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(54) **Circuit breaker using arc contact**

(57) A circuit breaker is disclosed, which has a resistor interposed in an arc contact to make a small breaking current flow, to facilitate breaking a fault current and to facilitate insulation recovery after breaking the fault current so that a breaking performance can be ultimately enhanced. A cylinder is filled with an arc-extinguishing gas. A fixed main contact is formed in the cylinder. A movable main contact is connected to the fixed main contact to form a first current path and then is separated from

the fixed main contact for breaking a fault current at the time of detecting the fault current. A fixed arc contact is formed in the cylinder and has a resistor interposed between a body and a tip of the fixed ac contact for reducing the fault current. A movable arc contact is connected to the fixed arc contact to form a second current path so that the movable arc contact is in contact with the resistor of the fixed arc contact and then is separated from the fixed arc contact for reducing the fault current at the time of detecting the fault current.

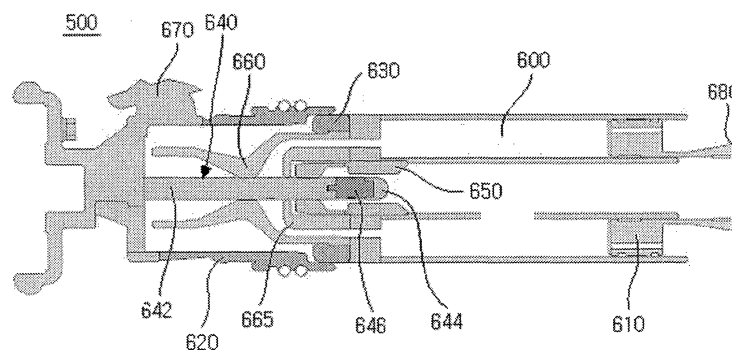


Fig. 6

Description

Field of the Invention

[0001] The present invention relates to a circuit breaker, and in particular, to a circuit breaker employing an arc contact with a resistor interposed, which automatically reduces a magnitude of a current to be interrupted in a procedure of breaking a fault current.

Background of the Related Art

[0002] When a fault occurs in a system, a circuit breaker is employed to break the fault current in order to protect the system and various power apparatuses.

[0003] FIGS. 1 to 4 are diagrams illustrating operations of breaking the fault current of a conventional circuit breaker, wherein FIG. 1 is a diagram illustrating a current path in a normal state, FIG. 2 is a diagram illustrating a current path at the time that a main contact is separated in a fault state, FIG. 3 is a diagram illustrating a current path at the time that an arc occurs after an arc contact is separated in a fault state, and FIG. 4 is a diagram illustrating the case that a fault current is interrupted and a transient recovery voltage is applied to succeed in breaking the fault current.

[0004] FIG. 5 is a diagram illustrating an operation of breaking the fault current of a conventional circuit breaker at the time that a fault occurs over time.

[0005] When a power system is in a normal state, a current path flowing in a circuit breaker 100 is usually divided into a path flowing through main contacts (1 and 2) and a path flowing through an arc contact and is combined in an outlet 11.

[0006] Referring to FIG. 2, at the time that a fault occurs in a system which has been in a normal state (i.e., ③ of FIG. 5), the circuit breaker 100 detects a fault current greater than a rated current and starts to break the fault current. In order to break the fault current, a main contact 2, a main nozzle 3, a second nozzle 4, a movable arc contact 6, and a compression cylinder 7, which are a movable unit, move first. As the movable units move, the fixed and movable main contacts 1 and 2 are first separated, and then only a current path through the fixed and movable arc contacts 5 and 6 is left as shown in FIG. 2.

[0007] As the movable units continue to move, the fixed and movable arc contacts 5 and 6 are even separated at the time ⑥ of FIG. 5, and an arc occurs between the fixed and movable arc contacts 5 and 6 (see FIG. 3). In addition, as the movable units move, an insulation gas (usually SF₆ gas) within the compression cylinder 7 is compressed to be blasted as an arc. At the time ⑦ of FIG. 5, the compressed gas is finally blasted to an arc. The arc will be cooled and extinguished by the compressed gas flow. As soon as the current is interrupted, a transient recovery voltage (TRV) is applied between the fixed and movable arc contacts 5 and 6, and breaking the current is successful when the insulation perform-

ance between the fixed and movable arc contacts 5 and 6 is good as shown in FIG. 4, otherwise a dielectric breakdown occurs to cause failure to break the current.

[0008] As described above, the breaking performance of the circuit breaker 100 is absolutely determined by the magnitude of the breaking current. An arc energy (which is denoted as a product of a breaking current and an arc voltage) is determined by the magnitude of the breaking current, and a stain of the insulation gas between the fixed and movable arc contacts 5 and 6 is determined by the arc energy. Consequently, the smaller the breaking current is, the easier breaking the current is, and the stain between the fixed and movable arc contacts 5 and 6 is small so that dielectric recovery can be easily implemented. However, it is almost impossible to reduce the magnitude of the breaking current using the existing circuit breaker 100 itself.

SUMMARY OF THE INVENTION

[0009] The present invention is directed to a circuit breaker employing an arc contact with a resistor interposed, which inserts a resistor into an arc contact to make a small breaking current flow, to facilitate breaking the current and to facilitate dielectric recovery after the current is interrupted so that a breaking performance can be ultimately enhanced.

[0010] One aspect of the present invention is to provide a circuit breaker, which comprises: a cylinder filled with an arc-extinguishing gas; a fixed main contact formed in the cylinder; a movable main contact connected to the fixed main contact to form a first current path and separated from the fixed main contact for breaking a fault current at the time of detecting the fault current; a fixed arc contact formed in the cylinder and having a resistor interposed between a body and a tip of the fixed arc contact for reducing the fault current; and a movable arc contact connected to the fixed arc contact to form a second current path so that the movable arc contact is in contact with the resistor of the fixed arc contact and then is separated from the fixed arc contact for reducing the fault current at the time of detecting the fault current.

[0011] Preferably, the magnitude in decrease of the fault current is determined by the specific resistance of the resistor. More preferably, the resistor is made of germanium, and the length of the resistor is determined based on an operating speed of the circuit breaker and a target point of time of breaking the fault current. Most preferably, the contact length between the resistor and the movable arc contact is determined based on a spaced distance between the main contacts.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and togeth-

er with the description serve by way of example only to explain the principle of the invention. In the drawings;

[0013] FIGS. 1 to 4 are diagrams illustrating operations of breaking a fault current of a conventional circuit breaker.

[0014] FIG. 5 is a diagram illustrating an operation of breaking a fault current of a conventional circuit breaker at the time that a fault occurs on a time basis.

[0015] FIG. 6 is a configuration diagram illustrating a circuit breaker employing an arc contact with a resistor interposed in accordance with embodiments of the present invention.

[0016] FIG. 7 is an enlarged diagram illustrating a fixed arc contact having a resistor shown in FIG. 6.

[0017] FIGS. 8 to 12 are diagrams illustrating operations of a circuit breaker employing an arc contact with a resistor interposed in accordance with embodiments of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0018] Hereinafter, a circuit breaker employing an arc contact with a resistor interposed according to embodiments of the present invention will be described in detail with reference to accompanying drawings.

[0019] FIG. 6 is a configuration diagram illustrating a circuit breaker 500 employing an arc contact with a resistor interposed in accordance with embodiments of the present invention. The circuit breaker includes a cylinder 600, a fixed main contact 620, a movable main contact 630, a fixed arc contact 640, and a movable arc contact 650.

[0020] The cylinder 600 is filled with an arc-extinguishing gas. The fixed main contact 620 is formed in the cylinder 600. The movable main contact 630 is connected to the fixed main contact 620 to form a first current path and is separated from the fixed main contact 620 for breaking a fault current at the time of detecting the fault current. A reference numeral 610 denotes a piston.

[0021] FIG. 7 is an enlarged diagram illustrating a fixed arc contact having a resistor shown in FIG. 6. The fixed arc contact 640 is formed in the cylinder 600 and has a resistor 646 interposed between the body 642 and the tip 644 of the fixed arc contact 640 for reducing the fault current. When the body 642 of the fixed arc contact 640 is made of an Cr-Cu alloy usually having a specific resistance of $2 \times 10^{-6} \Omega\text{m}$, the tip 644 is made of a W-Cu alloy usually having a specific resistance of about $5 \times 10^{-6} \Omega\text{m}$ and the resistor 646 is made of germanium having a specific resistance of about $1.0 \Omega\text{m}$, it is theoretically more difficult for the current to flow by about 1,000,000 times in comparison with the case where the resistor 646 is made of other materials than germanium.

[0022] The movable arc contact 650 is connected to the fixed arc contact 640 to form a second current path so that it is in contact with the resistor 646 of the fixed arc contact 640, and then is separated from the fixed arc

contact 640 for reducing the fault current at the time of detecting the fault current.

[0023] The magnitude in decrease of the fault current is determined by the specific resistance of the resistor 646. The resistor 646 is preferably made of germanium having a specific resistance of $1.0 \Omega\text{m}$. The length L_r of the resistor 646 is determined based on the operating speed and the target point of time of breaking the current of the circuit breaker. For example, when the current frequency is 60Hz, the operating speed of the circuit breaker is 5m/s and an effect of obtaining the decrease in current by a half period until the arc contact is separated is desired, the half period is 8.3ms so that L_r becomes 41.5mm ($= 8.3\text{ms} \times 5\text{m/s}$). The contact length between the resistor 646 and the movable arc contact 650 is determined based on a spaced distance between main contacts.

[0024] FIGS. 8 to 12 are diagrams illustrating operations of a circuit breaker employing an arc contact with a resistor 646 interposed in accordance with embodiments of the present invention, wherein FIG. 8 is a current path diagram in a normal state, FIG. 9 is a current path diagram at the time that the main contacts are separated in a fault state, FIG. 10 is a current path diagram before the arc contacts are separated in a fault state, FIG. 11 is a current path diagram at the time of generating an arc after the arc contacts are separated in a fault state, and FIG. 12 is a diagram illustrating the case that a fault current is successfully interrupted by applying a transient recovery voltage.

[0025] Referring to FIG. 8, the current path where the current flows in the circuit breaker through the inlet 670 is divided into a path through the fixed and movable main contacts 620 and 630, and a path through the fixed and movable arc contacts 640 and 650, and then is combined in an outlet 680 as shown in FIG. 8. That is, the current path in a normal state is the same as that in the conventional circuit breaker. To summarize this, currents do not flow through the fixed and movable main contacts 620 and 630 and the resistor 646, but have a path through the fixed and movable arc contacts 640 and 650.

[0026] Referring to FIG. 9, the circuit breaker has the same current path as the conventional circuit breaker shown in FIG. 1 until right after main contacts are separated. That is, when the fault occurs in the system which has normally operated (point of time © of FIG. 13), the circuit breaker 500 detects the fault current greater than a rated current and starts to break the fault current. In order to break the fault current, the compression cylinder 600, the movable main contact 630, the movable arc contact 650, the main nozzle 660, and the second nozzle 665, which are a movable unit, move first. As the movable unit moves, the fixed and movable main contacts 620 and 630 are then separated, so that only the current path through the fixed and movable arc contacts 640 and 650 is left as shown in FIG. 8. By doing so, the fixed and movable main contacts 620 and 630 can be prevented from being possibly damaged.

[0027] Referring to FIG. 10, at the point of time © of

FIG. 13, the movable arc contact 650 starts to be in contact with the resistor 646 so that the current path must be through the resistor 646. The current flowing through the resistor 646 will start to decrease and the magnitude of the decrease in current (I of FIG. 13) is determined by the specific resistance of the resistor 646.

[0028] Referring to FIG. 11, the arc to be generated between the arc contacts will be significantly small even when the fixed and movable arc contacts 640 and 650 are separated from each other because the current flowing through the resistor 646 is very small. Therefore, the small current leads to small arc energy, and the small arc energy leads to significantly reduced loss of the insulation gas between arc contacts.

[0029] Referring to FIG. 12, the fault current is interrupted at the point of time © of FIG. 13 and the insulation gas loss is significantly small even when a transient recovery voltage is applied thereto, so that insulation performance between arc contacts is significantly enhanced in comparison with the conventional circuit breaker 100 thereby facilitating insulation recovery.

[0030] FIG. 13 is a diagram illustrating a fault current interrupted by the circuit breaker of the present invention at the time that a fault occurs (on a time axis).

[0031] The present invention allows a breaking current to be reduced in itself and automatically during an operation of a circuit breaker. In addition, an arc generated by the reduced breaking current is small, and arc energy is also small to have a small loss of an insulation gas between arc contacts. Further, the loss of the insulation gas between the arc contacts is small so that a decrease in insulation performance can be reduced, and the circuit breaker can significantly stand a transient recovery voltage after a fault current is interrupted. Ultimately, the present invention can remarkably enhance the breaking performance of the circuit breaker.

arated from the fixed arc contact for reducing the fault current at the time of detecting the fault current.

- 5 2. The circuit breaker according to claim 1, wherein the magnitude in decrease of the fault current is determined by a specific resistance of the resistor.
- 10 3. The circuit breaker according to claim 1, wherein the length of the resistor is determined based on the operating speed of the circuit breaker and a target point of time of breaking the fault current.
- 15 4. The circuit breaker according to claim 1, wherein the contact length between the resistor and the movable arc contact is determined based on a spaced distance between the main contacts.
- 20 5. A circuit breaker employing an arc contact with a resistor interposed.

Claims

- 40 1. A circuit breaker employing an arc contact with a resistor interposed, comprising:

a cylinder filled with an arc-extinguishing gas;
a fixed main contact formed in the cylinder;
a moveable main contact, connected to the fixed
main contact to form a first current path and separated from the fixed main contact for breaking
a fault current at the time of detecting the fault
current;

a fixed arc contact formed in the cylinder and having a resistor interposed between body and tip of the fixed arc contact for reducing the fault current; and

a moveable arc contact connected to the fixed arc contact to form a second current path so that the moveable arc contact is in contact with the resistor of the fixed arc contact and then is sep-

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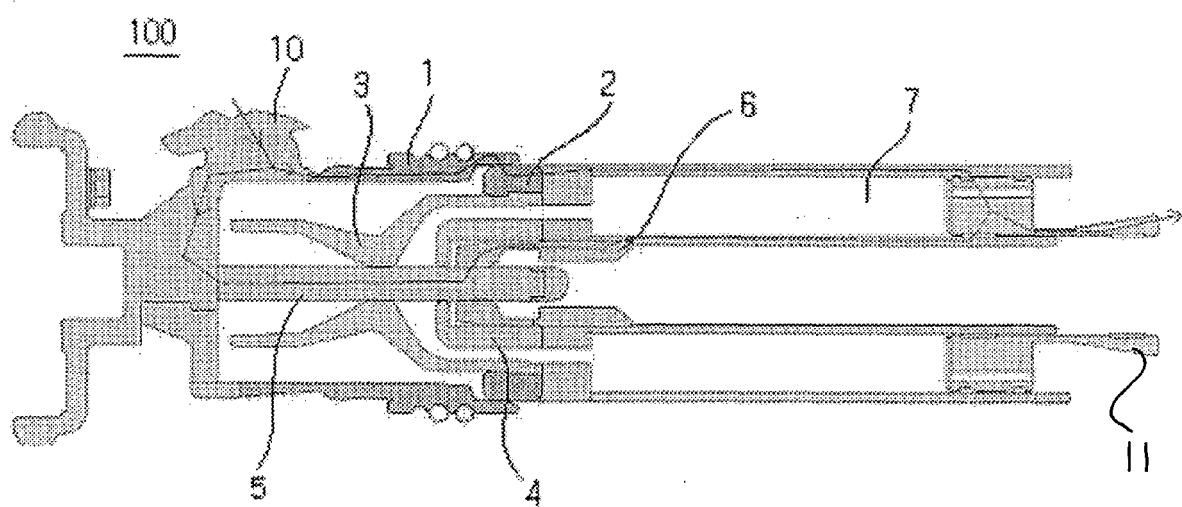


Fig. 1

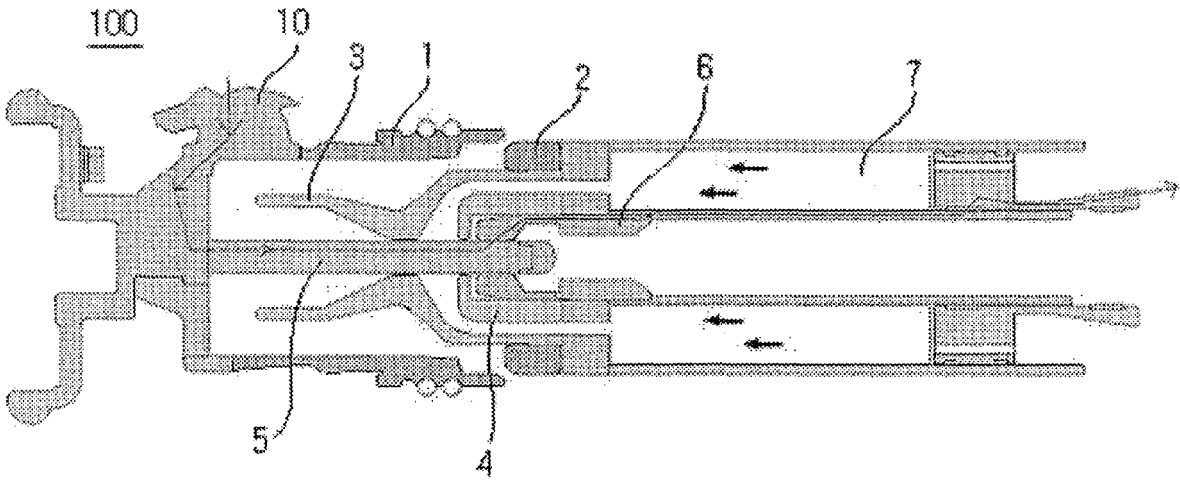


Fig. 2

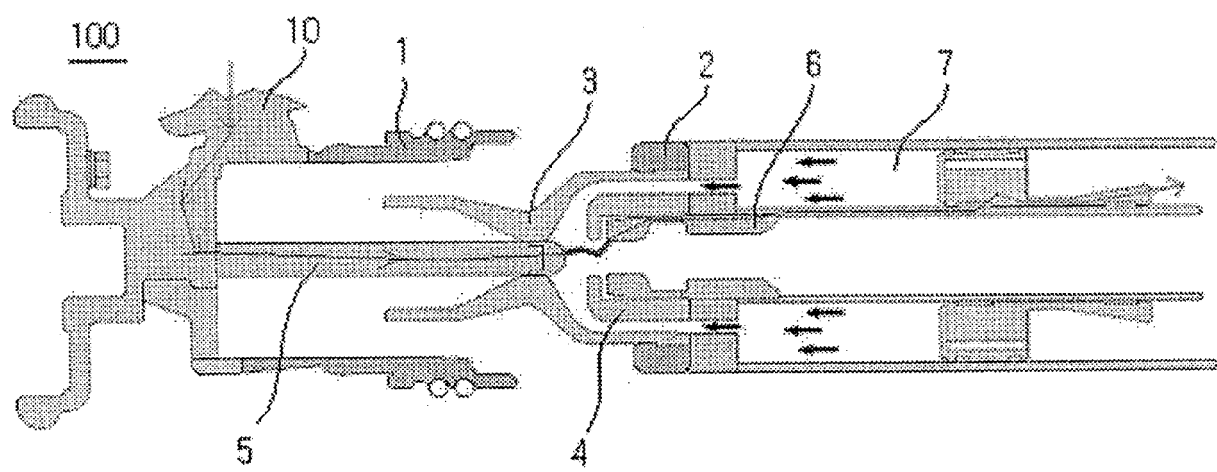


Fig. 3

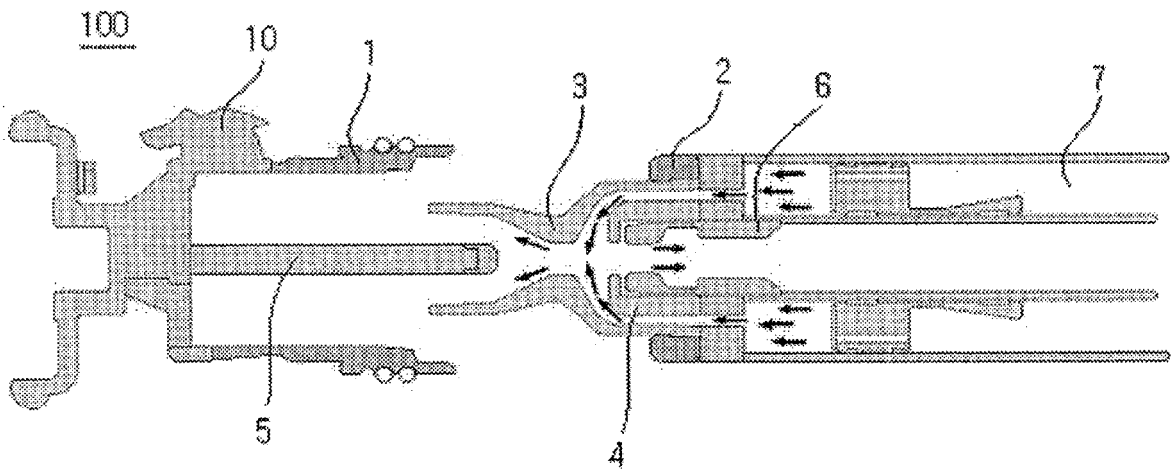


Fig. 4

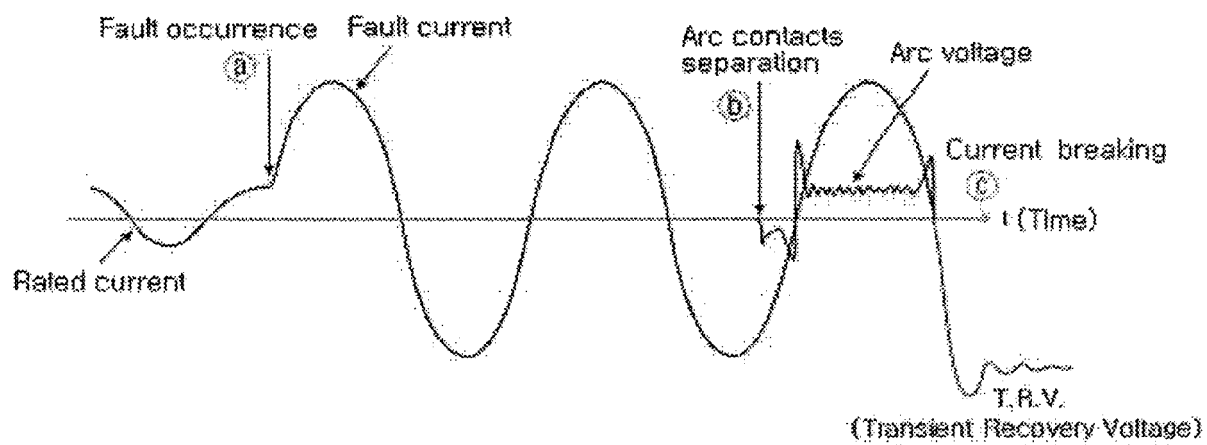


Fig. 5

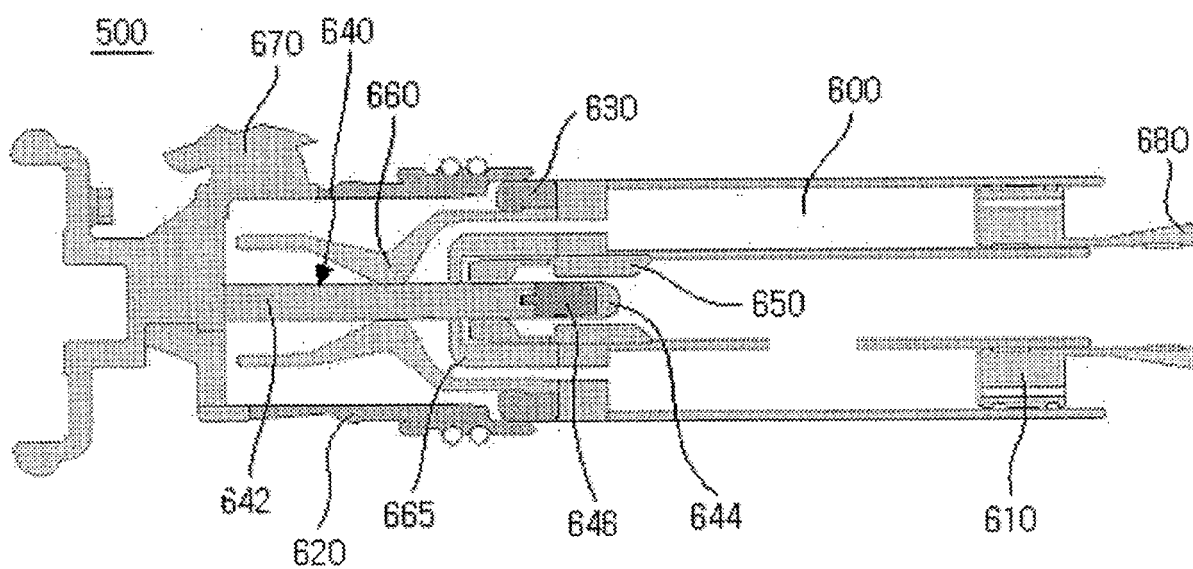


Fig. 6

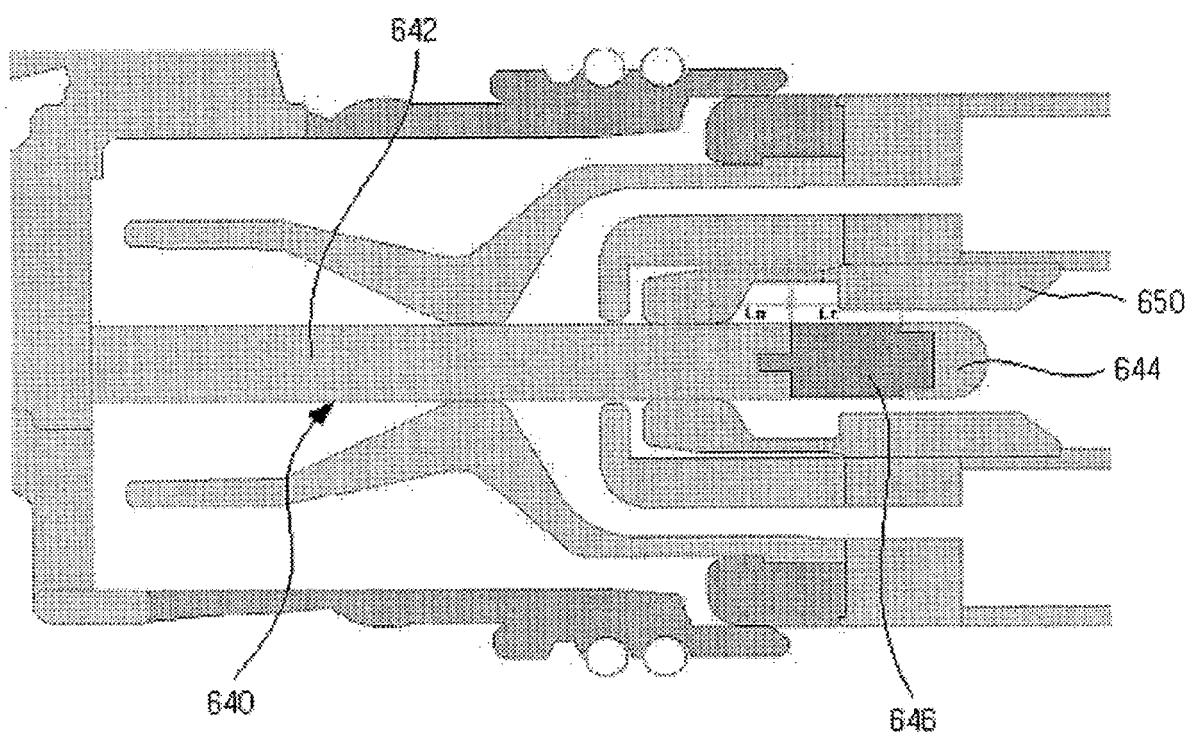


Fig. 7

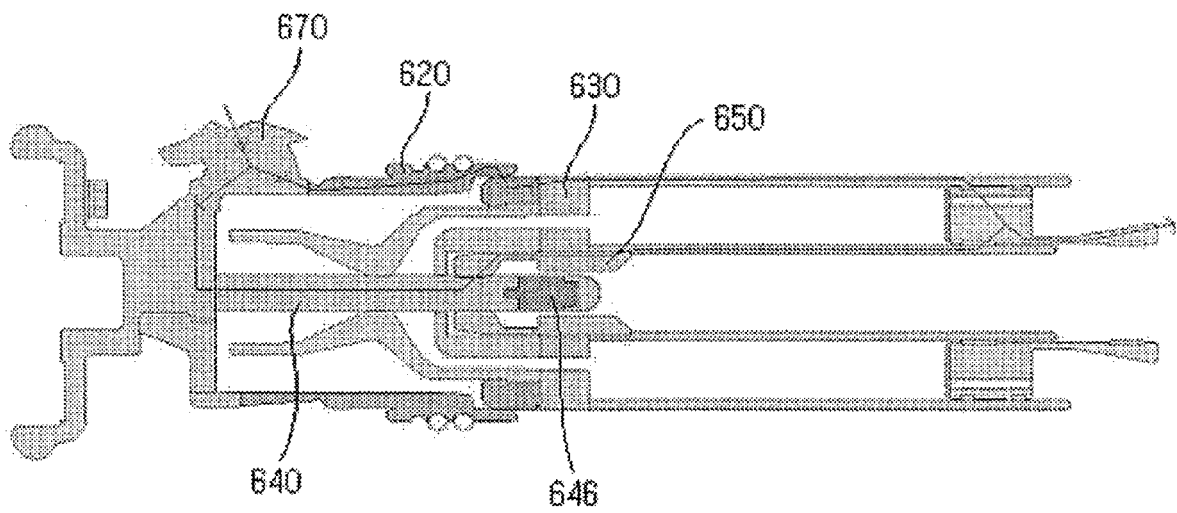


Fig. 8

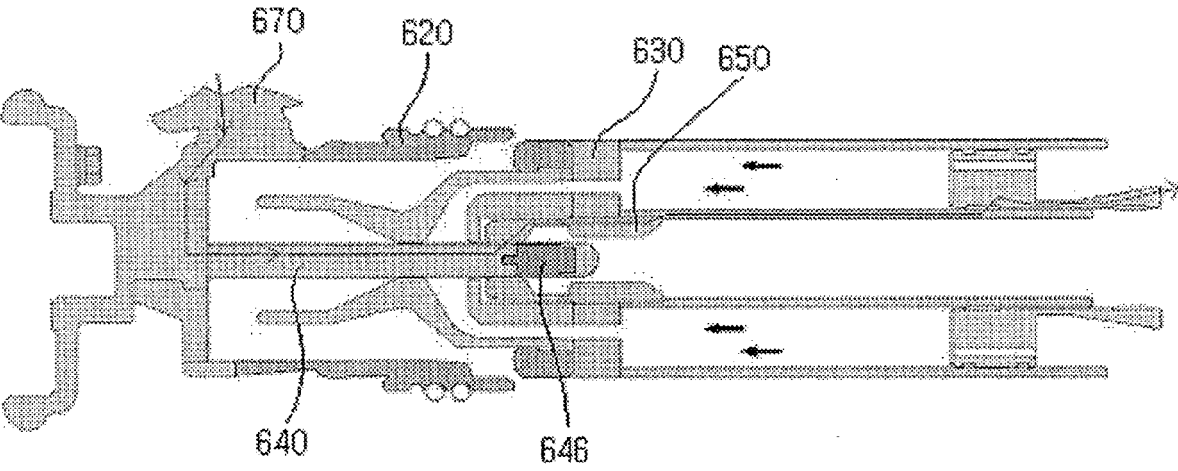


Fig. 9

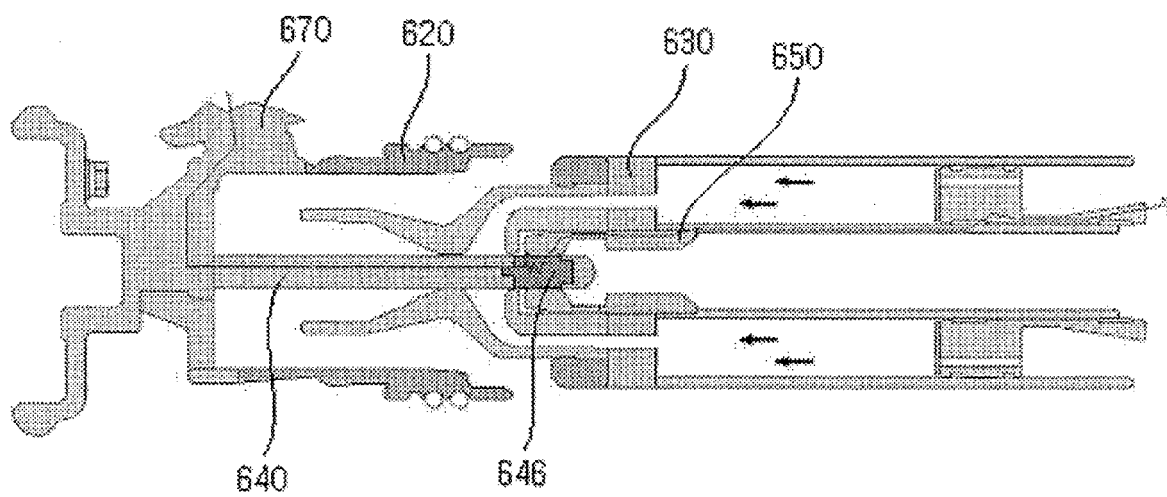


Fig. 10

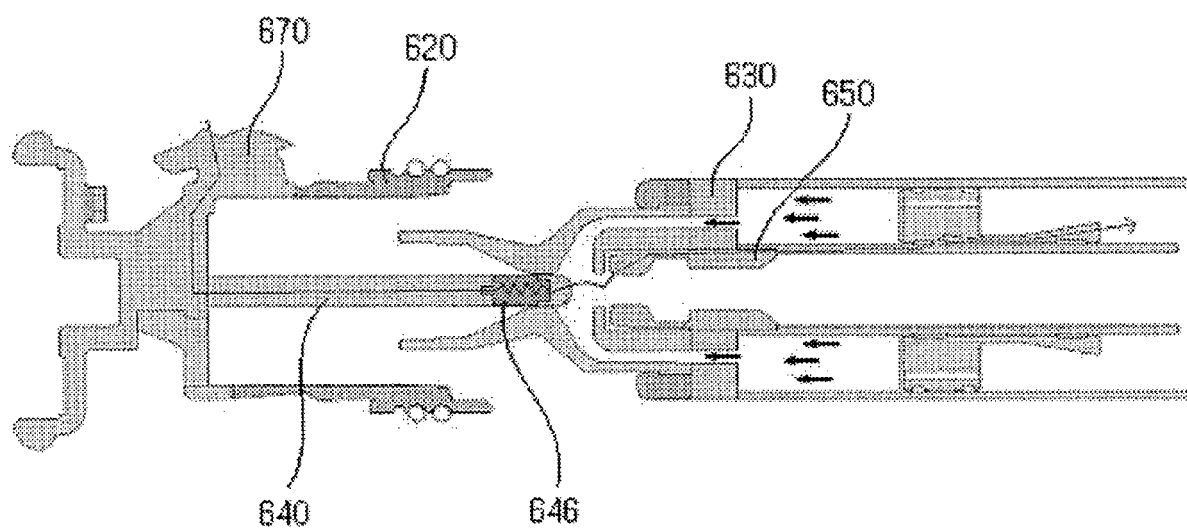


Fig. 11

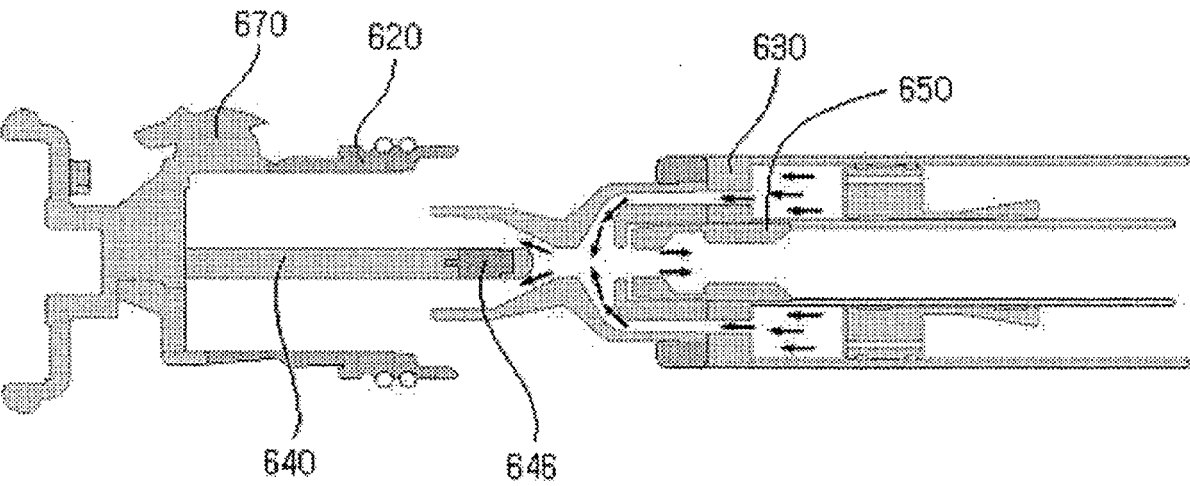


Fig. 12