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

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(54) Title: METHODS AND APPARATUS FOR THREE-PHASE INVERTER WITH REDUCED ENERGY STORAGE

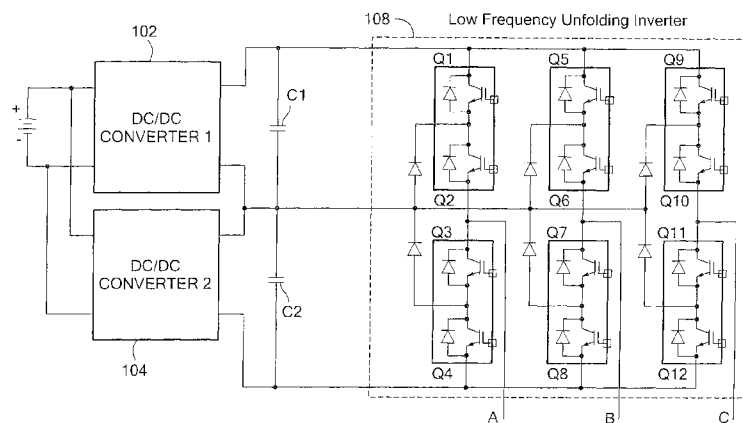


FIG. 7

(57) Abstract: Methods and apparatus for a circuit including first and second energy sources (102,104), a rectifier coupled to the first and second energy sources, first and second energy storage devices (c1,c2) coupled end-to-end across the positive and negative rails, and a single three-level inverter (108) coupled to the rectifier for providing three-phase sinusoidal output voltages.

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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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)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2004/125523 A1 (EDWARDS JOHN [US] ET AL) 1 July 2004 (2004-07-01) paragraph [0012] paragraph [0026] paragraph [0027] paragraph [0038] figure 1 figure 4 figure 7	1, 3, 11, 12, 14 2, 4-8, 13, 15-19, 21
Y	US 2005/284673 A1 (NAKAZAWA YOSUKE [JP] ET AL) 29 December 2005 (2005-12-29) paragraph [0084] figure 16 ----- -/--	2, 13



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8 document member of the same patent family

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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	US 2005/111246 A1 (LAI JIH-SHENG [US] ET AL) 26 May 2005 (2005-05-26) paragraph [0013] figure 10	4-7, 15-18
Y	----- FANG ZHENG PENG ET AL: "A multilevel voltage-source converter system with balanced DC voltages" POWER ELECTRONICS SPECIALISTS CONFERENCE, 1995. PESC '95 RECORD., 26TH ANNUAL IEEE ATLANTA, GA, USA 18-22 JUNE 1995, NEW YORK, NY, USA, IEEE, US, vol. 2, 18 June 1995 (1995-06-18), pages 1144-1150, XP010150694 ISBN: 978-0-7803-2730-6 paragraph [II.A] table 1	8,21
X	----- SHUAI LU ET AL: "Advanced Control and Analysis of Cascaded Multilevel Converters Based on P-Q Compensation" IEEE TRANSACTIONS ON POWER ELECTRONICS, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 22, no. 4, 1 July 2007 (2007-07-01), pages 1242-1252, XP011186930 ISSN: 0885-8993 paragraph [00II] figure 1 figure 5 figure 7 figure 17	10,22,23
Y	----- RAJU N R ET AL: "Harmonic cancellation for a twelve-pulse rectifier using DC bus modulation" CONFERENCE RECORD OF THE 2002 IEEE INDUSTRY APPLICATIONS CONFERENCE. 37TH IAS ANNUAL MEETING . PITTSBURGH, PA, OCT. 13 - 18, 2002; [CONFERENCE RECORD OF THE IEEE INDUSTRY APPLICATIONS CONFERENCE. IAS ANNUAL MEETING], NEW YORK, NY : IEEE, US, vol. 4, 13 October 2002 (2002-10-13), pages 2526-2529, XP010609944 ISBN: 978-0-7803-7420-1 page 2527, right-hand column figure 4 figure 6	19

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 2004125523	A1	01-07-2004	NONE	
US 2005284673	A1	29-12-2005	JP 2006025591 A	26-01-2006
			KR 20060048213 A	18-05-2006
US 2005111246	A1	26-05-2005	CA 2558001 A1	16-06-2005
			EP 1687891 A1	09-08-2006
			WO 2005055408 A1	16-06-2005