

G. I. SOKOL¹, A. T. ONISHCHENKO, L. V. NIKIFOROVA¹, T. S. MOLNAR¹, V. M. SAVCHUK²**MINIMIZING THE EFFECT OF INERTIA ON THE OPERATION OF UNITS WITH MOVABLE MEMBERS**¹*Oles Honchar Dnipro National University*

72 Gagarin Ave., Dnipro 72, Ukraine; e-mail: gsokol@ukr.net, tmodnar@mail.ru

²*Yuzhnoye State Design Office*

3 Krivorozhskaya St., Dnipro 49008, Ukraine; e-mail: voland@mail.ru

Existing designs of automatic devices of pneumohydraulic systems (PGSs) are synthesized based on the requirement of maximum design simplicity because device reliability decreases with increasing number of components. So this factor assures reliability. The abandonment of design complication and the adoption a wide range of system parameters are the basic principles of reliability growth in rocket engineering. This approach to the design of units may be correct if there are no dynamic operating regimes or dynamic inputs. Design simplicity leads to secondary dynamic effects, such as vibration sensitivity, overloads, pressure shocks and pulsations, and feedback loop closing. Flying vehicle PGSs feature high complexity, and each individual member of theirs has dynamic properties of its own. High dynamic loads on a flying vehicle call for long-term and expensive work on accuracy and reliability assurance. The design of automatic devices can be improved by reducing the sensitivity of the movable system of a unit to external disturbances. In the improved design, the operating members of each unit are connected by kinematic links into a system with one degree of freedom. The motion equations of the operating members of all PGS automatics units have the same form and differ only in the form of the functions that describe the forces acting on the operating members from the working medium flow. Hence, the problem of the derivation of analytical expressions that describe the restrictions imposed on the structure of units, the number of their movable members, the type of kinematic links between them, and the mutual orientation of their work motions is solved. Account is taken of the fact that the disturbing action of inertia produced in compound motions of the case of each unit is minimum. Kinematic diagrams with movable member interconnections that meet the restrictions obtained are developed. The presented developments are of importance in the design and calculation of rocket hardware.

Keywords: *rocket engineering, units, movable members, inertia, minimization.*

1. Gladky V. F. Flying Vehicle Strength, Vibration, and Reliability. Moscow: Nauka, 1975. 455 pp. (in Russian).
2. Liquid-Propellant Rocket Propulsion Systems. Moscow: 1966. 404 pp. (in Russian).
3. Mikishev G. N. Experimental Methods in Spacecraft Dynamics. Moscow: Mashinostroyeniye, 1978. 248 pp. (in Russian).
4. Kinytskyi Ya. T. Theory of Mechanisms and Machines. Kyiv: Naukova Dumka, 2002. 660 pp. (in Ukrainian).
5. Science for the Space Industry. Information Bulletin of the Coordination Council on the Organization of Joint Work of Yuzhnoye Design Office and Institutes of the National Academy of Sciences of Ukraine. No. 1. Dnipro, 2018. 120 pp. (in Ukrainian).
6. Sokol H. I. Theory of Robot System Mechanisms. Kinematics. Dnipropetrovsk, Dnipropetrovsk National University, 2002. 92 pp. (in Ukrainian).
7. Yang W., Shen Y., Bajenov A. Improving low-cost inertial-measurement-unit (IMU)-based motion tracking accuracy for a biomorphic hyper-redundant snake robot. Robotics and Biometrics. University of Nevada, Reno, December 2017. 9 pp. <https://doi.org/10.1186/s40638-017-0069-z>
8. Bickel B., Whiting E., Sorkine-Hornung O. Optimizing moment of inertia for spinnable objects. Communications of the ACM. 2017. V. 60. No. 8. Pp. 92-99. <https://doi.org/10.1145/3068766>

Received on July 17, 2019,
in final form on November 15, 2019