Justification of structural technological solutions for the restoration of plunger pairs

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Abstract. The article explores the relationship of structural technological solutions to recover plunger pairs. The results studied are presented in graphical form. Equipment and devices were selected and developed for the conditions of repair factories and auto repair shops. The mini-technology of restoring high-pressure fuel pump plunger pairs was demonstrated. Fixtures were designed to allow manual sizing of plungers and bushings. For the mechanical finishing of plungers, a construction of a flat-finishing machine with high precision has been developed. Designs of devices for checking piston pairs of diesel cars have been developed. It was found that the hydrostatic properties of the restored plunger pairs meet the requirements imposed on them. A six-stage description of plunger pair restoration technologies and equipment is provided.

1 Introduction

Great requirements are placed on the geometric shape of the plunger pairs. Deviations: cylindrical – up to 0.001 mm, circular – 0.0005 mm up to 0.0006 mm. To meet all these requirements, it is necessary to have high-precision technological equipment and suitable measuring tools. Auto restoration repair shops do not always have access to high-precision equipment and do not have a large repair fund. In addition, it should be noted that at present, a large number of vehicles from different manufacturers are used, and their fuel pumps have different designs and different sizes. In this situation, repair of plunger pairs is considered a difficult issue. There is no way to solve this problem without using non-standard recovery technologies.

A major drawback of existing standard factory methods of remanufacturing plunger pairs is, as mentioned above, that production requires a large number of plunger pairs of the same design and size. Because the existing industrial equipment for grinding and finishing plungers and for finishing cases is not designed and manufactured for mass production of the small number of plunger pairs of various designs and sizes. In addition, the prices of these devices are quite high and are not suitable for repair companies and workshops that are engaged in the restoration and repair of fuel pumps of different types and designs of auto tractor diesels of different manufacturing companies [1,2].

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2 Materials and methods

The phase equilibrium in the system "steam-liquid" for - one component of the mixture can be generally represented in the form of equation . The following equipment and devices were selected and developed for the conditions of repair factories and auto repair shops:

a. universal circular grinding machine;
b. equipment for electrolytic deposition of chromium with appropriate devices;
c. the plungers that bring the plunger pairs to the appropriate size for finishing and pairing;
d. g) a machine for flat-size y for finishing plungers
e. a device for rubbing cushions
f. c) a device for checking the hermetic tightness of restored plunger pairs.

Below is a description of plunger pair restoration technologies and equipment used.

The first stage refers to the preparatory process for repairing plunger pairs.

Plunger pairs are separated and separated into size groups using a MK 0-25mm micro meter. Then he separates the defective ones in order to remove the plungers with cracks and grooves. After that, the plungers are cleaned to remove dirt and debris [3, 4, 5].

After cleaning, the plungers are dried in a drying cabinet or in a stream of hot air. The dried plungers are then sent to grinding to remove corrosion marks.

Second stage - sanding, ZU110A brand universal rotating sander done on the machine. The plunger for grinding is placed in the center and grinding is carried out until the traces of corrosion are removed. Usually, the erosion reaches 25–30 μm in size. Checking the smoothing results is done using a protractor with a division value of 1 μm. Polished plungers are sent to chrome plating [6,7].

The third step is sizing to remove any signs of wear on the case.

This process is based on a table top vertical-drilling machine and is performed using a built-in fixture. The case is installed on a special device on the machine table. A self-cantering ball head with a cone clamp is used to ensure that the axis of the hole is perpendicular to the rubbed side surface (Figure 1). It is fitted with an openable and non-openable cast iron scraper polished to a predetermined size [8,9].

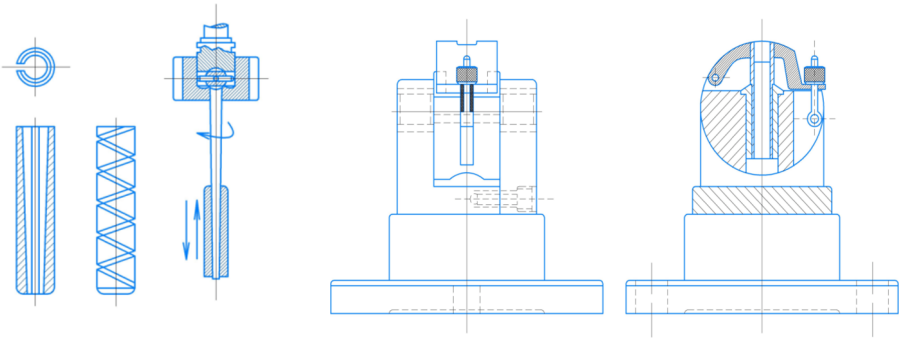


Fig. 1. A device for rubbing the bottle.

Grinding is carried out with the help of ASM 14-20 diamond paste when the spindle rotation of the machine tool is 250-350 rev/min and the grinding wheel makes 25-30 double movements per minute. Rubbing time is 3-5 min. After rubbing, the pods are cleaned to remove residual rubbing paste [10].

Non-adjustable scrapers do not have an opening device, because their outer diameter cannot increase during the finishing process. Such scrapers are very simple in construction

and are mainly used for sizing small diameter holes. The group of non-adjustable abrasives (Figure 2a) includes abrasives that size conical holes and grooved abrasives [11].

Adjustable scrapers (Figure 2b) have an opening device and their outer diameter can be enlarged during the finishing process. Opening reamers are widely used for sizing cylindrical bores larger than 15 mm in diameter. The opening device allows you to precisely adjust the abrasive according to the diameter of the hole to be processed.

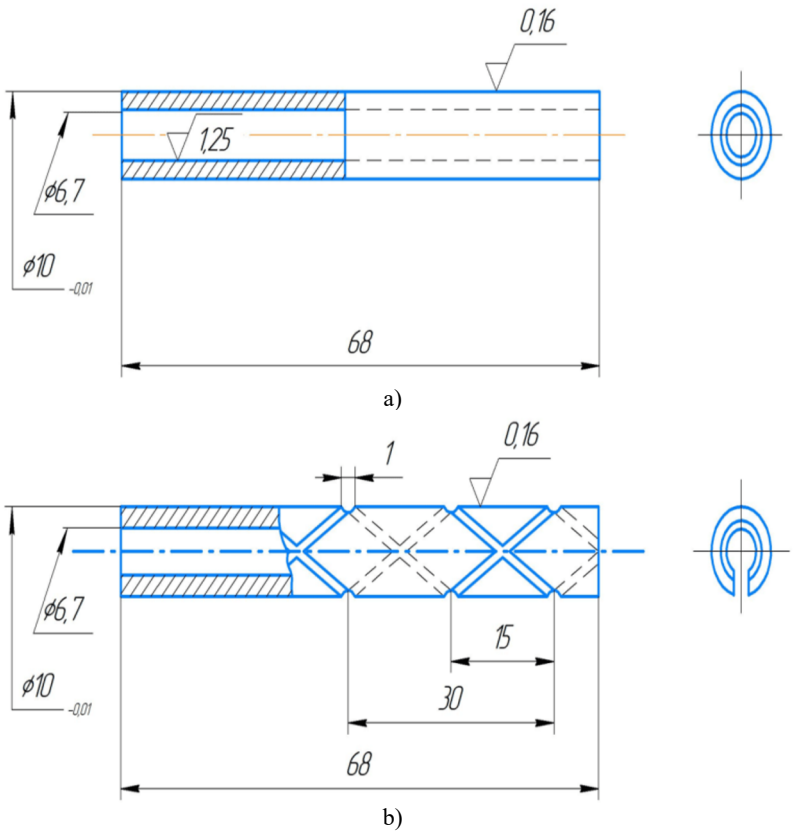


Fig. 2. Abrasives for finishing holes. Non-adjustable case without a-groove. b - an adjustable case with a groove.

The abrasive case is made 0.005-0.015 mm smaller than the diameter of the hole to be processed, depending on the grain size of the abrasive-finishing materials used. The length of the drill bit should be 30-60% greater than the depth of the hole to be processed.

The outer surface of the friction case can be smooth or have different types of grooves. Smooth-faced abrasives are used for final sizing, grooved abrasives for initial sizing [12].

The grooves on the working surface of the abrasive play the role of a reservoir, in which the abrasive-finishing materials are retained. During the finishing process, the abrasive-finishing mixture retained in the grooves is gradually activated. This event has a positive effect on the progress of the processing process.

The fourth stage is chroming of plungers, which is carried out in a bath for chroming in the mode indicated in the section on the method of conducting the experiment. Plungers intended for chrome plating are treated with rubbing alcohol or alkali diluted in water to a paste state. Plungers are coated with this paste using an iron brush, then washed in cold

running water. Then the prepared plungers are collected in a special hook (Figure 3) and loaded with the hook into a treatment bath, where the plungers are treated.

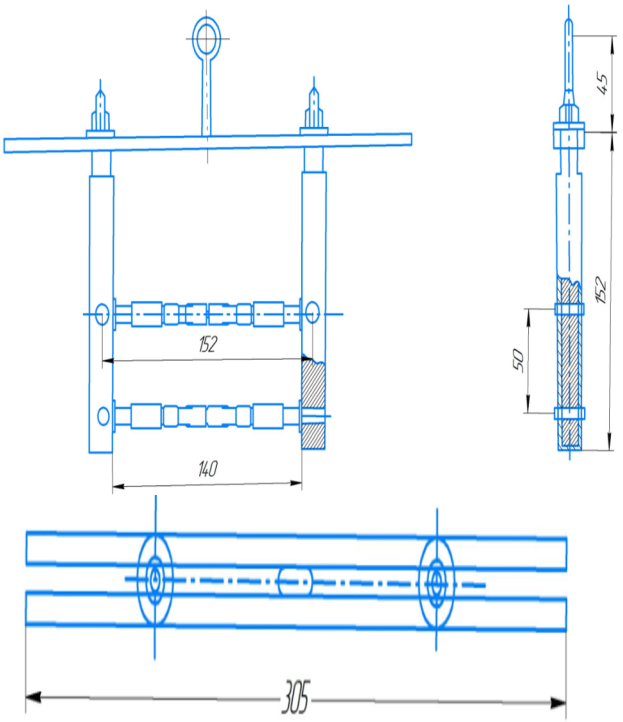


Fig. 3. Sample hook for chrome plating plungers. Insulating material; 2-specified details for chroming.

Fig. 4. Exterior view of Howo car and Case combine chrome plungers.

Chemical treatment is carried out to remove a thin oxide film from the surface of the plungers. The treatment process is carried out at a temperature of 10-25°C, for 1.5-3 minutes, in the used chroming solution. The treated plunger hook is rinsed in running water and placed in the main chroming bath. The chroming process is carried out using a rectifier with a total output voltage of 5-6V and a current consumption of each plunger of 13-15A, corresponding to the number of loaded plungers [13]. The composition of the electrolyte is described in Chapter 2 of "Methodology of Experimentation". Before chroming, plungers should be heated directly in the chroming bath to a chroming temperature of 50°C, after which a current shock of 1.5-2 times more than the operating mode is given for 5-10 minutes. Chrome plating time depends on the degree of corrosion of the plunger and usually does not exceed three hours. Plunger chrome plating should be thick enough to compensate for the amount of wear and have allowance for subsequent grinding [14].

The fifth stage - dehydrogenation is carried out in order to eliminate the brittleness of the chrome layer. Drying is carried out in a cabinet at a temperature of 150°C, the plungers are installed in the device and lowered into a bath filled with oil and kept there for two hours. Under the influence of temperature, gaseous hydrogen is released from the chrome coating.

The sixth step is to size the plungers. Two methods of sizing plungers for final finishing have been developed. The first method is done by hand - a semi-mechanical method, in babkas that are made to size. The plunger is fixed to the chuck, which rotates with the spindle of the machine tool. The advance-return movement of the scraper is carried out manually. In other words, the friction working surface moves the friction back and forth in the axial direction along its path (Figure 5).

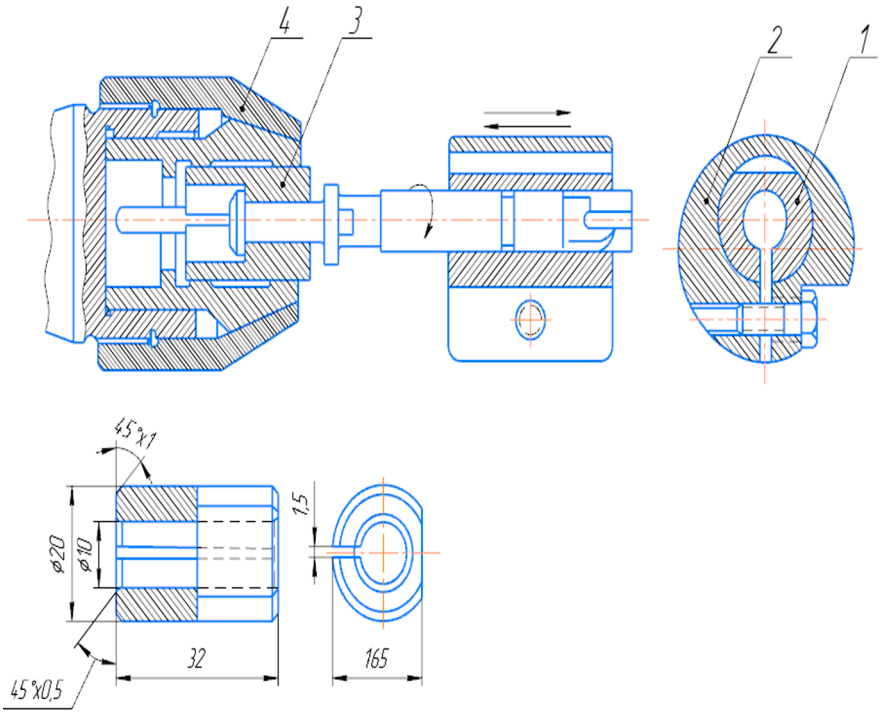
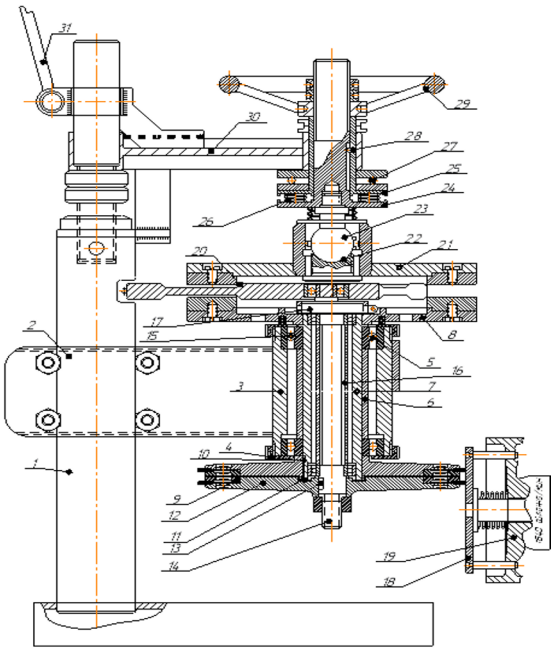


Fig. 5. Device for rubbing the plunger. 1-rubber; 2-nd clamp; 3-sukhari; Clamp to the 4th leg.

Thus, ¼ of the length of the rubbed plunger after being clamped is inserted into the finished case.

In order to increase the productivity and reduce the labor cost of plunger finishing, a two-flat disk sizing machine design was developed on the basis of a drilling machine (Figure 6). It is clear that the deviations of the shapes of the surfaces used for sizing cylinder details on a machine with a two-disk eccentric adjuster are 0.2-0.3 mkm, and the deviation of the working surfaces of the rubbing surfaces from the plane should be within 1 mkm. Since the upper friction has a greater degree of freedom than the lower friction, the upper friction self-aligns with respect to the lower friction and frictionally adapts to the lower friction surface. The use of a flat sizing machine made it possible to process 8 to 12 plungers at a time.



1-st column; 2 – lower bracket; 3 – bracket pipe; 4- fastening nut, 5- ball bearing, 6- bearing thrust mechanism, 7- roller, 8- lower working disc, 9- upper driving friction disc gear, 10- key, 11- nut, 12- lower driving friction disc gear, 13- key, 14- eccentric, 15- ball bearing for eccentric shaft, 16- push mechanism, 17- eccentric, 18- leading friction disk drive, 19- clutch, 20- outer shell, 21- upper working disk, 22- support screw, 23- bearing bolt, 24- fastening washer, 25- base washer, 26- spring, 27- bearing, 28- guide pin, 29- flywheel, 30- upper bracket, 31- stop handle.

Fig. 6. Plunger finishing machine.

3 Results and discussion

As a result, it is possible to get a set of pairs of plungers of the same size, which has a positive effect on the periodic transmission of the high-pressure fuel pump. Rubbing of plungers on a flat sizing machine is done after installing the plungers in a special separator. The separator consists of an aluminum disc with a groove cut to accommodate the plungers. A separator with plungers is placed between two flat friction plates. With the help of the upper flywheel, the pressure of the upper friction on the plungers and the lower friction is created [15,16]. The friction gear ensures the rotation of the eccentric shaft, and during the operation of the plunger, it has a complex movement consisting of rotation around its axis, vibration along the circumference of the disc and longitudinal sliding. The removal of the insert from the plungers occurs due to the friction of the parts sliding against the working surface. The

cleanliness, accuracy and speed of detailing depends on the preparation of the abrasives, the quality of the sizing paste, the angle of inclination of the plungers, the size of the eccentricity and the duration of the machining. The best cleanliness of the plunger surface is achieved at a slope of 12-15℃. The rounding speed of the outer edge of the plunger should be 15-30m/min. Chromium oxide with a grain size of 2-3 mkm is used as a sizing paste[17]. When sizing the plungers, SCH 18-36 gray cast iron discs are eaten, which causes the plungers to have a shape error. In order to determine the worn abrasive discs in time, the dependence of the plane deviation of the working surface of the abrasive on the finishing length is plotted (Figure 7).

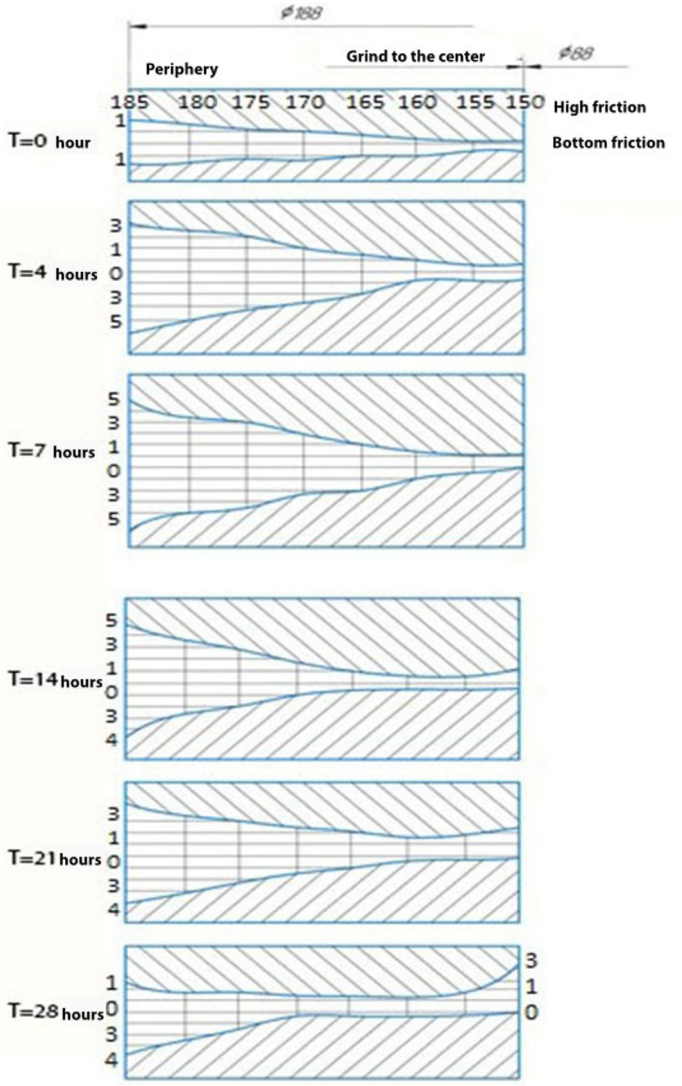


Fig. 7. Changing the shape of the working surface of the exercise flat last machine depending on the duration of decoration for the mode n = 26 rev/min (a).

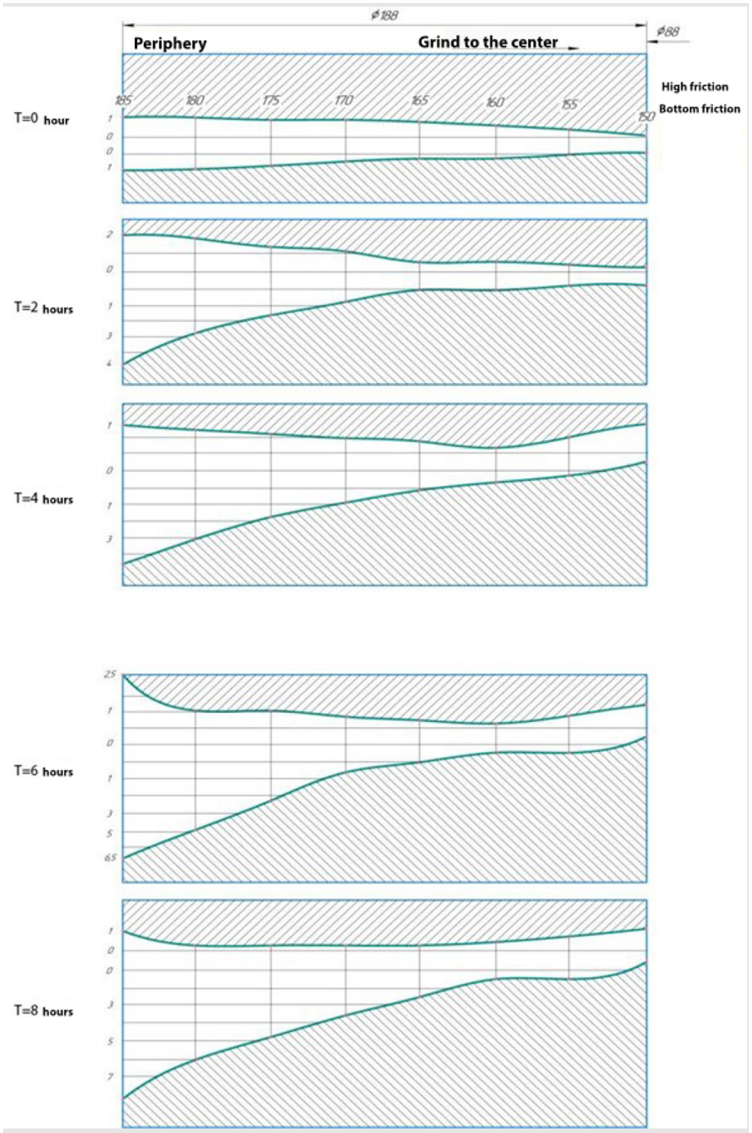


Fig. 8. Mode for decorate duration looking exercise flat last car worker surface shape change n = 47 rpm (a).

Of the discs reaches 6-8 μm, disc scrapers are rubbed together with M14 abrasive paste until the shape errors of the discs are eliminated [18].

4 Conclusion

Designs of devices for hydraulic testing of plunger pairs have been developed. The developed constructions made it possible to check the piston pairs of Kamaz, Mercedes Benz, Howo cars, combine "Keys" for hydraulicity. The construction of a flat-finishing machine for finishing plungers has been developed. The developed design increased the productivity of the plunger finishing operation by 18-20%. A mini-technology for restoring high-pressure fuel pump plunger pairs was demonstrated. The design of the devices for manual sizing of

plungers and bushings has been determined. The construction of a flat-finishing machine with high precision for mechanical finishing of plungers has been proven. Designs of devices for checking piston pairs of diesel cars have been developed. Stand and operational tests of restored plunger pairs showed their high corrosion resistance and reliability.

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