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Increasing the industrial locomotives resource by improving technologies of the crankshaft engine rehabilitation

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Summary. The technological process of renewal of crankshafts of large diameters is described by the method of polishing and induction hardening of necks. The stages of technological process are described in detail, a flow-chart is built.

Key words: technological process, crankshaft, peening, polishing, quirk, neck of billow, oily channel, nitrided layer

FORMULATION OF THE PROBLEM.

One of the most pressing problems of Ukrainian railways is the physical and mental aging of locomotive fleet. The resource of previously issued locomotives has been exhausted, so the technical services of Ukrzaliznytsya had to develop a strategy of providing the traffic on the railways of the country. The Ukrainian Cabinet of Ministers approved the locomotive fleet renewal program of the Ukrainian railways for 2012-2016. [1, 14]. The purpose of this program is to upgrade the locomotive fleet of the railways of the country to ensure a smooth transportation of passengers and cargo. Given the state of the Ukrainian economy and the distribution of operating costs for rail locomotive economy prospects replacing the worn-out locomotives with the new ones, more fuel-efficient, id unlikely. The most realistic way is the modernization of the existing locomotives. The problem of renewal of the traction rolling stock will be addressed, in addition to the development and procurement of the rolling stock of the new generation, in two areas [2, 3, 4, 20]:

- improving the efficiency and the use of the existing rolling stock through the *modernization and reduction of non-working park;*
- lengthening the service life of the existing rolling stock by performing the overhaul and refurbishment.

The same way chose the industrial enterprises engaged in a substantial amount of in-plant rail.

Crankshaft, without doubt, is one of the main, if not the most important, engine parts, that determines its reliability and durability. This is easily seen, if to compare the price of the crankshaft to the price of any other engine parts. [5, 13] Therefore, the crankshaft repair in the case of its damage during the usage of the locomotive is economically more advantageous than buying a new one. The technological process of repair and restoration of the crankshaft provides not only a remedy in the operation of geometric parameters, but also, and mainly, the containment of the destructive processes that naturally occur on the surface of its part. It means, for sufficiently large number of ways to restore the crankshaft, the urgent task still is to find new and effective repair technologies providing increase of their working surfaces.

ANALYSIS OF THE LATEST RESEARCHES AND PUBLICATIONS.

For recovery of the worn crankshafts the treatment for repairing size is the most commonly used. The essence of the method – the treatment of the crankshaft damaged surfaces in order to repair the damages, without changing the detail's geometrical axis [5]. The advantage of the method is its simplicity and low cost, as no additional

metal and sophisticated equipment is needed. The disadvantage of the method stems from the fact that the depth of the hardened layer necks, initially, in the manufacture of shafts, as a rule, does not exceed 0.25-0.4 mm, and reconstruction measures differ from one another in 0.25-0.5 mm in diameter, starting from the second repairing size, due to removal of the hardened layer of metal wear, the crankshafts rate wear rate of the main and connecting rod journals grows, which dramatically reduces the service life of the engine.

In order to overcome this limitation the re-nitriding recommended to use, but it has disadvantages, such as the duration of the process, the hazards of production, the use of high temperatures and deformation of hardened parts, and, consequently, the increase in allowances for machining, as well as high energy consumption[6].

Over the past several decades, the extensive use of non-traditional methods of hardening the details increased durability and strength characteristics of products, one of which is a discrete hardening. The method involves setting up a working surface of the detail with alloy materials in the form of spaced apart lines of all possible configurations etc. According to the research the result is a significant in - 1.5-3.5 times increase in wear resistance of samples surfaces with discrete hardening. This method is used to improve the wear resistance of the necks within the nitrided layer[5].

The method of discrete hardening is only applied within the removed layer of 2 mm in diameter, in practice. Because of the use of low quality oils, lack of proper oil level control, and late replacement of the filters, continuous operation of the engine at maximum output, etc., 10-15% of the crankshaft get damages indigenous or crank pins in the form of cracks, deep scoring, the size of which comes to 3 - 3.5 mm in diameter, such crankshafts cannot be restored using the above method [19].

Therefore, for diesel engines new, more advanced methods of restoration of crankshafts are needed. It is offered to repair these crankshafts by the method of grinding with subsequent induction hardened HDTV.

Technological processes of recovery of small size crankshafts for engines of the automobiles and tractors and described in the literature [6, 7, 8, 9, 15]. Repair and restoration of large crankshafts for diesel locomotive has a coherent description of the structure, there are only descriptions of the individual processes.

THE PURPOSE OF THE ARTICLE

The application of the method of grinding and induction hardening of the necks during the recovery of large diameter crankshaft used on diesel 5D49. Holistic description of the process of restoring the crankshaft 5D49 diesel by the method of grinding and induction hardening of the necks. Crankshaft 5D49 diesel engine is part of the shaft group with a diameter of the main and connecting rod journals from 150 mm to 300 mm, which are used in shunter locomotives in metallurgical, chemical, mining and other industrial plants.

During the operation these crankshafts work surface necks is damaged in depth up to 1.3 mm in the form of wear cracks, dents, corrosion.

Materials and research results. Preparatory step crankshaft recovery technology by using the method of grinding and induction hardening of the necks are works on the cleaning, pre-stripping and "sanding" of all its necks. These transactions are made in order to prepare the shaft for detailed measurement and research, which will enable to produce all repairs and restoration operations in high quality.

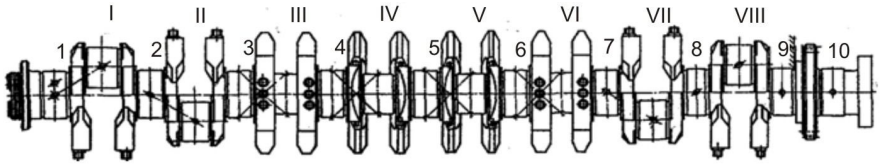
The first step is to carefully measure the shaft necks, to conduct the damage and visual inspection, the results of which are recorded in a defect paper (table 1) [17].

Next is the disassembly of the shaft, the removal of balances for this the shaft is mounted on a stand, the installation marking of the balances is checked, and it is restored if it is absent.

The next step in the restoration of the crankshaft is gagging on a special stand. In order to hold the shaft gaging should the amount of each main necks beats in 2 planes should be measured. The shaft gaging is made in order to preserve the "natural axis" and to provide a uniform metal removal at the reducing shaft necks [10]. Many manufactures do not pay attention to the deformation of the crankshaft. They take and polished curves crankshafts, and think that they would become straight after that. And that's enough. But it is not. As, at the ends of the crankshaft there are seating surface gears, pulleys, flywheels, and the working surface of the packing. All of these surfaces after repairing the crankshaft grinding are misalignment to the main necks, it means they acquire mutual beating. In addition, this crankshaft in further operation "remembers" its correct position and returned to it, and therefore, once again comes into disrepair.

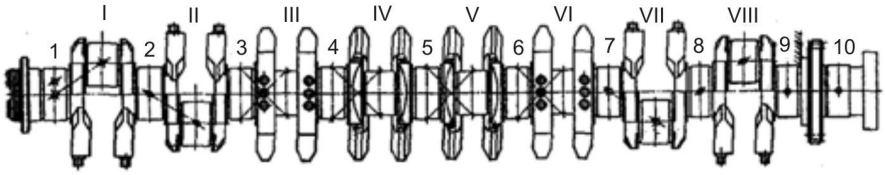
Table 1. Defect sheet of the crankshaft,

that is given in for repair according to the agreement №_____ from _____year
diesel locomotive №_____section_____diesel_____№_____ crankshaft №____
place of examination_____ date_____



measuring diameters of indigenous necks should be performed at the location of the 1st and 8th crank necks at the upper position (see the figure)

beating of the indigenous necks relating the axis	Number of neck	diameter indigenous necks	Diameter of indigenous necks, mm									Notes
			Size from drawing∅ 220									
			Waist of measuring									
			A-A			B-B			C-C			
			Plane of measuring									
	1		I-I	II-II	III-III	I-I	II-II	III-III	I-I	II-II	III-III	
	…											
	10											



measuring diameters of indigenous necks should be performed at the location of the 1st and 8th crank necks at the upper position (see the figure)

Number of neck	Diameter of indigenous necks, mm Size from drawing ∅ 190									Notes
	Waist of measuring									
	A-A			B-B			C-C			
	Plane of measuring									
	I-I	II-II	III-III	I-I	II-II	III-III	I-I	II-II	III-III	
1										
…										
8										

Representative of the customer_____ Representative of the executive

Now it is needed to conduct the work on the crankshaft preparing to quenching HDTV: cut and cement the fillet damaged necks, re-check or correct the axis of the crankshaft, by grinding to remove the defects (scratches, cracks, flows, etc.) on a damaged necks. In preparation for the restoration of damaged necks the attention should be paid to completely remove the nitrided layer from them. Particularly the removal of the nitrided layer is checked in oil canals of the damaged necks to a depth of 40 mm. This is done so that when hardening HDTV not to created the conditions for the appearance of cracks in the oil canals.

Next, the shaft should be put on a special rig on hardening HDTV crankshaft necks (fig. 1)

Before you begin the process of hardening it is necessary to isolate the inductors from possible closure. It is done using protective devices made from fiberglass, which isolate the inductor from the cheeks of the crankshaft. On broken neck the protection device is installed in a copper cap (fig. 2), which is put into the oil canal tightly and secured by a special pin. The protrusions of the pins are gashed with the surface of crankshaft neck. Then the surface of the neck and the cheeks is cleaned from copper shavings and dirt, and the

degreasing is done. The next step is setting the inductor, withstanding the necessary gaps by connecting the inductor to the power supply, water cooling of the setup.

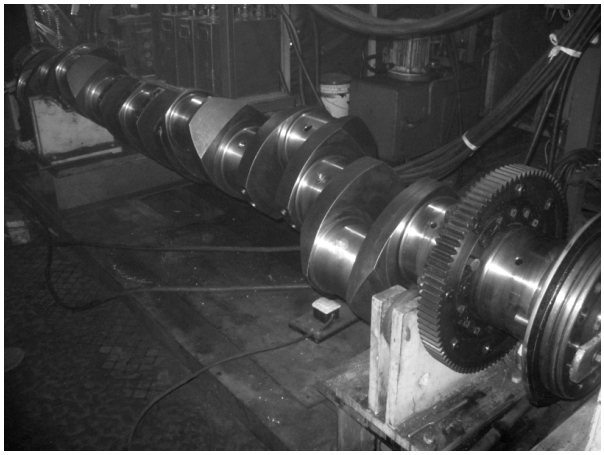


Fig. 1. The setting of the shaft on a special stand

Fig. 2. A copper pin, installed on the damaged neck and polish flush

Immediately before the actual process of tempering it is necessary to make testing:

- of the isolation of the rotating parts of the shaft and the inductor with OM-meter;
- the feed rate of inductor on the length of the quenched neck;
- the voltage and current on the inductor.

After testing the hardening of the crankshaft is performed according to the technological regimes (fig. 3). Then, the cooling of the shaft is conducted in position on the cheeks reduction (fig. 4).

The removal of inductors after hardening is permitted, and it is necessary to prevent the ingress of water from the inductors on the surface of the neck.

After quenching the hardness is checks, the protection is removed and the oil canals are gashed on the depth of the nitrided layer removal that is followed by a test for cracks. After quenching HDTV, before finishing sanding, it is necessary to re-establish the axis of the shaft by editing.

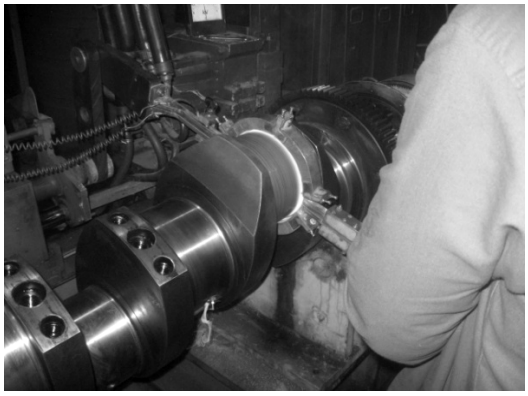


Fig. 3. Induction crankshaft hardening

Fig. 4. Hardened crankshaft radical necks

After the final sanding it is mandatory to blunt a radius of 2 mm of oil canaledge to the surface of the neck [11]. This edge is needed to be cemented, by polishing the surface of the necks which should be brought up to the required amount of surface cleanliness. The crankshaft must necessarily pass the penetrant for cracks, the measuring of diametrical sizes to match the size of the drawing, as well as the axial and axial and end face beats. [12]

Fig. 5. Shaft construction on a special stand

Fig. 6. Preserved crankshaft

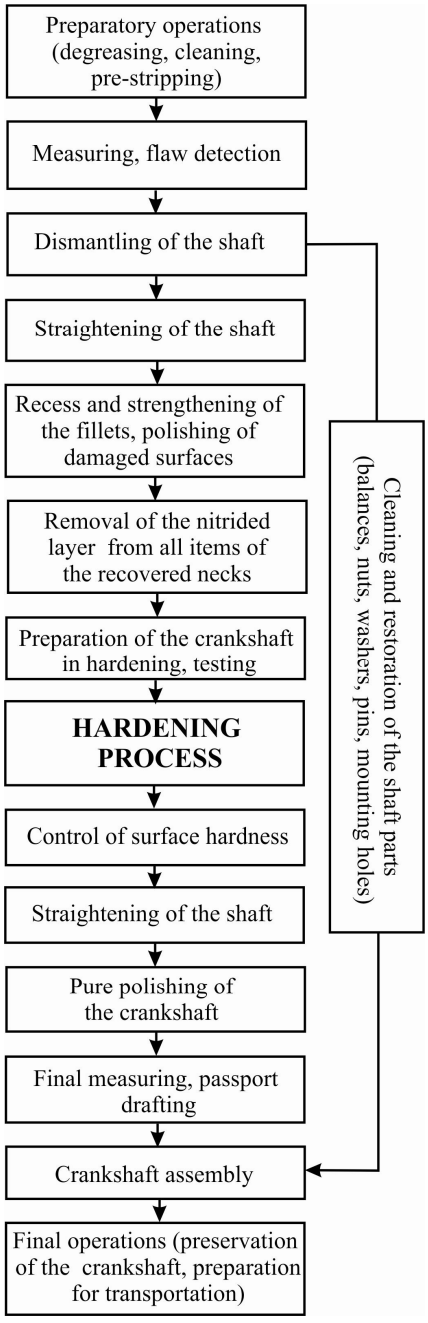


Fig. 7. The technological process of the crankshaft recovery by the method of quenching HDTV

The final stage of the process is construction of the shaft on a special stand. Counterweights are installed in accordance with the marking on the places. The studs and tighten are screwed with a special key with the use of a small-sized hydraulic tool (press) (fig. 5) The crankshaft, having last overhaul and refurbishment should be carefully preserved, so that during the storage and transport its surface does not corrode (fig. 6).

The entire cycle of recovery of the crankshaft is implemented in the new process (fig. 7).

CONCLUSIONS

1. This method allows to recover 20-40 crankshaft per year, in condition that the repair cost will not exceed 40-60% of the cost of a new crankshaft, this method can be considered appropriate.

2. Holistic process for recovery by using the method of grinding and induction hardening of the crankshaft necks 5D49 gives the opportunity to optimize the recovery process of large diameter shafts. 5D49 shaft is a part of the shafts with a diameter of main and connecting rod neck from 150 mm to 300 mm, which are used in shunter locomotives in metallurgical, chemical, mining and other industrial plants.

REFERENCES

1. **Nechaev G.I. Balitskaya O.M., 2011.:** Improving the performance of the rolling stock by improving the technology of repair its units. - Visnyk of ENU named after V. Dal. - № 4 (158) part 2. - p. 126-131.
2. **Nechaev G.I. Balitskaya O.M., 2011.:** Perfection of technology of repair of rolling stock of railway transport // Lokomotiv-Inform. - December, p. 68-70.
3. **Dotsenko G.N., 1970.:** Restoring of iron crankshafts using the automatic welding. M., Transportation., 56 p.
4. **Nechaev G., Izotov S., Kaver I. 2010.:** Transit potential of Ukraine. Post-crisis strategy// Teka. Kom. Mot. I Energ. Roln. – OL PAN, 10 D, p. 207-213.
5. **YesenberlinR.E., 1989.:** Major car repair. – M.: Transport, 335p.
6. Instruction manual on repairing the crankshafts by grinding and induction hardening of the necks (TI-RDM/ITAO-07), Moscow.
7. Diesel Crank Shaft 5D49. Repair method of grinding and induction hardening of the necks. Specifications. Poltava regional scientific and technical center of standardization metrology and certification. TU 35.2-01124483-060:2009
8. **Grybinichenko M.V. Dzetsyna A.P., 2007.:** Maintenance and repair of motor vehicles Transport:

Manual. - Lugansk: publ. ENU named after V. Dal, 218 p.

9. **Blokhin, A.S., 2007.:**About the trends in the development of the park trunk locomotives in the 2006-2010. - Railway Transport of Ukraine. - № 1. - p. 9-19.
10. Complex Program of Ukrainian railway rolling stock updates for 2006-2010. - Kiev, 2006. -27 p.
11. **Sergienko N.I., 1999.:**Ways of reduction of the usage expenditure in locomotive economy of Ukrainian Railways - Railway Transport of Ukraine, - № 4.-p. 28-30.
12. **Pushkarev Y.F., Pakhomov E.A., 1985.:** Monitoring and Evaluation of locomotives technical conditions.- M.: Transport, 160 p.
13. **Nikitin E.A., 1987.:** Diesel diagnostics -M.: Engineering, 224p
14. **Korop G., Zaverkin A., Shikun O., 2010.:** Development of procedure of search of rational variant of tehnological treatment of incoming car traffic volume// Teka. Kom. Mot. I Energ. Roln. – OL PAN, 10 A, p. 276-284.
15. **Gonchar B.M., 1968.:** Numerous modeling of diesel working process. - Enerhomashynostroenye., № 7, pp. 34-35.
16. Patent for invention № 2296169 "Method of crankshaft restore with using the method of hardening HDTV"
17. **Nechaev G.I., Balytskaya A.M., 2012.:** Description of technological process of the crankshaft restore of the industrial locomotives. – Visnyk ENU after V. Dal. - № 6 (177) Part 1. - p. 325-333.
18. **Nechaev G.I., Kamel, G.I., Yakovleva A.G., Balitskaya O.M., 2011.:** Decomposition of functional parameters and types of mating surfaces wear of conical tribosystem. - Visnyk of ENU after. V. Dal. - № 5 (159) part 1. - p. 305-310.
19. **Tartakovsky E.D., Goncharov, V.G., Sapozhnikov V.M.,2009.:** Analysis of the existing methods effectiveness of diesel crankshaft 5D49 repair.
20. **Dyachenko S.S., Savchenko B.V., Goncharov V.G., Ponomarenko, I.V., AksenovS.I., Sapozhnikov V.M., 2007.:** Study of diesel crankshaft maintainability. // Lokomotiv-Inform. - August, p. 16-17.

ПОВЫШЕНИЕ РЕСУРСА ПРОМЫШЛЕННЫХ ТЕПЛОВОЗОВ ЗА СЧЁТ СОВЕРШЕНСТВОВАНИЯ ТЕХНОЛОГИИ ВОССТАНОВЛЕНИЯ КОЛЕНЧАТОГО ВАЛА ДИЗЕЛЯ

Григорий Нечаев, Ольга Балицкая

Аннотация. Описывается технологический процесс восстановления коленчатых валов больших размеров методом шлифования и индукционного закаливания шеек. Подробно описаны этапы техпроцесса, построена блок-схема.

Ключевые слова: технологический процесс, коленчатый вал, рихтовка, шлифование, галтель, шейка вала, маслоканал, азотированный слой.