



(51) International Patent Classification:

H01H 9/14 (2006.01) H01H 33/66 (2006.01)
H01T 4/08 (2006.01) H01H 33/59 (2006.01)

(21) International Application Number:

PCT/EP2013/003001

(22) International Filing Date:

4 October 2013 (04.10.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12007043.8 11 October 2012 (11.10.2012) EP

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

[Continued on next page]

(54) Title: A POLE PART OF A MEDIUM VOLTAGE CIRCUIT BREAKER ARRANGEMENT COMPRISING A TRIGGERED GAP UNIT

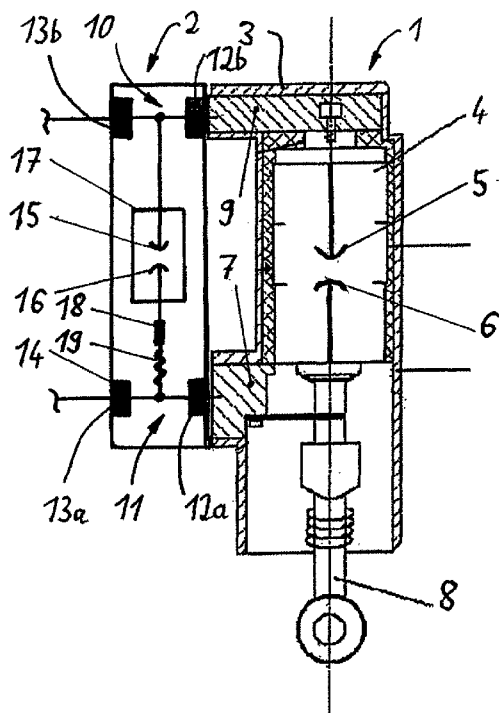


Fig. 1

(57) Abstract: A pole part (1) of a low-, medium- or high voltage circuit breaker arrangement comprising a pole housing (3) for accommodating a vacuum interrupter (4) with a pair of corresponding electrical contacts (5, 6), wherein a fixed electrical contact (5) is connected to an upper electrical terminal (9) and a movable electrical contact (6) is connected to a lower electrical terminal (7) and operated by a push-rod (8), and a triggered -vacuum gap or -gas gap or the combination of gas and vacuum gap connected in series unit (2) is parallel connected to the electrical contacts (5, 6) in order to avoid contacts welding, wherein the triggered vacuum gap or gas gap unit (2) is removably mounted between the upper electrical terminal (9) and the lower electrical terminal (7) arranged adjacent to the pole housing (3). Furthermore there is the possibility to trigger directly the vacuum interrupter device to get a similar effect to protect the vacuum interrupter device from inrush current load during the closing operation especially during capacitive switching.



Published:

— *with international search report (Art. 21(3))*

5

**A pole part of a medium voltage circuit breaker arrangement comprising
a triggered gap unit**

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Field of the invention

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The invention relates to a pole part of a low, medium or high voltage circuit breaker arrangement comprising a pole housing for accommodating a vacuum interrupter with a pair of corresponding electrical contacts, wherein a fixed electrical contact is connected to an upper electrical terminal and a movable electrical contact is connected to a lower electrical terminal at the pole housing and operated by a pushrod. An encapsulated triggered gap unit (vacuum gap or pressurized gap unit) is parallel connected to the electrical contacts in order to avoid contacts welding during capacitive switching operation here to take the inrush current during the closing operation to avoid "point welding of the contact system" under vacuum atmosphere.

Background of the invention

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A circuit breaker arrangement with vacuum interrupter inserts accommodated in respective pole parts is usually used in the low- medium- and high- voltage range up to 72kV for load current switching and for occasional short circuit interruption. The current interruption in a vacuum interrupter is realized by contacts separation. During contacts separation an electrical arc burns between the electrical contacts of the vacuum interrupter until the next current zero crossing. The arc is extinguished at this moment and the vacuum gap between the electrical contacts becomes insulating which withstands the subsequently recovery voltage across the gap. Optimized contact material compositions are used for high current switching, but they can hardly fulfill the

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requirements of capacitive switching, especially for the voltage range of 24kV, 36kV and higher.

During the making operation while closing the electrical contacts there is a time period of 1 to maximal 15ms just before they touch in which the electric field across them becomes high enough to force and at least fire a breakdown. This will give rise to a so called prestrike arc, which will form between the electrical contacts and will carry the power circuit's current. When an arc is initiated between the electrical contacts as they close, a high current will flow through a small contacts spot between the electrical contact surfaces. As the arc persists until the final contact closing, the passage of high current density causes a contact melting at the spot which yields in contacts welding. This effect can be named as "point welding with prearcing under the vacuum atmosphere of the vacuum interrupter".

For conventional medium voltage applications for short circuit current interruption a standard vacuum circuit breaker fulfills the entire requirements. However, for high performance applications which combine capacitive switching and short circuit current breaking capability, technical problems will arise as described above.

The WO 2003/107369 A1 discloses a technical solution for a fast and precise switching which. The circuit breaker arrangement comprises a moveable switching contact which is connected to a drive device embodies as bi-staple magnetic drive. A triggerable vacuum gap is mounted parallel to the switching contacts. An instrument transformer is serially connected to the triggered vacuum gap whereupon the secondary side thereof is connected to the drive arrangement. The current flowing after the triggering of the triggered vacuum gap in the latter and the parallel current path containing the instrument transformer triggers a switch-on movement of the drive device. The moveable switching contact moves into a closed position. The closed vacuum interrupter receives the current fed to it via triggered vacuum gap unit. The moment of closure of the interrupter insert is determined by the moment when the vacuum gap unit is triggered.

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It is an object of the present invention to provide a pole part of a medium voltage circuit breaker arrangement which is easily combinable with a standard hermetically sealed triggered vacuum gap or gas-filled spark gap unit.

5 Brief description of the invention

According to the invention a triggered vacuum / or gas-filled gap unit is removable mounted between the upper electrical terminal and the lower electrical terminal in a manner that it is arranged adjacent to the pole housing. Furthermore the triggered vacuum gap can be integrated directly inside the vacuum interrupter itself, here the
10 inrush current will flow during the contacts are closing but the effect will be finished before the contacts are closed. In case of this the vacuum interrupter is modified and no additional part at the pole part is needed.

15 With other words the triggered vacuum / or gas-filled gap unit or the vacuum interrupter themselves according to the invention is in the both first cases an additional electrical device which can be optionally combined with standard pole parts of a medium voltage circuit breaker arrangement in order to provide a sufficient capacitive switching performance.

20 A triggered vacuum gap unit (TVG) and triggered gas-filled spark gap (TSG) are high-voltage devices for applications where a wide operating voltage range is desired, especially from 300 V to 100kV or above. The low end of the operation voltage range is independent from the static breakdown voltage (max. DC withstand voltage across the
25 main gap). These devices are commonly used in crowbar circuits for protection against overvoltage conditions. By using a suitable TVG or TSG unit the switching time from the trigger input to the start of main gap current flow decreases at a microsecond level. To avoid the possibility of breakdown in both devices in case the TVG or the TSG will be an additional part parallel to the vacuum interrupter the use of a double gap
30 arrangement will be an advantage. In double or multigap arrangement it will not occur a breakdown in the device.

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According a preferred embodiment of the invention the triggering vacuum gap or spark gap unit is provided with an upper electrical terminal adapter and a lower electrical terminal adapter each comprising a first electrical plug for connecting to the corresponding electrical terminals and a second electrical plug for connecting an electrical conductor.

In order to achieve an adapter function it is recommended that the first electrical plug is opposite arranged to the second electrical plug at the triggering vacuum gap or spark gap (or multigap) unit, which provides a compact design for the triggering vacuum gap unit.

Furthermore, the triggering vacuum gap or spark gap (or multigap) unit preferably comprises a pair of electrical contacts which are arranged one to another in a fixed spaced manner inside a vacuum or a gas-filled container. Since the electrical contacts are kept always at a fixed distance there will be no contacts weld within the triggered vacuum gap or spark gap (or multigap) unit. Only in case of the direct use of the vacuum interrupter with the additional function as a triggered vacuum gap here the contacts will touch after closing. The electrical contacts of the triggering vacuum gap or spark gap unit are preferably made of erosion resistance material in case the contact will be not touch.

Once the electrical contacts of the vacuum interrupter insert are closed with no-load or with a very little current, the plasma arc across the electrical contacts of the triggered vacuum gap or spark gap(or multigap) unit will switch off and a contacts welding at the electrical contacts of the vacuum interrupter ~~insert~~ is avoided. As a consequence the tips formation at the electrical contacts surface is reduced or suppressed after opening of the contact by breaking the slight weld caused by the closing operation under inrush current load. Switching the capacitive current with the vacuum interrupter ~~insert~~ can be further improved by eliminating or substantially minimizing the restrikes and other breakdowns.

Further technical improvements can be achieved by using inline connection of a resistor and/or inductance and/or NTC-type power thermistor to limit the inrush current which extends the lifetime of the triggered vacuum gap or spark gap unit. These

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electrical elements are preferably arranged between one of the pair of electrical contacts of the triggered vacuum or spark gap (or multigap) unit and one of both electrical terminal adapters.

5 The triggering of the triggered vacuum gap or spark gap unit can be simply carried out from the beginning of trip signal of the vacuum circuit breaker arrangement itself. The trigger signal is preferably delayed from the trip signal of the vacuum circuit breaker arrangement because because the own time of the vacuum circuit breaker arrangement will be in the range of 30ms and the inrush current flow will be in the
10 range of 5ms and maximal up to 15ms. The triggering of the multigap arrangement has to be made in each compartment. The trigger signal can be inserted in the device or the gap by an electrical impulse or by a laser triggering of the electrically loaded gap of the device.

15 Brief description of the drawings

The foregoing and other aspects of the invention will become apparent following the detailed description of the invention, when considering in conjunction with the enclosed drawings.

20 Figure 1 shows a schematical side view of a pole part of a medium voltage circuit breaker arrangement, and

Figure 2 shows an inrush current-time-diagram of the circuit breaker arrangement
25 while closing operation.

Detailed description of the drawings

30 According to Figure 1 a medium voltage circuit breaker arrangement generally consists of a pole part 1 and triggered vacuum gap or spark gap (or multigap) unit 2. There can be the multigap arrangement made by a serial connection of vacuum and gas gap or as described above as a vacuum or a gas multigap arrangement. The triggered

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vacuum gap and/or spark gap (multigap) unit 2 is adjacent arranged to the pole part 1 as an accessory device.

The pole part 1 comprises a pole housing 3 made of an epoxy or a thermoplastics material for accommodating a vacuum interrupter 4. The vacuum interrupter ~~insert~~ 4 contains a pair of corresponding electrical contacts 5 and 6. The fixed electrical contact 5 is connected to an upper electrical terminal 9 molded in the pole housing 3. The opposite moveable electrical contact 6 is connected to a lower electrical terminal 7 of the pole housing 3 and it is operated by a pushrod 8 for interrupting the current flow through the vacuum interrupter 4.

The triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 is electrically parallel connected to the electrical contacts 5 and 6 of the vacuum interrupter 4 in order to avoid contacts welding while closing and at closing position in capacitive switching operation (here the typical capacitive load as specified in IEC 62271-100).

In order to removable connect the triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 onto the pole part 1 of the medium voltage circuit breaker arrangement, the triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 is provided with an upper electrical terminal adapter 10 and a lower electrical terminal adapter 11, each comprising a first electrical plug 12a and 12b respectively for connecting to the corresponding electrical terminal 7 and 9 respectively. A second electrical plug 13a and 13b respectively is provided for connecting the triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 to an electrical conductor 14. The first electrical plug 12a; 12b is opposite arranged to the second electrical plug 13a; 13b at the triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2.

The triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 comprises a pair of electrical contacts 15 and 16

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which are arranged in a fixed spaced manner one to another inside a further vacuum or gas-filled container 17 or the combination of vacuum and gas in series arrangement.

The pair of electrical contacts 15 and 16 is connected to the upper electrical terminal adapter 10 and the lower electrical terminal adapter 11 respectively. An additional

5 resistor 18 as well and/or as an inductor and/or NTC 19 are arranged between the electrical contact 16 and the lower electrical terminal adapter 11 of the triggered

vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2. The triggered vacuum gap or spark gap or the combined gas and vacuum gap (or the single multi vacuum or gas gap) unit 2 is automatically

10 activated by a trip signal of the vacuum interrupter 4 of the pole part 1.

According to Figure 2 the inrush current of the medium voltage circuit breaker arrangement decreases rapidly and reaches the nominal current level after 3 or few milliseconds.

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Reference signs

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| 1 | pole part |
| 2 | triggered vacuum gap or spark gap or the combined gas and vacuum gap (or |
| 5 | the single multi vacuum or gas gap) unit (TVG) |
| 3 | pole housing |
| 4 | vacuum interrupter insert |
| 5 | fixed electrical contact |
| 6 | movable electrical contact |
| 10 | 7 lower electrical terminal |
| 8 | pushrod |
| 9 | upper electrical terminal |
| 10 | upper electrical terminal adapter |
| 11 | lower electrical terminal adapter |
| 15 | 12 first electrical plug |
| 13 | second electrical plug |
| 14 | electrical conductor |
| 15 | electrical contact |
| 16 | electrical contact |
| 20 | 17 vacuum container |
| 18 | resistor |
| 19 | inductor |

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Claims

1. A pole part (1) of a medium voltage circuit breaker arrangement comprising a pole housing (3) for accommodating a vacuum interrupter insert (4) with a pair of
5 corresponding electrical contacts (5, 6), wherein a fixed electrical contact (5) is connected to an upper electrical terminal (9) and a movable electrical contact (6) is connected to a lower electrical terminal (7) and operated by a pushrod (8), and a triggered gap unit (2) is parallel connected to the electrical contacts (5, 6) in order to avoid contacts welding in capacitive switching operation,

10 **characterized in that** the triggered gap or multigap unit (2) is removable mounted between the upper electrical terminal (9) and the lower electrical terminal (7) arranged adjacent to the pole housing (3).

2. A pole part (1) of a medium voltage circuit breaker arrangement comprising a
15 pole housing (3) for accommodating a vacuum interrupter insert (4) with a pair of corresponding electrical contacts (5, 6), wherein a fixed electrical contact (5) is connected to an upper electrical terminal (9) and a movable electrical contact (6) is connected to a lower electrical terminal (7) and operated by a pushrod (8), and a triggered vacuum gap unit (2) is inserted at the vacuum interrupter to the electrical
20 contacts (5, 6) in order to avoid contacts welding in capacitive switching operation,
characterized in that the triggered vacuum gap or multigap unit (2).

3. A pole part (1) according to Claim 1 and 2,
characterized in that the triggering gap unit (2) is provided with an upper electrical
25 terminal adapter (10) and a lower electrical terminal adapter (11) each comprising a first electrical plug (12a; 12b) for connecting to the corresponding electrical terminal (7; 9) and a second electrical plug (13; 13b) for connecting an electrical conductor (14).

4. A pole part (1) according to Claim 2,
30 **characterized in that** the first electrical plug (12a; 12b) is opposite arranged to the second electrical plug (13a; 13b) at the triggering gap unit (2).

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5. A pole part (1) according to Claim 1,
characterized in that the triggering gap unit (2) comprises a pair of electrical contacts (15; 16) which are arranged one to another in a fixed spaced manner inside a vacuum device (17).

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6. A pole part (1) according to Claim 1,
characterized in that the triggering gap unit (2) comprises a pair of electrical contacts (15; 16) which are arranged one to another in a fixed spaced manner inside a gas-filled container (17).

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7. A pole part (1) according to Claim 4 and 5,
characterized in that the pair of electrical contacts (15; 16) is connected to the upper electrical terminal adapter (10) and to the lower electrical terminal adapter (11) respectively.

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8. A pole part (1) according to Claim 4 and 5,
characterized in that a resistor (18) is arranged between one of the pair of electrical contacts (5; 6) and one of both electrical terminal adapter (11).

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9. A pole part (1) according to Claim 4 and 5,
characterized in that an inductor (19) is arranged between one of the pair of electrical contacts (15; 16) and one of both electrical terminal adapter (11).

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10. A pole part (1) according to Claim 4 and 5,
characterized in that an NTC-type resistor (18) is arranged between one of the pair of electrical contacts (15; 16) and one of both electrical terminal adapter (11).

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11. A pole part (1) according to Claim 1,
characterized in that the triggered gap unit (2) is automatically activated by a trigger pulse generator derived from the trip signal of the vacuum interrupter insert (4).

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12. A pole part (1) according to Claim 1 and 10,
characterized in that the triggered gap unit (2) is automatically activated by a trip
signal relatively delayed from the trip signal of the vacuum interrupter (4).

5 13. A pole part (1) according to Claim 1, 4 and 5,
characterized in that the triggered gap unit (2) is laser-triggered after the trip signal of
the vacuum interrupter ~~insert~~ (4) in order to achieve Bi-directional triggering.

10 14. A pole part (1) according to Claim 1, 4 and 5,
characterized in that the triggered gap unit (2) consists in two triggering gaps anti-
parallelly connected and tripped simultaneously after the trip signal of the vacuum
interrupter ~~insert~~ (4) in order to achieve Bi-directional triggering.

15 15. A pole part (1) according to Claim 1, 4 and 5,
characterized in that the triggered gap unit (2) has a middle electrode connected to
trigger pulse generator and tripped after the trip signal of the vacuum interrupter (4) in
order to achieve Bi-directional triggering.

20 16. A pole part (1) according to Claims above,
characterized in that the triggered gap unit (2) is arranged as a multigap arrangement
as a vacuum gap or a gas gap or a combination of vacuum and gas.

25 17. A pole part (1) according to Claims above,
characterized in that the triggered gap unit (2) is integrated directly in the vacuum
interrupter itself.

30 18. A pole part (1) according to Claims above,
characterized in that the triggered gap unit (2) has a combination of resistor and NTC,
NTC and inductor, resistor and inductor in series arrangement with the triggered gap
unit.

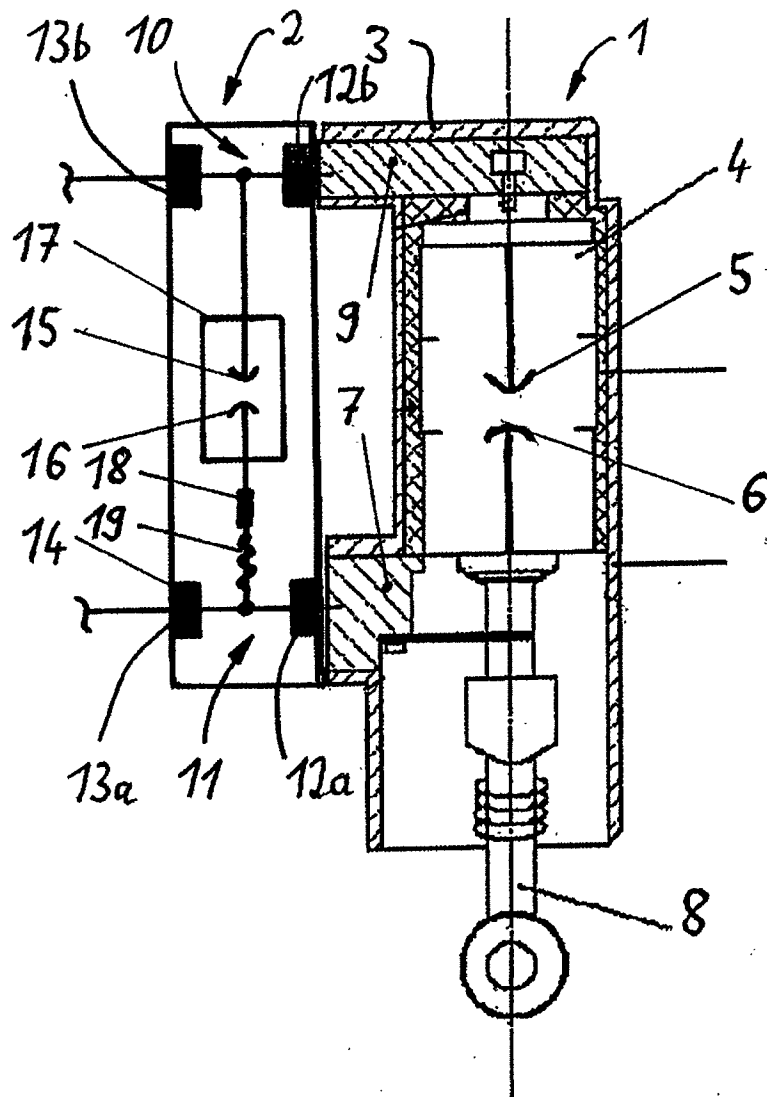


Fig.1



Fig.2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/003001

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H9/14 H01T4/08 H01H33/66 H01H33/59
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)
H01T H01H H02H

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 469 048 A (LEE THOMAS H ET AL) 23 September 1969 (1969-09-23)	1-7,9, 11-17
Y	column 2, line 30 - column 8, line 44; figures 1-3	8,10,18
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Y	----- WO 2006/012754 A1 (HUBER & SUHNER AG [CH]; GROTH SIEGFRIED [CH]; GOEBEL UHLAND [CH]; NUEC) 9 February 2006 (2006-02-09) claim 18	10,18
A	----- US 3 585 449 A (DETHLEISEN ROLF) 15 June 1971 (1971-06-15) the whole document	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

16 December 2013

Date of mailing of the international search report

02/01/2014

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/003001

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