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(54) **GAS-INSULATION SWITCH DEVICE**

GASISOLIERTE SCHALTVORRICHTUNG

DISPOSITIF DE COMMUTATION À ISOLATION GAZEUSE

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**JP-U- H0 553 094** **JP-U- H03 116 638**  
**US-A1- 2013 168 357**

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## Description

### FIELD

**[0001]** Embodiments of the present disclosure relate to a gas-insulated switchgear that has improved insulation characteristics.

### BACKGROUND

**[0002]** A switchgear for a high voltage that has a duty of breaking an accident current in a power system is required to surely break currents from a small current to a large current. In particular, as for a large-current breaking, the following two current breaking duties must be satisfied. One is a duty of breaking a short-distance line fault (SLF) current, and the other is a duty of breaking a breaker terminal short-circuit fault (BTF) current. The SLF current is a current having a voltage in a triangular waveform which has a low absolute value but has a keen change rate at the initial stage of rising of a transient recovery voltage produced immediately after a current zero point. The BTF current is a current to which a voltage having a gentle rise at the initial stage of the transient recovery voltage but has a high absolute value at the final stage.

**[0003]** Conventionally, a switchgear that accomplishes the above-described two current breaking duties by a single contact unit has been broadly adopted. However, when it is attempted to accomplish the two current breaking duties by a single contact unit, the weight of a movable member in the contact unit becomes heavy, and a load on an operation mechanism that actuates a movable member increases. Hence, a scheme of accomplishment by a single contact unit may be inadequate for an application where a quite-short current breaking time is required.

**[0004]** In recent years, a reduction of a current breaking time is desired, and there is a request to reduce the weight of the movable member of the contact unit and reduce a load on the operation mechanism. Accordingly, a multipoint current breaking switchgear that includes a plurality of contact units specialized for respective current breaking duties to separately accomplish the above-described two current breaking duties is proposed. In the multipoint current breaking scheme, different types of contact units are electrically connected in series, enabling accomplishment of multiple kinds of current breaking duties. An example known contact unit specialized for a current breaking duty is a vacuum current breaking unit, a gas contact unit, etc.

**[0005]** A vacuum current breaking unit is a contact unit with excellent current breaking characteristics for a keen voltage change, and breaks an accident current. The gas contact unit is a contact unit with high insulation characteristics, and executes insulation after a current breaking. In multipoint current breaking switchgear that has such two contact units, since the respective contact units share

different current breaking duties, the weight of the movable member per each contact unit can be reduced. Hence, a load on the operation mechanism can be reduced, and the current breaking time can be efficiently reduced. Accordingly, the multipoint current breaking switchgear is suitable for an application where a quite-short current breaking time is required. Prior patent literature EP 2278604 A1 discloses a high-voltage switch with a housing which is filled with insulating gas. Further, prior patent literature US 2013/168357 A1 discloses a puffer-type gas circuit-breaker having improved interruption performance and dielectric performance. Prior patent literature EP 2662877 A1 discloses a switchgear such as a disconnecting switch and/or a circuit breaker which opens or closes an electrical path in an electric power system, and relates to an improvement in arc extinguishing performance.

### CITATION LIST

#### PATENT LITERATURES

##### [0006]

Patent Document 1: JP 2015-43656 A  
 Patent Document 2: WO 2015/185095 A1  
 Patent Document 3: JP S55-053824 A  
 Patent Document 4: JP H8-321233 A  
 Patent Document 5: JP 2002-075148 A  
 Patent Document 6: JP 2008-112633 A  
 Patent Document 7: JP S61-14444 A  
 Patent Document 8: JP 2014-72032 A  
 Patent Document 9: JP 2015-79635 A  
 Patent Document 10: JP 2015-185381 A  
 Patent Document 11: JP 2015-185467 A  
 Patent Document 12: US Patent No. 5,258,590  
 Patent Document 13: US Patent NO. 5,258,590

### SUMMARY

**[0007]** According to the multipoint current breaking switchgear, when a vacuum current breaking unit that breaks an accident current, and a gas contact unit that executes insulation after the current breaking are provided as the contact units that share the current breaking duties, there are the following technical problems. That is, when the vacuum current breaking unit extinguishes the accident current, an arc is produced in the vacuum current breaking unit until the accident current is fully dissipated, and not only that, an arc is also produced in the gas contact unit.

**[0008]** Hence, an insulating gas in the gas contact unit becomes a thermal gas with a high temperature because of the production of arc. This thermal gas remains in the gas contact unit for a long time, even after the arc is extinguished. Consequently, there is a possibility that an insulation performance of the gas contact unit decreases. In particular, when the amount of remaining thermal gas

is large, ignition of an arc may occur again in the gas contact unit, which may result in a failure of the current breaking itself.

**[0009]** Embodiments has been proposed in order to address the above-described technical problems, and an objective is to provide a gas-insulated switchgear which efficiently removes a remaining thermal gas to improve an insulation performance, and which can easily accomplish a current breaking duty required in a switchgear for a high voltage.

**[0010]** In order to accomplish the above objective, an embodiment of the present disclosure provides a gas-insulated switchgear that includes a pressure chamber in which an insulating gas is gas-tightly filled, a fixed contact base and a movable contact base placed in the pressure chamber so as to face with each other, a fixed arcing contact fixed to the fixed contact base, a fixed shield fixed to the fixed contact base so as to surround the fixed arcing contact, a fixed conductive contact placed at the fixed shield, a movable contact placed so as to face the fixed conductive contact and to be freely movable, a movable shield fixed to the movable contact base so as to surround the movable contact, an operation rod which is connected to the movable contact and to which a piston is fixed, and an operation mechanism that reciprocates the operation rod so as to move the movable contact to be apart or in contact relative to the fixed arcing contact and the fixed conductive contact, in which the following features (1) to (6) are included.

(1) Inside the movable shield, with the piston of the operation rod acting as a partition wall, a compression chamber and a suction chamber are formed at a movable-contact-base side and at the movable-contact side, respectively.

(2) The operation rod is provided with a hollow portion, and a communication hole that communicates the hollow portion and the compression chamber.

(3) The movable contact is provided with a ventilation hole that passes completely through from an end surface of the movable contact to the hollow portion of the operation rod.

(4) The compression chamber compresses the insulating gas therein by a movement of the piston associated with a movement of the operation rod at a time of circuit opening operation, and sprays the insulating gas to an arc produced between the fixed arcing contact and the movable contact via the communication hole, the hollow portion, and the ventilation hole.

(5) A clearance is provided between an outer circumference of the movable contact and an inner circumference of the movable shield.

(6) The suction chamber reduces an internal pressure by expanding an internal space by a movement of the piston associated with a movement of the operation rod at a time of circuit opening operation, and sucks the high-temperature insulating gas heated by

the arc into the internal space through the clearance.

(7) A first suction hole to suction the insulating gas into the compression chamber at the time of circuit closing operation is formed in an end surface of the movable contact base facing with the compression chamber.

(8) A valve which blocks the first suction hole at the time of circuit opening operation and which opens the first suction hole at the time of circuit closing operation is attached to the first suction hole.

## BRIEF DESCRIPTION OF DRAWINGS

### **[0011]**

FIG. 1 is a cross-sectional view illustrating a close-circuit state of a gas-insulated switchgear according to a first embodiment, which is not encompassed by the wording of the claims but is considered as useful for understanding the invention;

FIG. 2 is a cross-sectional view illustrating an open-circuit state of the gas-insulated switchgear according to the first embodiment;

FIG. 3 is a cross-sectional view illustrating a close-circuit state of a gas-insulated switchgear according to a second embodiment according to the present invention;

FIG. 4 is a cross-sectional view illustrating an open-circuit state of the gas-insulated switchgear according to the second embodiment;

FIG. 5 is a cross-sectional view illustrating a close-circuit state of a gas-insulated switchgear according to a third embodiment, which is not encompassed by the wording of the claims but is considered as useful for understanding the invention;

FIG. 6 is a cross-sectional view illustrating an open-circuit state of the gas-insulated switchgear according to the third embodiment;

FIG. 7 is a cross-sectional view illustrating a close-circuit state of a gas-insulated switchgear according to a fourth embodiment, which is not encompassed by the wording of the claims but is considered as useful for understanding the invention; and

FIG. 8 is a cross-sectional view illustrating an open-circuit state of the gas-insulated switchgear according to the fourth embodiment.

## DETAILED DESCRIPTION

**[0012]** Embodiments of a gas-insulated switchgear according to the present disclosure will be described below with reference to the drawings. Gas-insulated switchgears to be described in below embodiments all have a plurality of contactors which can share a current breaking duty and which are electrically connected in series, and are applied to a gas contact unit that is a contact unit.

[First Embodiment]

(Structure)

**[0013]** With reference to FIGS. 1 and 2, a structure according to a first embodiment, which is not encompassed by the wording of the claims but are considered as useful for understanding the invention, will be described. FIG. 1 is a cross-sectional view illustrating a close-circuit state according to the first embodiment, and FIG. 2 is a cross-sectional views illustrating an open-circuit state according to the first embodiment. As illustrated in FIGS. 1 and 2, a gas-insulated switchgear 1 is provided with a pressure chamber 2 in which an insulating gas is gas-tightly filled. A fixed contact unit 10 and a movable contact unit 20 are placed in the pressure chamber 2 so as to face with each other.

**[0014]** The movable contact unit 20 includes a movable shaft 3 that extends out to the exterior of the pressure chamber 2, and the movable shaft 3 is connected to an operation mechanism 5. The operation mechanism 5 is attached to the pressure chamber 2. The operation mechanism 5 linearly reciprocates the movable contact unit 20 via the movable shaft 3, and moves the movable contact unit 20 to be apart or in contact relative to the fixed contact unit 10.

**[0015]** In the following description, end portions of the fixed contact unit 10 and the movable contact unit 20 that relatively come close to each other are defined as respective tip end portions of the contactor units 10 and 20, and the opposite sides thereto are defined as respective basal end portions. In FIGS. 1 and 2, in the movable contact unit 20, the right side in FIG. 1 is a basal-end portion side, and the opposite side is a tip-end portion side. In contrast, in the fixed contact unit 10, the right side in FIG. 1 is a tip-end portion side, and the opposite side is a basal-end portion side. Note that when the tip end portion is an end surface, this will be also referred to as a tip end surface.

(Fixed contact Unit)

**[0016]** The fixed contact unit 10 includes a fixed arcing contact 11, a fixed conductive contacts 12, a fixed contact base 13, and a fixed shield 14, all arranged concentrically to one another. A spring 16 is placed inside the fixed shield 14.

**[0017]** The fixed contact base 13 is fixed to the pressure chamber 2. The fixed arcing contact 11 in a bar shape is attached to the center part of the fixed contact base 13. A cylindrical portion 13a that is thinner than the outer diameter of the base 13 protrudes and is formed on the tip end surface of the fixed contact base 13, and the fixed conductive contact 12 is placed so as to surround the cylindrical portion 13a.

**[0018]** The plurality of fixed conductive contacts 12 is placed in the circumferential direction, and the tip end portions are bent toward the internal side. The fixed con-

ductive contacts 12 are pushed by the spring 16 in the internal direction, and at the same time abuts the outer circumference of the cylindrical portion 13a of the fixed contact base 13, and thus the movement toward the internal side by the spring 16 is restricted.

**[0019]** The fixed shield 14 is fixed to the outer circumference of the fixed contact base 13 so as to surround the fixed conductive contact 12. The tip end portion of the fixed shield 14 is bent toward the internal side so as to cover the tip end portion of the fixed conductive contact 12. A circular opening 14a is formed in the tip end portion of the fixed shield 14.

**[0020]** An arc-resistant metal 15 that has arc-resistant characteristics is firmly attached to the tip end portion of the fixed arcing contact 11. The arc-resistant metal 15 is formed in a spindle shape that expands outwardly. The fixed arcing contact 11 is provided with slit 17 that has tip end portion sides split in the lengthwise direction. The plurality of slits 17 is provided in parallel with each other. By these slits 17, the fixed arcing contact 11 has spring characteristics that deforms the tip end portion in the radial direction.

(Movable contact Unit)

**[0021]** The movable contact unit 20 includes a movable contact 21, a movable contact base 22, a movable shield 23, and an operation rod 25, all arranged concentrically to one another. Among these components, the operation rod 25 has the tip end portion connected to the movable contact 21, and the basal end portion connected to the movable shaft 3. The operation rod 25 moves the movable contact 21 to be apart or in contact relative to the fixed arcing contact 11 and the fixed conductive contact 12 due to the movable shaft 3 performing reciprocation movement by the operation mechanism 5.

**[0022]** A piston 25a in a disk shape is fixed to the operation rod 25. Moreover, a hollow portion 25b that extends in the lengthwise direction is provided in the center part of the operation rod 25. Furthermore, a communication hole 25c which is orthogonal to the hollow portion 25b and which reaches the outer circumference of the actuation rod 25 from the hollow portion 25b is provided in the operation rod 25. The communication hole 25c is a hole that communicates the hollow portion 25b and a compression chamber 30 to be described later.

**[0023]** The movable contact 21 is attached to the tip end portion of the operation rod 25, and is placed so as to be freely movable and face the fixed current-carrying contactor 12 in the lengthwise direction. The outer diameter of the movable contact 21 is formed so as to be smaller than the internal diameter of the opening 14a of the fixed shield 14, so that the movable contact 21 can be inserted in the opening 14a of the fixed shield 14. When the movable contact 21 is inserted in the opening 14a of the fixed shield 14, the movable contact 21 is provided so that the outer circumference is in contact with the inner circumference of the fixed conductive contact

12.

**[0024]** An arc-resistant metal 24 that has arc-resistant characteristics is firmly attached to the tip end portion of the movable contact 21. The arc-resistant metal 24 is formed in a ring shape so that the arc-resistant metal 15 of the fixed arcing contact 11 is in contact or moves apart relative to the inner circumference. That is, in the movable contact unit 20, the operation rod 25 and movable contact 21 are members that move in an circuit opening operation and circuit closing operation. In contrast, the movable contact base 22 is a component that is fixed to the pressure chamber 2, and the movable shield 23 is a component that is fixed to the movable contact base 22 even in the movable contact unit 20.

**[0025]** In the movable contact 21, at the basal end portion side when viewed from a portion where the arc-resistant metal 15 is inserted, a plurality of ventilation holes 21a each extending in the lengthwise direction of the movable contact 21 is provided. The ventilation hole 21a is a hole that passes completely through from the end surface of the movable contact 21 to the hollow portion 25b of the operation rod 25. An opening of the ventilation hole 21a at the tip end portion side is arranged so as to face the end portion of the arc-resistant metal 15 of the fixed arcing contact 11.

**[0026]** The movable contact base 22 is fixed to the pressure chamber 2. The movable contact base 22 is a hollow cylindrical component, and the interior is in communication with an internal space 22a of the pressure chamber 2. A thick flange 22d is formed at the tip end portion of the movable contact base 22. In the end surface of the flange 22d of the movable contact base 22, a corner portion that faces the communication hole 25c of the operation rod 25 at the end of the circuit opening operation is defined as a gas flow volume limiting portion 22e. The gas flow volume limiting portion 22e is provided so as to cover at least a part of the communication hole 25c with a predetermined clearance at the end of the circuit opening operation.

**[0027]** A holder hole 22c is opened at the center of the flange 22d of the movable contact base 22. The operation rod 25 is inserted in the holder hole 22c. A clearance 33 is formed between the inner circumference of the holder hole 22c of the movable contact base 22 and the outer circumference of the operation rod 25. This clearance 33 becomes a gap when the gas flow volume limiting portion 22e of the movable contact base 22 covers the communication hole 25c.

**[0028]** Placed in the clearance 33 are a collecting contactor 26 and a slide packing 27 so as to contact the inner circumference of the movable contact base 22 and the outer circumference of the operation rod 25. In the flange 22d of the movable contact base 22, the collecting contactor 26 is attached to the basal end portion side, and the slide packing 27 is attached to tip end portion side, respectively. Since the slide packing 27 is installed in the clearance 33, the insulating gas compressed in the compression chamber 30 does not flow toward the internal

space 22a of the movable contact base 22 through the clearance 33. Moreover, the slide packing 27 is configured to block a part of the communication hole 25c of the operation rod 25 at the end of a circuit opening operation.

**[0029]** The movable shield 23 is fixed to the outer circumference of the flange 22d of the movable contact base 22, and a circular opening 23a is formed in the tip end surface so as to surround the outer circumference of the movable contact 21. The outer diameter of the movable contact 21 is formed to be smaller than the internal diameter of the opening 23a. Hence, a clearance 31a is formed between the outer circumference of the movable contact 21 and the inner circumference of the opening 23a of the movable shield 23.

**[0030]** Two spaces are formed in the internal space of the movable shield 23 with the piston 25a of the operation rod 25 being a partition wall. One is the compression chamber 30 formed in the movable contact base 22 side, and the other is a suction chamber 31 formed in the movable contact 21 side. The internal diameter of the compression chamber 30 is designed to be larger than the internal diameter of the suction chamber 31. A clearance 34 is formed between the inner circumference of the movable shield 23 and the outer circumference of the piston 25a. A slide packing 28 is placed in the clearance 34 so as to contact the inner circumference of the movable shield 23 and the outer circumference of the piston 25a.

**[0031]** The compression chamber 30 is a space surrounded by the piston 25a of the operation rod 25, the outer circumference of the operation rod 25, the flange 22d of the movable contact base 22, and the inner circumference of the movable shield 23. The compression chamber 30 compresses the insulating gas therein by a movement of the piston 25a associated with the movement of the operation rod 25 at the time of the circuit opening operation. Moreover, the compression chamber 30 sprays the compressed insulating gas to an arc 40 (illustrated in FIG. 2) produced between the arc-resistant metal 15 of the fixed arcing contact 11 side and the arc-resistant metal 24 of the movable contact 21 side through the communication hole 25c, the hollow portion 25b, and the plurality of ventilation holes 21a. Note that since the insulating gas in the compression chamber 30 has a low temperature in comparison with a thermal gas, the insulating gas in the compression chamber 30 will be referred to as a low-temperature gas.

**[0032]** The suction chamber 31 is a space surrounded by the piston 25a of the operation rod 25, the outer circumference of the operation rod 25, the outer circumference of the movable contact 21, and the inner circumference of the movable shield 23. The suction chamber 31 decreases the pressure in the chamber by an expansion of the internal space due to the movement of the piston 25a associated with the movement of the operation rod 25 at the time of the circuit opening operation, and sucks a high-temperature insulating gas (will be referred to as a thermal gas below) heated by the arc 40 in the chamber through the clearance 31a, .

## (Circuit Opening Operation)

**[0033]** The circuit opening operation according to the first embodiment that employs the above-described structure will be described through a transition from a close-circuit state illustrated in FIG. 1 to an open-circuit state illustrated in FIG. 2. First, in the close-circuit state illustrated in FIG. 1, the movable contact 21 is in contact with the fixed arcing contact 11 and with the fixed conductive contact 12, and is in a conduction state.

**[0034]** In the close-circuit state, the fixed conductive contact 12 is pushed against the outer circumference of the movable contact 21 by the elastic force of the spring 16. Moreover, in the close-circuit state, since the fixed arcing contact 11 deforms to shrink in the radial direction by the plurality of slits 17, the arc-resistant metal 15 firmly attached to the tip end portion of the fixed arcing contact 11 is pushed in the outer circumference direction, and is pressed against the inner circumference of the movable contact 21.

**[0035]** With the above-described close-circuit state being an initial state, when the operation mechanism 5 is activated by a circuit opening command transmitted from the exterior and the movable shaft 3 is driven to the right side in FIG. 1, the operation rod 25 and the movable contact 21 are also driven to the right side. Hence, the movable contact 21 becomes apart first from the fixed conductive contact 12. At this time, since the fixed arcing contact 11 is in contact with the movable contact 21, no arc 40 is produced between the movable contact 21 and the fixed conductive contact 12.

**[0036]** Subsequently, when circuit opening operation advances and the movable contact 21 becomes apart from the fixed arcing contact 11, the arc 40 (illustrated in FIG. 2) is produced between the arc-resistant metal 24 of the movable contact 21 side and the arc-resistant metal 15 of the fixed arcing contact 11 side. Since the arc 40 is in extremely high temperature, the insulating gas there-around becomes the high-temperature thermal gas, and remains between the fixed arcing contact 11 and the movable contact 21.

**[0037]** When the circuit opening operation further advances, an accident current is broken by the other switchgear (unillustrated) that is connected in series with the gas-insulated switchgear 1. Hence, the arc 40 produced between the fixed arcing contact 11 and the movable contact 21 extinguishes. However, even when the arc 40 is extinguished, the thermal gas due to the arc 40 still remains between the fixed arcing contact 11 and the movable contact 21. Hence, it is in a state in which the insulation performance relative to the transient recovery voltage after the current breaking is decreased.

**[0038]** Hence, according to the first embodiment, in order to suppress the reduction of the insulation performance, the following operation is executed. That is, in the circuit opening operation, the piston 25a that is driven to the right side associated with the movement of the operation rod 25 compresses the low-temperature gas in the

compression chamber 30. The low-temperature gas compressed in the compression chamber 30 passes through the communication hole 25c, the hollow portion 25b, and the plurality of ventilation holes 21a in sequence, and is sprayed between the fixed arcing contact 11 and the movable contact 21.

**[0039]** Moreover, in the circuit opening operation, the internal space of the suction chamber 31 expands because the piston 25a has moved to the right side, and the pressure of the insulating gas in the chamber becomes lower than the surroundings. At this time, the internal space of the suction chamber 31 and the space where the arc 40 is produced are in communication with each other by the clearance 31a provided between the outer circumference of the movable contact 21 and the inner circumference of the opening 23a of the movable shield 23. Hence, the thermal gas present around the arc-resistant metal 24 and the movable contact 21 can be taken into the suction chamber 31 via the clearance 31a.

**[0040]** At the end of the circuit opening operation, the gas flow volume limiting portion 22e provided in the end surface of the flange 22d of the movable contact base 22 covers at least a part of the communication hole 25c of the operation rod 25, and the slide packing 27 blocks a part of the communication hole 25c (a state illustrated in FIG. 2). The circuit opening operation ends when the state transitions to the state in FIG. 2 from the state in FIG. 1. At the end of the circuit opening operation, the movable contact 21 is completely retained in the movable shield 23.

## (Circuit Closing Operation)

**[0041]** Next, a circuit closing operation of the gas-insulated switchgear 1 illustrated in FIG. 2 where a transition to the close-circuit state illustrated in FIG. 1 from the open-circuit state occurs will be described. First, in the open-circuit state illustrated in FIG. 2, the movable contact 21 moves apart from the fixed arcing contact 11 and the fixed conductive contact 12, and is in non-conductive state.

**[0042]** With the above-described open-circuit state being an initial state, when the operation mechanism 5 is activated by a circuit closing command transmitted from the exterior and the movable shaft 3 is driven to the left side in FIG. 2, the operation rod 25 and the movable contact 21 are driven to the left side, and the movable contact 21 is closed and in contact with the fixed arcing contact 11, and then is closed and in contact with the fixed conductive contact 12.

**[0043]** Since the piston 25a is driven to the left side in FIG. 2 as the circuit closing operation advances, the internal space of the compression chamber 30 expands, and the pressure of the insulating gas becomes lower than the surroundings. Hence, the insulating gas around the fixed arcing contact 11 is taken into the compression chamber 30 through the communication hole 25c, the

hollow portion 25b, and the ventilation hole 21a.

**[0044]** Moreover, by driving the piston 25a to the left side in FIG. 2, the insulating gas in the suction chamber 31 is compressed, and the insulating gas is sprayed toward the arc-resistant metal 24 side of the movable contact 21 via the clearance 31a. The circuit closing operation ends when the state transitions to the state in FIG. 1 from the state in FIG. 2, and the movable contact 21 is closed and in contact with the fixed arcing contact 11 and the fixed conductive contact 12, and is in the conductive state.

(Action an Effect)

**[0045]**

(1) According to the first embodiment, in the compression chamber 30, the insulating gas in the chamber is compressed by the movement of the piston 25a associated with the movement of the operation rod 25 at the time of the circuit opening operation, and the low-temperature gas is sprayed to the arc 40 via the communication hole 25c, the hollow portion 25b, and the plurality of ventilation holes 21a. At this time, the plurality of ventilation holes 21a faces a portion where the arc-resistant metal 15 of the fixed arcing contact 11 is inserted.

**[0046]** Hence, the ventilation hole 21a can intensively spray a large amount of low-temperature gas from the compression chamber 30 to the thermal gas due to the arc 40. Accordingly, the thermal gas due to the arc 40 can be cooled efficiently, and the remaining thermal gas can be diffused all around from the space where the arc 40 is produced, and can be blown away from between the fixed arcing contact 11 and the movable contact 21.

**[0047]** In addition, according to the first embodiment, since the piston 25a that starts moving compresses the insulating gas in the compression chamber 30, the low-temperature gas can be sprayed toward the space where the arc 40 is produced from the initial stage of the circuit opening operation. Therefore, the thermal gas can be promptly diffused, contributing to an improvement in insulation performance.

**[0048]** According to the first embodiment, simultaneously with the above-described diffusion of the thermal gas, the thermal gas due to the arc 40 can be suctioned by the suction chamber 31. Hence, the thermal gas can be efficiently removed from between the fixed arcing contact 11 and the movable contact 21. At this time, the clearance 31a that becomes a flow channel for the thermal gas to the suction chamber 31 is located at the outer circumference of the movable contact 21.

**[0049]** Accordingly, the thermal gas diffused along the outer circumference of the movable contact 21 by the sprayed low-temperature gas can smoothly flow toward the clearance 31a. Moreover, according to the first embodiment, since the pressure in the suction chamber 31

decreases by the piston 25a that starts moving, the suction chamber 31 can quickly suction the thermal gas through the clearance 31a from the initial stage of the circuit opening operation.

**[0050]** As described above, according to the gas-insulated switchgear 1 of the first embodiment, since the thermal gas is removed from between the fixed arcing contact 11 and the movable contact 21, re-ignition of the fixed arcing contact 11 and the movable contact 21 hardly occurs. Accordingly, an excellent insulation performance relative to the transient recovery voltage after the current breaking can be obtained. Hence, the gas-insulated switchgear 1 can easily achieve the current breaking duty required for a switchgear for a high voltage, and reduces a load on the operation mechanism 5, contributing to a reduction of a current breaking time.

**[0051]** (2) According to the first embodiment, since the gas flow volume limiting portion 22e of the flange 22d of the movable contact base 22 covers at least a part of the communication hole 25c of the operation rod 25 at the end of the circuit opening operation, the cross-sectional area of the communication hole 25c in communication with the compression chamber 30 decreases. Accordingly, immediately before the end of the circuit opening operation, the flow volume of the low-temperature gas that flows toward the ventilation hole 21a from the compression chamber 30 can be reduced, and the internal pressure of the compression chamber 30 increases.

**[0052]** Consequently, puffer reaction force that acts in the direction opposite to the driving direction in the circuit opening operation, that is, the leftward direction in FIG. 2 to the piston 25a increases, and the operation rod 25 and to the movable contact 21 can be braked immediately before the end of the circuit opening operation. This can ease a shock produced when the circuit opening operation ends, and the operational reliability can be improved.

**[0053]** (3) According to the first embodiment, at the end of the circuit opening operation, the slide packing 27 blocks only a part of the communication hole 25c of the operation rod 25. That is, the communication hole 25c is not completely blocked by the slide packing 27. Accordingly, as described in the previous paragraph, although the flow volume of the low-temperature gas from the compression chamber 30 is reduced immediately before the end of the circuit opening operation, the flow volume does not become completely zero, and the low-temperature gas is degassed from the compression chamber 30 to the ventilation hole 21a through the communication hole 25c.

**[0054]** Consequently, immediately before the end of the circuit opening operation, even if the internal pressure of the compression chamber 30 increases by the reduction of the flow volume of the low-temperature gas, the pressure in the compression chamber 30 does not excessively increase. Hence, at the end of the circuit opening operation, the piston 25a is prevented from moving in the opposite side to the left side in FIG. 2 because of the puffer reaction force.

**[0055]** (4) According to the first embodiment, immediately before the end of the circuit closing operation, the internal space of the compression chamber 30 expands and the pressure of the insulating gas becomes lower than the surroundings. Conversely, in the suction chamber 31, the pressure becomes higher than the surroundings, and the puffer reaction force that is in the direction opposite to the driving direction in the circuit closing operation, that is, the rightward direction in FIG. 1 acts on the piston 25a. Accordingly, the braking force can be surely applied to the operation rod 25 and the movable contact 21 can be surely braked immediately before the end of the circuit closing operation, and a shock produced when the circuit closing operation ends can be eased.

**[0056]** (5) According to the first embodiment, the spring 16 pushes the fixed conductive contact 12 against the outer circumference of the movable contact 21. Hence, an electrical resistance decreases, and heat generation by conduction can be suppressed. Moreover, the fixed arcing contact 11 deforms so as to shrink in the radial direction by the plurality of slits 17 to have elastic force in the outer circumference direction, and thus the fixed arcing contact 11 is pushed against the inner circumference of the movable contact 21. Hence, like the fixed conductive contact 12, the electrical resistance decreases, and there is an advantage that heat generation by conduction is suppressed.

[Second Embodiment]

(Structure)

**[0057]** A structure according to a second embodiment according to the invention will be described with reference to FIGS. 3 and 4. FIG. 3 is a cross-sectional view illustrating a close-circuit state according to the second embodiment, and FIG. 4 is a cross-sectional view illustrating an open-circuit state according to the second embodiment. Note that the same or similar component as that of the first embodiment will be denoted by the same reference numeral, and the duplicated description will be omitted.

**[0058]** According to the second embodiment, a plurality of first suction holes 22b is formed in the flange 22d of the movable contact base 22. The first suction hole 22b is a hole that communicates the internal space 22a of the movable contact base 22 and the compression chamber 30, and suctions the insulating gas in the internal space 22a into the compression chamber 30 at the time of the circuit closing operation.

**[0059]** A valve 32 in a ring-plate shape is placed inside the compression chamber 30. The valve 32 is fitted in a groove 32a formed in the inner circumference of the movable shield 23, has the restricted movable range by abutting the end portion of the groove 32a. The groove 32a is a positioning portion for the valve 32 at the end of the circuit closing operation. The valve 32 has a structure to block the first suction holes 22b by pressure difference

when the pressure in the compression chamber 30 becomes higher than the pressure in the internal space 22a.

(Circuit Opening Operation)

**[0060]** A circuit opening operation according to the second embodiment that employs the above structure will be described through a transition from a close-circuit state illustrated in FIG. 3 to the open-circuit state illustrated in FIG. 4. However, as for the same feature as that of the circuit opening operation in the first embodiment, the detailed description will be omitted.

**[0061]** At the time of the circuit opening operation, the pressure in the compression chamber 30 becomes higher than the pressure in the internal space 22a because the piston 25a is driven to the right side in FIG. 3, and the valve 32 blocks the first suction hole 22b (a state in FIG. 4). Accordingly, no insulating gas flows in the compression chamber 30 from the internal space 22a through the first suction holes 22b.

**[0062]** Accordingly, the low-temperature gas in the compression chamber 30 can be efficiently compressed by the driven piston 25a, and the low-temperature gas in the compression chamber 30 can be intensively sprayed toward the fixed arcing contact 11 side via the communication hole 25c, the hollow portion 25b, and the ventilation hole 21a. Moreover, according to the second embodiment, like the first embodiment, since the internal space of the suction chamber 31 expands and the pressure of the insulating gas becomes lower than the surroundings, the insulating gas around the arc-resistant metal 24 is taken in the interior of the suction chamber 31 through the clearance 31a.

(Circuit Closing Operation)

**[0063]** A circuit closing operation according to the second embodiment will be described through a transition from the open-circuit state illustrated in FIG. 4 to the close-circuit state illustrated in FIG. 3. However, as for the same feature as that of the circuit closing operation according to the first embodiment, the detailed description will be omitted.

**[0064]** In the circuit closing operation, the pressure in the compression chamber 30 becomes lower than the pressure in the internal space 22a because the piston 25a is driven to the left side in FIG. 4, and the valve 32 opens the first suction holes 22b. Hence, the insulating gas in the internal space 22a flows into the compression chamber 30 via the first suction hole 22b, and a pressure reduction by the expansion of the internal space of the compression chamber 30 is suppressed. Accordingly, the piston 25a does not become a condition that is difficult to move in the circuit opening direction (the leftward direction in FIG. 4) associated with the pressure reduction of the compression chamber 30. The valve 32 abuts the end portion of the groove 32a at the end of the circuit closing operation, and the valve 32 is positioned.



## (Action and Effect)

**[0065]** According to the second embodiment, the action and effect similar to the first embodiment can be achieved, and there are the following further unique action and effect. That is, at the time of circuit closing operation, since the valve 32 opens the first suction holes 22b, the insulating gas flows into the compression chamber 30 from the internal space 22a of the movable contact base 22 via the first suction holes 22b. Accordingly, suppression force to the circuit closing operation produced relative to the piston 25a decreases without a pressure reduction of the compression chamber 30.

**[0066]** In addition, according to the second embodiment, since the internal space 22a of the movable contact base 22 is adopted as a space for supplying the insulating gas into the compression chamber 30, it is easy to ensure the flow volume of the insulating gas into the compression chamber 30. Moreover, adjustment of the flow volume of the insulating gas is facilitated by changing the size of the first suction holes 22b. Consequently, the circuit closing operation can be executed with the minimum energy, a further reduction of a load on the operation mechanism 5 is advanced, and the current breaking time is further reduced.

## [Third Embodiment]

## (Structure)

**[0067]** A structure according to a third embodiment will be described with reference to FIGS. 5 and 6. FIG. 5 is a cross-sectional view illustrating a close-circuit state according to the third embodiment, which is not encompassed by the wording of the claims but is considered as useful for understanding the invention, and FIG. 6 is a cross-sectional view illustrating an open-circuit state according to the third embodiment. Note that the same or similar component as that of the first embodiment will be denoted by the same reference numeral, and the duplicated description will be omitted.

**[0068]** According to the third embodiment, a plurality of second suction holes 25d is formed in the piston 25a. The second suction holes 25d communicates the compression chamber 30 and the suction chamber 31, and suctions the insulating gas into the compression chamber 30 at the time of circuit closing operation like the first suction holes 22b.

**[0069]** The valve 32 in a ring-plate shape is placed inside the compression chamber 30. The valve 32 has the movable range restricted by a retainer ring 32b that is fixed to the outer circumference of the operation rod 25. The retainer ring 32b is a positioning portion of the valve 32 at the end of the circuit closing operation. Furthermore, the valve 32 has a structure that blocks the second suction holes 25d by pressure difference when the pressure in the compression chamber 30 becomes higher than the pressure in the suction chamber 31.

## (Circuit Opening Operation)

**[0070]** A circuit opening operation according to the third embodiment that employs the above structure will be described through a transition from the close-circuit state illustrated in FIG. 5 to the open-circuit state illustrated in FIG. 6. However, as for the same feature as that of the circuit opening operation in the first embodiment, the detailed description will be omitted.

**[0071]** At the time of the circuit opening operation, the pressure in the compression chamber 30 becomes higher than the pressure in the suction chamber 31 because the piston 25a is driven to the right side in FIG. 5, and the valve 32 blocks the second suction holes 25d. Accordingly, no insulating gas flows into the compression chamber 30 from the suction chamber 31 through the second suction holes 25d, and the insulating gas can be efficiently compressed in the compression chamber 30.

**[0072]** Accordingly, the low-temperature gas in the compression chamber 30 can be intensively sprayed toward the fixed arcing contact 11 from the compression chamber 30 via the communication hole 25c, the hollow portion 25b, and the ventilation hole 21a. Furthermore, according to the third embodiment, like the first and second embodiments, the internal space of the suction chamber 31 expands, the pressure of the insulating gas becomes lower than the surroundings, and the insulating gas around the arc-resistant metal 24 is taken in the interior of the suction chamber 31 through the clearance 31a.

## (Circuit Closing Operation)

**[0073]** A circuit closing operation according to the third embodiment will be described through a transition from the open-circuit state illustrated in FIG. 6 to the close-circuit state illustrated in FIG. 5. However, as for the same feature as that of the circuit closing operation according to the first embodiment, the detailed description will be omitted.

**[0074]** At the time of the circuit closing operation, the pressure in the compression chamber 30 becomes lower than the pressure in the suction chamber 31 because the piston 25a is driven to the left side in FIG. 6, and the valve 32 opens the second suction holes 25d. Hence, the insulating gas in the suction chamber 31 flows in the compression chamber 30 via the second suction holes 25d, and the insulating gas in the suction chamber 31 decreases and the insulating gas in the compression chamber 30 increases.

**[0075]** Accordingly, the pressure in the compression chamber 30 and in the suction chamber 31 can be equalized, and a pressure reduction of the compression chamber 30 and a pressure increase of the suction chamber 31 can be simultaneously suppressed. Consequently, the piston 25a does not become a condition that is difficult to move in the circuit closing operation direction (the leftward direction in FIG. 6). The valve 32 abuts the retainer

ring 32b at the end of the circuit closing operation, and the valve 32 is positioned.

(Action and Effect)

**[0076]** According to the third embodiment, the action and effect similar to those of the first and second embodiments can be achieved, and furthermore, not only the pressure reduction of the compression chamber 30 but also the pressure increase of the suction chamber 31 can be suppressed at the time of circuit closing operation. Hence, in the circuit closing operation, the suppression force to the circuit closing operation produced at the piston 25a can be surely reduced, and the circuit closing operation can be executed by a further smaller energy. Accordingly, a reduction of load on the operation mechanism 5 can be further advanced, and the current breaking time can be efficiently reduced.

[Fourth Embodiment]

(Structure)

**[0077]** A structure according to a fourth embodiment will be described with reference to FIGS. 7 and 8. FIG. 7 is a cross-sectional view illustrating a close-circuit state according to the fourth embodiment, which is not encompassed by the wording of the claims but is considered as useful for understanding the invention, and FIG. 8 is a cross-sectional view illustrating an open-circuit state according to the fourth embodiment. Note that the same or similar component as that of the first embodiment will be denoted by the same reference numeral, and the duplicated description will be omitted.

**[0078]** The fourth embodiment is a modified example relating to the ventilation hole 21a of the movable contact 21 illustrated in FIGS. 1 and 2. A ventilation hole 21b is formed to increase the flow-channel cross-sectional area for the insulating gas from a portion connected to the hollow portion 25b of the actuation rod 25 toward the end surface of the movable contact 21. That is, the ventilation hole 21b increases the flow-channel cross-sectional area from the portion in communication with the hollow portion 25b toward the portion where the low-temperature gas is sprayed. In to the fourth embodiment, the number of ventilation holes 21b is one.

(Action and Effect)

**[0079]** According to the above fourth embodiment, in addition to the action and effect similar to those of the first embodiment, the following unique action and effect are achieved. That is, also in the fourth embodiment, the low-temperature gas compressed in the compression chamber 30 at the time of circuit opening operation is sprayed from the ventilation hole 21a via the communication hole 25c and the hollow portion 25b.

**[0080]** At this time, the ventilation hole 21b has the

flow-channel cross-sectional area that increases from the portion in communication with the hollow portion 25b toward the spray portion to the fixed arcing contact 11. Hence, the low-temperature gas that passes through the ventilation hole 21b increases the flow velocity when sprayed to the thermal gas. Accordingly, the thermal gas can be more efficiently cooled, and diffused. Consequently, a further better insulation performance relative to the transient recovery voltage after current breaking can be obtained.

[Other Embodiments]

**[0081]** Several embodiments of the present disclosure have been described, but those embodiments are merely presented as examples, and are not intended to limit the scope of the present disclosure. Those embodiments can be carried out in other various forms, and various omissions, replacements, and modifications can be made without departing from the scope of the present disclosure. Such embodiments and modified forms thereof are within the scope of the present disclosure, and also within the scope of the invention as recited in appended claims.

**[0082]** For example, the shape and dimension of the clearance 31a that is formed along the outer circumference of the movable contact 21, the shape and dimension of the movable contact 21, the number, shape, and dimension of the ventilation hole 21a formed in the movable contact 21, and the number, shape, and dimension of the hollow portion 25b and the communication hole 25c formed in the operation rod 25, etc., can be selected as appropriate, and by simply adjusting the flow volume of the low-temperature gas to be sprayed toward the space where the arc 40 is produced, diffusion and cooling of the thermal gas due to the arc 40 can be efficiently executed. Moreover, in the end surface of the movable contact base 22 and the slide packing 27, the size of the area that covers the communication hole 25c at the end of the circuit opening operation can be changed as appropriate as long as braking of the operation rod 25 and the movable contact 21 is achievable.

#### REFERENCE SIGNS LIST

**[0083]**

1 Gas-insulated switchgear

2 Pressure chamber

3 Movable shaft

5 Operation mechanism

10 Fixed contact unit

11 Fixed arcing contact

12 Fixed conductive contact

13 Fixed contact base

13a Cylindrical portion

14 Fixed shield

14a, 23a Opening

15, 24	Arc-resistant metal	
17	Slit	
20	Movable contact unit	
21	Movable contact	
21a, 21b	Ventilation hole	5
22	Movable contact base	
22a	Internal space	
22b	First suction hole	
22c	Holder hole	
22d	Flange	10
22e	Gas flow volume limiting portion	
23	Movable shield	
25	operation rod	
25a	Piston	
25b	Hollow portion	15
25c	Communication hole	
25d	Second suction hole	
26	Collecting contactor	
27, 28	Slide packing	
30	Compression chamber	20
31	Suction chamber	
31a, 33, 34	Clearance	
32	Valve	
32a	Groove	
32b	Retainer ring	25
40	Arc	

## Claims

### 1. A gas-insulated switchgear (1) comprising:

a pressure chamber (2) in which an insulating gas is gas-tightly filled;

a fixed contact base (13) and a movable contact base (22) placed in the pressure chamber (2) so as to face with each other;

a fixed arcing contact (11) fixed to the fixed contact base (13);

a fixed shield (14) fixed to the fixed contact base (13) so as to surround the fixed arcing contact (11);

a fixed conductive contact (12) placed at the fixed shield (14);

a movable contact (21) placed so as to face the fixed conductive contact (12) and to be freely movable;

a movable shield (23) fixed to the movable contact base (22) so as to surround the movable contact (21);

an operation rod (25) which is connected to the movable contact (21) and to which a piston (25a) is fixed; and

an operation mechanism (5) that reciprocates the operation rod (25) so as to move the movable contact (21) to be apart or in contact relative to the fixed arcing contact (11) and the fixed conductive contact (12), wherein:

inside the movable shield (23), with the piston (25a) of the operation rod (25) being a partition wall, a compression chamber (30) and a suction chamber are formed at a movable-contact-base side and at the movable-contact side, respectively;

#### characterized in that

the operation rod (25) is provided with a hollow portion (25b), and a communication hole (25c) that communicates the hollow portion (25b) and the compression chamber (30);

the movable contact (21) is provided with a ventilation hole (21a, 21b) that passes completely through from an end surface of the movable contact (21) to the hollow portion (25b) of the operation rod (25);

the compression chamber (30) compresses the insulating gas therein by a movement of the piston (25a) associated with a movement of the operation rod (25) at a time of circuit opening operation, and sprays the insulating gas to an arc (40) produced between the fixed arcing contact (11) and the movable contact (21) via the communication hole (25c), the hollow portion (25b), and the ventilation hole (21a, 21b);

a clearance (31a, 33, 34) is provided between an outer circumference of the movable contact (21) and an inner circumference of the movable shield (23); and

the suction chamber reduces an internal pressure by expanding an internal space (22a) by a movement of the piston (25a) associated with a movement of the operation rod (25) at a time of circuit opening operation, and suctions the high-temperature insulating gas heated by the arc (40) into the internal space (22a) through the clearance (31a, 33, 34).

a first suction hole (22b) to suction the insulating gas into the compression chamber (30) at the time of circuit closing operation is formed in an end surface of the movable contact base (22) facing with the compression chamber (30); and

a valve (32) which blocks the first suction hole (22b) at the time of circuit opening operation and which opens the first suction hole (22b) at the time of circuit closing operation is attached to the first suction hole (22b).

### 2. The gas-insulated switchgear (1) according to claim 1, wherein:

a second suction hole (25d) which communicates the suction chamber and the compression

- chamber (30), and which is to suction the insulating gas in the suction chamber into the compression chamber (30) at the time of circuit closing operation is formed in the piston (25a); and a valve (32) which block the second suction hole (25d) at the time of circuit opening operation and which opens the second suction hole (25d) at the time of circuit closing operation is attached to the second suction hole (25d).
3. The gas-insulated switchgear (1) according to claim 1 or 2, wherein the valve (32) is placed in the compression chamber (30).
4. The gas-insulated switchgear (1) according to any one of claims 1 to 3, further comprising a valve positioning portion that positions the valve (32) at an end of the circuit closing operation.
5. The gas-insulated switchgear (1) according to any one of claims 1 to 4, wherein the ventilation hole (21a, 21b) is formed so as to increase a flow-channel cross-sectional area for the insulating gas from a portion connected to the hollow portion (25b) of the operation rod (25) toward an end surface of the movable contact (21).
6. The gas-insulated switchgear (1) according to any one of claims 1 to 5, wherein a gas flow volume limiting portion (22e) which covers at least a part of the communication hole (25c) at an end of the circuit opening operation is provided at an end surface of the movable contact base (22).
7. The gas-insulated switchgear (1) according to any one of claims 1 to 6, further comprising a slide packing (27, 28) placed so as to contact an inner circumference of the movable contact base (22) and an outer circumference of the operation rod (25), wherein the slide packing (27, 28) is configured to block a part of the communication hole (25c) of the operation rod (25) at an end of the circuit opening operation.

## Patentansprüche

1. Gasisolierte Schaltvorrichtung (1), aufweisend:

eine Druckkammer (2), in der ein Isoliergas gasdicht eingefüllt ist;  
einen festen Kontaktsockel (13) und einen beweglichen Kontaktsockel (22), die so in der Druckkammer (2) angeordnet sind, dass sie einander zugewandt sind;  
einen festen Lichtbogenkontakt (11), der an dem festen Kontaktsockel (13) befestigt ist;  
eine feste Abschirmung (14), die so an dem festen

ten Kontaktsockel (13) befestigt ist, dass sie den festen Lichtbogenkontakt (11) umgibt;  
einen festen leitenden Kontakt (12), der an der festen Abschirmung (14) angeordnet ist;  
einen beweglichen Kontakt (21), der so angeordnet ist, dass er dem festen leitenden Kontakt (12) zugewandt ist und frei beweglich ist;  
eine bewegliche Abschirmung (23), die so an dem beweglichen Kontaktsockel (22) befestigt ist, dass sie den beweglichen Kontakt (21) umgibt;  
eine Betätigungsstange (25), die mit dem beweglichen Kontakt (21) verbunden ist und an der ein Kolben (25a) befestigt ist; und  
einen Betätigungsmechanismus (5), der die Betätigungsstange (25) hin- und herbewegt, um den beweglichen Kontakt (21) so zu bewegen, dass er relativ zu dem festen Lichtbogenkontakt (11) und zu dem festen leitenden Kontakt (12) getrennt oder in Kontakt ist, wobei:

innerhalb der beweglichen Abschirmung (23), mit dem Kolben (25a) der Betätigungsstange (25) als Trennwand, eine Kompressionskammer (30) und eine Saugkammer auf Seiten des beweglichen Kontaktsockels bzw. auf Seiten des beweglichen Kontakts gebildet sind;

### **dadurch gekennzeichnet, dass**

die Betätigungsstange (25) mit einem hohlen Abschnitt (25b) versehen ist, und einem Verbindungsloch (25c), das den hohlen Abschnitt (25b) und die Kompressionskammer (30) verbindet; wobei der bewegliche Kontakt (21) mit einem Belüftungsloch (21a, 21b) versehen ist, das vollständig von einer Endfläche des beweglichen Kontakts (21) bis zu dem hohlen Abschnitt (25b) der Betätigungsstange (25) hindurchgeht;  
die Kompressionskammer (30) das darin befindliche Isoliergas durch eine Bewegung des Kolbens (25a) komprimiert, die mit einer Bewegung der Betätigungsstange (25) zum Zeitpunkt des Kreislauföffnungsvorgangs einhergeht, und das Isoliergas zu einem Lichtbogen (40), der zwischen dem festen Lichtbogenkontakt (11) und dem beweglichen Kontakt (21) erzeugt wird, über das Verbindungsloch (25c), den hohlen Abschnitt (25b) und das Belüftungsloch (21a, 21b) versprüht;  
ein Zwischenraum (31a, 33, 34) zwischen einem Außenumfang des beweglichen Kontakts (21) und einem Innenumfang der beweglichen Abschirmung (23) vorgesehen ist; und  
die Saugkammer einen Innendruck verringert, indem sie einen Innenraum (22a)

- durch eine Bewegung des Kolbens (25a) erweitert, die mit einer Bewegung der Betätigungsstange (25) zum Zeitpunkt des Kreislauföffnungsvorgangs einhergeht, und das durch den Lichtbogen (40) erhitze Hochtemperaturisoliertgas durch den Zwischenraum (31a, 33, 34) in den Innenraum (22a) ansaugt;  
 ein erstes Ansaugloch (22b) zum Ansaugen des Isoliertgases in die Kompressionskammer (30) zum Zeitpunkt des Kreislaufschließvorgangs in einer Endfläche der beweglichen Kontaktsockel (22) ausgebildet ist, die der Kompressionskammer (30) zugewandt ist; und  
 ein Ventil (32), das das erste Ansaugloch (22b) zum Zeitpunkt des Kreislauföffnungsvorgangs blockiert und das das erste Ansaugloch (22b) zum Zeitpunkt des Kreislaufschließvorgangs kreislauföffnet, an dem ersten Ansaugloch (22b) angebracht ist.
2. Gasisolierte Schaltvorrichtung (1) nach Anspruch 1, wobei:
- ein zweites Ansaugloch (25d), das die Saugkammer und die Kompressionskammer (30) verbindet und das dazu dient, zum Zeitpunkt des Kreislaufschließvorgangs das Isoliertgas in der Saugkammer in die Kompressionskammer (30) zu saugen, in dem Kolben (25a) ausgebildet ist; und  
 ein Ventil (32), das das zweite Ansaugloch (25d) zum Zeitpunkt des Kreislauföffnungsvorgangs blockiert und das das zweite Ansaugloch (25d) zum Zeitpunkt des Kreislaufschließvorgangs öffnet, an dem zweiten Ansaugloch (25d) angebracht ist.
3. Gasisolierte Schaltvorrichtung (1) nach Anspruch 1 oder 2, wobei das Ventil (32) in der Kompressionskammer (30) angeordnet ist.
4. Gasisolierte Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 3, ferner aufweisend einen Ventilpositionierungsabschnitt, der das Ventil (32) am Ende des Kreislaufschließvorgangs positioniert.
5. Gasisolierte Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 4, wobei das Belüftungsloch (21a, 21b) so ausgebildet ist, dass es eine Strömungskanalquerschnittsfläche für das Isoliertgas von einem mit dem hohlen Abschnitt (25b) der Betätigungsstange (25) verbundenen Abschnitt in Richtung einer Endfläche des beweglichen Kontakts (21) vergrößert.
6. Gasisolierte Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 5, wobei ein Gasdurchströmungsbegrenzungsabschnitt (22e), der an einem Ende des Kreislauföffnungsvorgangs mindestens einen Teil des Verbindungslochs (25c) abdeckt, an einer Endfläche des beweglichen Kontaktsockels (22) vorgesehen ist.
7. Gasisolierte Schaltvorrichtung (1) nach einem der Ansprüche 1 bis 6, ferner aufweisend eine Gleitdichtung (27, 28), die so angeordnet ist, dass sie einen Innenumfang des beweglichen Kontaktsockels (22) und einen Außenumfang der Betätigungsstange (25) berührt, wobei die Gleitdichtung (27, 28) so ausgebildet ist, dass sie an einem Ende des Kreislauföffnungsvorgangs einen Teil des Verbindungslochs (25c) der Betätigungsstange (25) blockiert.
- Revendications**
1. Appareillage de commutation à isolation gazeuse (1) comprenant :
- une chambre de pression (2) dans laquelle un gaz isolant est rempli de manière étanche au gaz;  
 une base de contact fixe (13) et une base de contact mobile (22) placées dans la chambre de pression (2) de manière à se faire face ;  
 un contact d'arc fixe (11) fixé à la base de contact fixe (13);  
 un blindage fixe (14) fixé à la base de contact fixe (13) de manière à entourer le contact d'arc fixe (11);  
 un contact conducteur fixe (12) placé au niveau du blindage fixe (14);  
 un contact mobile (21) placé de manière à faire face au contact conducteur fixe (12) et à être librement mobile ;  
 un blindage mobile (23) fixé à la base de contact mobile (22) de manière à entourer le contact mobile (21) ;  
 une tige de manoeuvre (25) qui est raccordée au contact mobile (21) et à laquelle est fixée un piston (25a) ; et  
 un mécanisme de commande (5) qui fait effectuer un mouvement de va-et-vient à la tige de manoeuvre (25) de manière à déplacer le contact mobile (21) pour qu'il soit séparé ou en contact par rapport au contact d'arc fixe (11) et au contact conducteur fixe (12), dans lequel :
- à l'intérieur du blindage mobile (23), le piston (25a) de la tige de manoeuvre (25) étant une cloison de séparation, une chambre de compression (30) et une chambre d'aspira-

tion sont formées au niveau d'un côté de base de contact mobile et au niveau du côté de contact mobile, respectivement ;

**caractérisé en ce que**

la tige de manoeuvre (25) est dotée d'une partie creuse (25b), et un trou de communication (25c) qui fait communiquer la partie creuse (25b) et la chambre de compression (30) ;

le contact mobile (21) est pourvu d'un trou de ventilation (21a, 21b) qui traverse complètement depuis une surface d'extrémité du contact mobile (21) jusqu'à la partie creuse (25b) de la tige de manoeuvre (25) ;

la chambre de compression (30) comprime le gaz isolant à l'intérieur par un mouvement du piston (25a) associé à un mouvement de la tige de manoeuvre (25) à un moment d'une opération d'ouverture de circuit et pulvérise le gaz isolant sur un arc (40) réalisé entre le contact d'arc fixe (11) et le contact mobile (21) via le trou de communication (25c), la partie creuse (25b) et le trou de ventilation (21a, 21b) ;

un espace (31a, 33, 34) est ménagé entre une circonférence externe du contact mobile (21) et une circonférence interne du blindage mobile (23) et la chambre d'aspiration réduit une pression interne en élargissant un espace interne (22 a) par un mouvement du piston

(25a) associé à un mouvement de la tige de manoeuvre (25) au moment de l'opération d'ouverture de circuit et aspire le gaz isolant à haute température chauffé par l'arc (40) dans l'espace interne (22a) à travers l'espace (31a, 33, 34) ;

un premier trou d'aspiration (22b) pour aspirer le gaz isolant dans la chambre de compression (30) au moment de l'opération de fermeture de circuit est formé dans une surface d'extrémité de la base de contact mobile (22) faisant face à la chambre de compression (30) ; et

une vanne (32) qui bloque le premier trou d'aspiration (22b) au moment de l'opération d'ouverture du circuit et qui ouvre le premier trou d'aspiration (22b) est fixé au premier trou d'aspiration (22b) lors de l'opération de fermeture de circuit.

2. Appareillage de commutation à isolation gazeuse (1) selon la revendication 1, dans lequel :

un deuxième trou d'aspiration (25d) qui fait communiquer la chambre d'aspiration et la chambre de compression (30), et qui doit aspirer le gaz isolant dans la chambre d'aspiration à l'intérieur

de la chambre de compression (30) au moment de l'opération de fermeture de circuit est formé dans le piston (25a) ; et

une vanne (32) qui bouche le deuxième trou d'aspiration (25d) au moment de l'opération d'ouverture du circuit et qui ouvre le deuxième trou d'aspiration (25d) au moment de l'opération de fermeture de circuit est fixé au deuxième trou d'aspiration (25d).

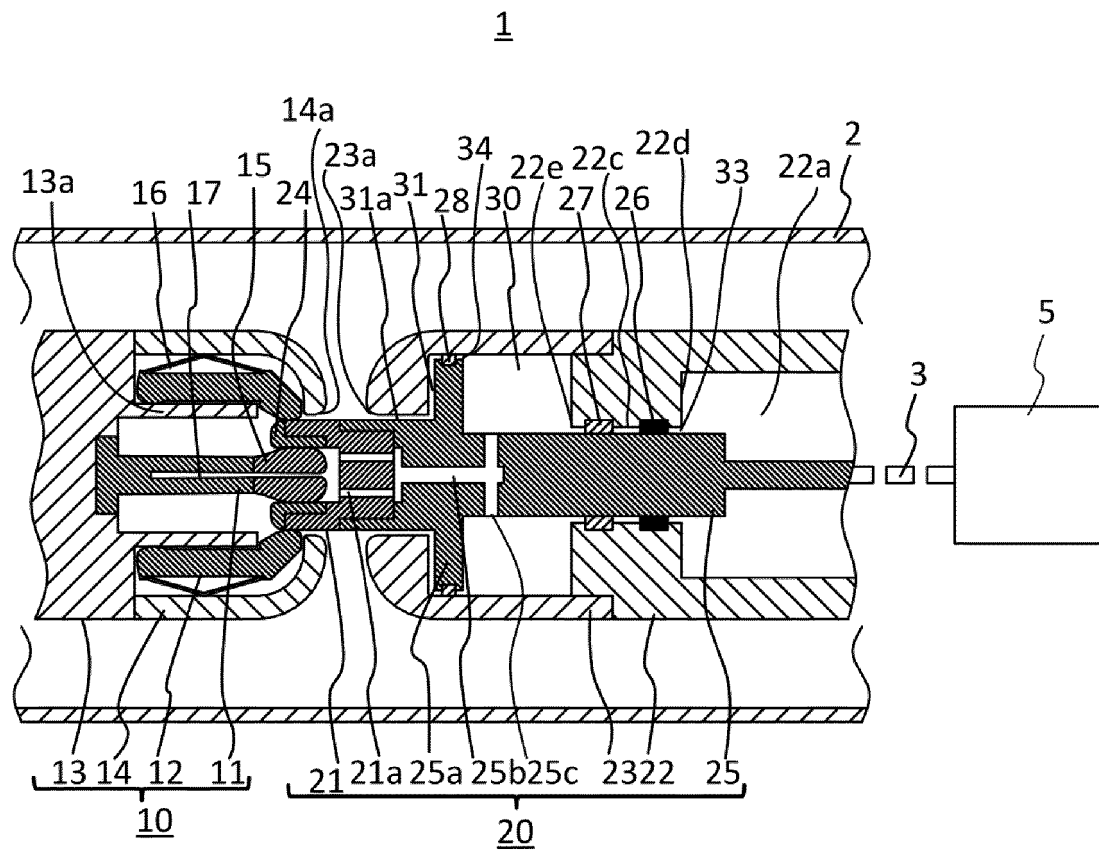
3. Appareillage de commutation à isolation gazeuse (1) selon la revendication 5, 1 ou 2, dans lequel la vanne (32) est placée dans la chambre de compression (30).

4. Appareillage de commutation à isolation gazeuse (1) selon une quelconque des revendications 1 à 3, comprenant en outre une partie de positionnement de vanne qui positionne la vanne (32) à une fin de l'opération de fermeture de circuit.

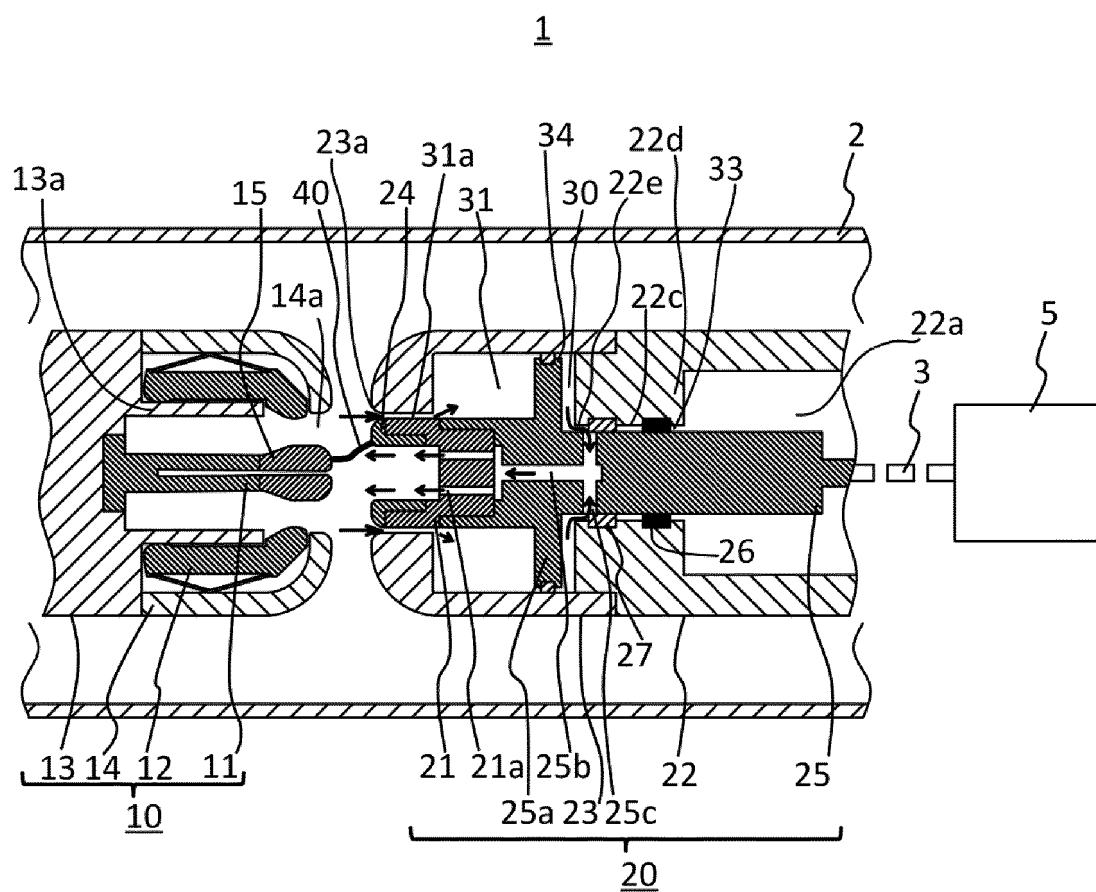
5. Appareillage de commutation à isolation gazeuse (1) selon une quelconque des revendications 1 à 4, dans lequel l'orifice de ventilation (21a, 21b) est formé de manière à augmenter la surface transversale du canal d'écoulement pour le gaz isolant depuis une partie raccordée à la partie creuse (25b) de la tige de manoeuvre (25) vers une surface d'extrémité du contact mobile (21).

6. Appareillage de commutation à isolation gazeuse (1) selon une des revendications 1 à 5, dans laquelle une partie de limitation du volume du flux de gaz (22e) qui recouvre au moins une partie du trou de communication (25c) à une fin de l'opération d'ouverture de circuit est disposée au niveau d'une surface d'extrémité de la base de contact mobile (22).

7. Appareillage de commutation à isolation gazeuse (1) selon une quelconque des revendications 1 à 6, comprenant en outre une garniture coulissante (27, 28) placée de manière à entrer en contact avec une circonférence intérieure de la base de contact mobile (22) et une circonférence extérieure de la tige de manoeuvre (25), dans lequel la garniture coulissante (27, 28) est configurée pour bloquer une partie du trou de communication (25c) de la tige de manoeuvre (25) à la fin de l'opération d'ouverture de circuit.

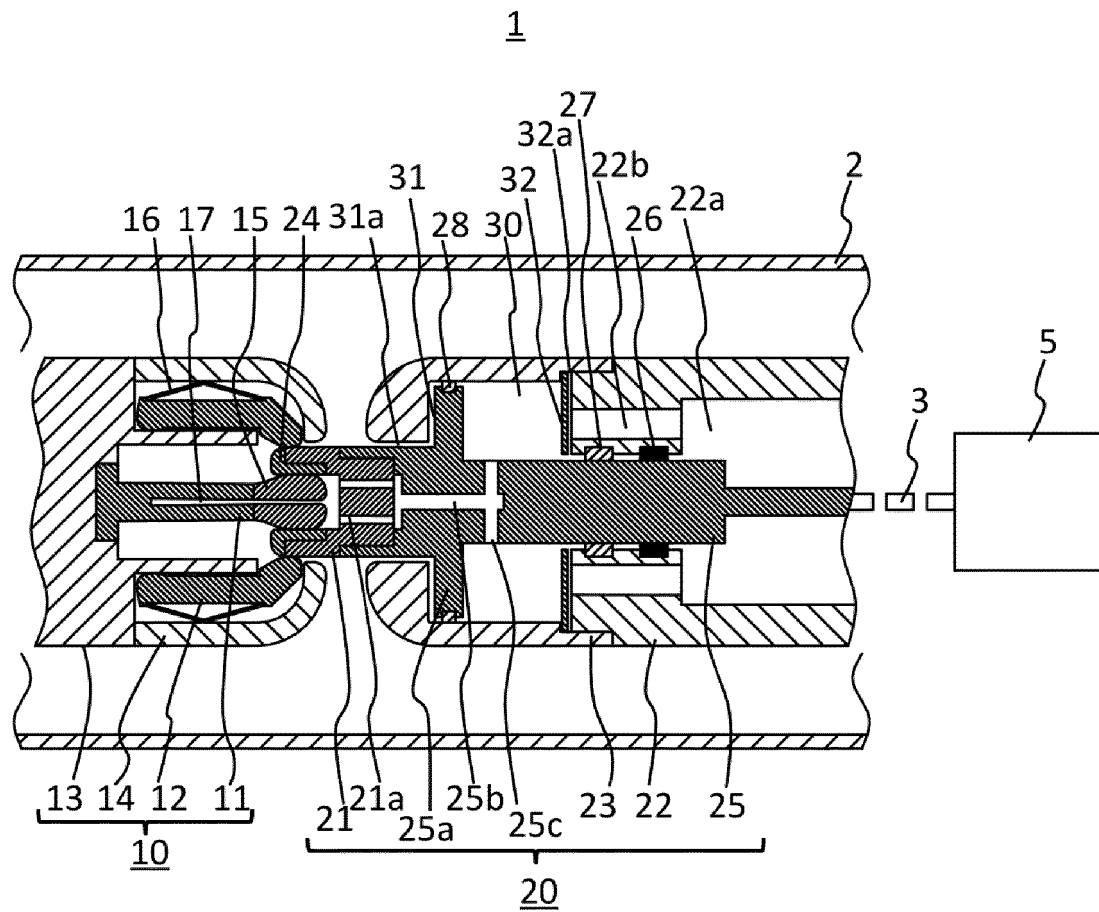


**FIG. 1**

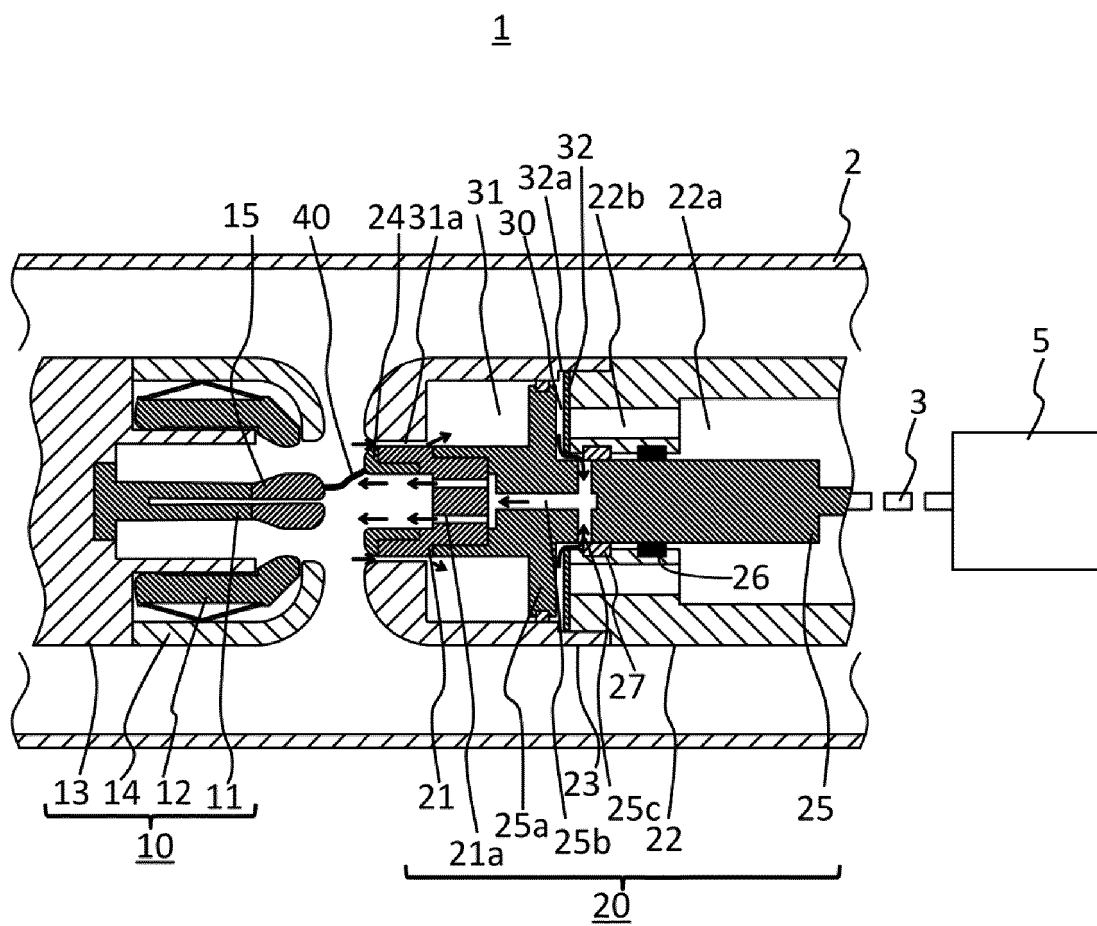


**FIG. 2**

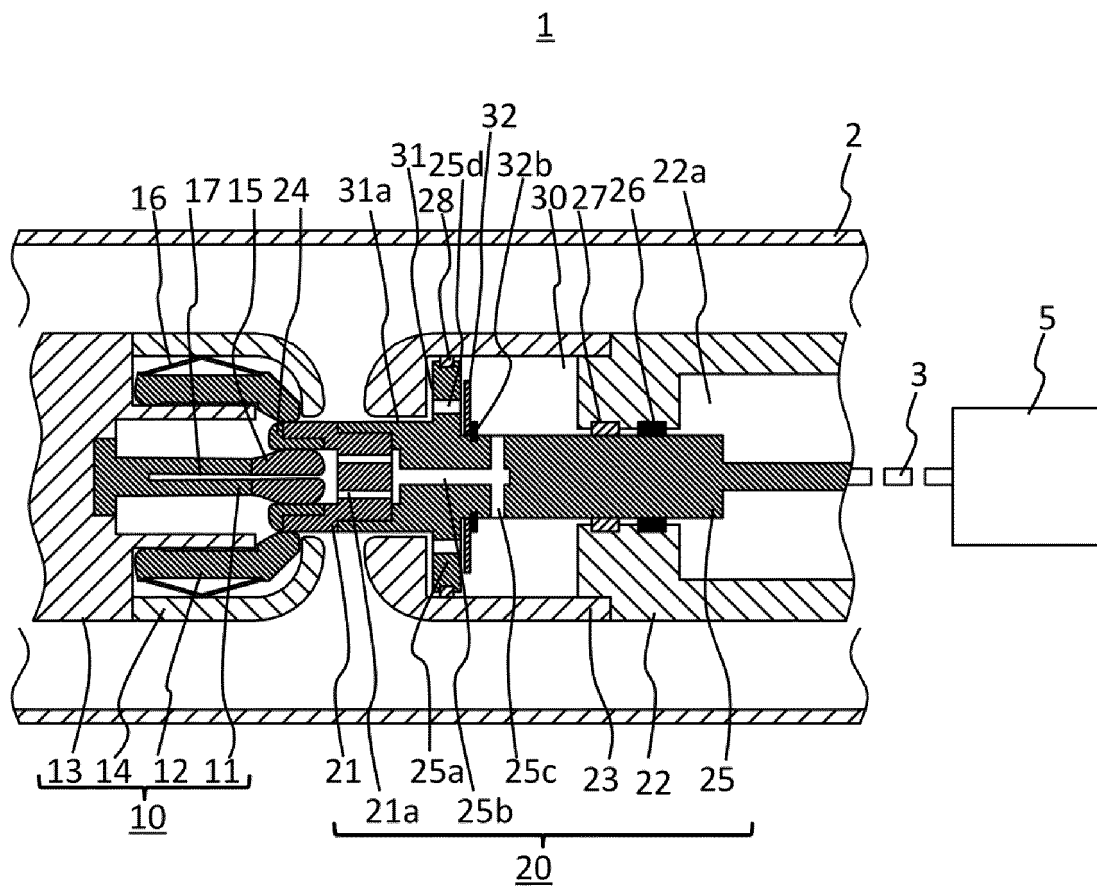




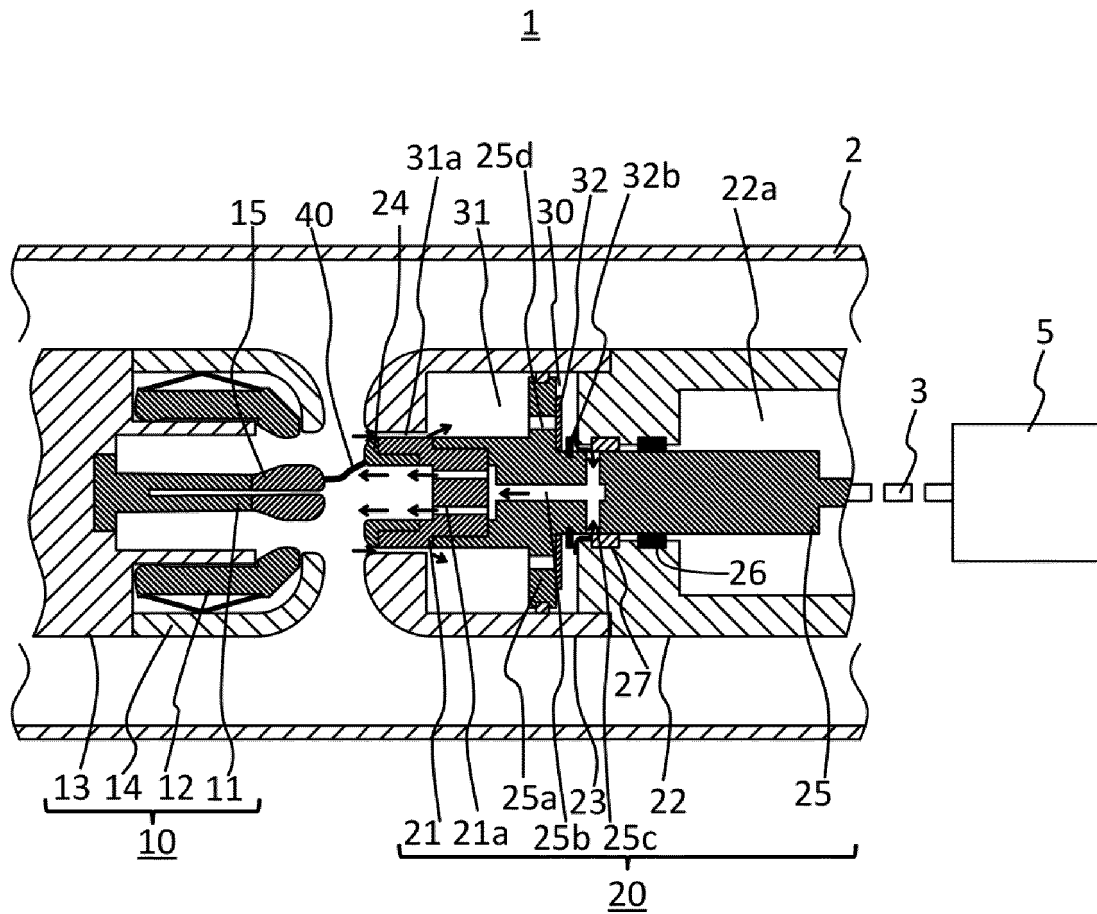
**FIG. 3**



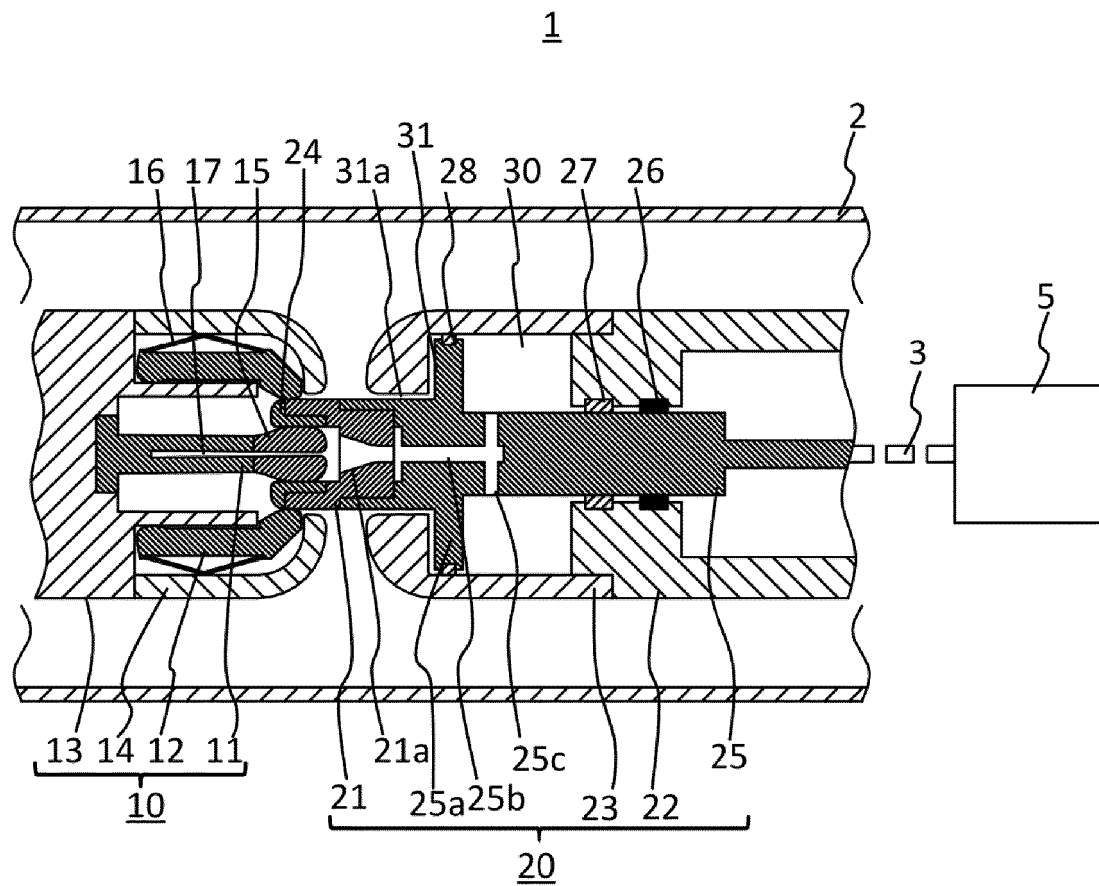
**FIG. 4**



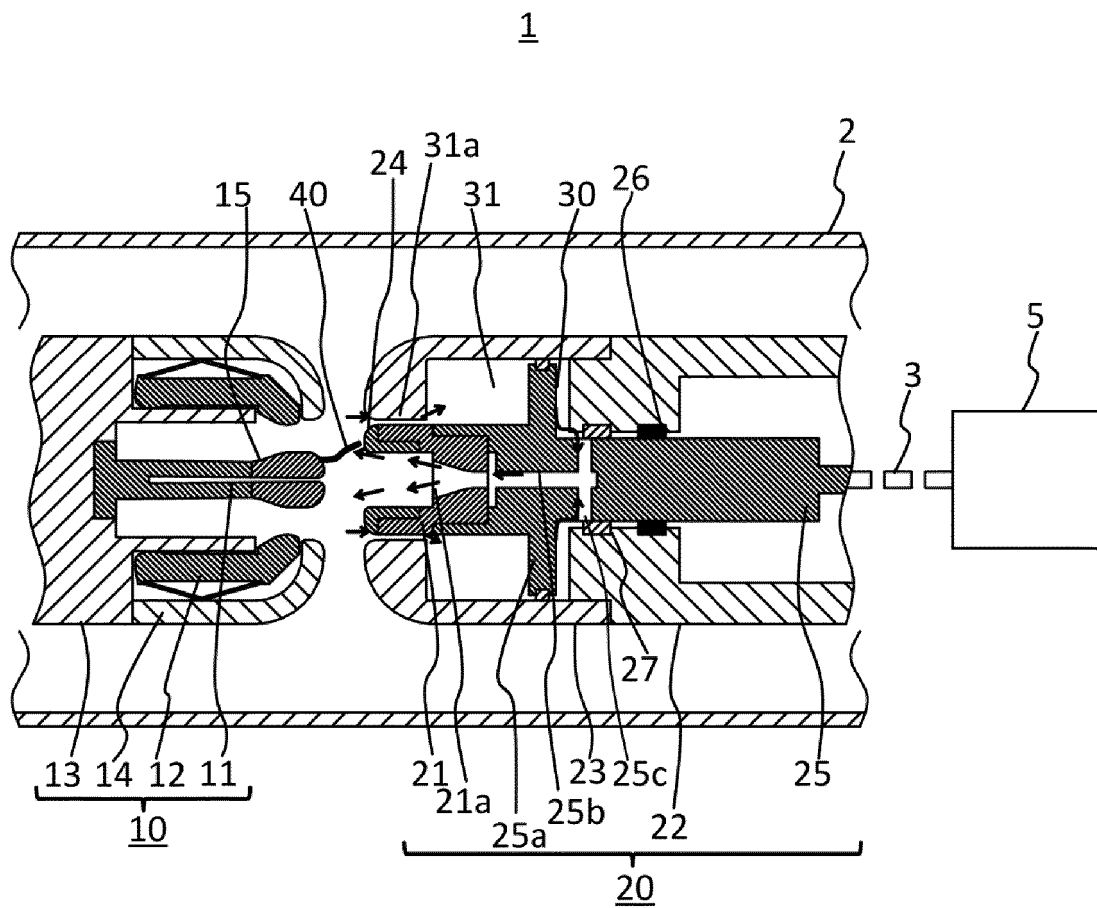
**FIG. 5**



**FIG. 6**



**FIG. 7**



**FIG. 8**

**REFERENCES CITED IN THE DESCRIPTION**

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