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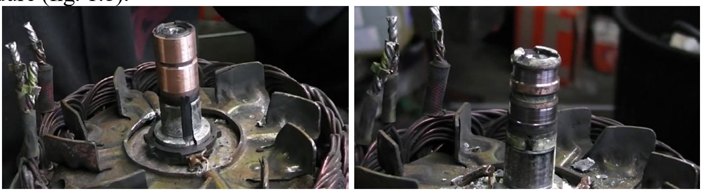
Lifetime Improvement of Contact Brush Unit of Automotive Power Machines

A new approach of lifetime improvement of automotive power machines like an alternator or starter is proposed. The result of experimental research of improvement technique on laboratory specimens is provided.

Problem statement.

The automotive electric equipment involves the electric machines (starter, alternator) incorporating the brush unit (fig. 1.a) and hybrid drive vehicles as well. It is the friction joint of conducting copper and graphite brush [1]. Work efficiency and lifetime of these machines strongly depend on the contact quality and general state of this friction joint. Wear products of graphite and copper results in short-circuiting of the starter plated commutator thus reducing its performance during the ICE start procedure (fig. 1.b).



a) b)

Fig. 1. Typical wear defects of the alternator contact brush unit: a) – new contact ring commutator: b) – worn contact ring commutator

Research objective. Thus preset objective of this study is research of friction joint of brush unit “copper-graphite” under working current flow and technique of its superficial improvement.

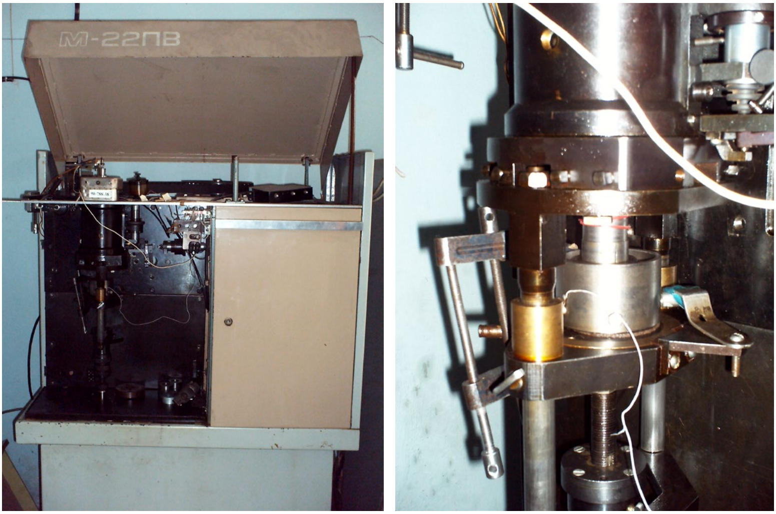
Methods. For experimental purposes the samples of M1E electric conductive copper ГОСТ 859-2001 complying with ТУ 1276-003-38279335-2013 were fabricated in dimensions of hole disks 16×6×2,5 mm in order to provide the least friction contact area for experiment acceleration (fig. 2.a).

a) b)

Fig. 2. Experimental testing samples: a) – new just fabricated copper samples simmulating contact ring commutator: b) – real graphite alternator brush simmulating itself.

As the friction counterbody the conventional alternator brush (fig. 2. b) made of graphite ГЭ-1, ГОСТ 7478-75 was used. Copper samples were strengthened by electro-spark alloying using the unit ALIER-52 on 6-7 modes by aluminum electrode made of rod aluminum ГОСТ 15176-89. Electrospark alloying of copper-alluminium metals couple allows acquisition of different coatings using the direct and reverse polarity and particularity of mass transffer process [2].

The coated and uncoated samples were tested on the friction test bench M-22ПВ (fig. 3.) under "pin-on-shaft" layout. Conventional vehicle alternator brush unit has been used in a friction test bench, so the load was equal to brush spring force. Friction speed was about 1,5-2 m/s that complies the test bench shaft rotation speed about 2000-2400 rpm. In order to simulate the brush unit work the 24 V DC voltage was applied to friction contact and linear wear rate was detected.



a) b)

Fig. 3. Friction test machine M-22ПВ, allowing tests of insulated samples under current and in vacuum chamber as well: a) – general view: b) – view of friction unit.

Main research results. So uncoated samples have demonstrated the wear rate of 345,5 micrometers per kilometer, unlike coated samples that have the wear rate 81,8 micrometers per kilometer what is about 4,26 times improvement of electro erosive wear resistance. Unlike it the graphite brush has worsened the wear resistance, so together with uncoated sample graphite brush had the wear rate 52,2 micrometers per kilometer comparing with the coated sample 178 micrometer per kilometer, so the brushes will wear the 3,4 time faster than the coated ring of vehicle alternator under electro erosive wear voltage (fig 4. a and b).

In order to explain and improve the obtained tribotechnical behavior of copper sample with graphite under the electro erosive wear that models the friction unit of ring-brush conductor of vehicle alternator the initial structure of copper, copper coating and friction surfaces were studied on the optical and electronic microscope. The strengthening phase in copper is the gamma-phase solid solution of aluminum in copper. It is well conductive for current and heat from the surface. Enriching the superficial content of aluminum the delta-phase solid solution of aluminum in copper, which hardness and melting temperature is less and bigger conductivity close to aluminum [3].

a)

b)

c)

Fig. 4. Experimental testing samples: a) – coated copper samples after testing: b) – uncoated copper samples after testing: c) – graphite brush after testing.

Conclusion. Thus the technique researched is suitable and can be recommended for improvement of brush units of vehicle alternators and starters, DC engines collectors for electric power vehicles, hybrid vehicles and quadracopters as well.

References

1. Carbon brushes for motors and generators. Technical Guide. Mersen's. 2020, 39 p.
2. M. F. Dmitrichenko, V. V. Varyuhno, A. V. Kulinich, A. G. Dovgal, and V. P. Koba, Extension of Resource of Power-Plants' Parts of Aviation Ground Equipment under Operating Conditions, Metallofiz. Noveishie Tekhnol., 39, No. 1: (2017) 69–81.
3. Andrii Dovhal Lifetime Improvement of Contact Brush Units of Automotive Power Machines. Book of Abstracts of 8th International Materials Science Conference HighMatTech-2023, October 2-6, 2023 Kyiv, Ukraine. p. 83.