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PRESSURE MEASURING IN A VALVE PLATE CLEARANCE AND RESULT ANALYSIS

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ABSTRACT:
In the work is analyzed signal which have been received from pressure sensor installed in the gap of valve plate for multystroke, radial piston hydromotor.
KEYWORDS:
Valve plate, pressure destribution

1. INTRODUCTION

Valve plates are used in high - torque radial piston hydromotors with pressure values over *30 MPa* . For the calculation of the leakage and of the separating force in the valve plate clearance, the distribution of the pressure in it should be known.

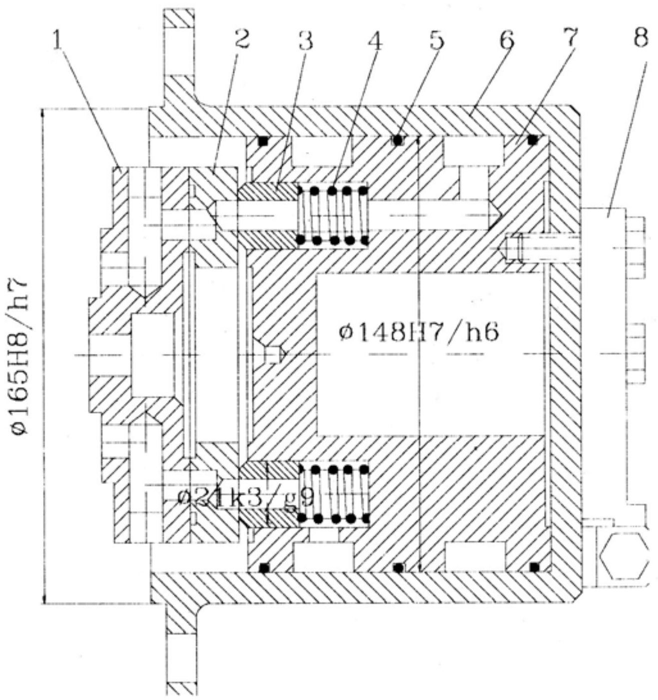


FIGURE 1. 1-Plate of the cylinder block, 2-valve plate, 3-bush. 4-spring , 5-seal. 6-corpus. 7-body

The author of the present work have made a theoretical and experimental research of the pressure of the valve plate clearance of the hydromotor designed and build in Rousse University and intended for rotating of an excavator rotor. The design of the valve plate is represented in *Fig. 1.*

The hydromotor is an eight cylinder $z = 8$ and six stroke one $m = 6$. The common additional multiplier of z and m is $x = 2$. In this case the work of the hydromotor could be divided in two symmetrical parts [1], with pistons equally positioned to the working profile and the cylinder block inlets to the inlets of the valve plate . The simplest the clearest to analyze the movement of the pistons is by their reducing to one profile, with which z pistons with a step $\Delta\theta = 2\pi x/mz$ are in interaction. The above methods for analyzing the processes in the hydromotor by reducing the pistons to one profile of the guiding surface simplifies considerably the research of the processes in the valve plate. According to this methods a sector with a central angle $\psi/=\pi/m$ is adopted as a calculating system for both theoretical and experimental research of the valve plate, which includes the area around one inlet channel and two outlet channels in the periphery *(Fig. 2)*.

2. EXPOSITION

The left - side outlet channel is accepted as a base and the rotation of the block is analyzed in relation to it, the rotation angle being represented by *в*. All processes taking place in the sector 1 of the valve plate are repeated in the rest of the sectors, with the difference that they are phase - shifted. The results of the theoretical research have been published in [2] and [3], and the distribution of the pressure in the sector, the separating force and the leakage in the clearance have been calculated.

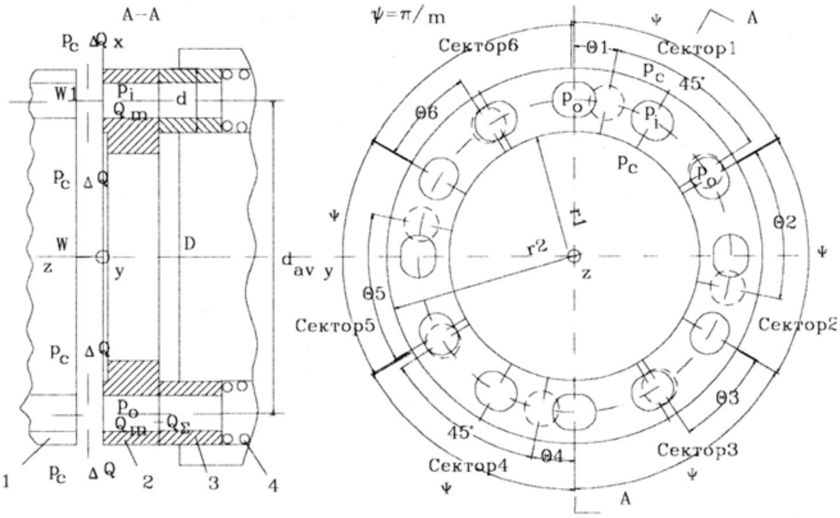


FIGURE 2. 1-Plate of the cylinder block, 2-valve plate, 3-bush. 4-spring

To check the results of the theoretical model manganese pressure sensors are installed in eight control points of the sector 1 of the valve plate. The position of the pressure sensors is represented in *Fig. 3* . and *Fig. 4* .

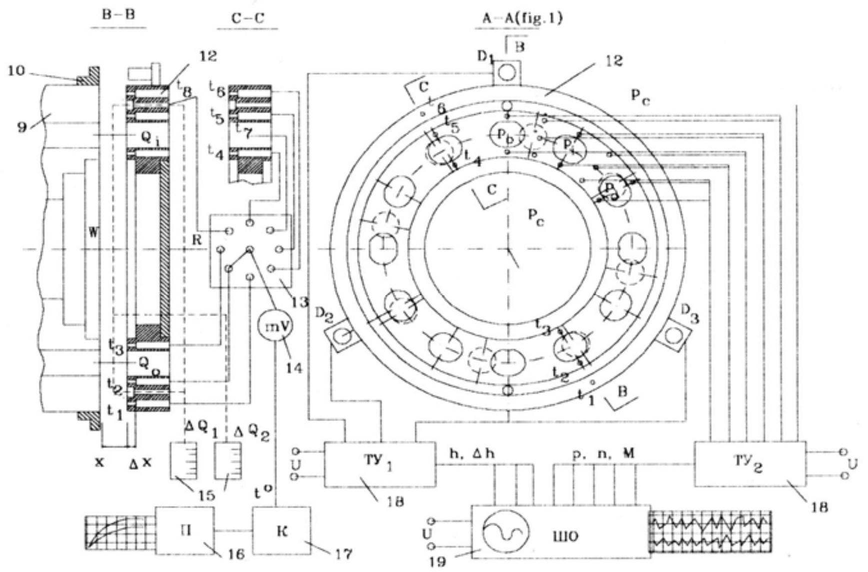
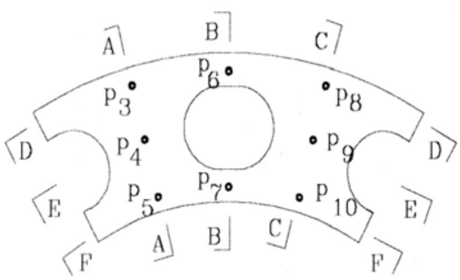


FIGURE 3. 9-cylinder block, 10-magnetick anchor, 12-valve plate, 13-package distributor. 4-spring , 5-seal. 6-corpus. 7-body



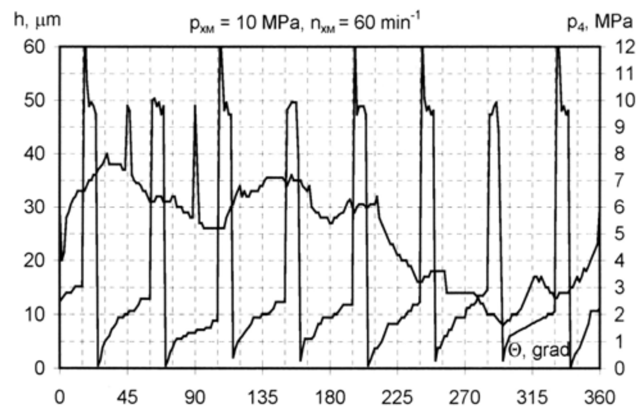


FIGURE 4. Sector I with the position of the pressure sensors

FIGURE 5. Grafics of the inductive sensor D1 and of the pressure sensor p4

Detailed information about the experimental installation and the research methods of the valve plate have been published in [4]. The pressure of the liquid in the control points is recorded by two manganese sensors (active and compensational ones) connected in a half- axle scheme in the input of the tenzoamplifier. Under the influence of the working liquid pressure, the resistance of the active sensor changes in proportion to the pressure in the valve plate clearance. In result the resistor axle isdisbalanced and generated voltage is formed in its diagonal, which amplifies and is recorded by a loop oscillator on photo sensitive paper.

An inductive sensors is installed on a carrier against the middle part of the left - side outlet channel in *sector 1*, connected in half - axle with compensation one. Three grooves *10, 20* and *30 μm* wide are made against the middle part of three inlets of the cylinder block on an armature. When this channels pass against the active inductive sensors, the magnetic transparency of the medium is reduced, the axle is disbalanced and a voltage impulse is formed, which is proportional to the depth of the groove and is recorded by an oscillator. Thus the inductive sensors are verified and the moment when the cylinder passes against the sensor is fixed. Its oscillatory record is decoded by the check up characteristic in the valve plate is calculated.

The most informative pressure tensors , giving notion of the processes which take place in the cylinder and in the valve plate clearance are *p4* and *p9*. The *Fig 5* represents the pressure on the tensor p4 for a full turn of the shaft in working condition of the hydromotor p_m=*10 MPa* and n_m = *10 min*^{1}. This diagram is represented together with the diagram of the inductive sensor *D1*. Such a presentation is very convenient for the present analysis, as the impulses, corresponding to the rapper grooves, fix the position of three of the cylinders. The angle distance between them is equal to *45°*. The first impulse of the inductive sensor corresponding to a groove *10 μm* deep, coincides with the middle part of the left - side outlet channel of *sector 1* and represent itself the starting counting point of the angle θ (the angle at which the *cylinder I* turns to the valve plate - *Fig. 2* and *Fig. 3)*. The signal of the inductive sensor is a sine one by reason of the slanting position of the armature plain to the valve plate plain. The amplitude of the sine is *32 μm* and it is equal to the face oscillation of the armature toward the valve plate plain. The minimum of the sine shows the value of the valve plate clearance at the adopted working conditions *h=8 μm*.

The signal of *p4* is a periodical one and it consists of eight similar impulses, each corresponding to the change of the pressure in one of the hydromotor cylinders. The part of the diagram, which corresponds to the first cylinder is between the first and the second impulse of the sensor. The signals of the following seven cylinders are placed in succession after it. The pressure in *p4* at a rotation angle of θ = *0°* has a value of about *2,5 MPa* to the moment when the cylinder inlet rotates at an angle of θ = *9°*. Then the sensor connects through the cylinder inlet with the outlet channel and the pressure decreases sharply to a value of p_o. At the rotation angle of *θ=15°* the pressure decreases once more in a impulse, as the value plate interspase cuts off the cylinder coupling from the inlet and outlet channels and the piston, following the guiding surface, begins moving in direction of increasing the cylinder volume. Each of the cylinders has a different impulse and with the *cylinder 4* and the *cylinder 7* it even is missing. This is due to the differences in the clearances between the cylinders and the pistons, to the differences in the angles α_o of the guiding surface , which allow the pistons to remain static at a given piston revolution angle at the end of the piston motion. Then the pressure increases sharply from almost *zero* to *12 MPa,* as a result of the connection of p4 through the cylinder inlet with the pressure inlet. The result is a hydraulic stroke whose value depends on the number of revolutions and on the pressure of the hydromotor . At the rotation of the block at an angle of *θ=20°* the pressure sensor is connected neither with the inlet nor with the outlet but the pressure decreases as a result of the approaching to it of the next cylinder inlet, which is connected with the outlet channel.

The Fig. 6 represents the dependence of *p4* graphic on the number of revolution *n*. At a number of revolution more then *20 min*$^{-1}$, a high - frequency pressure component occurs and the higher it is, the higher is its moment value. This increase of the moment pressure leads to the increase of the separating force which has been calculated theoretically. That is why, when calculating the valve plate characteristics, its maximum value is used, not the average one.

The *Fig. 7* represents the graphic of the sensor *p4* at a rotation frequency of n = *4 min*$^{-1}$ at the pressure of the hydromotor p_m = *10 MPa*, p_m = *20 MPa* and p_m = *30 MPa*. The increase of the hydromotor pressure only shift the graphic upwards to the high values but it doesnt influence its shape.

The same measuring of the pressure have been made in points *p3, p5, p6, p7, p8, p9* and *p10 (Fig. 4)*.

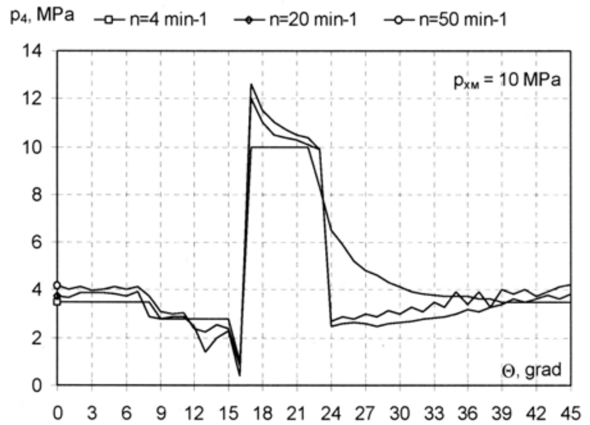


FIGURE 6. Grafics of the pressure recorded by the sensor p4 in sector 1 at different rotation number of revolution Grafics of the pressure recorded by the sensor p4 in sector 1 at different pressure valves

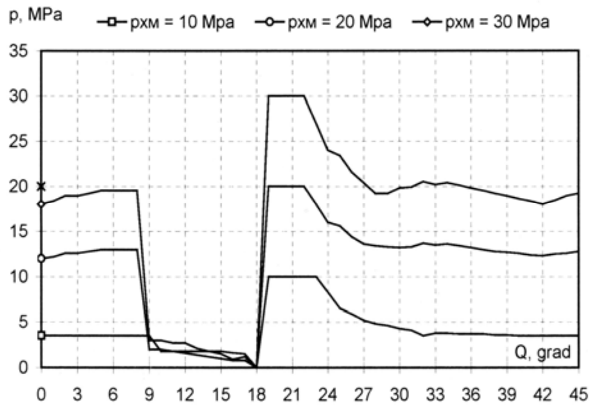


FIGURE 7. Grafics of the pressure recorded by the sensor p4 in sector 1 at different pressure valves

3. CONCLUSION

The recording of *p4* could be used for continuous condition control both of the valve plate and the cylinder block [5, 6].The results add knowledge to the theory of the current through the gap of valve plate for multystroke hydromotor and they could be used for improving the theory for account of the valve plate.

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