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(54) **SOFT CURRENT SWITCHING POWER SUPPLY**

(57) Embodiments of the present invention provide improved techniques and devices for reducing transformer commutation distortion caused by large load currents. Traditional power supplies which have two or more phases typically commutate a transformer during the end of each phase. When the load current is large, energy stored in the transformer's leakage inductance can cause undesirable effects during commutation. Embodiments of the present invention reduce these effects by lowering the voltage across the primary side of the transformer

prior to commutation. In one embodiment, a capacitor is added to the primary side of the transformer. A switch directs current through the capacitor prior to commutation, allowing the capacitor to absorb the transformer's leakage inductance energy and lower the primary side voltage. Other suitable components, such as resistors, diodes, transistors, or additional transformer windings, may also be used to reduce the primary-side voltage prior to commutation.

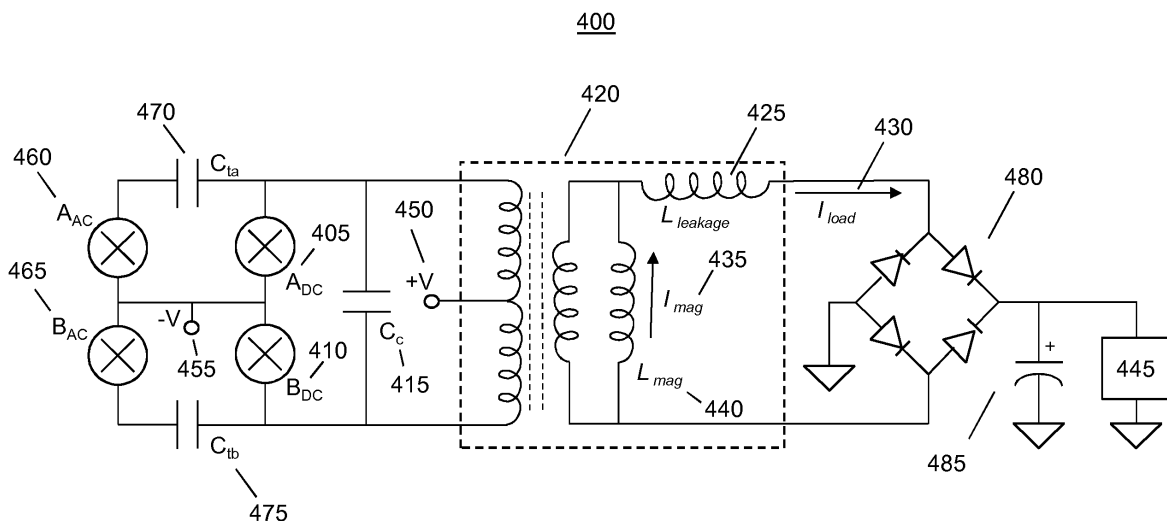


Figure 4



EUROPEAN SEARCH REPORT

Application Number
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 607 322 A (HENDERSON ERIC A [US]) 19 August 1986 (1986-08-19)	1-4,6-9, 12-14	INV. H02M3/335
Y	* column 2, line 60 - column 4, line 60; figures 1,3 *	5,10,11, 15	H02M1/34 H02M3/337
Y	----- WANG H ET AL: "Modeling and Analysis of a Current-Fed ZCS Full-Bridge DC/DC Converter with Adaptive Soft-Switching Energy", APPLIED POWER ELECTRONICS CONFERENCE AND EXPOSITION, 2009. APEC 2009. TWENTY-FOURTH ANNUAL IEEE, IEEE, PISCATAWAY, NJ, USA, 15 February 2009 (2009-02-15), pages 1410-1416, XP031442871, ISBN: 978-1-4244-2811-3 * page 1410 - page 1411; figure 1 *	10,11	
X	SU 877 757 A1 (YAKOVINA TATYANA [SU]; SHARAPOV ALEKSANDR S; MIKHEENKO VLADISLAV N) 30 October 1981 (1981-10-30)	1-4,6-14	
Y	* abstract; figures 1,2 *	5,10	TECHNICAL FIELDS SEARCHED (IPC)
Y	----- US 2007/201249 A1 (KNOTT ARNOLD [DE]) 30 August 2007 (2007-08-30) * figures 3,4 * * paragraph [0041] - paragraph [0045] *	5,15	H02M
----- The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 March 2017	Examiner Gusia, Sorin
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 16 19 2599

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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29-03-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4607322 A	19-08-1986	CA 1238948 A	05-07-1988
		EP 0195801 A1	01-10-1986
		IL 76067 A	30-06-1989
		JP S62500278 A	29-01-1987
		US 4607322 A	19-08-1986
		WO 8601950 A1	27-03-1986

SU 877757 A1	30-10-1981	NONE	

US 2007201249 A1	30-08-2007	EP 1811643 A1	25-07-2007
		US 2007201249 A1	30-08-2007

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82