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**United States Patent** [19]**Peng et al.**[11] **Patent Number:** **5,644,483**[45] **Date of Patent:** **Jul. 1, 1997**[54] **VOLTAGE BALANCED MULTILEVEL  
VOLTAGE SOURCE CONVERTER SYSTEM**[75] **Inventors:** **Fang Zheng Peng**, Oak Ridge;  
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Inc.**, Oak Ridge, Tenn.[21] **Appl. No.:** **446,366**[22] **Filed:** **May 22, 1995**[51] **Int. Cl.<sup>6</sup>** ..... **H02M 5/45**[52] **U.S. Cl.** ..... **363/37; 363/132**[58] **Field of Search** ..... **363/35, 36, 37,  
363/132**[56] **References Cited****U.S. PATENT DOCUMENTS**

4,651,266	3/1987	Fujioka et al.	363/39
5,038,267	8/1991	DeDoncker et al.	363/89
5,172,309	12/1992	DeDoncker et al.	363/132

**OTHER PUBLICATIONS**

D.A. Woodford, et. al., "Controlling a Back-to-Back DC Link to Operate as a Phase Shift Transformer", CIGRE 1994 Session Papers, Group 14, Paper 14-202, 1994 France.

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[57] **ABSTRACT**

A voltage balanced multilevel converter for high power AC applications such as adjustable speed motor drives and back-to-back DC intertie of adjacent power systems. This converter provides a multilevel rectifier, a multilevel inverter, and a DC link between the rectifier and the inverter allowing voltage balancing between each of the voltage levels within the multilevel converter.

The rectifier is equipped with at least one phase leg and a source input node for each of the phases. The rectifier is further equipped with a plurality of rectifier DC output nodes. The inverter is equipped with at least one phase leg and a load output node for each of the phases. The inverter is further equipped with a plurality of inverter DC input nodes. The DC link is equipped with a plurality of rectifier charging means and a plurality of inverter discharging means. The plurality of rectifier charging means are connected in series with one of the rectifier charging means disposed between and connected in an operable relationship with each adjacent pair of rectifier DC output nodes. The plurality of inverter discharging means are connected in series with one of the inverter discharging means disposed between and connected in an operable relationship with each adjacent pair of inverter DC input nodes. Each of said rectifier DC output nodes are individually electrically connected to the respective inverter DC input nodes. By this means, each of the rectifier DC output nodes and each of the inverter DC input nodes are voltage balanced by the respective charging and discharging of the rectifier charging means and the inverter discharging means.

**10 Claims, 9 Drawing Sheets**