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Plunger Pair Recovery Technology

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ABSTRACT: High demands are placed on the geometric shape of the plunger pairs. Deviations from a cylindrical shape - no more than 0.001 mm, non-roundness - no more than 0.0005 mm, taper - no more than 0.0006 mm. To fulfill all these requirements, it is necessary to have high-precision technological equipment and appropriate measuring instruments. In the conditions of repair factories for the restoration of auto funds, it is not always possible to use high-precision equipment, as well as the absence of a larger amount of repair fund. In addition, it should be noted that a large number of vehicles from various manufacturers are currently in operation, the fuel pumps of which have a different design and different standard sizes. Repair of plunger assemblies in these conditions is a difficult task. The solution of which is not possible without the use of non-standard recovery technologies.

KEYWORDS: tool, microhardness, running-in, structural adaptability, deformation, hardening, durability.

1. INTRODUCTION

The main disadvantage of the existing factory standard methods for restoring plunger pairs is that, as already noted above, it is necessary to have in production a large number of plunger pairs of the same type in design and size, since the existing industrial equipment for grinding plungers, as well as for their finishing and finishing of bushings is designed and is made for mass production and is not adapted to work with a small number of plunger pairs of different designs and sizes. In addition, the cost of this equipment is quite high and unacceptable for repair enterprises and workshops that are engaged in the repair and restoration of various types and designs of fuel pumps of various manufacturers of automotive diesel engines.

For the conditions of a repair plant or auto repair shops, we have selected and developed the following equipment and devices:

a) universal circular grinding machine;
b) equipment for electrolytic deposition of chromium with appropriate fixtures;
c) finishing headstock with devices for finishing and pairing of plunger pairs;
d) flat-lapping machine for lapping plungers;
e) devices for grinding bushings;
c) devices for testing remanufactured plunger pairs for tightness.

The following is a description of the technology and equipment used for the restoration of plunger pairs.

The first operation in the repair of plunger pairs is called the preparatory operation.

Plunger pairs are uncompleted and divided into groups by size using a MK 0-25mm micrometer. Then troubleshooting is carried out in order to eliminate plungers that have chips and dents. After troubleshooting, the plunger is flushed to remove dirt and carbon deposits.

After washing the plunger, dry it in an oven or under a stream of hot air. Then the dried plunger goes to grinding to remove traces of wear.

The second operation - grinding, is carried out on a universal cylindrical grinding machine ZU110A. The plunger, intended for grinding, is installed in the installation center and ground until the wear marks are removed. Typically, wear reaches 25 - 30 μm per side. The control of the grinding results is carried out using a passimeter with a graduation of 1 micron. The ground plungers are chrome plated.

The third operation is a finishing operation to eliminate wear marks in the bushing.

This operation is carried out with the help of designed, manufactured devices used on the basis of a vertical drilling table machine. A bushing is installed on the machine table in a special device. In order to ensure the perpendicularity of

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the axis of the hole to the lapped end surface, a self-centering ball head with a tapered mandrel (Fig.1) is used, on which an expanding or non-expanding cast-iron lap, previously ground to a given size, is placed.

II. MATERIAL AND METHODS

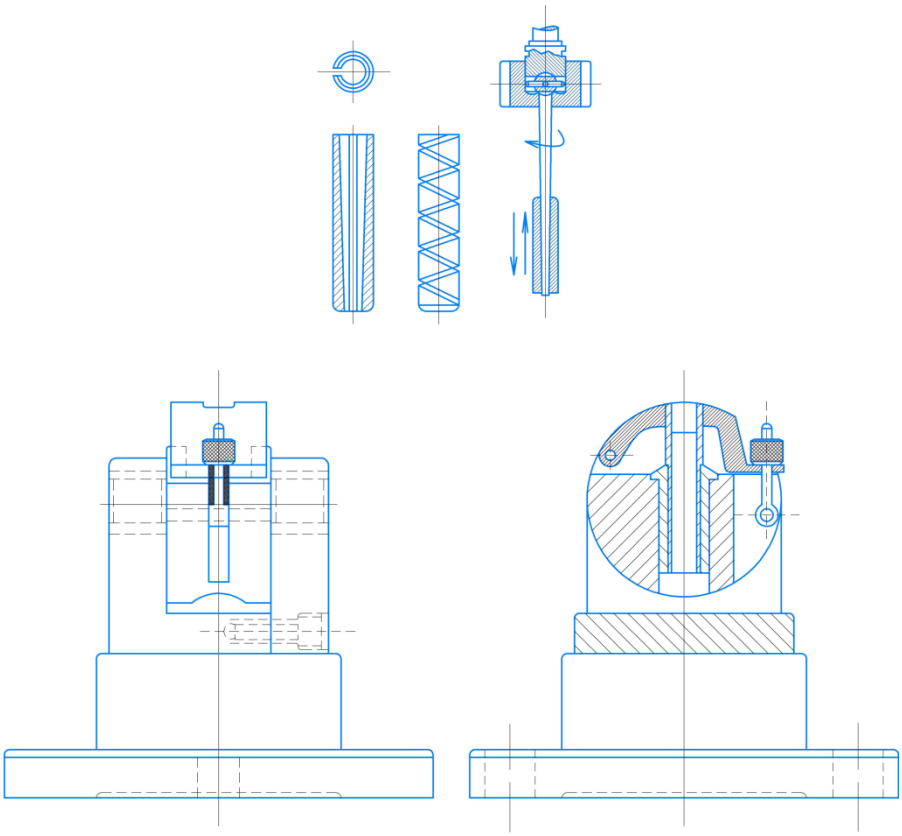

Fig.1. Bushing Lapping Tool
1-body, 2-swivel head, 3-sleeve, 4-blade, 5-taper mandrel, 6-lap.

Lapping is carried out using ASM 14-20 diamond paste at 250 - 350 rpm of the machine spindle and at 25 - 30 double strokes of lapping per minute. Duration of grinding is 3-5 minutes. After lapping, the sleeves are rinsed to remove any residual lapping paste.

Non-adjustable laps do not have an expanding device and their outer diameter cannot be increased during the finishing process. Such laps are very simple in design and are mainly used for finishing small-diameter holes. The group of non-adjustable laps (Fig. 2 a) also includes laps for finishing tapered holes and threaded laps.

Adjustable laps (Fig.2 b) have an expanding device and their outer diameter can be increased during the finishing process. Expanding laps are widely used for finishing cylindrical holes with a diameter of more than 15 mm. The expanding device allows you to very accurately adjust the lap to the diameter of the hole being machined.

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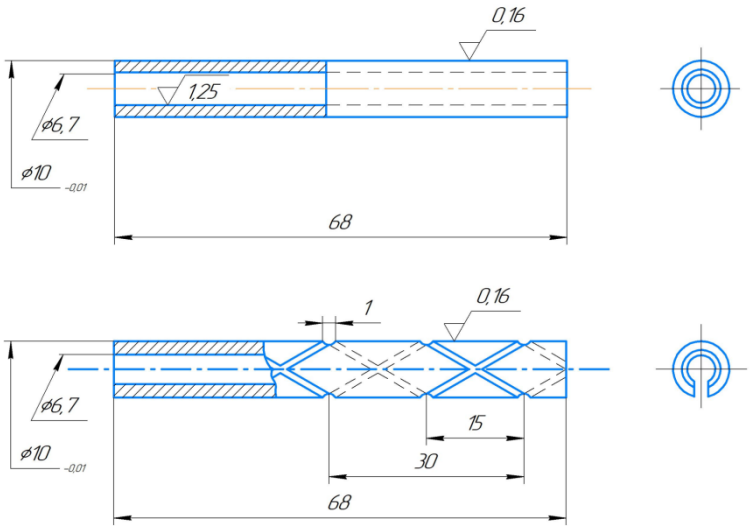

Fig. 2. Lapping for lapping holes.
a - non-adjustable bushing without grooves. b - adjustable sleeve with grooves.

The outer diameter of the lap sleeve, depending on the grain size of the abrasive and lapping materials used, is made 0.005-0.015 mm less than the diameter of the hole to be machined. The length of the lap sleeve should be 30-60% greater than the depth of the hole to be machined.

The outer surface of the lap sleeve can be smooth or with various types of grooves. Lapping with a smooth surface is used for final finishing, and lapping with grooves - for preliminary.

The grooves on the working surfaces of the lap act as reservoirs in which the abrasive and lapping materials are retained. The abrasive-lapping mixtures lingering in the grooves gradually come into operation during the lapping process. This phenomenon has a beneficial effect on the course of processing.

The fourth operation - chrome plating of the plungers, is carried out in a chrome plating bath with the modes specified in the section on the experimental procedure. The plunger to be chrome plated is first degreased by rubbing with alcohol or mustard diluted with water to a pasty state. Plungers are coated with this paste with a hair brush and then rinsed with running cold water. Then the prepared plunger is mounted on a special suspension (Fig. 3) and together with the suspension is loaded into a pickled bath, where the plungers are pickled.

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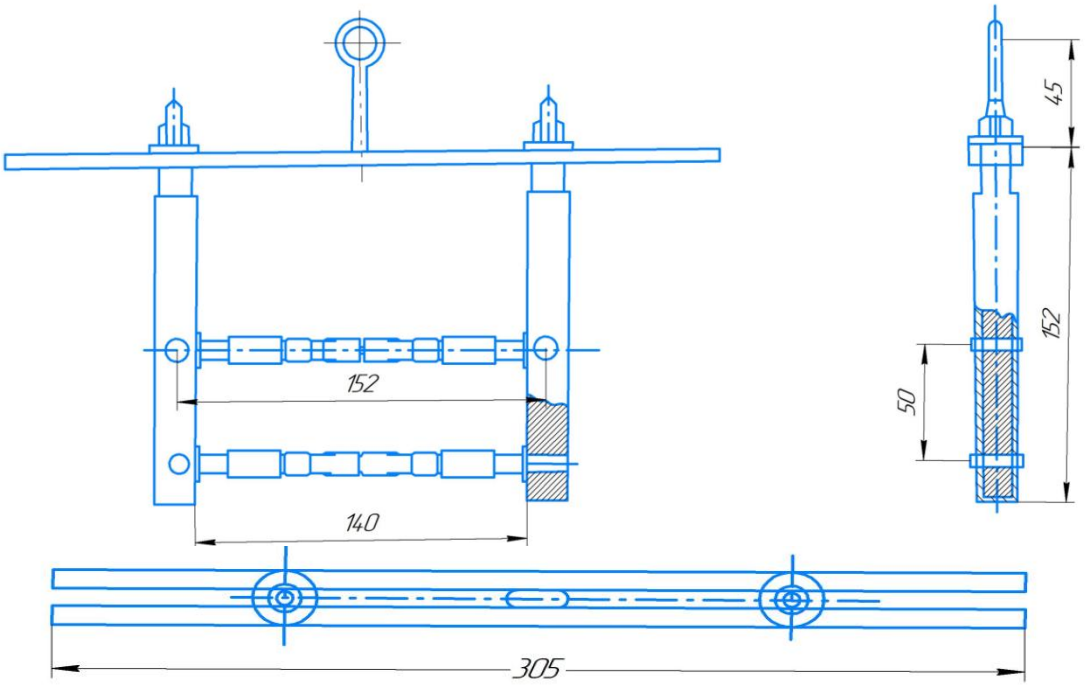

Fig. 3. Typical hanger for plunger chrome plating: 1-insulating material; 2-piece set for chrome plating.

Chemical pickling is carried out to remove oxides from the surface of the plungers with a thin film. The pickling process is carried out by current in a treated chrome-plating solution at a temperature of 10-25°s, for a duration of 1.5-3 minutes. After pickling, the suspension with plungers is rinsed in running water and loaded into the main chrome bath. The chrome plating process is carried out using a current rectifier, the power of which corresponds to the number of loaded plungers, each plunger accounts for 13-15A of current consumption with a total output voltage of 5-6V. The composition of the electrolyte is described in chapter 2 “Procedure for conducting the experiment”. Before chrome plating, the plunger must be heated directly in the chrome plating bath, to a chrome plating temperature of 50°C, after which a current impulse is given for 5-10 minutes, exceeding the current operating mode by 1.5-2 times for 5-10 minutes. The chrome plating time depends on the degree of wear of the plunger and, as a rule, does not exceed three hours. The chrome plating of the plunger must be suitable for wear and allow for subsequent grinding.

The fifth operation - dehydration is carried out in order to eliminate the fragility of the chrome layer. Carried out in a drying cabinet at a temperature of 150°C, the plungers are installed in a device that is immersed in an oil bath and withstands for two hours. Under the influence of temperature, hydrogen gas is released from the chrome coating.

The sixth operation - grinding, chrome-plated plungers are ground to fit the size of the lapped sleeve with a small allowance of 3-4 microns for the final finishing of the plunger. The control of the grinding operation is carried out with an MK0-25 micrometer and a passameter with a scale division of 1 micron.

The seventh operation is the finishing of the plungers. For the final finishing of the plungers, two finishing methods have been developed. The first manual method is a semi-mechanical method, carried out on finishing headstock. The plunger is mounted in a collet chuck that rotates with the machine spindle. The reciprocating movement of the lap is carried out manually.

III. SIMULATION & RESULTS

It is known that when finishing cylindrical parts of not two disk machines with eccentric adjustment, in order to achieve shape errors (deviations from cylindricality) of machined surfaces with deviations of no more than 0.2-0.3 microns, it is

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necessary that deviations from the flatness of the working surfaces of the laps were within 1 micron ... Due to the presence of the upper lap of a large number of degrees of freedom than the lower one, the upper lap self-aligns along to the lower lap and runs in to the surface of the lower lap. The use of a flat-watering machine makes it possible to process plungers in an amount of 8 to 12 pieces at a time, which makes it possible to obtain a set of plunger pairs of the same size, which has a positive effect on the cyclic supply of the high-pressure fuel pump. The lapping of plungers on a flat-watering machine is carried out after installing the plungers in a special separator. The separator is an aluminum disc with cut grooves for installing plungers. A cage with plungers is placed between two flat laps. Using the upper flywheel, the upper lap pressure is created on the plunger and the lower lap. The friction drive provides rotation on the eccentric shaft and, during plunger processing, perform a complex movement, consisting of rotation around its axis, rolling around the disk circumference and longitudinal sliding. Removal of the allowance from the plungers occurs due to the sliding of parts relative to the working surfaces of the laps. The cleanliness, accuracy and speed of processing parts depends on the preparation of laps, the quality of the finishing paste, the angles of inclination of the plungers, the magnitude of the eccentricity and the duration of processing. The best plunger surface cleanliness is achieved with a 12-15° tilt. The rounding speed of the outer end of the plunger should be 15-30m / min. Chromium oxide with a grain size of 2-3 microns is used as a finishing paste. In the process of finishing the plungers, the lap discs made of gray cast iron of the СЧ18-36 brand wear out, which leads to an error in the shape of the plungers (barrel shape, taper). In order to timely determine the wear of the lapping discs, the dependence of the deviation from the flatness of the working surface of the lapping on the duration of the lapping was built.

When the wear of the peripheral part of the disks reaches 6-8 microns per disk, the disk laps are subject to mutual lapping with an abrasive paste M14 until the error in the shape of the disks is eliminated.

The eighth operation is mutual lapping (pairing) of the plunger pairs. Mutual lapping of the plunger and bushing is carried out after the lapped plungers are inserted into the bushings by ¼ of their length before biting. This technology guarantees that the clearance between the plunger and the sleeve will not exceed 1.5 microns. Mutual lapping of the plunger and sleeve is carried out on the lapping heads. The plunger is clamped into a collet chuck (Figure 4.4), a layer of diamond lapping paste with a grain size of M1-M2 is applied to the plunger. A working lapper puts the sleeve on the plunger and slowly pushes the sleeve onto the plunger. The plunger is given a rotational movement and thus mutual lapping occurs. Lapping is carried out until the sleeve is free to move along the plunger. The lapped plungers are washed in diesel fuel to remove adhering lapping paste and lapping products (lapping slag).

The ninth operation is a control operation in which the plunger pairs are checked for external defects, the smoothness of the plunger movement into the bushings is also checked in order to prevent the plunger from sticking. After inspection, the plunger pairs are sorted into groups by size within the range of 1-5 microns.

IV. CONCLUSION

1. A mini-technology for the recovery of plunger pairs of high-pressure fuel pumps has been developed.
2. Designs of devices for manual adjustment of plungers and bushings have been developed.
3. The design of a flat lapping machine for mechanical lapping of plungers with high machining accuracy has been developed.
4. Designs of devices for checking plunger pairs from Kamaz, Howo, Mercedes-Benz vehicles have been developed.
5. It was found that the hydraulic tightness of the reconditioned plunger pairs corresponds to the requirements imposed on them.

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