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(72) Inventor: **Kriegel, Martin**
5420 Ehrendingen (CH)

(74) Representative: **Michalski Hüttermann & Partner**
Patentanwälte mbB
Speditionstraße 21
40221 Düsseldorf (DE)

(71) Applicant: **ABB Power Grids Switzerland AG**
5400 Baden (CH)

(54) **TWO WAY PISTON INTERRUPTER**

(57) A high-voltage self-blast circuit breaker, comprising:
an enclosure filled with an interrupting and insulation medium;
a contact arrangement held in said enclosure, having first and second contact members being movable relative to each other along an axis during a switching operation, the first contact member comprising a first arcing contact, the second contact member comprising a second arcing contact, the first and second arcing contacts defining an arcing zone therebetween,
the first contact member further comprising a heating volume and a nozzle defining a heating channel between the heating volume and the arcing zone;
a secondary compression volume configured for being expanded during an opening operation of the high-voltage circuit breaker, and for being compressed during a closing operation of the high-voltage circuit breaker;
an inlet check valve arranged between an enclosure vol-

ume within the enclosure and the secondary compression volume for allowing a forward flow of the interrupting and insulation medium from the enclosure volume through the inlet check valve into the secondary compression volume during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the secondary compression volume into the enclosure volume during the closing operation of the high-voltage circuit breaker;
an outlet check valve arranged between the secondary compression volume and the heating volume for allowing a forward flow of the interrupting and insulation medium from the secondary compression volume through the outlet check valve into the heating volume during the closing operation of the high-voltage circuit breaker, and for blocking a reverse flow from the heating volume into the secondary compression volume during the opening operation of the high-voltage circuit breaker.

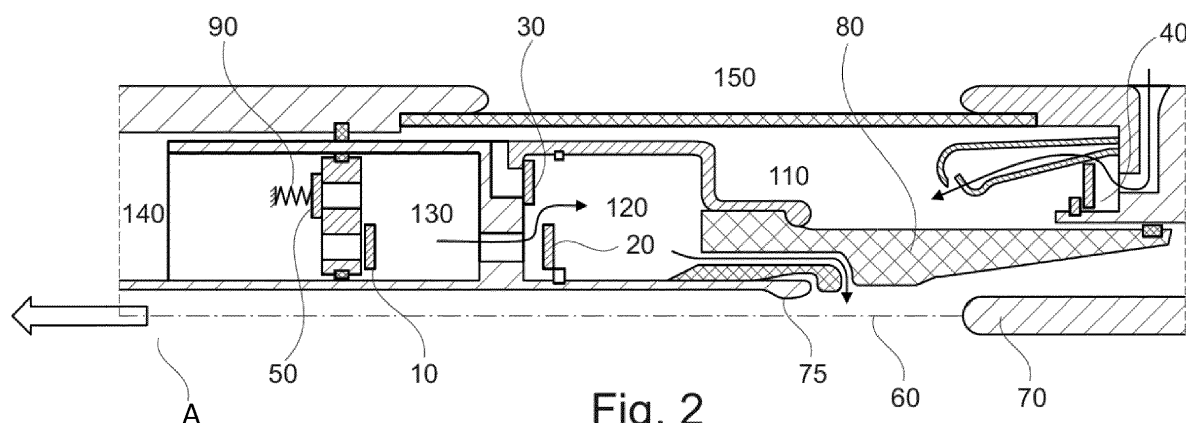


Fig. 2

Description

FIELD OF INVENTION

[0001] The disclosure relates to the field of electrical switching devices, for example load break circuit breakers or circuit breakers (CB), in particular for a high or medium voltage circuit breaker (HVCB, MVCB) with an arc-extinguishing capability. In particular, the application concerns tulip-type arcing contacts used in such load break circuit breakers and circuit breakers.

BACKGROUND OF INVENTION

[0002] Electrical switching devices, for example load break switches or circuit breakers (CB), in particular for a high or medium voltage circuit breaker (HVCB, MVCB), may constitute an integral part of units assigned to the task of switching load currents, with typical load currents being in a range of 1 kA to 300 kA root mean square. The load break switch is opened or closed by a relative movement of contacts, e. g. a plug contact and a tulip-type contact. When the contacts are moved away from each other during a current-breaking operation, an electric arc may be formed between the separating contacts which may be also called "arcing-contacts".

[0003] In load break switches or circuit breakers (CB), generally a compressed interrupting and insulation medium (e.g. a gas) may be used to extinguish an arc between the arcing contacts. To interrupt the current flow between the arcing contacts, an electric conductivity of the medium between the arcing contacts must be sufficiently reduced to stop the current from flowing in the opposite direction after current zero (arc quenching). In addition, the interrupting medium may be configured to regain sufficient dielectric strength to avoid breakdown and reignition of the electric arc, as the breaker must sustain the total voltage of the interrupted circuit (recovery). Both arc quenching and recovery must be successful to ensure a successful interruption.

[0004] This compressed fluid/gas may be provided by several ways. In some load break switches with an arc-extinguishing capability, e.g. a mechanism may be employed, called a puffer mechanism. An interrupting and insulation medium ("quenching gas"), like e.g. SF₆, is compressed in a puffer volume and released into an arcing region or arc quenching region.

[0005] The interrupting and insulation medium may be compressed and an overpressure may occur in a compression volume. At the same time, a tulip contact is pulled away from the plug contact, and the electric arc is generated. During the interruption, the arc heats up the gas volume around the contacts.

[0006] Hot insulation gas has a lower insulation capability than the same insulation gas at a lower temperature. The hot gas increases a risk of a dielectric re-strike, even if the arc was successfully interrupted beforehand (i. e., even if a preceding thermal interruption was successful).

Therefore cool gas with a sufficient pressure has to be directed to the arcing region.

[0007] In case a breaker needs to perform an "open-close-open" operation, following may happen: After the first O (open) operation, the density in the heating volume may be reduced. During the subsequent C (close) operation the compression volume will be re-filled with gas through the check valve between the exhaust volume and the compression volume.

[0008] The heating volume however almost is filled with the same interrupting and insulation medium. The second O (opening) operation therefore may show reduced interruption capability.

[0009] Thermal radiation from the arc may cause ablation (vaporization) of e.g. polytetrafluoroethylene (PTFE) from an insulating nozzle which may surround the arcing region. This may lead to a flow of interrupting and insulation medium from the high pressure arc zone back to the heating volume. This may be known as back heating. In case of a high current and therefore hot arc, the arc may be said to be "ablation controlled" at this time.

[0010] The generated arc between the arcing contacts evaporate a thin layer of insulating material, which may surround the arcing region. This evaporation process, and the resulting gas/vapor, may cool the arc, cause a reduction in arc conductivity and improve the arc-quenching properties.

[0011] During a closing (C) operation, a pre-arcing may take place between the arcing contacts. While the arc during opening is blown, the arc which may occur during is not controlled by a gas flow during closing. This may have a negative impact on the ablation.

[0012] It is therefore an object of the disclosure to provide an improved circuit breaker which may improve a pressure behavior and therefore may have an improved extinguishing capacity, not only during an opening but also during a closing operation.

SUMMARY OF INVENTION

[0013] In order to address the foregoing and other potential problems, embodiments of the present disclosure propose:

[0014] In a first aspect of the present disclosure, a high-voltage self-blast circuit breaker is proposed. The self-blast circuit breaker may comprise an enclosure filled with an interrupting and insulation medium;

[0015] The circuit breaker may further comprise a contact arrangement held in said enclosure. The contact arrangement may have first and second contact members being movable relative to each other along an axis (A) during a switching operation. The first contact member may comprise a first arcing contact, the second contact member may comprise a second arcing contact. The first and second arcing contacts may define an arcing zone there between,

[0016] The first contact member may further comprise a heating volume and a nozzle. The nozzle may define

a heating channel between the heating volume and the arcing zone.

[0017] The circuit breaker may also comprise a secondary compression volume. The secondary compression volume may be configured for being expanded during an opening operation of the high-voltage circuit breaker and for being compressed during a closing operation of the high-voltage circuit breaker.

[0018] The circuit breaker may further comprise an inlet check valve which may be arranged between an enclosure volume within the enclosure and the secondary compression volume for allowing a forward flow of the interrupting and insulation medium from the enclosure volume through the inlet check valve into the secondary compression volume during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the secondary compression volume into the enclosure volume during the closing operation of the high-voltage circuit breaker.

[0019] Further comprised in the circuit breaker may be an outlet check valve. The outlet check valve may be arranged between the secondary compression volume and the heating volume. The outlet check valve may allow for a forward flow of the interrupting and insulation medium from the secondary compression volume through the outlet check valve into the heating volume during the closing operation of the high-voltage circuit breaker and for blocking a reverse flow from the heating volume into the secondary compression volume during the opening operation of the high-voltage circuit breaker.

[0020] In another aspect, of the present disclosure, a method for operating the high voltage circuit breaker according to any other aspect is provided. The method may comprise at least one of:

[0021] Opening the high-voltage circuit breaker, thereby expanding the secondary compression volume, whereby the interrupting and insulation medium flows from the enclosure volume to the secondary compression volume through the inlet check valve, whereby the outlet check valve may be closed; and

closing the high-voltage circuit breaker, thereby compressing the secondary compression volume, whereby the interrupting and insulation medium may flow from the secondary compression volume to the heating volume through the outlet check valve, whereby the inlet check valve may be closed.

BRIEF DESCRIPTION OF DRAWINGS

[0022] Embodiments of the present disclosure will be presented in the sense of examples and their advantages are explained in greater detail below, with reference to the accompanying drawings, wherein:

FIG. 1 shows an embodiment of a high-voltage self blast circuit breaker according to the disclosure;

FIG. 2 shows an embodiment of a high-voltage self blast circuit breaker according to the disclosure during an opening operation;

5 FIG. 3 shows an embodiment of a high-voltage self blast circuit breaker according to the disclosure during a closing operation;

10 FIG. 4 shows an embodiment of a high-voltage self blast circuit breaker according to the disclosure;

FIG. 5 shows an operating method according to embodiments of the disclosure.

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DETAILED DESCRIPTION OF EMBODIMENTS

[0023] Hereinafter, the principle and spirit of the present disclosure will be described with reference to the illustrative embodiments. It should be understood, all these embodiments are given merely for the skilled in the art to better understand and further practice the present disclosure, but not for limiting the scope of the present disclosure. For example, features illustrated or described as part of one embodiment may be used with another embodiment to yield still a further embodiment.

20 **[0024]** In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions should be made to achieve the developer's specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

30 **[0025]** The disclosed subject matter will now be described with reference to the attached figures. Various structures, systems and devices are schematically depicted in the drawings for purposes of explanation only and so as to not obscure the description with details that are well known to those skilled in the art. Nevertheless, the attached drawings are included to describe and explain illustrative examples of the disclosed subject matter. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understanding of those words and phrases by those skilled in the relevant art.

40 **[0026]** No special definition of a term or phrase, i.e. a definition that is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, i.e. a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification

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in a definitional manner that directly and unequivocally provides the special definition for the term or phrase.

[0027] FIG. 1 shows an embodiment of the present disclosure. A second puffer check valve 10 is arranged between an exhaust volume 140 and a compression volume 130. The compression volume 130 may also be referred to as "primary compression volume". The compression volume may be of small dimensions and can thus provide a quantity of compressed interrupting and insulation medium which may be sufficient for a successful thermal blow-out of a switching arc between the arcing contacts 70, 75. A first puffer check valve 20 may be arranged between compression volume 130 and heating volume 120.

[0028] In addition to these known check valves 10 and 20, two additional check valves 30 and 40 may be introduced according to the disclosure. The first additional check valve 30 may be an outlet check valve.

[0029] This outlet check valve 30 may be arranged between a secondary compression volume 110 (sometimes referred to as nominal contact volume) and the heating volume 120. The outlet check valve 30 enables a forward flow of interrupting and insulation medium from the secondary compression volume 110 to the heating volume 120. The outlet check valve 30 on the other hand is adapted to block a reverse flow of interrupting and insulation medium from the heating volume 120 back to the secondary compression volume 110.

[0030] The second additional check valve may be an inlet check valve 40. This inlet check valve 40 may be arranged between the enclosure volume 150 and the secondary compression volume 110.

[0031] Between the enclosure volume 150 and the secondary compression volume 110 no other connection may be present as the flow channel which may be opened or closed by the inlet check valve 40. The inlet check valve 40 is configured to allow a forward flow of interrupting and insulation medium from the enclosure volume 150 to the secondary compression volume 110. The inlet check valve 40 is configured to block a reverse flow of interrupting and insulation medium from the secondary compression volume 110 to the enclosure volume 150.

[0032] All check valves may be pre-loaded with a spring force by a spring element like e.g. spring element 90. The spring-force, which may have a different, individual value (e.g. spring constant, linear or non-linear) for each of the check valves, may enable a well-defined position of any of the check valves 10, 20, 30, 40, 50 in opened or closed state. Opening/closing characteristics for each of the check valves may be defined in this way.

[0033] As an example, inlet check valve 40 may have a position that may allow some intended controlled minor flow of interrupting and insulation medium for cooling the nominal contacts. In other embodiments, the inlet check valve 40 may intentionally completely block the flow of interrupting and insulation medium between the secondary compression volume 110 and the enclosure volume 150.

[0034] FIG. 2 shows the self-blast circuit breaker during an opening (O) operation. The secondary compression volume 110 may be increased when the contact arrangement is moved to an "open" position along its axis A. The pressure of interrupting and insulation medium in the secondary compression volume 110 is reduced and may be lower than in the compression volume 130 and in the enclosure volume 150. Depending on a pressure/compression ratio, outlet check valve 30 may be closed and inlet check valve 40, which may be arranged in the flow path between the enclosure volume 150 and the secondary compression volume 110 may be opened.

[0035] Check valve 20, which may be adapted to control a forward flow of interrupting and insulation medium from the compression volume 130 to the heating volume 120 is open. A forward flow of interrupting and insulation medium, as indicated by the arrow in flow channel between compression volume 130 and heating volume 120 is possible.

[0036] This status of the circuit breaker, and the respective (check-) valves may be comparable to the state-of-the-art interrupter without the inlet and outlet check valves 30, 40. There is no flow of interrupting and insulation medium between secondary compression volume 110 and heating volume 120.

[0037] However, the interrupting and insulation medium may flow from enclosure volume 150 to secondary compression volume 110 as indicated by the arrow in the channel between the secondary compression volume 110 and the enclosure volume 150 and controlled by inlet check valve 40. Fresh and cool interrupting and insulation medium from the enclosure volume 150 can enter the secondary compression volume 110.

[0038] During interruption of heavy current with a back heating, check valve 20 and outlet check valve 30 are adapted to be closed. In particular, the spring forces, which may act on the valves 20 and 30, may be configured to achieve such a closing behavior. Back-heating may be a condition in the circuit-breaker, when a pressure in the heating volume 120 quickly rises, when, due to quick expansion of interrupting and pressurized insulation medium from the burning arc, medium re-enters the heating volume 120.

[0039] FIG. 3 shows the high voltage circuit breaker during a closing operation. The secondary compression volume 110 is reduced when the contact arrangement is moved along longitudinal axis A. In effect, the pressure of the interrupting and insulation medium rises in the secondary compression volume 110. The increased pressure of the interrupting and insulation medium acts against inlet check valve 40 and closes it or maintains the inlet check valve 40 in a closed position. As check valve 40 will close, there will be no gas flow of the interrupting and insulation medium towards the tank volume 150. Outlet check valve 30 will open.

[0040] Interrupting and insulation medium may flow from secondary compression volume 110 through a flow channel (indicated by an arrow in FIG. 3) which can be

blocked by outlet check valve 30 into heating volume 120. At the same time as compression volume 130 is increased and pressure reduced in compression volume 130. Check valve 20 may close and check valve 10 may open.

[0041] Thus, interrupting and insulation medium may flow from the exhaust volume 140 into the compression volume 130, as indicated by the "flow arrow" in FIG. 3 in the flow channel between exhaust volume 140 and the compression volume 130. Check valve 10 may be pre-loaded with a spring force exercised by a spring element. In this way, the pressure ratio between volumes 130 and 140 may be adjustable by the spring force of check valve 10. A low spring-force may result in an easy flow of interrupting and insulation medium between the two volumes 130 and 140, thereby influencing an opening/closing force of the contact arrangement.

[0042] The flow of interrupting and insulation medium from secondary compression volume 110 through the outlet check valve 30 into heating volume 120 may lead to a flow of interrupting and insulation medium towards the arcing zone (indicated by a "flow arrow" in FIG. 3). This may blow the arc, which may develop between the first and second arcing contacts 70, 75 during a closing operation of the contact arrangement. In other words, also the movement of the contact arrangement during the closing operation generates a flow of the interrupting and insulation medium towards the arcing zone 60 to extinguish the arc between the arcing contacts 70, 75.

[0043] As a further advantageous effect, hot interrupting and insulation medium with low density and therefore reduced/poor arc extinguishing capacity in the heating volume 120, may be replaced by a cooler interrupting and insulation medium with a high density and sufficient arc-extinguishing capacity.

[0044] FIG. 4 shows a slightly modified embodiment of the present disclosure. The exhaust volume 140 may have a direct connection to the enclosure volume 150 by a channel 160.

[0045] The high-voltage self-blast circuit breaker according to the present disclosure has been modified in a way that a flow of interrupting and insulation medium may be created during opening as well as during closing of the contacts in the circuit breaker. In other words, the present disclosure proposes to implement an arc extinguishing function which also provides extinguishing capability in a closing operation of the circuit-breaker.

[0046] The present disclosure proposes a high-voltage self-blast circuit breaker. The high-voltage self-blast circuit breaker may comprise: an enclosure which may be filled with an interrupting and insulation medium. A contact arrangement may be held in said enclosure and may have a first and a second contact member being movable relative to each other along an axis (A) during a switching operation.

[0047] The first contact member comprising a first arcing contact 75, the second contact member comprising a second arcing contact 70, the first and second arcing

contacts 70, 75 defining an arcing zone 60 there between, **[0048]** The first contact member further comprising a heating volume 120 and a nozzle 80 defining a heating channel between the heating volume 120 and the arcing zone 60. The nozzle 80 may comprise of an insulating material such as PTFE. This nozzle may surround a free end of the arc contact 70.

[0049] The interrupting and insulation medium, in other words an insulating gas like e.g. SF₆, may flow between the heating volume 120 and the arcing zone 60 to cool and extinguish an arc between the arcing contacts 70, 75. The heating channel 120 may be formed such, that the interrupting and insulation medium flow may be directed to the arcing zone 60.

[0050] The high voltage circuit breaker may further comprise a secondary compression volume 110 which may be configured for being expanded during an opening operation of the high-voltage circuit breaker (see broad arrow pointing to the left in FIG. 2), and for being compressed during a closing operation (see broad arrow pointing to the right in FIG. 2) of the high-voltage circuit breaker.

[0051] The high voltage circuit breaker may further comprise an inlet check valve 40 which may be arranged between an enclosure volume 150 within the enclosure and the secondary compression volume 110 for allowing a forward flow of the interrupting and insulation medium from the enclosure volume 150 through the inlet check valve 40 into the secondary compression volume 110 during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the secondary compression volume 110 into the enclosure volume 150 during the closing operation of the high-voltage circuit breaker.

[0052] The high voltage circuit breaker may further comprise an outlet check valve 30 which may be arranged between the secondary compression volume 110 and the heating volume 120. The outlet check valve 30 may be configured to allow a forward flow of the interrupting and insulation medium from the secondary compression volume 110 through the outlet check valve 30 into the heating volume 120 during the closing operation of the high-voltage circuit breaker. The outlet check valve 30 may further be configured to block a reverse flow from the heating volume 120 into the secondary compression volume 110 during the opening operation of the high-voltage circuit breaker.

[0053] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the first contact member may have a first nominal contact, and the second contact member may have a second nominal contact. The secondary compression volume 110 may contain the first and second nominal contacts.

[0054] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the secondary compression volume 110 may radially surround the nozzle 80 at least partially.

[0055] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the outlet check valve 30 may be arranged on a side of the heating volume 120 opposite to the heating channel. This may allow that a flow of interrupting and insulating medium, may be created during the closing operation of the high-voltage circuit breaker. The gas flow may be flowing through the heating volume 120 and via the heating channel towards the arcing zone 60. In this way, the arc that may build up between the arcing contacts 70, 75 during the closing operation of the contact arrangement may be extinguished.

[0056] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the high-voltage circuit breaker may be configured for opening the inlet check valve 40 and for closing the outlet check valve 30 during the opening operation of the high-voltage circuit breaker. The secondary compression volume 110 may be reduced during the opening operation as shown in FIG. 2 and by the pressure difference between the secondary compression volume 110 and the enclosure volume 150, the inlet check valve 40 may open and the secondary compression volume 110 may be "flushed" with "fresh" interrupting and insulating medium from the enclosure volume 150.

[0057] The fresh interrupting and insulating medium may have a higher density since it has been delivered from the "cooler" enclosure volume 150. This may prepare the circuit breaker e.g. for a direct subsequent closing operation with improved arc extinguishing capability since medium with higher density has a better arc extinguishing characteristic.

[0058] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the high-voltage circuit breaker may be configured for closing the inlet check valve 40 and for opening the outlet check valve 30 during the closing operation of the high-voltage circuit breaker.

[0059] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the high-voltage circuit breaker may be configured for closing the outlet check valve 30 to block a reverse gas flow from the heating volume 120 to the secondary compression volume 110 in case of a backheating during the closing operation of the high-voltage circuit breaker.

[0060] Backheating may occur, when an arc between the arcing contacts heats-up the arc-surrounding interrupting and insulation media (another expression may be "quenching gas"). Pressure of the medium in this part of the circuit breaker rises very quickly and the hot medium may flow from the arcing zone back to the heating volume 120 through the passage between the heating volume 120 and the arcing-zone.

[0061] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that at least one of the check valves 10, 20, 30, 40, 50 may be preloaded with a spring element 90 to

enable predefined pressure values for opening and/or closing the check valves 10, 20, 30, 40, 50.

[0062] It may be possible, that every valve 10, 20, 30, 40, 50 is equipped with a spring element. The spring elements may provide a specific pre-tension to the valves 10, 20, 30, 40, 50. The spring-force and thereby the pre-tension may be chosen individually for every valve. This may enable, that the opening- closing behavior of the valves may be adjusted to fulfil specific needs. For instance it may be possible, that the spring force is adjusted such that the heating volume 120 may be flushed at an early state of movement with higher-density gas from the enclosure volume 150. Or, for instance, check valve 40 may be preloaded with a spring force which may allow a minor interrupting and insulation medium flow for e.g. cooling the nominal contacts but the minor medium flow may not negatively influence the gas flow pressure which extinguishes the arc. In other words, an independent adjustment of the spring-forces at the check valves may enable to adjust flow conditions of the interrupting and insulating medium and therefore also the arc-extinguishing capability in a wide range to adapt the circuit breaker to different operating conditions.

[0063] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose that the circuit breaker further comprises a compression volume 130. The compression volume 130 may be configured for being compressed during an opening operation of the high-voltage circuit breaker, thereby compressing the interrupting and insulation medium provided therein. The compression volume 130 may be configured for being expanded during a closing operation of the high-voltage circuit breaker.

[0064] A first puffer check valve 20, arranged between the heating volume 120 and the compression volume 130 may allow a forward flow of the compressed interrupting and insulation medium from the compression volume 130 through the first puffer check valve 20 into the heating volume 120 during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the heating volume 120 into the compression volume 130.

[0065] Another embodiment of the present disclosure, which may be combined with other embodiments, may further propose to comprise an exhaust volume 140 and a second puffer check valve 10 which may be arranged between the exhaust volume 140 and the compression volume 130. This arrangement may allow a forward flow of the interrupting and insulation medium from the exhaust volume 140 through the second puffer check valve 10 into the compression volume 130 during the closing operation of the high-voltage circuit breaker, and for blocking a reverse flow from the compression volume 130 into the exhaust volume 140.

[0066] FIG. 3 shows the closing operation of the circuit breaker. The "flow-arrow" in the passage between exhaust volume 140 and compression volume 130 indicates the flow of interrupting and insulating medium be-

tween the both volumes. The first puffer check valve 20 which may be adapted to allow a forward flow of interrupting and insulation medium from the compression volume 130 to the heating volume 120 is closed as well.

[0067] Another embodiment of the present disclosure, which may be combined with other embodiments, may propose to further comprise a pressure relief valve 50 which may be arranged between the compression volume 130 and the exhaust volume 140 and may be adapted for relieving an overpressure from the compression volume 130 into the exhaust volume 140. If the pressure in the compression volume 130 exceeds a predetermined limit value, the pressure check valve 50, which may also be designated as "pressure relief valve", may open (the FIGs do not show an opened check valve 50).

[0068] After the opening of the check valve 50, the compression volume 130 communicates with the exhaust volume 140 via this check valve 50 and thus limits the pressure in the compression volume 130.

[0069] The Check valve/pressure relief valve 50 may be preloaded from spring element 90 with a spring force. The spring force may be configurable so that specific opening characteristics of the valve 50, and therefore also different pressure characteristics, may be achieved. In other words, by choosing different spring forces, a pressure limit at which the compressed interrupting and insulation medium is released from the compression volume 130 to the exhaust volume 140 may be adjustable.

[0070] Another embodiment of the present disclosure, may propose a method 500, as shown in FIG. 5, for operating the high voltage circuit breaker according to any one of the preceding claims. The method may comprise at least one of:

[0071] Opening the high-voltage circuit breaker in block 510, thereby expanding the secondary compression volume 110, whereby the interrupting and insulation medium may flow from the enclosure volume 150 to the secondary compression volume 110 through the inlet check valve 40, whereby the outlet check valve 30 may be closed.

[0072] Closing, in block 520, the high-voltage circuit breaker, thereby compressing the secondary compression volume 110, whereby the interrupting and insulation medium may flow from the secondary compression volume 110 to the heating volume 120 through the outlet check valve 30, whereby the inlet check valve 40 may be closed.

[0073] Blocks 510 and 520 may be executed repeatedly during an open-close-open cycle of the circuit breaker.

[0074] In summary, the present disclosure may provide in an advantageous manner a circuit breaker with an improved arc-extinguishing capacity. Additional valves in the circuit breaker allow that arcs between the arcing contacts may be extinguished not only during an opening/breaking operation.

[0075] The arc extinguishing capability of the circuit breaker may also be provided during a closing operation

of the contacts, where an arcing of the contacts may occur as well.

[0076] Two additionally provided valves allow a functionality similar to a two-way pump, where both moving directions (opening-closing) may be used to generate a gas flow towards the arcing zone to extinguish an arc.

Claims

1. A high-voltage self-blast circuit breaker, comprising:

an enclosure filled with an interrupting and insulation medium;

a contact arrangement held in said enclosure, having first and second contact members being movable relative to each other along an axis (A) during a switching operation, the first contact member comprising a first arcing contact (75), the second contact member comprising a second arcing contact (70), the first and second arcing contacts defining an arcing zone (60) therebetween,

the first contact member further comprising a heating volume (120) and a nozzle (80) defining a heating channel between the heating volume (120) and the arcing zone;

a secondary compression volume (110) configured for being expanded during an opening operation of the high-voltage circuit breaker, and for being compressed during a closing operation of the high-voltage circuit breaker;

an inlet check valve (40) arranged between an enclosure volume (150) within the enclosure and the secondary compression volume (110) for allowing a forward flow of the interrupting and insulation medium from the enclosure volume (150) through the inlet check valve (40) into the secondary compression volume (110) during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the secondary compression volume (110) into the enclosure volume (150) during the closing operation of the high-voltage circuit breaker;

an outlet check valve (30) arranged between the secondary compression volume (110) and the heating volume (120) for allowing a forward flow of the interrupting and insulation medium from the secondary compression volume (110) through the outlet check valve (30) into the heating volume (120) during the closing operation of the high-voltage circuit breaker, and for blocking a reverse flow from the heating volume (120) into the secondary compression volume (110) during the opening operation of the high-voltage circuit breaker.

2. The high voltage circuit breaker according to claim

- 1, wherein
the first contact member has a first nominal contact,
and the second contact member has a second nominal contact, and wherein
the secondary compression volume (110) contains the first and second nominal contacts. 5
3. The high voltage circuit breaker according to any one of the preceding claims, wherein
the secondary compression volume (110) radially surrounds the nozzle (80) at least partially. 10
4. The high voltage circuit breaker according to any one of the preceding claims, wherein
the outlet check valve (30) is arranged on a side of the heating volume (120) opposite to the heating channel, such that during the closing operation of the high-voltage circuit breaker a gas flow is created, the gas flow flowing through the heating volume (120) and via the heating channel towards the arcing zone. 15 20
5. The high voltage circuit breaker according to any one of the preceding claims, wherein
the high-voltage circuit breaker is configured for opening the inlet check valve (40) and for closing the outlet check valve (30) during the opening operation of the high-voltage circuit breaker. 25
6. The high voltage circuit breaker according to any one of the preceding claims, wherein
the high-voltage circuit breaker is configured for closing the inlet check valve (40) and for opening the outlet check valve (30) during the closing operation of the high-voltage circuit breaker. 30 35
7. The high voltage circuit breaker according to any one of the preceding claims, wherein
the high-voltage circuit breaker is configured for closing the outlet check valve (30) to block a reverse gas flow from the heating Volume (120) to the secondary compression volume (110) in case of a backheating during the closing operation of the high-voltage circuit breaker. 40 45
8. The high voltage circuit breaker according to any one of the preceding claims, wherein
at least one of the check valves (10, 20, 30, 40, 50) is preloaded with a spring element (90) to enable predefined pressure values for opening and/or closing the check valves (10, 20, 30, 40, 50). 50
9. The high voltage circuit breaker according to any one of the preceding claims, further comprising
a compression volume (130) configured for being compressed during an opening operation of the high-voltage circuit breaker, thereby compressing the interrupting and insulation medium provided therein, 55
- and for being expanded during a closing operation of the high-voltage circuit breaker;
a first puffer check valve (20), arranged between the heating volume (120) and the compression volume (130) for allowing a forward flow of the compressed interrupting and insulation medium from the compression volume (130) through the first puffer check valve (20) into the heating volume (120) during the opening operation of the high-voltage circuit breaker, and for blocking a reverse flow from the heating volume (120) into the compression volume (130).
10. The high voltage circuit breaker according to claim 9, further comprising
an exhaust volume (140); and
a second puffer check valve (10), arranged between the exhaust volume (140) and the compression volume (130) for allowing a forward flow of the interrupting and insulation medium from the exhaust volume (140) through the second puffer check valve (10) into the compression volume (130) during the closing operation of the high-voltage circuit breaker, and for blocking a reverse flow from the compression volume (130) into the exhaust volume (140).
11. The high voltage circuit breaker according to claim 10, further comprising
a pressure relief valve (50) arranged between the compression volume (130) and the exhaust volume (140) for relieving an overpressure from the compression volume (130) into the exhaust volume (140).
12. Method (500) for operating the high voltage circuit breaker according to any one of the preceding claims, the method comprising at least one of:

Opening (510) the high-voltage circuit breaker, thereby expanding the secondary compression volume (110), whereby the interrupting and insulation medium flows from the enclosure volume (150) to the secondary compression volume (110) through the inlet check valve (40), whereby the outlet check valve (30) is closed; and
Closing (520) the high-voltage circuit breaker, thereby compressing the secondary compression volume (110), whereby the interrupting and insulation medium flows from the secondary compression volume (110) to the heating volume (120) through the outlet check valve (30), whereby the inlet check valve (40) is closed.

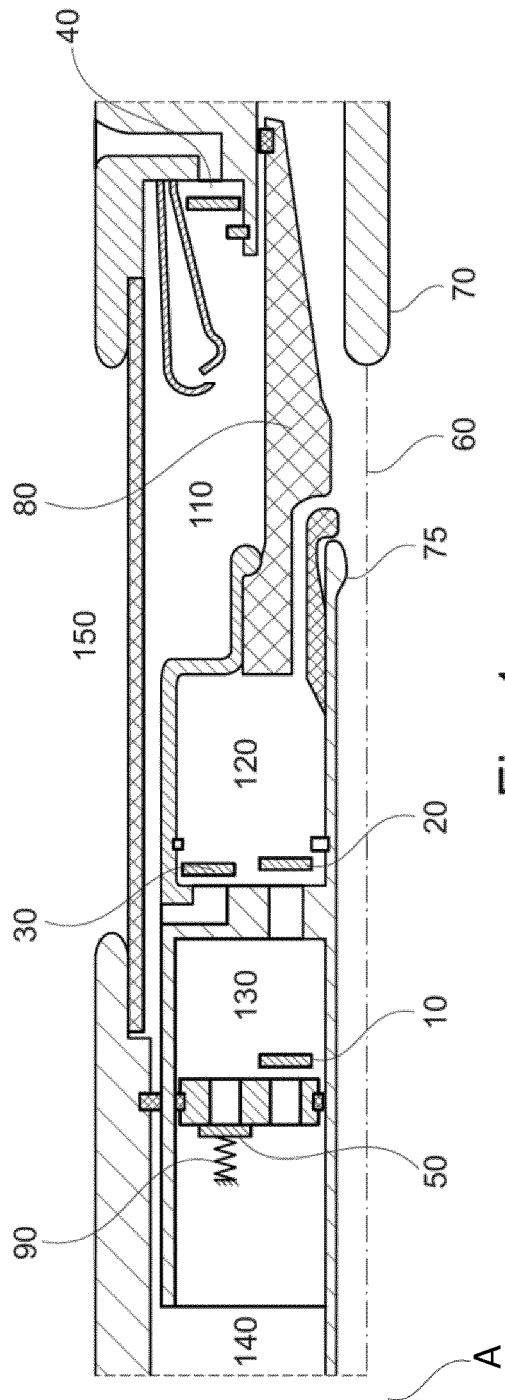


Fig. 1

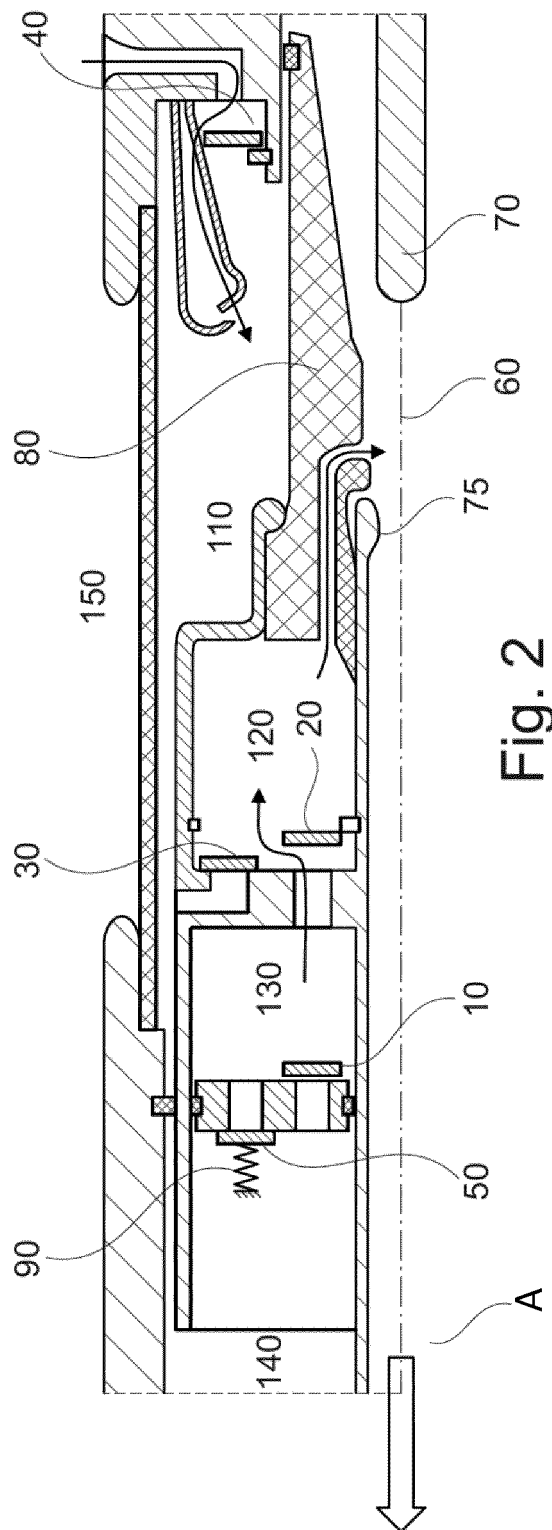
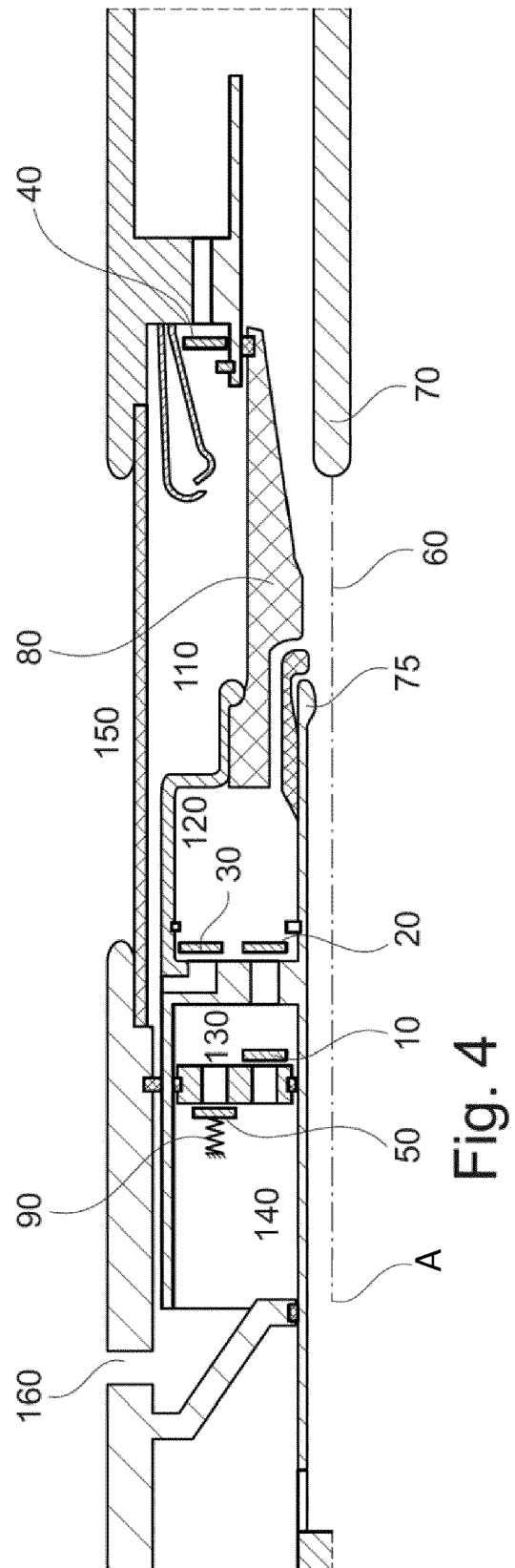
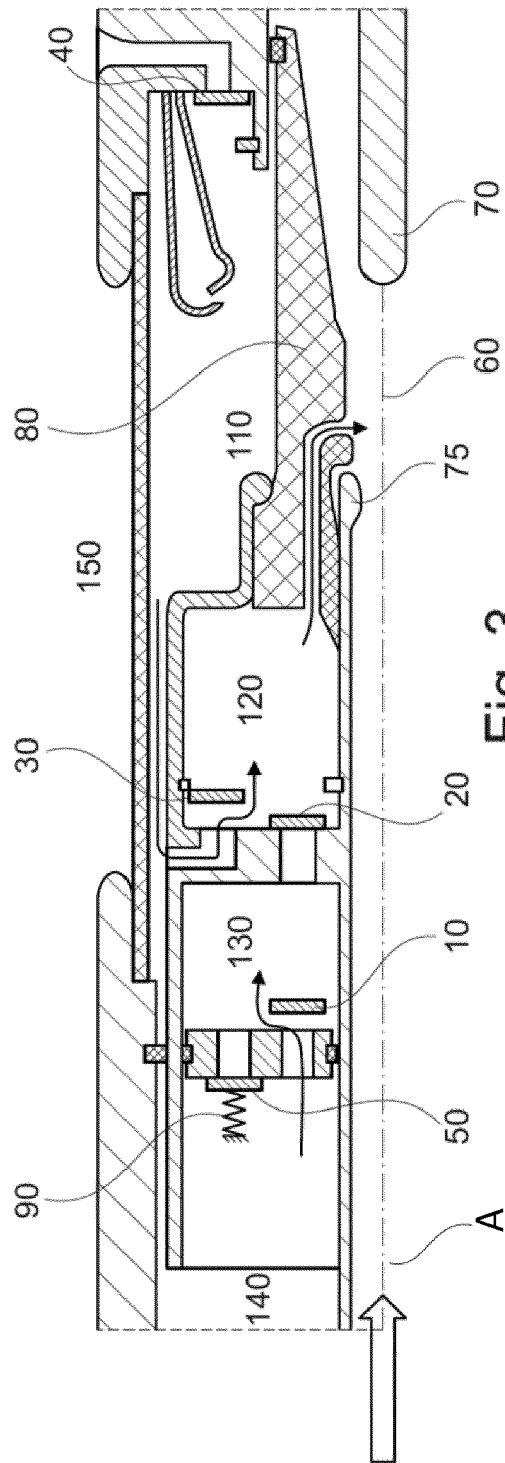


Fig. 2



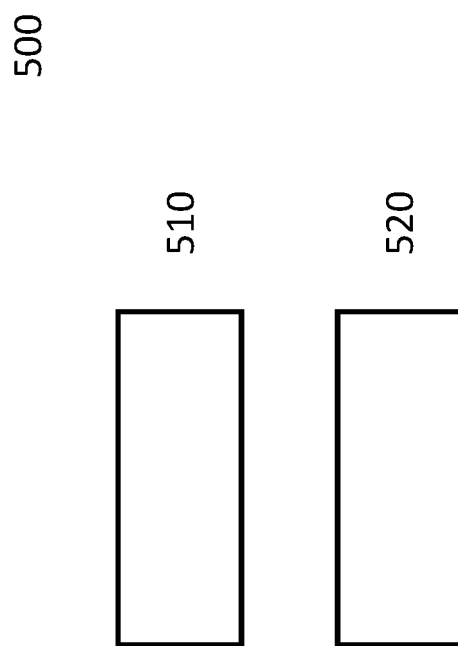


Fig. 5



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Place of search Munich		Date of completion of the search 5 May 2020	Examiner Findeli, Luc
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