

DEVELOPMENT OF A STRUCTURAL SCHEMATIC OF A BIFUNCTIONAL SYSTEM FOR ROCKET ENGINE THRUST VECTOR CONTROL

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Space hardware improvement is largely determined by a further increase in the efficiency of rocket propulsion systems. Extending the functional capabilities of propulsion systems is of special importance to stage flight control. The main advantage of thrust vector control by rotating the engine mounted on a cardan joint is the possibility of producing sufficiently large control forces with a minimum of specific impulse loss caused by the control process. The advantage of the gas-dynamic control system is its high dynamic performance. The new control system concept considered in this paper consists in combining the two above-mentioned control systems (the mechanical one and the gas-dynamic one) into a single bifunctional thrust vector control system (BTVCS). The BTVCS, which is an integral part of the rocket stage flight control system, must produce control forces needed to implement the flight program and counteract disturbances acting on the stage with an optimum distribution of functions between its two constituents: the mechanical system and the gas-dynamic system. In doing so, it is necessary to minimize the power consumption for control without affecting the control quality.

The aim of this work is to substantiate the advantages of possible BTVCS layouts and the proposed procedure of separate analysis of the BTVCS input signals, which is the heart of the BTVCS structural schematic.

It is shown that for a space rocket stage the BTVCS allows one, with a minimum of power consumption for control, to implement the combined task of counteracting deterministic disturbances (produced, for example, when a part of the payload is detached) and stabilizing the motion in cases where random disturbances of wide frequency spectrum act on the rocket stage. A new approach to BTVCS input signal analysis and a control signal generation algorithm are proposed. The static component extracted from the total BTVCS input signal is counteracted by the mechanical thrust vector control system, which basically implements the task of guiding the space stage along the desired trajectory. The dynamic component of the signal, which is due to random (as a rule, high-frequency) disturbances, is counteracted by the gas-dynamic thrust vector control system and basically implements the stage stabilization task. The procedure was verified by the example of telemetry data on the pitch angle of the first combustion chamber of an 11D520 liquid-propellant rocket engine.

Keywords: *rocket engine, thrust vector control system, mechanical system, gas-dynamic system, bifunctional system.*

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