Power Supply for Powerful Generators with high pulse repetition rate

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Problem

- Typically, high-power pulse generators are fed from a three-phase mains supply of 380V 50Hz. The Larionov bridge (three-phase bridge rectifier) is used for rectifying this AC voltage and converting it to DC voltage with maximum amplitude of 545V. In this case, 300Hz output voltage ripples are about 17%. Since, in some cases, such waveform is not suitable for system power supply, the ripples can be reduced by a capacitive filter connected downstream of the Larionov rectifier. High-power pulse generators (>300Hz) require high-capacitance filters. So, in the S-5N generator [1] with an output frequency of 1kHz, a 32mF filter is used. Such filters are bulky, heavy, and expensive. Moreover, high energy content reduces reliability of the system in case of uncontrolled deep discharge as a result of a failure or emergency.

- When operating with a high pulse frequency, the filter supplies power to the system when it is recharging. Therefore, during such periods, the voltage in the filter decreases with each pulse based on the energy taken. The supply voltage reduction causes changes in the output pulse parameters. In some cases, it is unacceptable. This phenomenon is most noticeable in systems comprising a magnetic compressor [2, 3].

- To solve this problem, it is possible to use power sources with operating frequencies much higher than those of the generated pulses (high-frequency inverters). However, the construction of units with such output power (tens of kilowatts) is not a trivial task. The proposed approach allows reducing development costs of the power supply unit while ensuring the output voltage stability.

Solutions

- A hybrid power supply source combining the efficiency and simplicity of the Larionov bridge, as well as voltage stability of high-frequency inverter is proposed. Briefly, a relatively low-power source (1) is connected to a standard rectifier with a filter. According to the experiment, its power does not exceed 10% of the total power consumption. Creating an additional high-frequency power supply source with an output power of several kilowatts is no longer a challenging task. Fig. 1 shows a block diagram and operating principle of the power supply source. The Larionov bridge (2) provides the primary power of the source. An additional high-frequency inverter stabilizes the output voltage and eliminates the ripples. It allows reducing the capacity of the output filter (3) significantly, without affecting the output parameters of the power supply source. A feedback circuit, which provides real-time monitoring of the output voltage, is designed to stabilize the output voltage (4, 5).

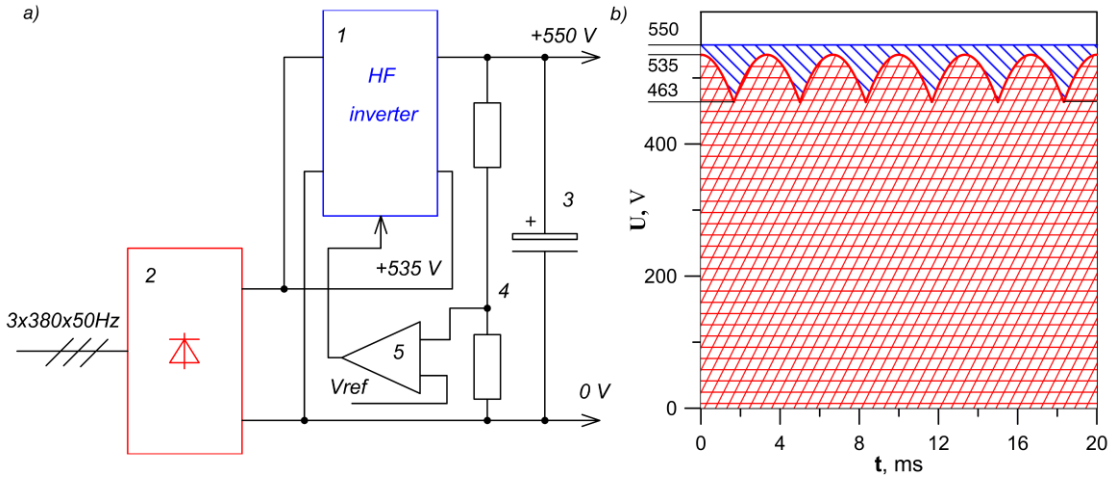

Fig. 1. Block diagram (a) and operating principle (b) of the power supply source

Conclusion

- The developed hybrid power supply source has the following advantages:
- Supply voltage stability, eliminating changes in the pulse parameters of the high-voltage power generator;
- Reduced dimensions, weight, and cost of the capacitive filter;
- Increased reliability and safety due to reducing the filter capacity and, therefore, the stored energy;
- Lower development costs.

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