The design of automotive alternator with high efficiency

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Abstract. A technical solution aimed at increasing the motor life and efficiency of the automotive alternator to an average of 80% is suggested by replacing the permanent magnets on the stator with electromagnetic ones, reducing the number of gaps and their geometric parameters, as well as eliminating brush contacts.

1. Introduction
The proposed technical solution relates to the field of electrical equipment of the vehicle, in particular the electric generators of the vehicle (alternator). It can be used in the automotive industry.

Famous automotive alternator [1-9], which contains the rotor with pole halves on a movable shaft; a stationary magnetic circuit with the field winding between the rotor and the pole halves; the stator winding of the generator. In this case, the pole halves of the movable rotor are located between the magnetic core with the excitation winding and the magnetic core of the stator with the generator winding.

The disadvantage of it [1] is the low efficiency due to the set of gaps and their geometric dimensions. For example, there is the gap between the rotor and the fixed magnetic core with the excitation system winding and the gaps between the pole halves, as well as the gap between the stator magnetic core with the generator winding and the mentioned pole halves.

2. Problem Statement
The increasing of the service life and the efficiency of the automotive alternator to 80% by the replacement of the permanent magnets on the stator solenoid and reducing the number of clearances and geometry, as well as the exception of the brush contacts.

3. Technical Solution
Automotive alternator includes a movable shaft of the rotor pole halves, a stationary magnetic circuit with the field winding and a stationary magnetic circuit of the stator winding of the generator. The rotating pole halves of the rotor are located in the gap between the mentioned stationary magnetic cores with the excitation winding and the stator with the generator winding. A rotating shaft made of non-magnetic material has support bearings at the ends. The first magnetic core of the rotor with a six-phase winding of the machine pathogen system is situated at one end. In the middle of the shaft there are two three-phase rectifiers with "LC" high-pass filter, the input of which is connected to the multiphase winding, and the output is connected to the excitation winding of the generator. The excitation winding of the generator is located on the second magnetic circuit and is located at the other
end of the shaft. In this case, the excitation winding with a magnetic core is located inside the cavity of its stationary second stator, represented by a magnetic core with a generator winding.

The winding of the rotor of the machine exciter has a six-phase "star" scheme, symmetrically located in the grooves along the surface of the rotor magnetic circuit. The winding of its fixed stator is connected to a DC source, and the ends of the stator windings of the generator according to the scheme "star" are displayed on the clips on the generator housing. Two three-phase rectifiers are connected to the six ends of the rotor windings, on the terminals of which there is a "LC" high-pass filter. The rectifiers and the "LC" filter are evenly mounted on the shaft of the generator. The general body of the machine exciter system and the generator system is made of non-magnetic material and contains the inputs of the stator excitation winding of the machine exciter, provided for the parameters for connection to the car battery. The output of the stator winding of the generator has a three-phase circuit provided for the parameters for connection to the electrical loads of the car.

4. The principle of operation of the presented generator.

The schematic diagram of the generator is presented in Fig. 1. A battery is connected to the input (1) of the stator winding (2) of the machine exciter system (3). The current flowing through the winding (2) forms a constant electromagnetic field of the stator of the machine exciter system (3). Since the shaft (4) rotates by rotor windings (5), an induction voltage (EMF) is formed in them. The induction voltage is rectified by two three-phase rectifiers then filtered by the "LC" filter (7) into a constant voltage. The rectified voltage is applied to the excitation winding (8). Since the excitation winding is located on a rotating shaft, a rotating constant electromagnetic field is formed, the power lines of which cross the stationary winding (9) of the stator of the generator system (10). As a result, the required three-phase alternating voltage of the generator system is generated in the stator winding.

In this case, the generator has two gaps with minimum dimensions, on average 1mm, the excitation system is on the one hand along the shaft, the diodes of the two rectifiers and the "LC" filter are in the middle, and the generator system is on the other side.

Figure 1. Schematic diagram of the generator.
1 – input, 2 – machine exciter, 3 – machine exciter systems, 4 – shaft, 5 – rotor windings, 6 – diodes, 7 – "LC" filter, 8 – excitation winding, 9 – stationary stator winding of the generator system, 10 - three-phase alternating voltage of the generator system, 11 – bearings.

5. Conclusion.

This technical solution ensures the implementation of the goal – to increase the efficiency of the automotive generators on average up to 80% by eliminating permanent magnets, the use of
electromagnets, reducing the number of gaps and their geometric dimensions, as well as eliminating brush connections in electrical circuits.

The proposed technical solution is protected by a utility model patent [10] and can be implemented in the automotive industry.

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