



- (51) International Patent Classification:  
*H01H 33/70* (2006.01)
- (21) International Application Number:  
PCT/EP2012/067634
- (22) International Filing Date:  
10 September 2012 (10.09.2012)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
11 58072 12 September 2011 (12.09.2011) FR
- (71) Applicant (for all designated States except US): **AL-STOM Technology Ltd** [CH/CH]; Brown Boveri Strasse 7, CH-5400 Baden (CH).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **DUFURNET, Denis** [FR/FR]; 16b avenue Carnot, F-69580 Sathonay-camp (FR).
- (74) Agent: **ILGART, Jean-Christophe**; Brevalex, 95 rue d'Amsterdam, F-75378 Paris Cedex 8 (FR).
- (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, IS, JP, KE, KG, KM, 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, 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, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

**Published:**

- with international search report (Art. 21(3))

(54) Title: INTERRUPTING CHAMBER FOR A CIRCUIT BREAKER

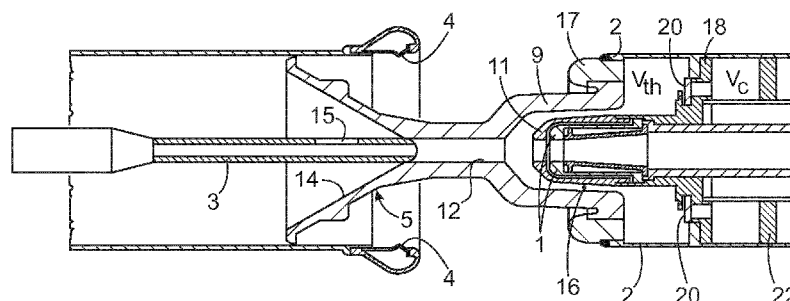


FIG. 2

(57) Abstract: The interrupting chamber comprises two arcing contacts (1) and (3) separating from each other on opening of the circuit breaker and subsequent to prior separation of the main contacts (2, 4). The interrupting chamber further comprises a blast nozzle (5) having a generally cylindrical shape and including a neck (12) and defining a volume of revolution including an upstream portion and a downstream portion (14). The downstream portion of the blast nozzle includes a single conical portion. The arcing contact (3), situated downstream from the neck of the nozzle in the direction of the gas flow, is hollow. The length of the neck of the blast nozzle is sufficient for the arcing contact (3) to remain in contact with the neck (12) while the blast nozzle (5) is moving during opening of the circuit breaker.



**INTERRUPTING CHAMBER FOR A CIRCUIT BREAKER****DESCRIPTION**

The present invention relates to an interrupting  
5 chamber for a circuit breaker, the chamber comprising  
two arcing contacts separating from each other on  
opening of the circuit breaker and subsequent to prior  
separation of the main contacts, the interrupting  
chamber further comprising a blast nozzle secured to  
10 one of the main contacts and to one of the arcing  
contacts, the blast nozzle having a generally  
cylindrical shape including a neck and defining a  
volume of revolution including an upstream portion and  
a downstream portion.

15 French patent No. FR 2 809 531 is already known  
and describes an interrupting chamber for a circuit  
breaker of that type (see Figure 1). It includes a  
first contact 1, known as the movable arcing contact  
that is connected to the first main contacts 2, known  
20 as movable main contacts. It further includes a second  
arcing contact 3, known as the stationary contact and  
second main contacts 4, known as stationary main  
contacts. A blast nozzle 5 is connected to the movable  
main contact 2. The contacts 2 and 4 are known as main  
25 contacts because current passes mainly therethrough  
when the circuit breaker is in the closed position.  
During opening of the circuit breaker, as shown in  
Figure 1, those main contacts 2 and 4 separate first  
before separation of the arcing contacts 1 and 3, with  
30 an electric arc being formed between them when they  
separate and remaining until said arc is definitively  
broken. Contacts 1 and 2 are known as "movable" and  
contacts 3 and 4 are known as "stationary", because on  
opening, only contacts 1 and 2 move towards the right  
35 of the figure.

The interrupting chamber includes a blast nozzle 5. As can be seen in Figure 1, the nozzle 5 presents the general shape of a body of revolution. The chamber includes a neck 12 that separates the volume of revolution into an upstream portion 7 and a downstream portion 8. At the location of the neck 12, the inside volume of the blast nozzle is cylindrical and it is blocked by the stationary arcing contact 3 while the circuit breaker is in the closed position and also for a few milliseconds after separation of the contacts 1 and 3. In its upstream portion, the nozzle 5 includes a portion 9 surrounding the movable arcing contact 1.

The downstream portion of the inside volume defined by the nozzle 5 includes a first conical portion 8a immediately following the neck, having an angle lying in the range  $8^{\circ}$  to  $17^{\circ}$ . This last portion 8a is followed by a second portion 8b that is also conical and that has a cone angle that lies in the range  $12^{\circ}$  to  $25^{\circ}$ . Given the speed with which the contacts separate, the lengths of the various portions, namely the neck 12, the first conical portion 8a, and the second conical portion 8b are calculated so that the end of the second arcing contact 3 is located inside the first conical portion 8a, as shown in Figure 1, over a time period that lies in the range the minimum arcing duration to the mean arcing duration after separation of the contacts. Provision is also made for said same end of the stationary arcing contact 3 to be located inside the second conical portion 8b over the time period that lies in the range the mean arcing duration and the maximum arcing duration after separation of the contacts.

However, a device of this type presents the following drawbacks:

The rise in pressure is insufficient with low currents, namely currents that are less than or equal to 30% of the rated breaking capacity of the circuit breaker, the rated breaking capacity being the maximum current that the circuit breaker is able to break. Consequently, the rise in pressure solely as a result of thermal effect is insufficient. It is necessary to compress the gas. The breaking operation requires more energy.

10 An object of the present invention is specifically to provide an interrupting chamber for a circuit breaker that overcomes those drawbacks.

These objects are achieved in accordance with the invention, by the fact that the downstream portion of the blast nozzle includes a single conical portion, by the fact that the stationary arcing contact is hollow, and by the fact that the length of the neck of the blast nozzle is sufficient for the stationary contact to remain in contact with the neck while the blast nozzle is moving during opening of the circuit breaker. The sole purpose of the conical portion is to prevent hot gas from arriving between the main contacts and giving rise to arcing between said contacts during the voltage recovery stage after the circuit has been broken.

By means of these characteristics, the arc is completely enclosed inside the blast nozzle. The arc vaporizes the material, which makes it possible to use this property to increase the pressure inside the blast nozzle and then inside the blast volume  $V_{th}$  to which this rise in pressure is communicated when the current has an amplitude that is sufficient for generating said rise in pressure. When the current crosses zero said pressure escapes and blasts the arc. The cone is very long and continues until it covers the stationary

contact in the open position of the circuit breaker. Blasting makes it possible to cool the arc and to eliminate the conductance of the medium between the arcing contacts. Voltage recovery can then take place  
5 after the current has been interrupted.

In comparison with the prior art, the rise in pressure due solely to the thermal effect is sufficient for low short-circuit currents that are less than 30% of the short-circuit breaking power of the circuit  
10 breaker, e.g. 10% of the rated short-circuit breaking capacity. As a result, there is no need to compress the gas for currents that are greater than about 10% of the rated short-circuit breaking capacity. There is therefore less need for energy for the breaking  
15 operation.

Preferably, the arcing contact includes side openings so as to make it easier for the blast gas to escape.

More preferably, the interrupting chamber  
20 includes a separation wall arranged in the movable main arcing contact, the separation wall co-operating with the upstream portion of the blast nozzle to define a thermal volume  $V_{th}$ , valves being provided in the separation wall and a stationary piston situated  
25 upstream from said wall, the piston co-operating with the separation wall to define a compression volume  $V_c$ .

This device operates when currents are low. When the arc is too weak to generate a pressure that is sufficient, the compression of the gas inside the  
30 volume  $V_c$  makes it possible to produce the rise in pressure necessary for breaking the circuit. When the separation wall moves, the gas is compressed inside the volume  $V_c$ . The valve(s) 20 open(s) and the high pressure in  $V_c$  is exhausted into the volume  $V_{th}$  inside  
35 the blast nozzle, until the arc is extinguished.

Additional and/or alternative characteristics are listed below:

• The arcing contacts are of the arcing rod and tulip contact type;

5       • The two contacts may be: one stationary and the other movable, or both movable, the movements separating them from each other during opening of the circuit breaker as shown in patent EP 1 032 009;

10       • The interrupting chamber presents arcing contacts that are of the butt contact type and include a spring behind the movable arcing contact so as to produce the contact force necessary in the closed position.

15       • The interrupting chamber is designed for a circuit breaker that is insulated externally in air;

• The interrupting chamber is designed for a gas-insulated metal-enclosed circuit breaker.

20       • The interrupting chamber is designed for a circuit breaker of the "dead tank" type, i.e. a circuit breaker having its active portion contained in a gas-insulated metal enclosure, and with current inlets and outlets via air-insulated overhead bushings.

25       Other characteristics and advantages of the present invention also appear on reading the following description of an example given by way of illustration, with reference to the accompanying figures, in which:

• Figure 1, described above, shows an interrupting chamber of the prior art.

30       • Figure 2 shows an interrupting chamber of the present invention.

This interrupting chamber is shown with the circuit breaker in the open position. This interrupting chamber includes the first movable main contact 2 and stationary main contacts 4. When the  
35       circuit breaker is in the closed position, the movable

contacts 2 are inside the main contacts 4. Current passes mainly through said contacts when the circuit breaker is in the closed position. During opening of the circuit breaker, the stationary 4 and movable 2  
5 main contacts separate by moving towards the right of the set of movable contacts.

The interrupting chamber also includes a stationary arcing contact 3. As can be seen in Figure 2, this stationary contact is hollow. It  
10 includes one or more side blast openings 15. These openings 15 facilitate evacuation of blast gas. The circuit breaker also includes a movable arcing contact 1. This movable arcing contact is housed behind an insulating cap 11.

15 The blast nozzle 5 includes an inside channel 12 that is cylindrical in shape, of constant section, and of great length. The cylindrical channel 12 is sufficiently long that, even when the circuit breaker is fully in the open position, the end of the  
20 stationary arcing contact 3 that is to the right in the figure is still inside the blast nozzle 5. At its downstream portion, the blast nozzle includes a portion of conical shape. However, unlike in the prior art the exit cone 14 of the nozzle has only one cone angle. As  
25 mentioned above, the prior art device includes a first conical portion 8a and a second conical portion 8b having a different cone angle and immediately following the conical portion 8a. On the contrary, in the invention, as shown in Figure 2, the blast nozzle  
30 includes a conical portion 14 having only one cone angle and that does not contribute to blasting between arcing contacts 1 and 3. The sole purpose of the conical portion is to prevent the hot gas passing through the openings 15 from arriving between the main  
35 contacts 2 and 4 and giving rise to arcing between said

contacts during the voltage recovery stage after the current has been interrupted.

In its upstream portion, the conical nozzle includes a cylindrical portion 9 of larger diameter, that surrounds the stationary contact. This upstream portion 9 is connected to the movable main contact 2 by means of a ring 17 attached to the movable main contact 2. A through channel 16 is provided between the cylindrical volume 12 and a thermal chamber  $V_{th}$ . A separation wall 18 separates the chamber  $V_{th}$  from a chamber  $V_c$ . One or more valves 20 are disposed in the separation wall 18. When said valves are open, they enable the high pressure that is being established in the chamber  $V_c$  to pass into the chamber  $V_{th}$ . In Figure 2, the chamber  $V_c$  is terminated on the right by a stationary piston 22.

The device operates as follows. During opening of the circuit breaker, the movable unit constituted by the blast nozzle 5, the ring 17, the stationary arcing contacts 1, the cover cap 11, the chamber  $V_{th}$  and the movable main contact 2 moves towards the right, as shown in Figure 2. When the stationary arcing contact 3 separates from the movable arcing contact 1, an arc appears between said two parts. This electric arc is completely enclosed inside the cylindrical portion 12 of the part 6, including in the maximum opening position of the circuit breaker. The cylindrical portion 12 of the nozzle 5 goes as far as covering the end of the stationary arcing contact 3. The arc is completely enclosed inside said insulating cylinder and it vaporizes the material constituting the walls of the cylindrical volume 12, thereby creating a high pressure. When the alternating current crosses zero, said high pressure escapes and blasts the arc. Unlike the prior art, a particularity of the invention is that

the neck 12 of the nozzle 5 is very long and it goes as far as covering the end of the stationary arcing contact 3. The blast chamber  $V_{th}$  includes a volume that increases in pressure with increasing energy of the arc. The hot gas moves up the inside of the channel 16 and the pressure of the chamber  $V_{th}$  increases. When the alternating current crosses zero, the movement reverses and the gas escapes into the movable arcing contact 1 and the stationary arcing contact 3. For interrupting low currents, the operating member (not shown) pulls the movable portion, in particular, the movable arcing contact 1, the main arcing contact 2, and the nozzle 5 towards the right, and that compresses the gas contained in the volume  $V_c$ , the volume of said chamber being reduced when the separation wall 18 moves towards the stationary piston 22. The high pressure inside the chamber  $V_c$  opens the valve(s) 18 that communicate with the thermal volume  $V_{th}$ , which has substantially the same high pressure. When the current crosses zero, the high pressure exhausts through the orifices of the hollow contacts 1 and 3, cooling the arc and interrupting the current.

When interrupting a high current, operation is similar, but in this event the energy of the electric arc vaporizes the inside surface of the nozzle 5 and of the insulating cap 11 situated in front of the movable arcing contact 1. The high rise in pressure inside the volume  $V_{th}$  closes the valve(s) 20 between the volumes  $V_{th}$  and  $V_c$ . Arc blasting is carried out by exhausting the volume  $V_{th}$  through the insides of the stationary contact 3 and of the movable contact 1.

The conical portion 14 situated in downstream side of the blast nozzle 5 makes it possible to prevent the hot gas that passes through the openings 15 from flowing between the main contacts 2 and 4. The arcing

contacts may be of the arcing rod and tulip contact type, or of the butt contact type. One of the arcing contacts may be stationary and the other may be movable, or both may be movable.

5           The advantages of the present invention are as follows:

          The invention requires less operating energy in comparison with automatic blast circuit breaker chambers of the conical type.

10           Its design is simpler in comparison with dual motion contact chambers.

          For interrupting capacitive currents (low currents) the necessary opening speed may be obtained with a single movement of the contacts since the compression energy is low and the rise in pressure is low during the first 8 to 10 milliseconds after contact separation. A more sophisticated design, such as for example with dual motion of the contacts, is not always necessary.

20

**CLAIMS**

1. An interrupting chamber for a circuit breaker, the chamber comprising two arcing contacts (1) and (3) separating from each other on opening of the circuit breaker and subsequent to prior separation of the main contacts (2, 4), the interrupting chamber further comprising a blast nozzle (5) secured to one (2) of the main contacts, the blast nozzle (5) having a generally cylindrical shape and including a neck (12) and defining a volume of revolution including an upstream portion (9) and a downstream portion (14), the interrupting chamber being characterized in that the downstream portion (14) of the blast nozzle includes a single conical portion, in that the arcing contact (3), situated downstream from the neck of the nozzle in the direction of the gas flow, is hollow, and in that the length of the neck of the blast nozzle (5) is sufficient for the arcing contact (3) to remain in contact with the neck (12) while the blast nozzle (5) is moving during opening of the circuit breaker.

2. An interrupting chamber according to claim 1, characterized in that one (3) of the two contacts is stationary, and the other contact (1) is movable.

3. An interrupting chamber according to claim 1, characterized in that both of the arcing contacts (1, 3) are movable, the contacts being separated from each other by a relative movement during opening of the circuit breaker.

4. An interrupting chamber according to claim 2, wherein the stationary arcing contact (3) includes side openings (15) so as to make it easier for the blast gas to escape.

5. An interrupting chamber according to any one of claims 1 to 4, characterized in that it includes a separation wall (18) arranged in the movable main arcing contact, the separation wall (18) co-operating with the upstream portion of the blast nozzle to define a thermal volume  $V_{th}$ , valves (20) being provided in the separation wall and a stationary piston (22) situated upstream from said wall (18), the piston co-operating with the separation wall (18) to define a compression volume  $V_c$ .

6. An interrupting chamber according to claim 5, characterized in that the arcing contacts (1, 3) are of the arcing rod and tulip contact type.

7. An interrupting chamber according to any preceding claim, presenting arcing contacts that are of the butt contact type and including a spring behind the movable arcing contact so as to produce the contact force necessary in the closed position.

8. An interrupting chamber according to any preceding claim, designed for a circuit breaker that is insulated externally in air.

9. An interrupting chamber according to any one of claims 1 to 7, designed for a gas-insulated metal-cloud circuit breaker.

10. An interrupting chamber according to any one of claims 1 to 7, designed for a circuit breaker of the "dead tank" type having the active portion contained in a gas-insulated metal enclosure, and with current inlets and outlets via air-insulated overhead bushings.

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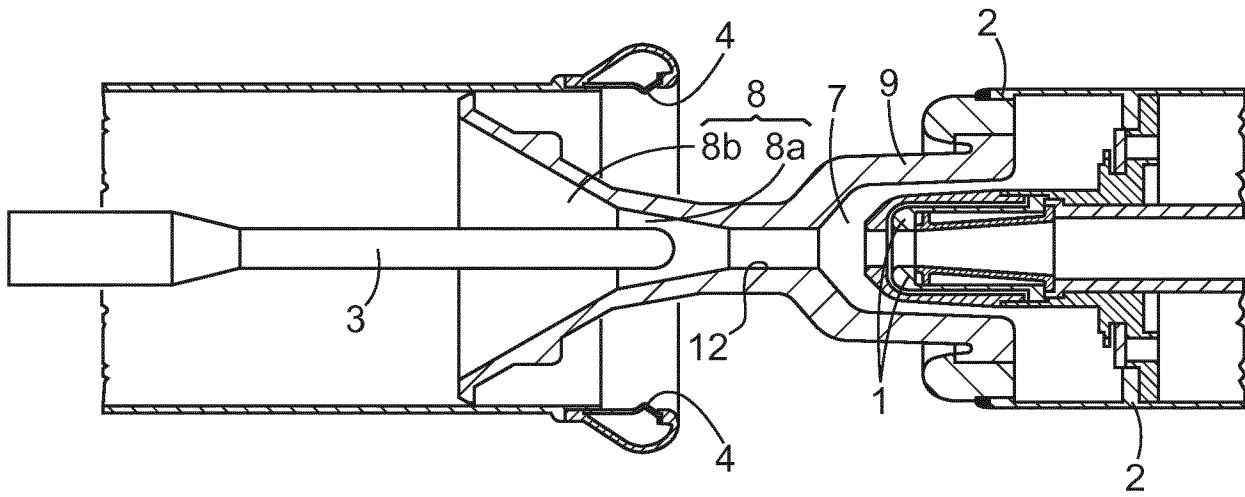


FIG.1

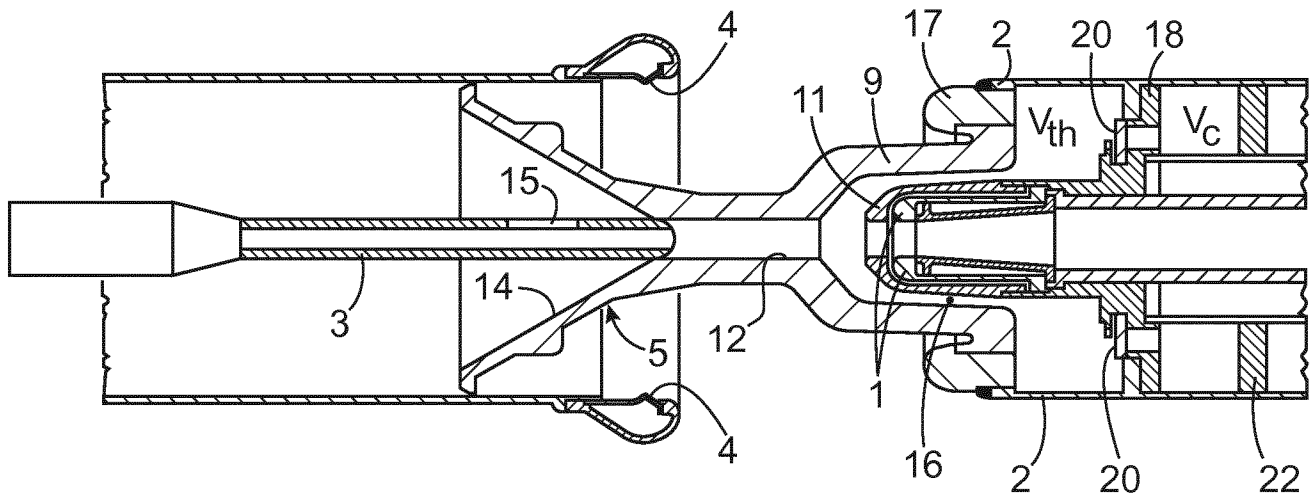


FIG.2

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/EP2012/067634

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. H01H33/70  
 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)  
 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

<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 809 531 A1 (ALSTOM [FR]) 30 November 2001 (2001-11-30) cited in the application page 3, line 18 - page 5, line 15; figures 2-5	1-10
A	----- JP 8 167357 A (NISSIN ELECTRIC CO LTD) 25 June 1996 (1996-06-25) abstract; figures 1,2	1-10
A	----- FR 2 760 890 A1 (GEC ALSTHOM T & D SA [FR]) 18 September 1998 (1998-09-18) page 2, line 11 - page 3, line 33; figure 1	1-10

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "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)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "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
- "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
- "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
- "&" document member of the same patent family

Date of the actual completion of the international search <b>30 November 2012</b>	Date of mailing of the international search report <b>07/12/2012</b>
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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  <b>Pavlov, Valeri</b>
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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2012/067634

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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