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EXPERIMENTAL INVESTIGATION OF THE WORKING MEMBER OF THE FLOW RATE REGULATOR MADE FROM A POLYMERIC MATERIAL

The paper considers operating principle and design of the flow rate regulator with a working member made from a polymeric material. Dependence of the working member deformation on the pressure has been determined.

Keywords: *flow rate regulator, throttle control of the speed, polymeric working member, test rig.*

Throttle control of the working member speed is realized by varying the resistance to the working fluid flow. In order to ensure constant throttle flow rate in cases when the working member responses to the varying load, it is necessary to stabilize the pressure differential at it so that the load change at the actuator would not cause the change of the pressure differential at the throttle. For this purpose flow rate regulators (FR) are used. FR with traditional working members (spools, valves) have a number of drawbacks of technological and operational nature: complexity of manufacturing friction pairs; tendency to spools being pinched; obliterate sticking; possibility of the spool seizure by hard particles; limited response caused both by the spool inertia and friction forces; complexity of maintenance and repair when it is necessary to restore initial clearances in the "bushing – spool" pair, which are increased as a result of wear; high requirements to the working fluid filtration. At present such hydraulic units are known where working members are deformed rather than displaced, e. g. elastic shells. The designs of FR with polymeric working members are free from the above mentioned drawbacks.

One of the designs of FR with polymeric working members is presented in Fig. 1. The working member of FR is a shell and, therefore, theoretical investigation of FR can be performed only on the basis of analytical relationships describing the shell behavior under the influence of control and disturbing forces.

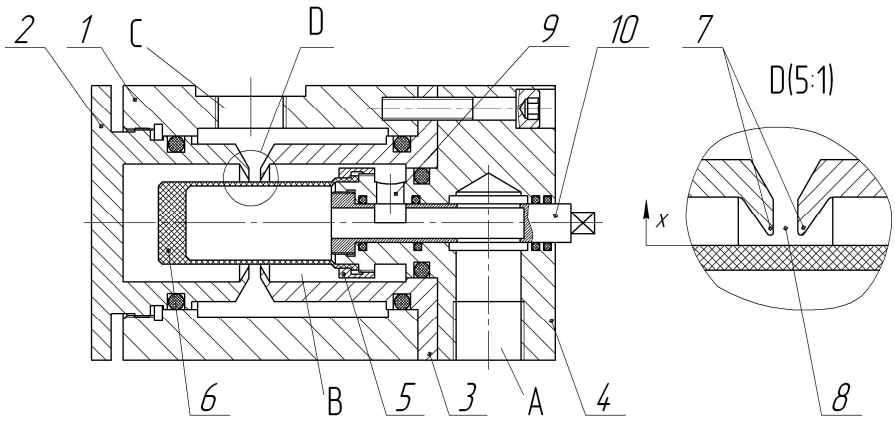

Fig. 1. Flow rate regulator with a polymeric working member

To determine the operating characteristics of FR with a polymeric working member (elastic cylindrical shell) it is necessary to determine the dependence of the elastic shell deformation on the pressure differential across the variable throttle, which directly influences the quality of control.

The character of the above-mentioned dependence is influenced by the shell stiffness in the radial direction c_r. For simulation study of the dynamic characteristics of FR with a polymeric working member deformation dependence on the load is presented by the formula (1.1):

$$c = \frac{\Delta p}{\Delta d}, \tag{1}$$

where c is stiffness of the cylindrical shell; Δp – load (fluid pressure); Δd – radial deformation of the cylindrical shell.

In order to confirm the adopted assumptions, experimental investigation of the deformation dependence on the load is necessary during simulation study of FR.

For this purpose a scheme of the experimental setup has been developed (Fig. 2 and Fig. 3). Its constructive dimensions make it possible to measure deformation of the working members of several standard sizes. The samples are manufactured from the material "modular polyamide 6 ТУ 6-05-988-87".

Radial deformation was registered by the clock-type multirev indicator – 1МИГ that provides measuring accuracy of $\pm 10^{-6}$ m. The indicator displacement relative to the fixed deformed shell was realized by means of a rack-and-pinion gear with the accuracy of $\pm 10^{-3}$ m. Fluid pressure in the shell was measured by a manometer (ГОСТ 6521-72) with the measurement range of 0…4 MPa.

By the results of the experimental investigation the dependence of deformation on the load has been built (Fig. 3) and the character of deformation of FR working member generatrix has been determined. (Fig. 4).

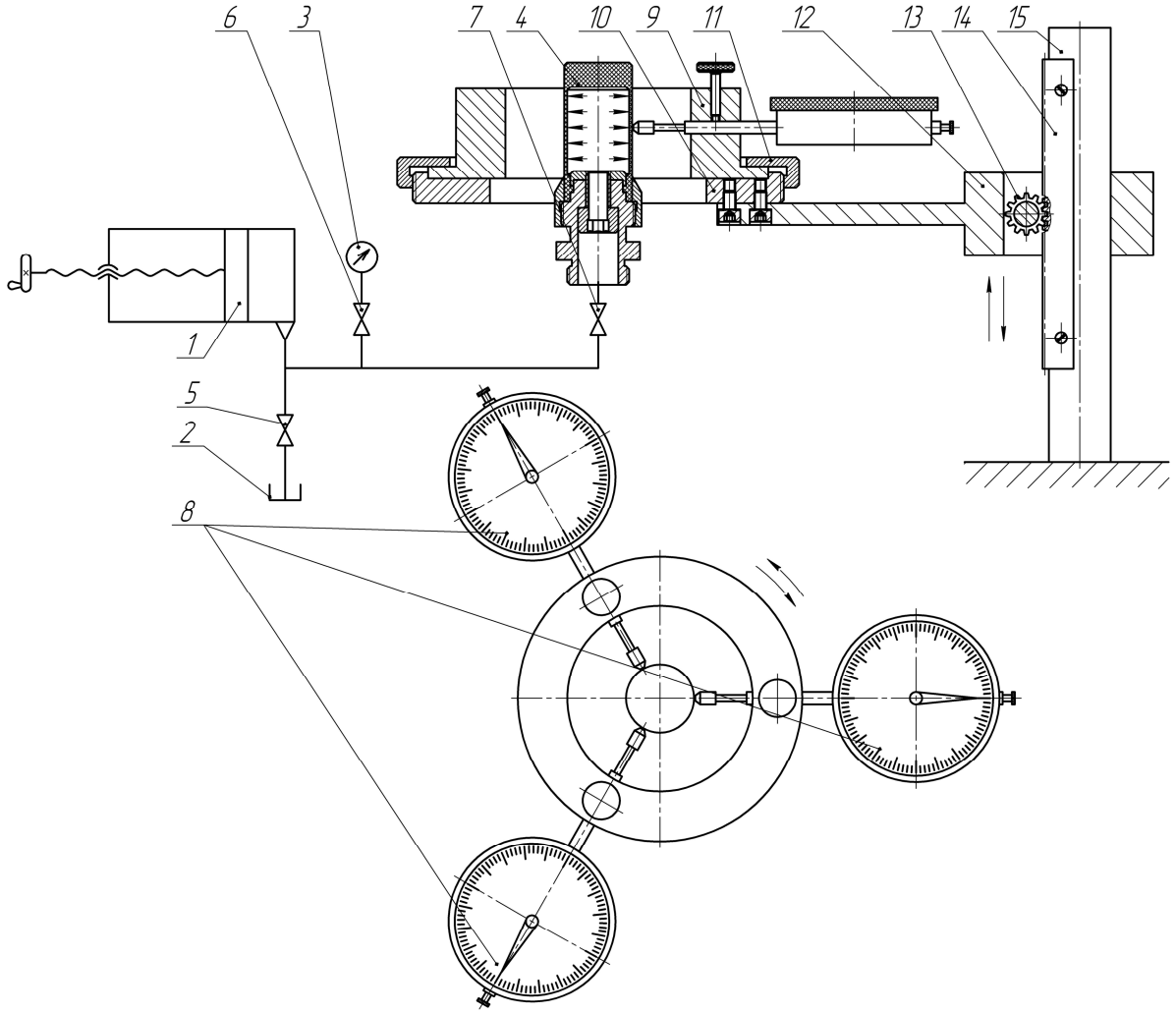

Fig. 2. Circuit of the test rig for investigation of FR working member:
1 – hydraulic cylinder; 2 – tank; 3 – manometer; 4 – shell; 5, 6, 7 – valves; 8 – inficator;
9 – body; 11 – nut; 10 – platform; 12 – slide; 13, 14 – rack -and-pinion gear, 15 – stand

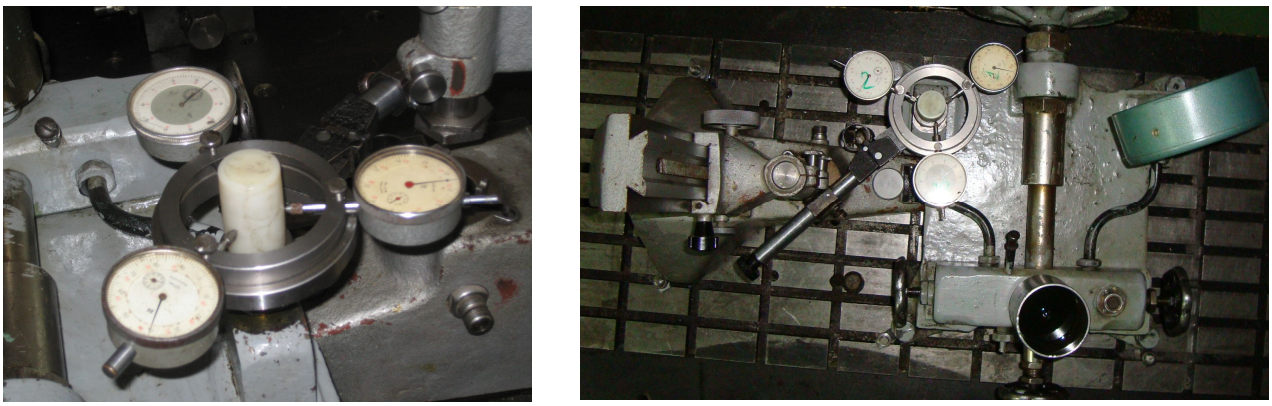

Fig. 3. Photos of the test rig for FR working member investigation

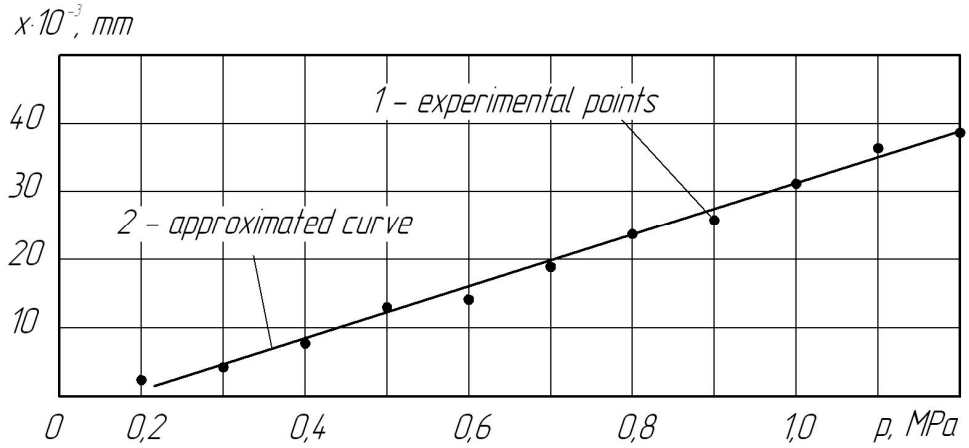

Fig. 4. Dependence of the shell deformation (polyamide 6) on pressure at the working port of the variable throttle

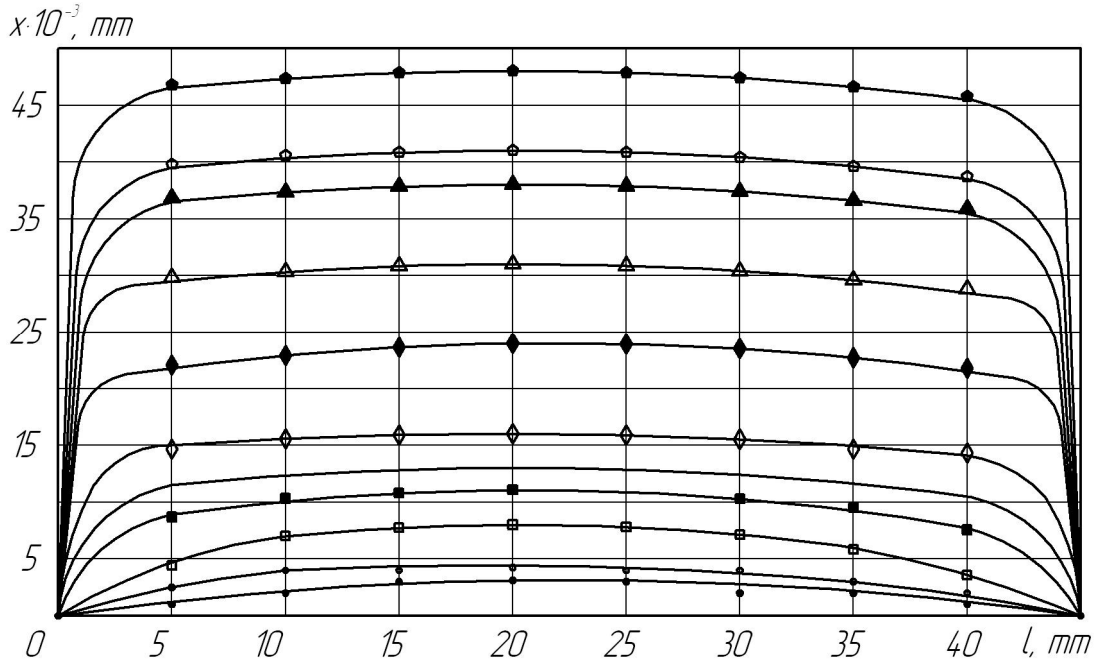

Fig. 5. Character of deformation of FR working member generatrix for the pressure range of 0…1,2 MPa.

Conclusions

By the experimental investigation results the dependence of the polymeric working member deformation on the control pressure has been obtained (Fig. 3). The dependence has the character approaching a linear one. Maximal deformation occurred in the middle of the working member generatrix. The deformation character is shown in fig. 4.

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