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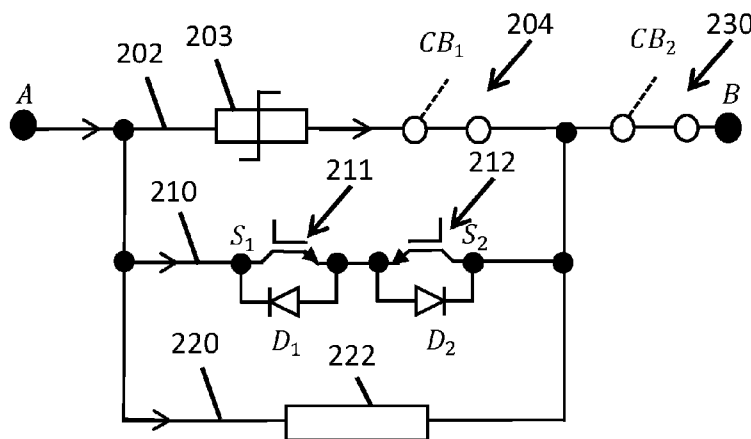
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[Continued on next page]

(54) Title: HYBRID DC CIRCUIT BREAKER AND METHOD FOR CONTROLLING



200

FIGURE 2

(57) Abstract: A circuit breaker and method of controlling Direct Current is disclosed. The circuit breaker has a primary conduction path (202) comprising a positive temperature coefficient (PTC) device with a positive temperature coefficient of resistance and a mechanical switch (204, CB1) is connected in series with the PTC device. There is a secondary conduction path (210) with a semiconductor switch device (211, S1; 212, S2) arranged in parallel with the PTC device. The PTC device is arranged to commutate current to the secondary conduction path in response to an increase in current through the primary conduction path. The semiconductor switch device (211, S1; 212, S2) is controllable to break current flow through the secondary conduction path.

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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) Date of publication of the international search report:

17 September 2015

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2014/051354

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	H02H7/26	H02J3/36	H03K17/0814	H03K17/10	H03K17/12
	H03K17/785	H01H9/54	H01H33/59	H02H3/02	H02H7/22
	H02H3/087	H02H9/04	H02H9/02		
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 H02H H02J H03K 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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 925 707 A (BHATE SURESH K ET AL) 9 December 1975 (1975-12-09)	1-7, 22-30
Y	column 4, line 12 - column 5, line 7; figure 2	8-16
Y	----- GB 2 493 911 A (UNIV MANCHESTER [GB]) 27 February 2013 (2013-02-27)	8-16
A	paragraphs [0014] - [0043]; figures 1-3	1-7, 22-30
A	----- US 5 933 311 A (CHEN WILLIAM W [US] ET AL) 3 August 1999 (1999-08-03) the whole document	1-16, 22-30
X	----- US 2008/043382 A1 (LEE BANG-WOOK [KR] ET AL) 21 February 2008 (2008-02-21) the whole document	1-7, 22-30
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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	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 24 February 2015	Date of mailing of the international search report 22/07/2015
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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 Wilhelm, Gunther
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INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2014/051354

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 199 39 066 A1 (SIEMENS AG [DE]) 8 March 2001 (2001-03-08)	1-7, 10-15, 22-30
Y	the whole document -----	8,9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2014/051354

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-16, 22-30

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-16, 22-30

Hybrid DC circuit breaker having primary, secondary and tertiary conduction paths arranged in parallel for diverting fault current away from the primary path into the secondary and/or tertiary path for preventing arcing of the mechanical switch when switching off the primary conduction path

2. claims: 17-21

snubber circuit

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2014/051354

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
US 3925707	A	09-12-1975	CA 1013459 A1 US 3925707 A	05-07-1977 09-12-1975

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