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[Continued on next page]

(54) Title: HIGH VOLTAGE DIRECT CURRENT LINK TRANSMISSION SYSTEM FOR VARIABLE SPEED WIND TURBINE

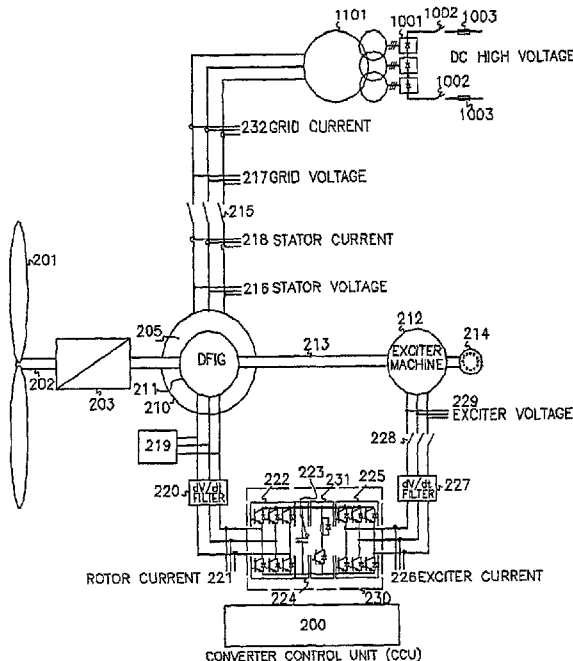


FIGURE 11

(57) Abstract: A variable speed wind turbine having a doubly fed induction generator (DFIG), includes an exciter machine (212) mechanically coupled to the DFIG and a power converter (230) placed between a rotor (211) of the DFIG and the exciter machine. Thus, the power converter is not directly connected to the HVDC system (1001, 1002, 1003) avoiding the introduction of undesired harmonic distortion and achieving a better power quality fed. Moreover, the variable speed wind turbine includes a power control and a pitch regulation.

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ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC,  
MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ,  
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**INTERNATIONAL SEARCH REPORT**

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**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. H02P9/00

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)  
H02P F03D

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 practical, 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	BAUER P ET AL: "Evaluation of electrical systems for offshore windfarms" INDUSTRY APPLICATIONS CONFERENCE, 2000. CONFERENCE RECORD OF THE 2000 IEEE 8-12 OCTOBER 2000, PISCATAWAY, NJ, USA, IEEE, vol. 3, 8 October 2000 (2000-10-08), pages 1416-1423, XP010521303 ISBN: 0-7803-6401-5	1,24
Y	page 1418, paragraph DOUBLEFEDINDUCTIONGENERATOR ----- -/--	2-7, 11-17

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 document 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

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## INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2007/002872

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>HANSEN L H ET AL: "Generators and power electronics technology for wind turbines" IECON'01. PROCEEDINGS OF THE 27TH. ANNUAL CONFERENCE OF THE IEEE INDUSTRIAL ELECTRONICS SOCIETY. DENVER, CO, NOV. 29 - DEC. 2, 2001; [ANNUAL CONFERENCE OF THE IEEE INDUSTRIAL ELECTRONICS SOCIETY], NEW YORK, NY : IEEE, US, vol. 3, 29 November 2001 (2001-11-29), pages 2000-2005, XP010571723 ISBN: 978-0-7803-7108-8 figure 5 page 2005, first column second paragraph</p>	2
Y	<p>LIE XU , BJARNE R. ANDERSEN: "Grid connection of large offshore wind farms using HVDC" WIND ENERGY, [Online] 1 December 2005 (2005-12-01), XP002524788 Retrieved from the Internet: URL:http://www3.interscience.wiley.com/cgi-bin/fulltext/112164179/PDFSTART&gt; [retrieved on 2008-04-21] page 376; figure 4</p>	3-5, 11-13, 16,17
Y	<p>WO 01/25628 A (VESTAS WIND SYSTEM AS [DK]; FEDDERSEN LORENZ [DK]) 12 April 2001 (2001-04-12) cited in the application abstract figure 1</p>	4,12
Y	<p>PATIN N ET AL: "Analysis and control of a cascaded doubly-fed induction generator" INDUSTRIAL ELECTRONICS SOCIETY, 2005. IECON 2005. 32ND ANNUAL CONFERENCE OF IEEE RALEIGH, NC, USA 6-10 NOV., 2005, PISCATAWAY, NJ, USA, IEEE, 6 November 2005 (2005-11-06), pages 2481-2486, XP010876268 ISBN: 978-0-7803-9252-6 page 1; figure 2</p>	6,7,14, 15

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2007/002872

## 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 allsearchable 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.:

1-8, 11-17, 24

### 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: 1-8,11-17,24

A variable speed wind turbine comprising: a rotor including at least one blade; a drive train coupled to the rotor, the drive train including at least a doubly fed induction generator (DFIG), said DFIG having at least a stator connectable to a power grid; at least an exciter machine coupled to the drive train; and at least a power conversion device isolated from the grid and electrically coupled to a rotor of the doubly fed induction generator and to the exciter machine to transfer electrical power between the rotor and the exciter machine; and a connection system which controls the DFIG for connection to the power grid; and a disconnection system which controls the DFIG for disconnection from the power grid.

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## 2. claims: 9-10, 18, 21,22

A variable speed wind turbine wherein the stator is connected to the HVDC system; wherein the DFIG is controlled in voltage regulation mode and the voltage is ramped up until current flows through the stator or a rectifier of the HVDC system; wherein an operating mode of the DFIG is controlled according to at least one of a DFIG output current control, DFIG output power control, HVDC system output current control and HVDC systems output power control, after the current flows through the stator or the rectifier and relative method for connecting the wind turbine to HVDC system

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## 3. claims: 20,23

A method of disconnecting a variable speed wind turbine from a HVDC system, wherein the variable speed wind turbine includes a doubly fed induction generator (DFIG) having a stator connectable to the HVDC system, an exciter machine and power converter, the method comprising: ramping down a controlled output variable of at least one of a DFIG output current control, a DFIG output power control, an HVDC output current control and an HVDC output power control; disable the DFIG side power converter if the controlled output variable approaches zero; disable the exciter side converter after the DFIG side power converter is disabled.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2007/002872

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0125628	A	12-04-2001	
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