UDC 621.793.7

RESEARCH OF A METHOD FOR RESTORING WORN AUTOMOBILE PARTS BY USING ELECTRO-SPIRCULATION COATINGS BASED ON ELECTRO-ESCRIPT NANOMATERIALS

R.S. Kryvoruchko, *Student of Group MM 1/2,*
S.S. Kurochkin, *Student of Group MM 1/2,*
S.V. Mostovyy, *Student of Group MM 1/2,*
D.D. Marchenko*, Assoc. Prof, PhD tech. sci.,*
O.O. Lymar*, Assoc. Prof, PhD phys. -math. sci.*
Mykolayiv National Agrarian University, Mykolayiv, Ukraine

A modern car consists of 15...20 thousand parts, of which 7...9 thousand lose their original properties during operation, and about 3...4 thousand parts have a service life shorter than that of the car as a whole. All this causes the greatest downtime of cars, resource costs of operation [1].

A literature review has shown that more than 70% of worn-out parts of automotive equipment would be rationally reused after restoration. This significantly reduces the resource costs of motor transport enterprises, and in addition, it is economically justified for repair production. The costs of restoring parts in most cases do not exceed 25-30% of their cost, and with a qualified appointment of restoration technology, 100% resource is achieved. The different service life of automotive parts is due to various reasons. The main ones are: functional purposes performed, a diverse range of loads, different types of friction in the connected parts and different materials from which they are made, accuracy and quality of processing in the connected parts [2].

Automotive parts of the “shaft” type make up a large part of the range of parts that are restored. In most cases, these parts limit the resource of machine components and assemblies. Their restoration coefficient during major repairs of machines is 0.25 ... 0.95. The length of the restored shafts is 100 ... 4000 mm, but more than 90% of these parts have a length of slightly more than 1000 mm. The diameters of the shafts are 12 ... 210 mm, but in 98% of the shafts the diameter does not exceed 60 mm. The average mass is about 3 kg.

In parts of the "shaft" type, defects most often appear on the bearing seating surfaces and threaded surfaces. Bearing surfaces are restored when wear exceeds 0.017...0.060 mm; surfaces of fixed connections (hub locations with keyways, etc.) due to additional parts - when wear exceeds 0.04...0.13 mm; surfaces of movable connections - when wear exceeds 0.4...1.3 mm; under seals - more than 0.15...0.20 mm [3]. Keyways are restored when wear exceeds 0.065...0.095 mm in width; spline surfaces - when wear exceeds 0.2...0.5 mm [4].

Of the entire set of restored shaft surfaces, 46% wear down to 0.3 mm; 27% - from 0.3 to 0.6 mm; 19% - from 0.6 to 1.2 mm and 8% - more than 1.2 mm (Fig. 1).

The main requirement that must be met when restoring shafts is to ensure the dimensions and roughness of the restored surfaces, their hardness, coating continuity, adhesion strength of the applied layers to the base metal, as well as symmetry, coaxiality, radial and end runout of the treated surfaces, and parallelism of the side surfaces of the teeth of the spline and keyway grooves of the shaft axis.

Automotive shafts are made mainly of medium-carbon and low-alloy steels [5]. They are subjected to surface hardening with high-frequency currents, carburizing with subsequent quenching, and normalizing.

After analyzing the literature [1-3], defects in "shaft" type automobile parts are usually divided into three groups: mechanical damage, chemical-thermal damage, and wear of "shaft" type automobile parts.

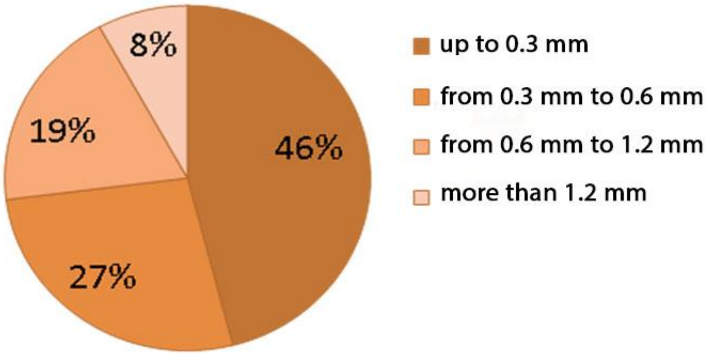

Fig. 1. - Analysis of defects of shaft-type parts by degree of wear

Mechanical damage to shaft-type parts occurs as a result of damage to its surface by cracks, risks and scoring, as well as possible bending of the shaft, its breakage or twisting [6].

In some cases, risks and gouges form on the working surfaces of shaft-type parts, especially often this occurs in shaft-slide bearing joints, due to contamination of the lubricant or the abrasive action of foreign particles [7].

When surfacing under a layer of flux, a loose flux is fed into the arc burning zone (Fig. 2), which consists of individual small grains (grains). Due to the influence of high temperature, part of the flux melts around the arc, forming an elastic shell that protects the molten metal from the action of nitrogen and oxygen [8]. After the arc moves, the liquid metal solidifies together with the flux, forming a brittle slag crust on the surfacing surface. The flux that has not melted can be used again. Surfacing under a layer of flux is used to restore various parts of cars, tractors and agricultural machinery.

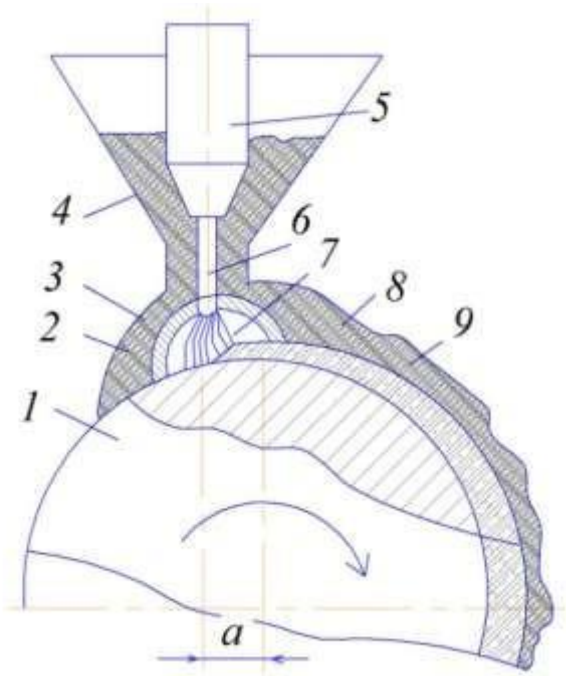

Fig. 2. - Scheme of automatic surfacing:
1 - part to be surfacing; 2 - liquid flux shell; 3 - elastic shell; 4 - hopper with flux; 5 - mouthpiece; 6 - electrode;
7 - electric arc; 8 - slag crust; 9 - surfacing metal; a - Offset from the zenith

In cases where it is necessary to weld a layer with a thickness of more than 3 mm (when performing welding on parts of the chassis of tractors and agricultural machines - rollers, axles, rollers, axles, etc.), automatic welding is effective [9, 10]. Deep penetration is undesirable, as it increases the deformation of the parts.

In the technology of mass restoration of smooth and splined shafts, the organizational plan applies the advanced principle of group restoration technology, the creation of unified group equipment for restored surfaces of parts [11]. According to the technology, it is necessary to switch to high-performance gas-thermal methods of applying powder materials with increased wear resistance for the external cylindrical surfaces of movable and fixed connections.

List of sources used

1. Mashkina, M. N. Vyvchennya vtrat kobalʹtu pry elektroeroziynomu dysperhuvannya splaviv hrupy VK / M. N. Mashkina // Zvaryuvannya i rodynni tekhnolohiyi v mashynobuduvanni i elektronitsi: rehionalʹnyy zbirka naukovykh pratsʹ. - 2001. - S.143-145.
2. Petrydis, A. U Doslidzhennya poroshku tverdoho splavu, otrymanoho elektroeroziynym dysperhuvannyam / A.V Petridis [ta in.] // Problemy khimiyi ta khimichnoyi tekhnolohiyi: tezy ta materialy dopovidey rehionalʹnoyi naukovo-tekhnichnoyi konferentsiyi. - 1995. - S.31-36.
3. Fominsʹkyy, L. P. Osoblyvosti poroshkiv, oderzhuvanykh elektroeroziynym dysperhuvannyam u vodi splavu typu sormayt / L. P. Fominsʹkyy, S. P. Tyrabina, M. S. Levchuk // Novi metody otrymannya metalevykh poroshkiv: zbirka naukovykh pratsʹ. - Kyiv, 1985. - S. 109-113.
4. Marchenko, D., Matvyeyeva, K. (2022). Increasing warning resistance of engine valves by gas nitrogenization method. Problems of Tribology, 27(2/104), 20–27. https://doi.org/10.31891/2079-1372-2022-104-2-20-27.
5. Marchenko, D., Matvyeyeva, K. (2022). Study of the Stress-Strain State of the Surface Layer During the Strengthening Treatment of Parts. Problems of Tribology, 27(3/105), 82–88. https://doi.org/10.31891/2079-1372-2022-105-3-82-88.
6. Marchenko, D., Matvyeyeva, K. (2023). Increasing the Wear Resistance of Restored Car Parts by Using Electrospark Coatings. Problems of Tribology, 28(1/107), 65–72. https://doi.org/10.31891/2079-1372-2023-107-1-65-72.
7. Marchenko, D., Matvyeyeva, K. (2023). Research of Increase of the Wear Resistance of Machine Parts and Tools by Surface Alloying. Problems of Tribology, 28(3/109), 32–40. https://doi.org/10.31891/2079-1372-2023-109-3-32-40.
8. Marchenko, D., Matvyeyeva, K., Kurepin, V. (2024). Increasing the wear resistance of plunger pairs of high-pressure fuel pumps using extreme pressure additives. Problems of Tribology, 29(4/114), 24–31. https://doi.org/10.31891/2079-1372-2024-114-4-24-31
9. Marchenko, D., Matvyeyeva, K. (2024). Study of Wear Resistance of Cylindrical Parts by Electromechanical Surface Hardening. Problems of Tribology, 29(1/111), 25–31. https://doi.org/10.31891/2079-1372-2024-111-1-25-31.
10. Kononov, Y., & Lymar, O. (2022). Stability of the Coupled Liquid-Elastic Bottom Oscillations in a Rectangular Tank. Journal of Theoretical and Applied Mechanics (Bulgaria), 52(2), 164-178. doi:10.55787/jtams.22.52.2.164.
11. Hruban, V., Pastushenko, A., Khramov, M., Lymar, O., & Sukovitsyna, I. (2024). Study of mechanical and technological properties of seed fruits of vegetable and melon crops. Ukrainian Black Sea Region Agrarian Science, 28(1), 29-39. https://doi.org/10.56407/bs.agrarian/1.2024.29.