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The Problem of Optimal Operation Speed of Positional Hydromechanical Drive Systems

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Abstract

The paper solves the problem of optimal operation of the positional hydrodrive dynamic system with hydraulic communication lines. The developed generalized structure of the hydrodrive dynamic system makes it possible to introduce the methods to solve the problems of optimal speed of operation and evaluation of output factors (based on transfer time, supplied power, positional accuracy, etc.).The use of the consequent simplication method of the multimass mathematical model results in finding a rational solution of the multicriteria problem of structural and parametric optimization with minimal timetable and capital inputs. The paper reviews the results of the experimental investigation which prove the adequacy of the proposed hydrodrive model and suboptimal trajectories of its output member displacement when managed by hydromechanic control units.

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Keywords: Optimal control; mathematical model; variable structure; positional hydrodrive; hydraulic circuits; control circuit.

1. Introduction

According to [1,2], the most promising technical solutions are those having such a hydrodrive power subsystem structure that can be changed for various parts of the positional cycle, featuring controller multifunctionality, and being integrated with electrical components into mechatronic units and modules, which help to organize optimal positional displacement trajectory control [3]. The paper gives an overview of investigations which aim at solving a problem of optimal control of the dynamic hydromechanic positional system featuring increased performance and accuracy as well as at creating a solution software support in form of control programs to provide optimal control of standard cycles of automated processing equipment.

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2. Hydrodrive construction principles and structure

Modern positional systems are defined by the optimal control of the technical objects' motion. Organizing optimal trajectories of prositional cycles results in a difficult multicriterion problem, especially in real engineering systems. Under these conditions with regard to hydromechanic positional systems with certain advantages [2], there emerges a necessity to form the following principles in order to create new circuit solutions and to improve the operating ones for automated processing equipment:

- development of new methods to solve multicriterion control problems;
- application of structural and parametric control of the positioning with the help of hydrodrive structures which can be changed on-the-run [4,5];
- minimization of elements and lengths of control circuits providing drive switches which are close to quasi-relay control [6];
- development of multifunctional control units integrated with an electronic component and programmed computer technologies[5];
- application of a single energy carrier for the power and control circuit of the hydrodrive, with minimal additional signal transformations.

The analysis of certain circuit solutions for the positional hydromechanic drive (PHMD) puts forward a generalized structure encompassing features of certain technical solutions regarding the configuration, control modes and laws of motion of machine's movable operating elements [2].

While outlining methods to control the hydrodrive, in terms of mathematical modeling, it is necessary to define a single approach to investigate hydromechanic devices on basis of their generalized dynamic hyndromechanic system, which reflects features of certain technical solutions regarding the configuration, control modes and laws of motion of machine's movable operating elements [7,8].

Figure 1 shows a principal hydrokinetical diagram of the generalized PHMD structure. The diagram defines the composition of devices, hydromechanic connections, key parameters which characterize subsystems.

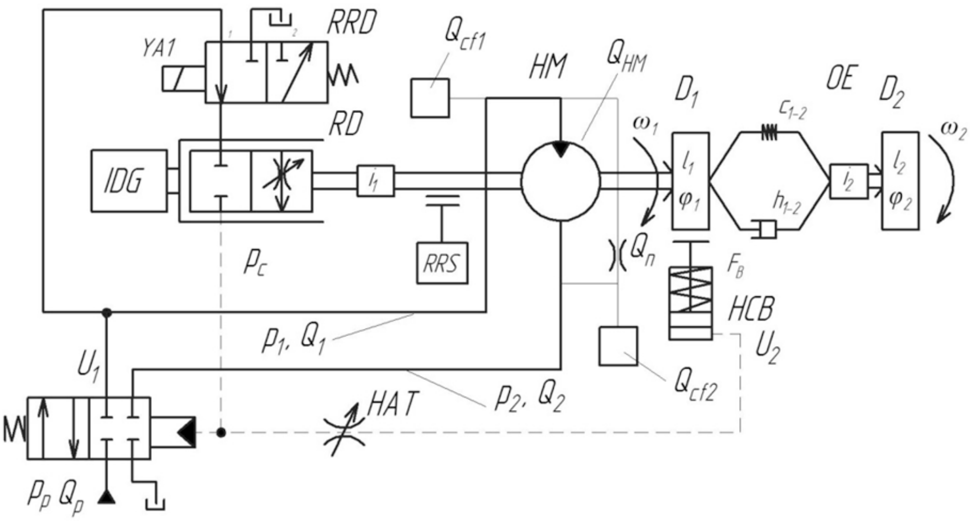

Fig. 1.The principal hydrokinetical PHMD diagram.

The mechanical subsystem is a multimass resilient dynamic system composed of a hydraulic motor HM, a transmission and transformation mechanism and an operating element OE. The installation of a hydrocontrolled brake HCB on the output member of the hydraulic motor widens the possibilities to control the position of the operating element OE. Hydraulic adjustable throttle HAT, allows you to change the alarm time management U_2 for hydraulically brakes HCB.

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