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(54) Title: MEDIUM VOLTAGE CIRCUIT BREAKER IN SUBSEA ENVIRONMENT

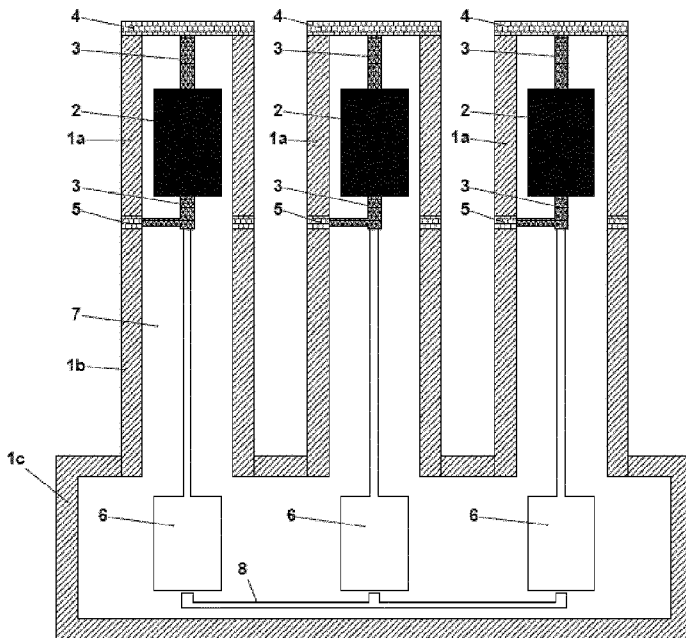


Figure 1

(57) Abstract: The invention relates to a medium voltage circuit breaker in highpressure subsea environment, with a vacuum circuit breaker in a pressure tight housing, according to the preamble of claim 1. In order to create a three phase switchgear for high environmental pressure, like in subsea, which is efficiently protected against this high high environmental pressure, by fulfilling additionally high switching performance, the invention is, that for an electrical three-phase arrangement, one vacuum circuit breaker per phase is in arranged in a separate pole housing each, and the resulting three pole housings are mounted to a common base compartment, in which all the three drives for the three vacuum circuit breaker are arranged in.

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

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5

Medium Voltage Circuit Breaker in Subsea Environment

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The invention relates to a medium voltage circuit breaker in highpressure subsea environment, with a vacuum circuit breaker in a pressure tight housing, according to the preamble of claim 1.

15

A known state of the art, US 4,568,804, disclosure is shown in the Figure 2. An insulating housing 1a and 1b, that contains a switching element 2 is located in an environment of high pressurized fluid. For example this can be a vacuum interrupter in a subsea application. The vacuum interrupter has to be protected against the high pressures, which can reach 300 bar or more. Therefore a pole part is needed, that withstands the pressure and keeps an atmospheric environment of 1-3 bar at the outer surface of the vacuum interrupter itself. The high pressurized fluid around is insulating fluid. This is in an enclosure on the seabed in order to prevent damage from contact with the seawater.

25

So it is the object of the invention, to create a three phase switchgear for high environmental pressure application, like in subsea, which is efficiently protected against this high environmental pressure, by fulfilling additionally high switching performance.

30

The invention is, that for an electrical three-phase arrangement, one vacuum circuit breaker per phase is arranged in a separate pole housing each, and the resulting three pole housings are mounted to a common base compartment, in which all the three drives for the three vacuum circuit breaker are arranged in, and that the three

pole housings and the common base compartment are attached in such, that they form commonly a pressure tight compartment. So the drives are located in a common compartment. But, there is no need for three separated compartment for each drive, but only one common compartment for all the three drives. So finally the pole houses and the common base compartment commonly form a gastight compartment for high withstand against high environmental pressure. By that the complete switchgear arrangement is easier to construct with such high pressure tightness from outside to inside.

One important embodiment of the invention is, that the external contacts of the circuit breaker are made of conducting material and at least one of the external contacts is or are integral part of the pressure tight housing. That means, that at least one of the external contacts are not constructed like a bushing, whiches tightness in that pressure range would be difficult.

So at least one contact, for example the top contact is not a bushing through a top cap of the insulting housing, but the top lid of the housing itself, which is fixed on top and using a sealing.

An advantageous embodiment is, that the drives are mounted inside the common compartment each on a separate frame.

A further advantageous embodiment is, that the three drives are mechanically linked together in such, if one or two drives fails to work, the force of the two remaining working drives is strong enough to switch all three vacuum circuit breaker in common. By that a high performance level of security is given, which is important for deepsea applications, because maintenance is not such easy then under normal environmental pressure.

In a further advantageous embodiment the three drives in the common compartment are connected to one common signal wire system, feed into the common compartment by only one bushing.

One big advantage of this embodiment is resulting in the fact, that the drives can be electrically connected to the signal wire in parallel or in line, depending to the desired functionality. So by the common compartment for all drives of a three-phase arrangement, only one bushing for the electrical signal wiring for the drives is
5 needed.

For high pressure environment, the partial volumina of the three pole housings and the volume of the common compartment for the drives are coherently resulting in a common volumina, which is pressure-tight against high environmental pressure of
10 300 bar or above in such, that the inner pressure results at round about 1 to 3 bar in total.

In a further advantageous embodiment is defined,
that the common volumina is filled with an insulating gas.

15 According to that, the insulating gas is sulfurhexafluoride (SF₆).

An embodiment of the invention is shown in the drawing.

20 According to figure 1, for the electrical connection 3 to the switching element 2, there is a conducting lid 4. Furthermore there is a conducting ring 5. These conducting elements 4, 5 are the contacts itself. These contacts 4 and 5 have to provide a good electrical connection. As well, they are part of the housing and have to be tight against leakage and stable against the pressure on the outside. In line
25 with the vacuum interrupter 2, there is a drive 6, that operates on low voltage. To have this appropriate for a medium voltage application, the housing parts 1a and 1b have to be made at least partly of insulating material. Furthermore the volume 7 can be filled with an insulating gaseous medium like SF₆.

30 The design according to figure 2, as state of the art, is a Circuit Breaker for a single current path. Its application is mostly given in three-phase-networks, where always three poles operate simultaneously. That means, that always three poles have to be

grouped in a switchgear arrangement and thus fixed to a frame and surrounding enclosure.

5 What is proposed in this invention disclosure is shown in Figure 1. Three pole housings are mounted to a common housing 1c. This housing part can be conducting or insulating because it is not in vicinity of the high voltage potential of the contacts 3 and 4 or the switching element 2. The drives are supported on frames not shown in this figure. This creates a three-phase-circuit-breaker, that can be handled and tested as a unit. Furthermore, this allows to implement a mechanical
10 link 8, that prevents a critical situation in case of a failed drive, because it provides a common opening of the switching elements. In normal condition every pole is operated by its own drive. If one drive fails, the energy of the remaining two drives is high enough to operate all three poles, at least in the more critical OFF operation. In addition the number of required low voltage signals or operating voltages to pass
15 the housing can be reduced, as the electrical connections of the three drives can be connected in parallel or in line, depending on the function. This reduces the risk of leakage and the costs for the expensive bushings.

20

Pos.-numbers

- 1a housing part
- 1b housing part
- 5 1c common housing part
- 2 switching element
- 3 contact
- 4 contact
- 5 conducting ring
- 10 6 drive
- 7 volume
- 8 mechanical link

15

Claims

1. Medium voltage circuit breaker in highpressure subsea environment, with a vacuum circuit breaker and a drive in a pressure tight housing,
5 **characterized in**
that for an electrical three-phase arrangement, one vacuum circuit breaker per phase is arranged in a separate pole housing each, and the resulting three pole housings are mounted to a common base compartment, in which all the three drives for the three vacuum circuit breaker are arranged in, and that the three pole
10 housings and the common base compartment are attached in such, that they form commonly a pressure tight compartment.
2. Medium voltage circuit breaker according to claim 1,
characterized in
15 that the external contacts of the circuit breaker are made of conducting material and at least one of the external contacts is or are integral part of the pressure tight housing.
3. Medium voltage circuit breaker according to claim 1 or 2,
20 **characterized in**
that the drives are mounted inside the common compartment each on a separate frame.
4. Medium voltage circuit breaker according to claim 3,
25 **characterized in**
that the three drives are mechanically linked together in such, if one of the drives fails of work, the force of the remaining working drives are strong enough to switch all three vacuum circuit breaker in common with two drives.
- 30 5. Medium voltage circuit breaker according to one of the aforesaid claims,
characterized in
that the three drives in the common compartment are connected to one common

signal wire system, feed into the common compartment by only one bushing.

6. Medium voltage circuit breaker according to claim 5,
characterized in

5 that the drives are electrically connected to the signal wire in parallel or in line,
depending to the desired functionality.

7. Medium voltage circuit breaker according to one of the aforesaid claims,
characterized in

10 that the partial volumina of the pole three housing and the volume of the common
compartment for the drives are coherently resulting in a common volumina, which is
pressure-tight against high environmental pressure of 300 bar or more, in such, that
the inner pressure results at round about 1 to 3 bar in total.

15 8. Medium voltage circuit breaker according to claim 7,
characterized in

that the common volumina is filled with an insulating gas.

9. Medium voltage circuit breaker according to claim 7,
characterized in

20 that the insulating gas is sulfurhexafluoride (SF₆).

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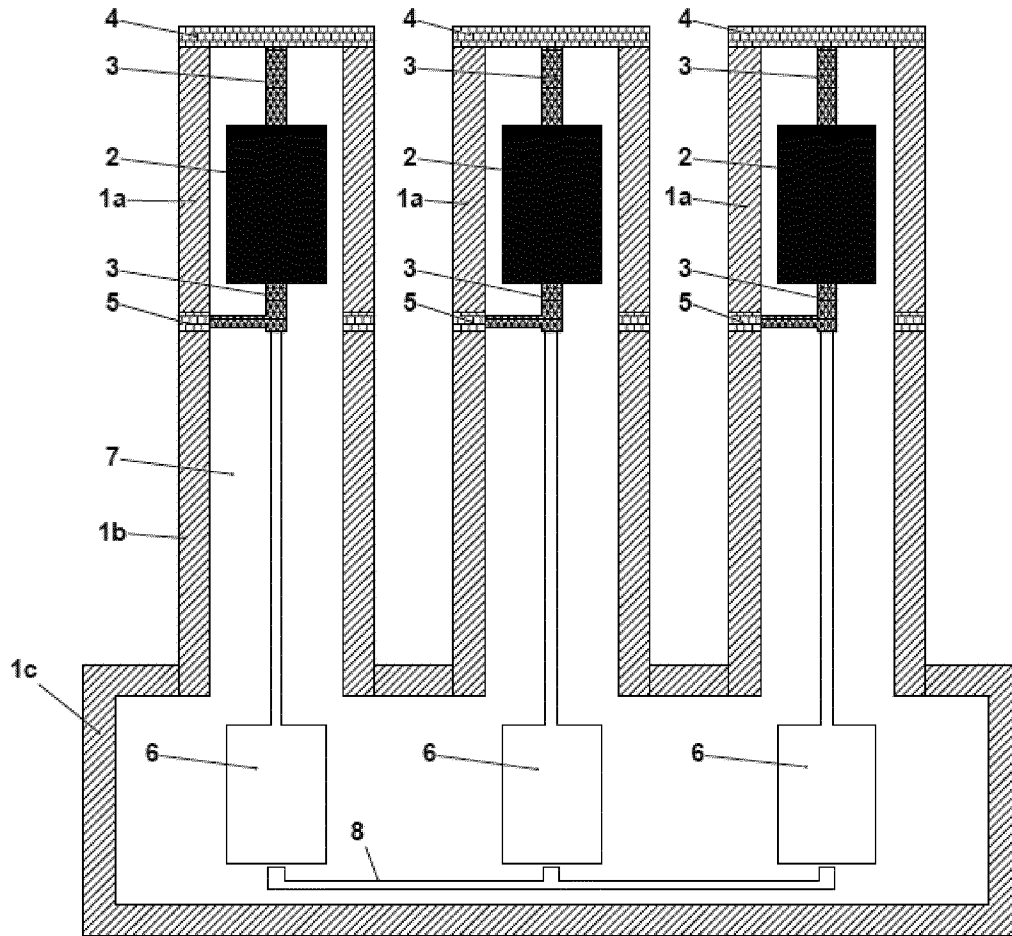


Figure 1

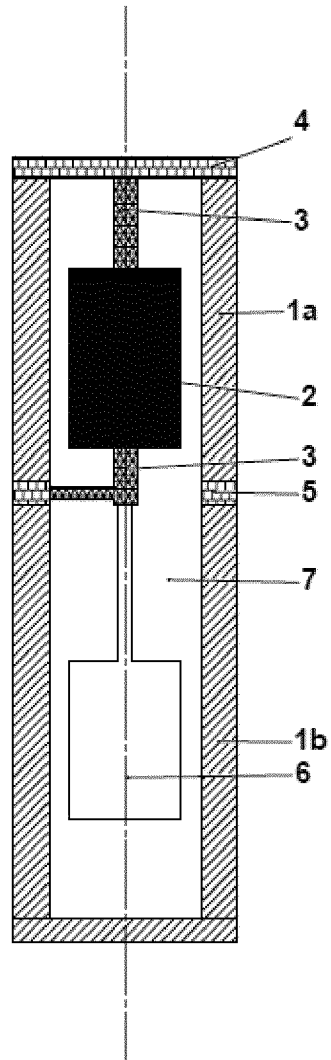


Figure 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/063914

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H02B13/045 H02B13/035 H01H33/666
 ADD.
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
 Minimum documentation searched (classification system followed by classification symbols)
 H02B H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 5 912 604 A (HARVEY IAN JAMES [US] ET AL) 15 June 1999 (1999-06-15)	1-6,8,9
Y	column 1, lines 6-10; figures 1, 2, 11 column 1, lines 55, 56 column 3, line 66 column 8, lines 17-22 column 3, line 62 - column 4, line 25	7
X	EP 2 341 518 A1 (LS IND SYSTEMS CO LTD [KR]) 6 July 2011 (2011-07-06) paragraphs [0027] - [0030]; figure 4	1
X	EP 1 496 535 A1 (MITSUBISHI ELECTRIC CORP [JP]) 12 January 2005 (2005-01-12) paragraphs [0058], [0059]; figure 11	1
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 15 July 2016	Date of mailing of the international search report 25/07/2016
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Bräckelmann, Gregor
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INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2015/028140 A1 (ABB TECHNOLOGY AG [CH]) 5 March 2015 (2015-03-05) page 1, lines 23-31 -----	7
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/063914

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