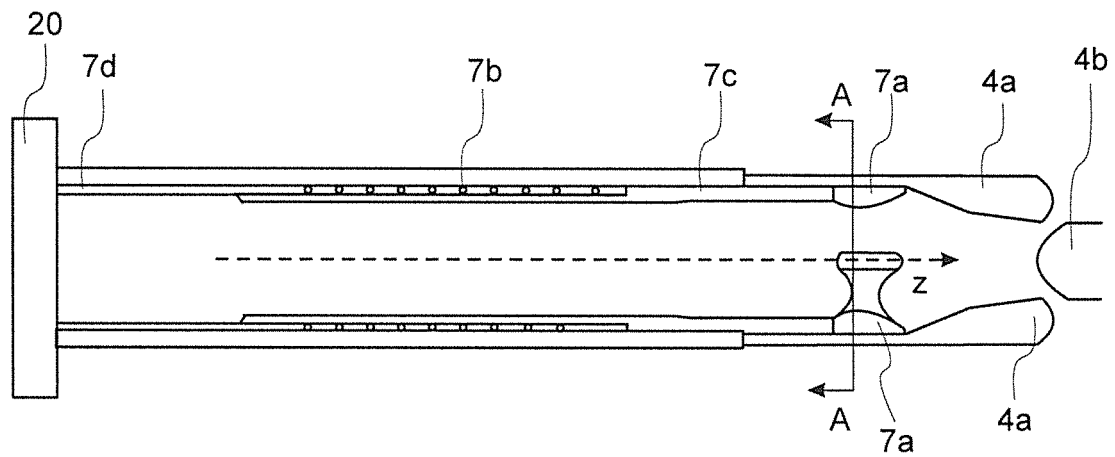


Fig. 7

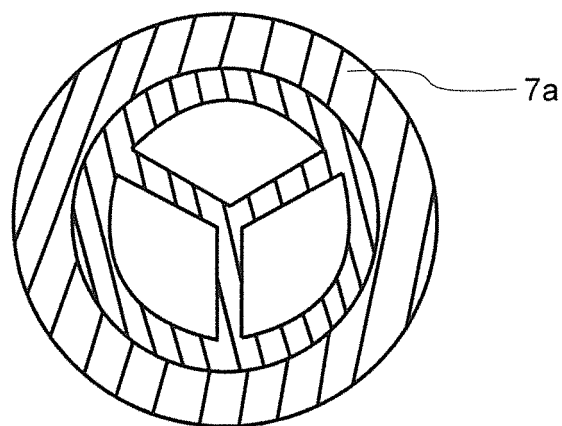


Fig. 8

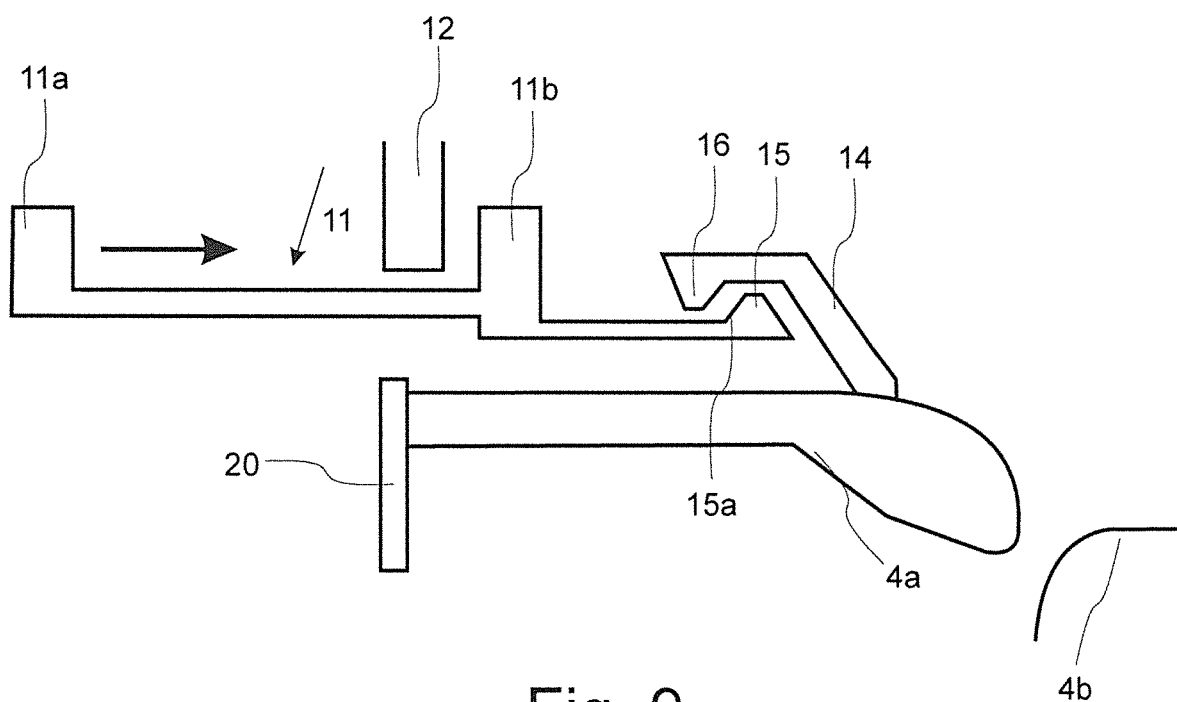


Fig. 9

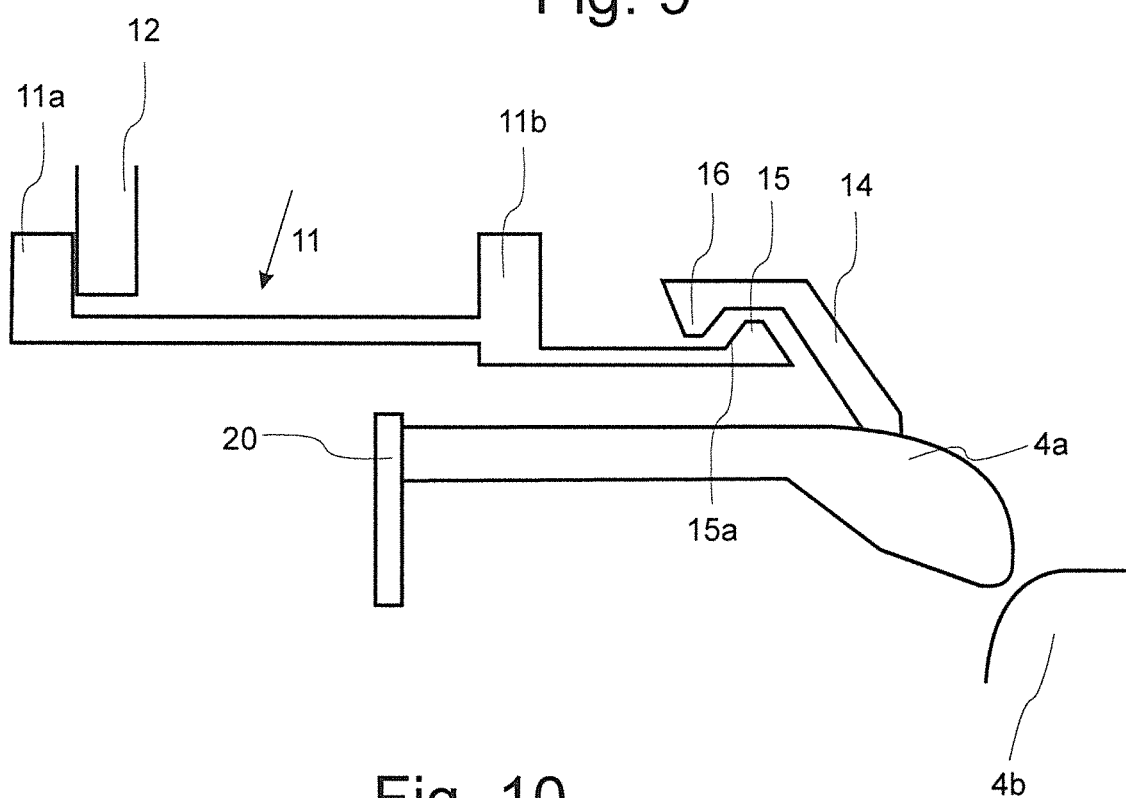


Fig. 10

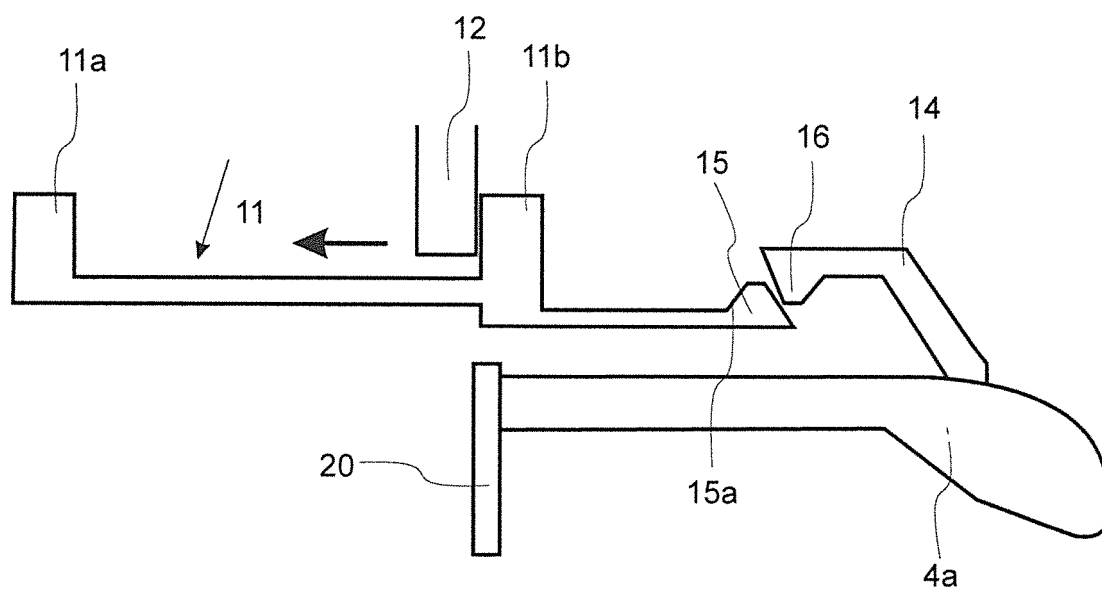


Fig. 11

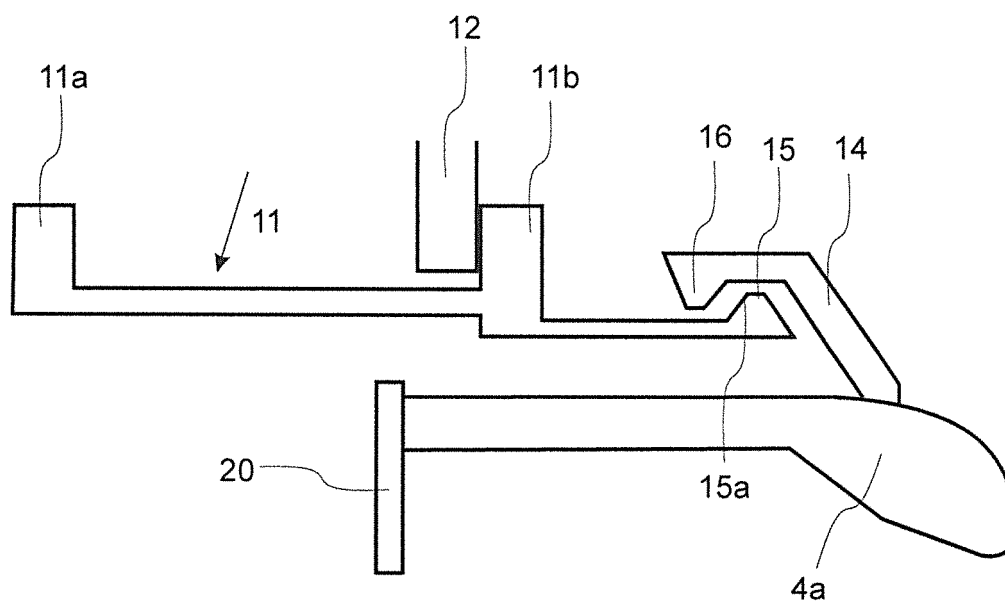


Fig. 12

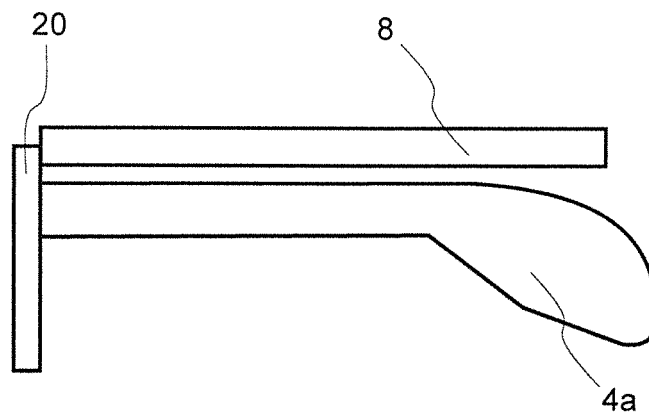


Fig. 13

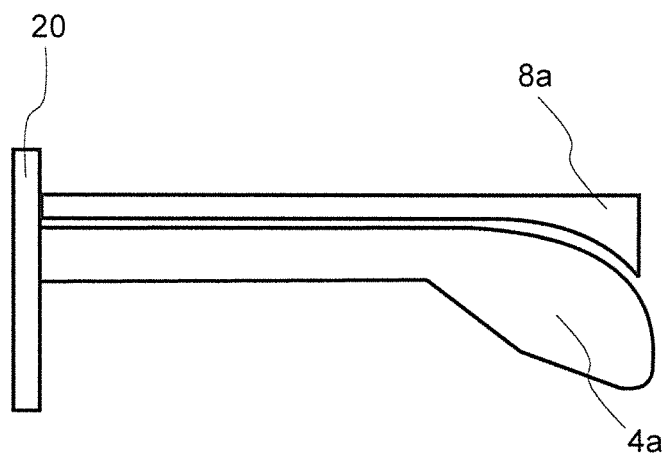


Fig. 14

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 0951038 A1 [0005]