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(54) **Circuit breaker drive**

(57) According an exemplary embodiment of the invention, a driving unit for an electric circuit breaker is provided, which comprises an expansion chamber and a reciprocating piston as well as a supply for supplying

a driving fluid to the expansion chamber. The driving fluid expands rapidly after occurrence of a triggering event thus driving the piston in order to switch the circuit breaker.

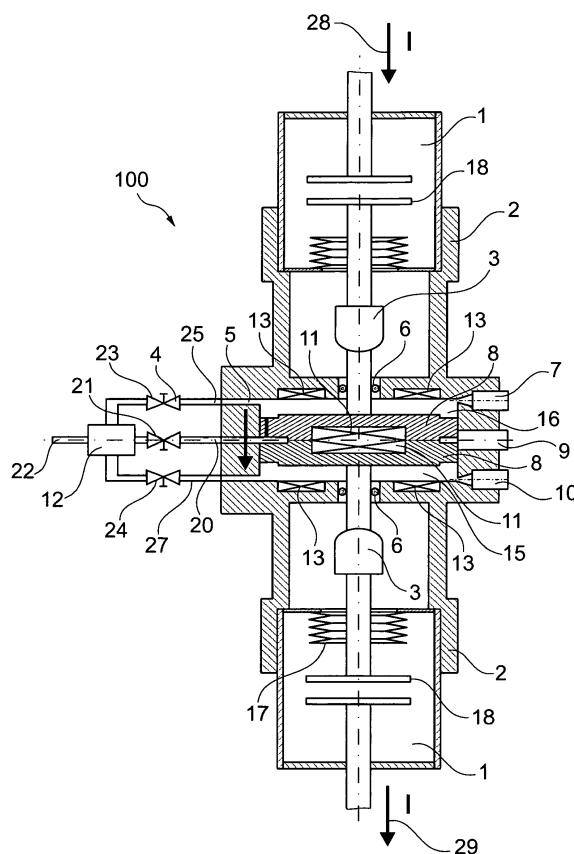


Fig. 1

Description

Field of the invention

[0001] The present invention relates to low voltage, medium voltage and high voltage switches and generator switches comprising pole units having vacuum interrupters, air interrupters or SF6 interrupters. In particular, the present invention relates to a driving unit for driving an electric circuit breaker, a power switch comprising such a driving unit, an electric power plant comprising such a power switch and a method for driving an electric circuit breaker.

Technological background of the invention

[0002] Switching on and switching off of a medium or high power circuit is performed with the help of mechanical, hydraulic or magnetic switches. The energy necessary for switching is either stored/provided mechanically or electrically. Furthermore, such switches may also be switched by hand.

[0003] Medium- and high-voltage breakers often comprise an insulating casing in which there is an interruption chamber with interruption mechanisms constituted by at least one fixed contact and at least one moving contact. Opening/closing manoeuvres of the circuit breaker are performed by engaging or disengaging the fixed contacts with respect to the moving contacts by using actuation devices. Such circuit breakers may be used in electric plants, such as switching stations, for breaking the power when necessary. A circuit breaker must be able to break and close normally power loads, and it must in particular be capable of rapidly breaking the short-circuit current arising when a fault occurs in the system. A circuit breaker's main components are the breaker chamber and the system for operating the chamber. Breaking and closing the current is achieved through contacts in the breaker chamber in which one is normally stationary and the other is mobile. The mobile contact is brought into contact with/separated from the stationary contact with operating means.

[0004] Control means for a circuit breaker traditionally employ breaking and closing springs storing enough energy for the breaking and closing operations. Triggering can be automatic or by manual action. The function of the closing spring is to close the switch and tension the releasing spring. The releasing spring operates in breaking. The closing spring is often tensioned by an electric motor.

[0005] Alternatively to a spring-operated circuit breaker hydraulic operating circuit breakers or electromagnetically operated circuit breakers may be used.

[0006] It is also possible to operate a circuit breaker by means of a rotating electric motor.

Summary of the invention

[0007] It may be seen as an object of the invention to provide for an alternative fast switching of a power switch, such as a circuit breaker.

[0008] According to a first aspect of the invention a driving unit for driving an electric circuit breaker is provided, the driving unit comprising an expansion chamber, a reciprocating piston and a supply for supplying a driving fluid to the expansion chamber. The driving unit is adapted for triggering an expansion of the driving fluid inside the expansion chamber, wherein the expansion of the driving fluid drives the piston in order to switch the circuit breaker.

[0009] In other words, the mechanical energy for driving the electric circuit breaker is stored inside the driving fluid and can be rapidly released by a particular triggering event, such as an ignition of the fluid.

[0010] The driving fluid can be a liquid, a gas, a gas mixture, or may comprise both a liquid and a gas or gas mixture.

[0011] According to another aspect of the invention, a power switch comprising an above and below described driving unit is provided.

[0012] According to another aspect of the invention, an electric plant comprising the above and below power switch is disclosed.

[0013] Furthermore, according to another aspect of the invention, a method for driving an electric circuit breaker is provided, in which a driving fluid is supplied to an expansion chamber of a driving unit of an electric circuit breaker. After that, an expansion of the driving fluid is triggered inside the expansion chamber and a piston of the driving unit is driven by expansion of the driving fluid, thereby switching the circuit breaker.

[0014] According to an exemplary embodiment of the invention, the driving fluid is a gas mixture which comprises oxygen gas and hydrogen gas for example in a ratio one part O₂ and two parts H₂.

[0015] According to another exemplary embodiment of the invention, the driving unit further comprises an ignition device, wherein triggering of the expansion of the driving fluid comprises an ignition of the driving fluid by the ignition device.

[0016] The ignition device comprises, according to another exemplary embodiment of the invention, a heatable filament, a laser diode and/or a (high power) light emitting diode.

[0017] According to another exemplary embodiment of the invention, the supply comprises a driving fluid generator for providing the driving fluid.

[0018] In case the driving fluid is a hydrogen gas/oxygen gas mixture, the driving fluid generator may be adapted in form of an electrolysis cell.

[0019] According to another exemplary embodiment of the invention, the driving fluid circulates in a closed circuit.

[0020] In other words, the driving fluid generator can

be adapted for receiving the driving fluid in a state (or composition) which the driving fluid has assumed after driving the piston. The driving fluid generator then changes this state into another state in which the driving fluid is able to expand rapidly and thus drive the piston. For example, in the case of H_2 and O_2 as driving fluid, the driving fluid generator, i.e. the electrolysis cell, may be fed by water and may then convert the water into hydrogen and oxygen gas. After the gas has been ignited and thus reacted to form water, the water is again fed into the electrolysis cell.

[0021] According to another exemplary embodiment of the invention, the power switch is adapted as an electric circuit breaker for medium or high voltages, in particular for voltages above 1.000 V.

[0022] According to another exemplary embodiment of the invention, the power switch comprises an interrupter, wherein the first driving unit of the power switch is adapted for driving the interrupter.

[0023] According to another exemplary embodiment of the invention, the first driving unit is adapted for switching the interrupter either on or off.

[0024] According to another exemplary embodiment of the invention, the power switch further comprises a second driving unit for switching the interrupter either off or on.

[0025] According to another exemplary embodiment of the invention, the power switch comprises an energy storage unit for storing mechanical energy for switching the interrupter either off or on. In this case, no second driving unit may be necessary.

[0026] It should be noted that the power switch may be adapted for driving the piston by driving fluid expansion on one side or even, selectively, on both sides of the piston. In the latter case, the piston can be driven reciprocatingly by the driving fluid. The power switch can be adapted for a single phase or for a three-phase switching unit. The switched-on and/or the switched-off state can be kept by means of a holding device (for example a permanent magnet) until the piston is driven in an opposite direction.

[0027] Furthermore, two or more reciprocating pistons can be arranged, for example facing each other, inside one expansion chamber. The pistons are then driven synchronously.

[0028] The driving fluid may be provided from outside the driving unit, i.e. the supply may be an external supply.

[0029] However, the supply may also be integrated inside the driving unit or inside the power switch, and may even be integrated inside or close to the expansion chamber. Thus, no supply lines are needed for supplying the driving fluid to the expansion chamber. In case hydrogen and oxygen gases are used as driving fluid, the water or water vapour which results from the reaction of O_2 with H_2 can be stored inside a porous material. Such a porous material can comprise ceramics, plastic and/or metal or a metal composition.

[0030] For providing the driving fluid, i.e. for switching

the circuit on and off, only one electrolysis cell may be used. For driving the piston in the opposite direction, energy is used which has been stored when the piston has been driven initially in the first direction.

[0031] The driving fluid can be ignited by means of a heatable filament or a spark or by means of light, for example focused light, light from a light emitting device or a laser diode.

[0032] Hand-mode operation can be single phase or by means of a three phase coupling of such units. In case, all three phases are driven by the driving fluid, the hand-mode operation can be for all those three phases.

[0033] In order to hold the piston and thus the electric circuit breaker in either a switched-on state or a switched-off state a mechanic locking device or permanent magnets can be used.

[0034] Furthermore, the vacuum interrupter chamber or the SF6-switching-pole can be moulded into a duroplast, a cast resin, a rubber elastic material, such as silicon or PUR (polyurethane) or a thermoplast, such as, for example, PET (Polyethylene terephthalate) or PA (polyamide) in order to provide for sufficient dielectric stability.

[0035] Furthermore, the power switch may also comprise a fast grounding system, for example on the side where the current leaves the switch.

[0036] These and other aspects of the present invention will become apparent from and elucidated with reference to the embodiments described hereinafter.

[0037] Exemplary embodiments of the present invention will be described in the following, with reference to the following drawings.

Short description of the drawings

[0038]

Fig. 1 shows a power switch according to an exemplary embodiment of the present invention in an off-state.

Fig. 2 shows the power switch of Fig. 1 in an on-state.

Fig. 3 shows a power switch in an off-state according to another exemplary embodiment of the present invention.

Fig. 4 shows an electric plant according to an exemplary embodiment of the present invention.

Fig. 5 shows a flow-chart of a method according to an exemplary embodiment of the present invention.

Detailed description of exemplary embodiments

[0039] The illustration in the drawings is schematically. In different drawings, similar or identical elements are provided with the same reference numerals.

[0040] Fig. 1 shows a power switch 100 according to an exemplary embodiment of the invention. It should be noted that the power switch 100 can be used as an alternative or additionally to already known switches. An advantage of the power switch according to an aspect of the invention may be that the size of the switch is considerably reduced as compared to other switches. Furthermore, the driving unit according to the invention may also be used for driving to circuit breakers in parallel in a synchronous manner. Several ten thousands of switching operations may be performed with the same switch.

[0041] The small sized power switch 100 can be operated in connection with various mechanical circuits, which are used for short circuit condition, load current condition, rated current condition and/or load-free condition.

[0042] The switch may be integrated into a pole-unit without having the need for a separate, external switch. The compact power switch according to the invention comprises an expansion or combustion chamber 14, 15, 16 which can be filled with a reactive driving fluid, such as an oxygen/hydrogen gas mixture delivered by an electrolysis cell or a separate gas tank or multiple separate gas tanks.

[0043] At both the switch-on side 14 (see Fig. 2) and the switch-off sides 15, 16 an ignition device 9, 7, 10 for triggering the driving fluid expansion is provided, such that the driving fluid can "explode" inside the driving chamber. The two pistons 8 can move reciprocatingly in opposite directions with respect to each other.

[0044] In case of a two-line switching arrangement (double interrupter chamber, in serial arrangement) triggering of the driving fluid expansion (i.e. ignition) between the pistons can be sufficient for driving the pistons in order to perform a switch-on operation. In order to perform a switch-off operation mechanical springs may be loaded by the switching-on movement of the pistons. The pretension of the springs may then be used for providing the energy necessary for performing the switching-off operation. In this case a mechanical or controlled magnetical blocking of the pistons in the switched-on position may be necessary.

[0045] However, the opposite operation is also possible, in which case the triggering of a driving fluid expansion results in a switching-off operation and some of the energy released by driving fluid expansion can be stored inside one or more mechanical springs, which can then be used for switching-on operation. Again, a locking mechanism is necessary for holding the switch in a switched-off state.

[0046] Furthermore, the switch 100 may also comprise only one piston 8 for driving single line switches.

[0047] In case an electrolysis cell is used for producing oxygen and hydrogen gas from water, a closed driving fluid cycle can be implemented. The electrolysis cell may be integrated inside or may be provided outside of the expansion chamber. In case the electrolysis cell is located outside the expansion chamber, a valve system may

be provided for delivering the reaction gas (H_2/O_2) to the chamber. Additionally or alternatively a sinter metal system can be used for delivering the driving fluid to the expansion chamber in which case a firewall between electrolysis cell and chamber may be necessary.

[0048] In case an electrolysis cell is used inside or close to the expansion chamber on one or even on both sides of the piston/the pistons, the water can be decomposed and to hydrogen gas and oxygen gas directly inside or next to the expansion chamber. In this case a valve system and/or sinter metal are not necessary.

[0049] As can be seen from Figs. 1 and 2, the electrical power switch 100 comprises a vacuum switching chamber or interruption chamber 1, which comprises a bellows 17. The interruption chamber 1 is fixed by the mounting unit 2 and connected to an explosion switch by the driving rod 3. The driving rod 3 therefore connects the piston 8 with the electrical contact plate 18. A sealing 6 is provided for sealing the gap between the driving rod 3 and the housing 2 used for mounting the interruption chamber 1. The switch 100 further comprises an electrolysis cell 12 for generating the driving fluid. The electrolysis cell 12 is located outside the housing of the switch.

[0050] As can be seen from Figs. 1 and 2, the switch is adapted as a double chamber switch and thus comprises two interruption chambers 1, 2 interruption electrodes 18, two driving rods 3 and two pistons 8, etc.

[0051] Driving fluid is delivered into the area 19 between the two pistons 8 via supply line 20, after valve 21 is opened. After that, the driving fluid is ignited in order to drive the two pistons 8 apart and thus close the circuit.

[0052] The ignition devices 7, 9, 10 may be adapted in form of a heating filaments or light sources, such as diodes or a lasers.

[0053] The electrolysis cell 12 may be adapted for producing the amount of driving fluid necessary for driving the pistons. The amount of gas produced by the electrolysis cell 12 may also be controlled by increasing or reducing water supplied to the cell 12 via supply line 22.

[0054] Furthermore, pressure sensors may be provided which provide pressure data of the driving fluid, which data can be used for controlling the valves 21, 23, 24.

[0055] Valves 23 and 24 are used for opening and closing the supply lines between the electrolysis cell 12 and chambers 15, 16 for driving the two pistons 8 together.

[0056] Instead of valves 21, 23, 24 and supply lines 20, 25, 27 the driving fluid (i.e. the driving gas/gas mixture) can be provided by a sinter metal in which case a fire barrier is provided to stop the flames from reaching the sinter metal. This may have the advantage that a control and a provision of valves 21, 23 and 24 is not necessary, since the supply of driving fluid is performed in an automated manner.

[0057] The possible current flow through the switch 100 is symbolized by arrows 28, 29. In other words, the current enters the device at the top 28 and exits the device at the bottom 29. The pistons 8 can be locked in both end positions (i.e. in both the switched-on state and the

switched-off state) mechanically or magnetically by permanent magnets 11, 13.

[0058] In case a mechanical spring or a hydraulic device is used for storing energy for either switching-on operation or switching-off operation, driving fluid has only to be provided to either chamber 14 between the two pistons 8 or chambers 15 and 16 below and above the two pistons. By feeding the water or water vapour, which is produced by the H_2/O_2 reaction, back into the electrolysis cell 12, a plurality of switching operations can be performed without the need for supplying fresh water through feed line 22.

[0059] In order to control the time for switching, the ignition devices 7, 9, 10 can be controlled accordingly.

[0060] Although Figs. 1 and 2 show a single phase double line switching device, one single driving unit may also be used for driving for example three or more poles.

[0061] Fig. 3 shows a power switch 100 according to another exemplary embodiment of the invention. The power switch 100 comprises a vacuum switching chamber or vacuum interrupter 1, also comprising a bellows 17, a housing 2 for holding the chamber 1 and a driving rod 3, which connects the contact electrode 18 to the piston 307. A gap between the driving rod 3 and the housing 2 is sealed by a sealing ring 6. The explosion switch comprises the piston 307 and two electrolysis cells 305, which are ring-shaped and arranged on either side of the piston 307 induced for generating the driving fluid.

[0062] In order to perform a switch-on operation the driving fluid between the piston 307 and the bottom 310 of the cylindrical housing 311 is ignited. Ignition is performed by the ignition device 309. Again, the ignition device 309 and also the ignition device 306 can be a heating filament or a light source, such as a strong diode or a laser diode.

[0063] Furthermore, a second ignition device 306 is provided for igniting driving fluid generated by electrolysis cell 305 in order to drive the piston 307 downwards for performing a switching-off operation.

[0064] As in the embodiment depicted in Figs. 1 and 2, permanent magnets 304, 308 are provided for holding the switch in a switched-on or a switched-off position.

[0065] As in the embodiment depicted in Figs. 1 and 2, a mechanical spring or a hydraulic device can be used for storing mechanical energy in order to perform a switching-on operation or a switching-off operation, in which case only one electrolysis cell (or driving fluid supply) and only one ignition device 309 or 306 is necessary.

[0066] Fig. 4 shows an electric plant 200 comprising at least one power switch 100 as described above.

[0067] Fig. 5 shows a flow-chart of a method according to the invention. In step 501 a driving fluid is applied to an expansion chamber of a driving unit of an electrical circuit breaker and in step 502 the driving fluid is ignited, thus triggering an expansion of the driving fluid inside the expansion chamber (step 503). In step 504 the driving piston of the driving unit is driven by the expansion of the driving fluid, thereby switching the circuit breaker from a

switched-on state into a switched-off state.

[0068] In step 505, driving fluid is supplied to the expansion chamber, but this time on another side of the driving piston. In step 506 the driving fluid is ignited, which results to an expansion of the driving fluid and thus to a movement of the piston in the opposite direction, which results to a switching-on of the circuit breaker (step 507).

[0069] Thus, a very compact system for driving a circuit breaker for medium or high voltage is provided. The system is able to drive a vacuum interrupter as well as SF₆ interrupter and uses the explosion of detonating gas ($2H_2 + O_2$) as operating power. For this the detonating gas, produced for example by a water electrolysis cell in the correct stoichiometric ratio is filled in an expansion chamber comprising a reciprocating piston. The gas is ignited by a filament or by focused light from a laser diode or a high power light emitting diode. Different arrangements of the drive are possible. Besides a system with a single piston driving one or three interrupters in parallel (Fig. 3) the arrangement of a double piston driving two interrupters in opposite directions is possible (Figs. 1 and 2). As the two pistons work very synchronously, it is possible to drive two interrupters in series for a high voltage application. The resulting drive is compact and cost-effective. In principle it is possible to drive each piston from both sides by a gas explosion or to store the energy on one side with a spring or a hydraulic system. The end positions of the piston can be locked mechanically or magnetically.

[0070] It should be noted that the term "comprising" does not exclude other elements or steps and the "a" or "an" does not exclude a plurality and that a single processor or system may fulfill the functions of several means or units recited in the claims. Also elements described in association with different embodiments may be combined.

[0071] It should also be noted, that any reference signs in the claims shall not be construed as limiting the scope of claims.

Claims

1. Driving unit for driving an electric circuit breaker, the driving unit comprising:

an expansion chamber (14, 15, 16);
a reciprocating piston (8);
a supply (12) for supplying a driving fluid to the expansion chamber (14, 15, 16);
wherein the driving unit is adapted for triggering an expansion of the driving fluid inside the expansion chamber (14, 15, 16);
wherein the expansion of the driving fluid drives the piston (8) in order to switch the circuit breaker.

2. Driving unit of claim 1,

wherein the driving fluid is a gas mixture which comprises oxygen gas and hydrogen gas, with and without an additive to avoid frozen situation (eis).

3. Driving unit of claim 1 or 2, further comprising: 5
 - an ignition device (7, 9, 10);
 - wherein triggering of the expansion of the driving fluid comprises an ignition of the driving fluid by the ignition device (7, 9, 10). 10
4. Driving unit of claim 3, wherein the ignition device (7, 9, 10) is selected from the group comprising a filament, a laser diode, and a light emitting diode. 15
5. Driving unit of one of the preceding claims, wherein the supply (12) comprises a driving fluid generator (12) for providing the driving fluid. 20
6. Driving unit of claim 5, wherein the driving fluid generator (12) is an electrolysis cell.
7. Driving unit of claim 5 or 6, 25
 - wherein the driving fluid circulates in a closed circuit.
8. A power switch comprising a first driving unit of one of the preceding claims. 30
9. Power switch of claim 8, adapted as an electric circuit breaker for medium or high voltages.
10. Power switch of claim 8 or 9, comprising: 35
 - an interrupter;
 - wherein the first driving unit is adapted for driving the interrupter.
11. Power switch of claim 10, 40
 - wherein the first driving unit is adapted for switching the interrupter either on or off.
12. Power switch of claim 11, further comprising: 45
 - a second driving unit for switching the interrupter either off or on.
13. Power switch of claim 11, further comprising: 50
 - an energy storage unit for storing mechanical energy for switching the interrupter either off or on.
14. An electric plant (200) comprising at least one power switch (100) of one of claims 8 to 13. 55
15. A method for driving an electric circuit breaker, the

method comprising the steps of:

supplying a driving fluid to an expansion chamber (14, 15, 16) of a driving unit of an electric circuit breaker;
 triggering an expansion of the driving fluid inside the expansion chamber (14, 15, 16);
 driving a piston (8) of the driving unit by expansion of the driving fluid, thereby switching the circuit breaker.

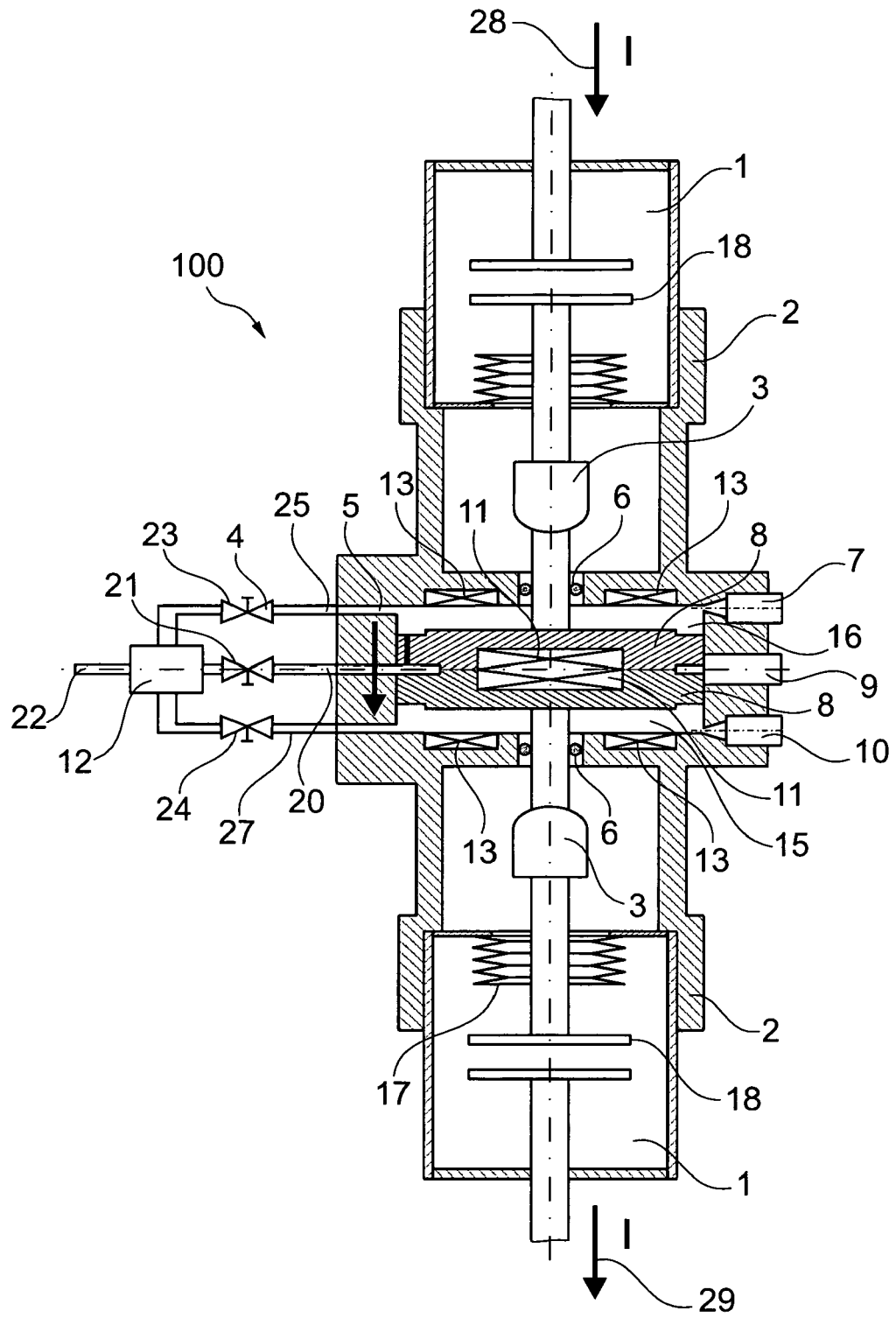


Fig. 1

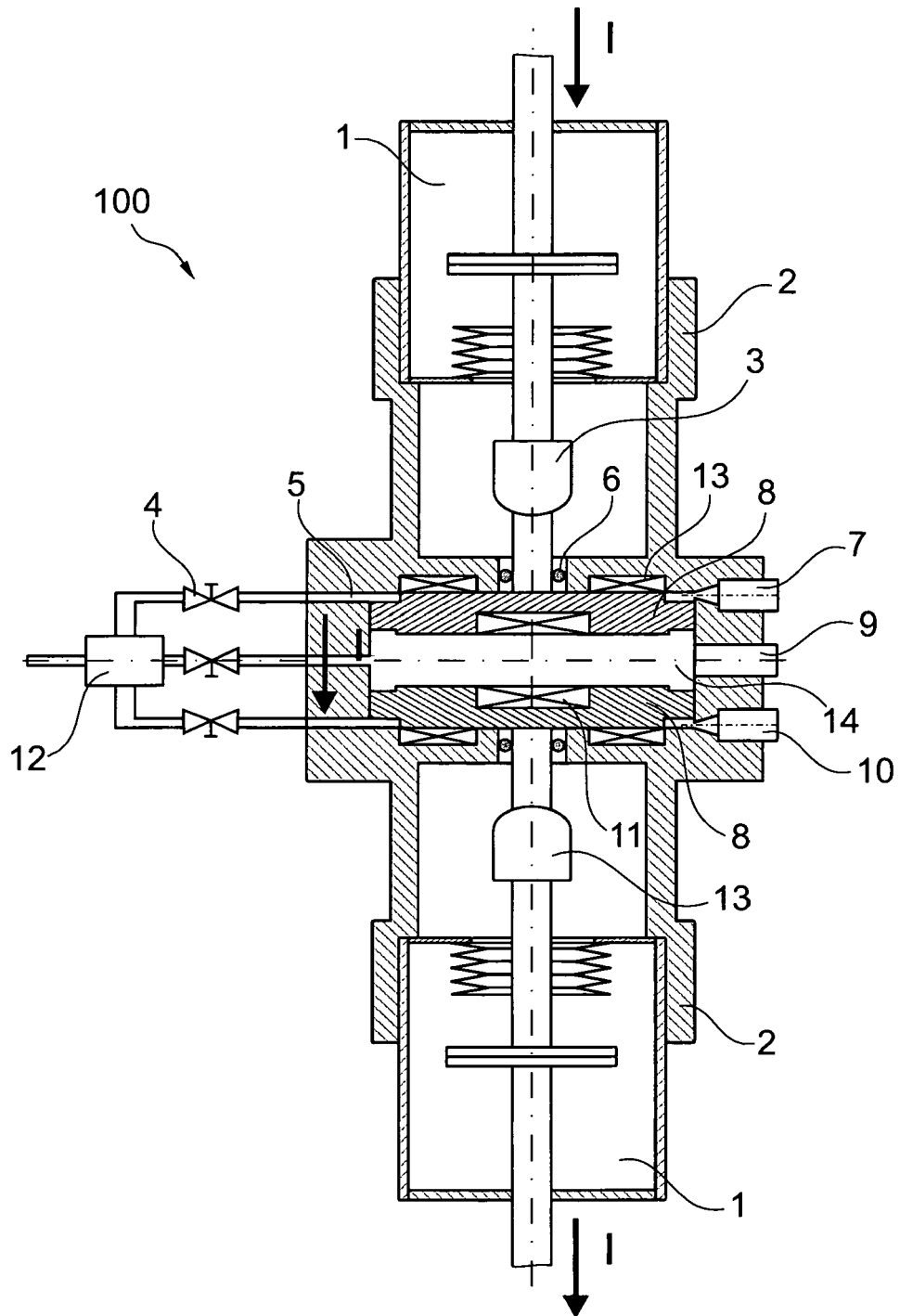


Fig. 2

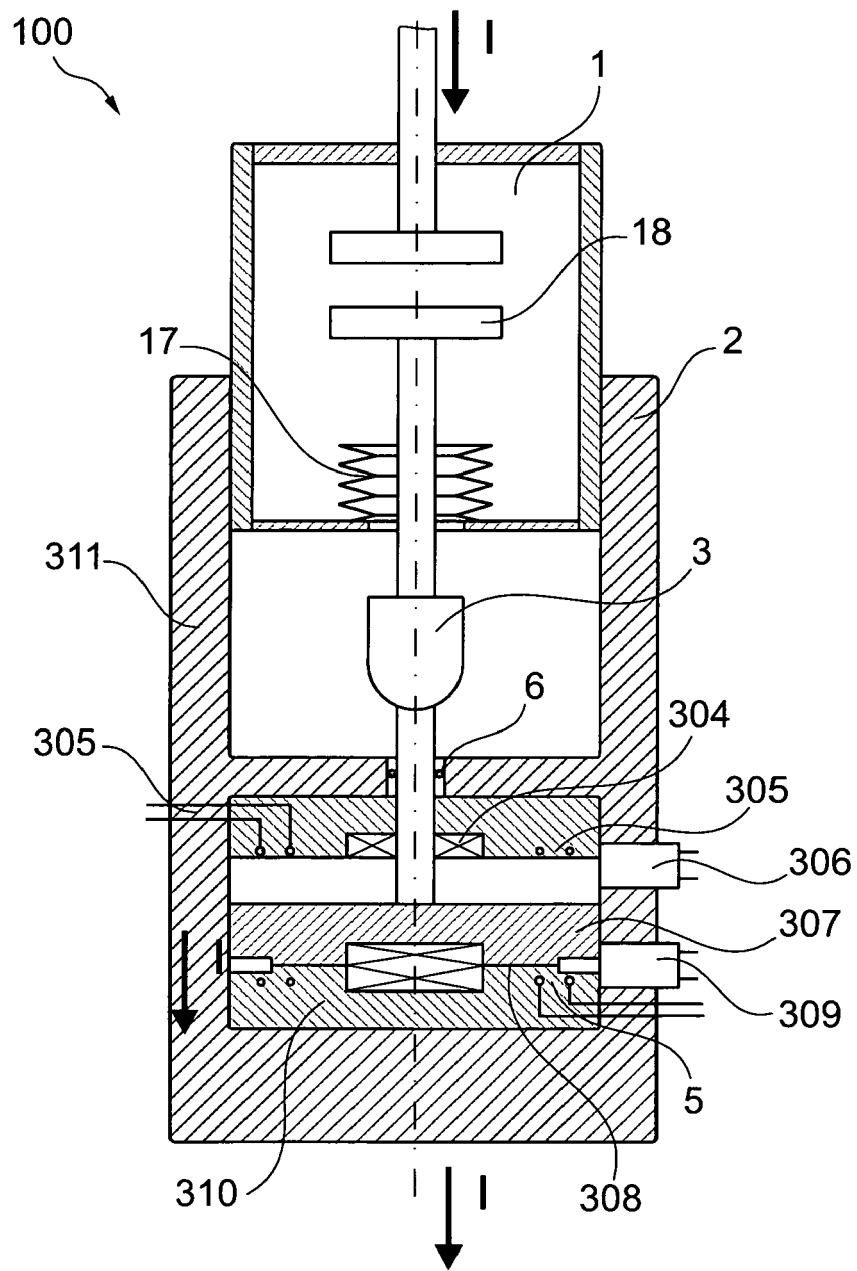


Fig. 3

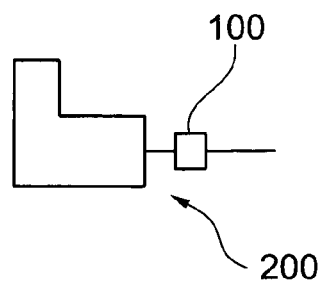


Fig. 4

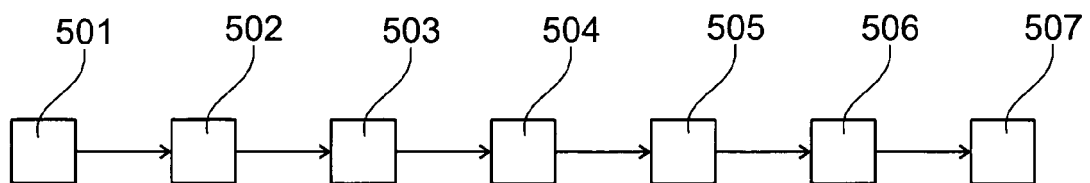


Fig. 5



EUROPEAN SEARCH REPORT

Application Number
EP 10 01 5935

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 May 2011	Examiner Socher, Günther
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 01 5935

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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10-05-2011

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