Rapid charging of traction batteries - Fully resonant power converter circuit for generating an isolated direct voltage

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The invention relates to a power converter circuit and a power converter circuit system for generating and using an isolated direct voltage, as well as a procedure for generating an isolated direct voltage using a power converter circuit.

- Reduction of costs for chargers in the range of up to several 100kW
- No DC link capacitors required
- Reduced number of power semiconductors, low switching losses and very small windings with frequency multiplication on mains and secondary side
- Modular design consisting of 6 individual modules (350kW each) - fully automated production possible

Fields of application

Fast charging of traction batteries (HPC) and use for all power converter circuits and power converter circuit systems to generate a potential separated DC voltage.

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Service

Technologie-Lizenz-Büro GmbH has been entrusted with the exploitation of this technology and assists companies in obtaining licenses.

Background

Mobile electrical applications, especially in vehicle technology, require increasingly powerful traction batteries and accumulators in order to be supplied with sufficient electrical power over a longer period of time. In order to charge such powerful traction batteries with direct voltage, an electrical isolation between the feeding alternating current circuit and the direct voltage to be applied to a traction battery is required due to the high protection requirements for such charging stations. In state-of-the-art technology, this electrical isolation is achieved either on the mains side using transformers or within a power converter by using a high-frequency clocked frequency converter. These frequency converters in the power converters are usually single-phased and are fed from an upstream direct voltage intermediate circuit.

Problem

For high charging capacities above 100 kW, charging stations with a mains-side transformer or a power converter with direct voltage intermediate circuit and frequency converter are very expensive. A fundamental reason for this is the cost of the winding material and the capacitors for intermediate power storage which are needed for such electrical circuits in the charging stations. In this case, suitable mains transformers cannot be produced automatically and, in addition, high manufacturing costs are incurred due to the high material costs for iron cores and winding material. When using frequency converters in this power range, the switching frequencies to be used are comparatively low and therefore force manual and thus cost-intensive wiring of the power converter circuits.

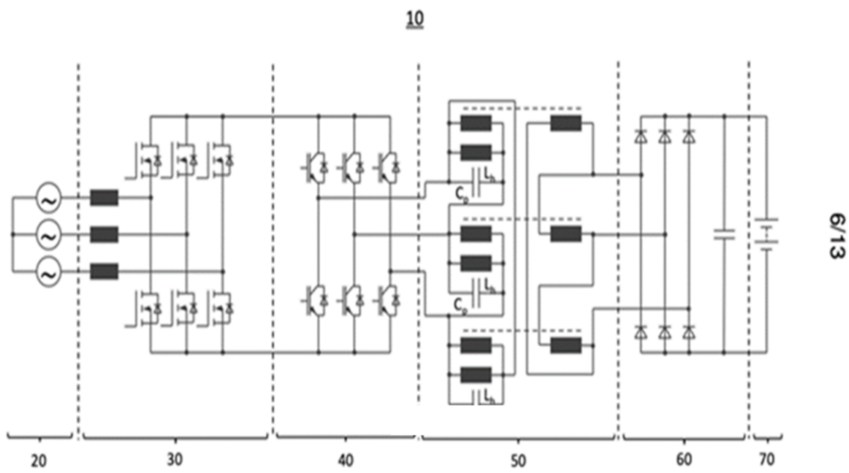
Solution

The present invention provides a power converter circuit and method for generating a potential-separated DC voltage, which results in lower costs for the winding materials and energy storage devices to be used and enables largely automated manufacturing.

The power converter, which generates sinusoidal currents on the mains side, is designed as a direct current converter without intermediate circuit capacitors. The electrical isolation is realized using a three-phased medium-frequency transformer with head gap which is extended to a three-phased parallel oscillating circuit (see Figs. 1 and 2). Owing to the principles involved, the isolation's power semiconductors do not have any switching loss.

The power converter circuit offers the advantage that higher switching frequencies are possible compared to conventional power converters with a direct voltage intermediate circuit and frequency converter. This makes it possible to reduce the size of the winding material used for input inductance and transformers. The use of large and therefore expensive capacitors such as electrolytic capacitors for intermediate power storage in the direct voltage intermediate circuit can be completely dispensed with. The smaller winding material and capacitors used for the power converter circuit are also more easily integrated into an automated manufacturing process of the power converter circuit and lower both the costs of material and the costs of the manufacturing process.

In this case, the power converter circuit does not require a direct voltage intermediate circuit, but instead, from the input side in the direction of the output, has an input power converter, an m-phase oscillating circuit power converter, an m-phase transformer and a rectifier bridge. The power converter circuit can be connected and/or joined on the input side to an n-phase mains supply and on the output side to an accumulator which is to be charged.



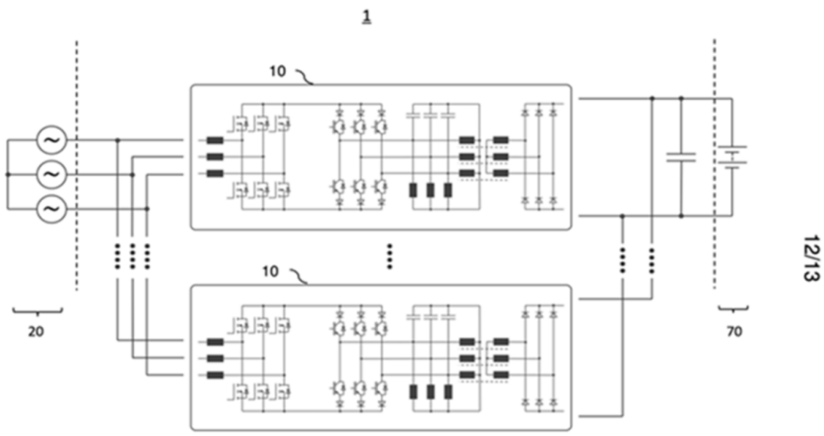


Fig 1 / Fig 2: 1 Power converter circuit system 10 Power converter circuit 20 Alternating current circuit 30 Input power converter 40 Oscillating circuit power converter 50 Transformer 60 Rectifier bridge 70 Accumulator Cp Oscillating circuit capacitor Lh Main inductance of the transformer

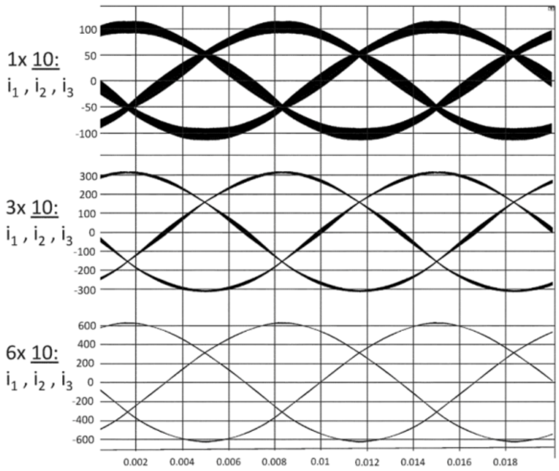


Fig 3: Time progression of input currents (i1, i2, i3) in a power converter circuit system with parallel (1x, 3x, 6x) switching power converter circuits 10. [Fig. 1-3: M.Kokes, Technology, Economics, Computer Science, University of Applied Sciences Heilbronn].