

MECHANICS

P. D. Balakin

Links of non-free mechanical man-made systems

The paper gives a complete classification of the links of non-free mechanical technogenic systems. It is shown that the joint use of holonomic and non-holonomic constraints in mechanical systems allows the creation of systems with adaptive properties.

The main method of synthesis of such systems is an additional motion to the main motion of the links, which can be either a small motion of self-adjustment or elastic deformation, or significant coming from the control circuit integrated in the system.

Keywords: mechanical system; additional to the main movement of the links; built-in control circuit.

POWER AND CHEMICAL ENGINEERING

S. S. Busarov, D. I. Bukhanets, D. C. Titov

Analysis of the efficiency of external cooling of low-speed, long-stroke, non-lubricated reciprocating compressor stages

The theoretical analysis of the working processes of the slow-moving long-range stage with variant cooling of different sections of the working chamber made it possible to determine the rational range of its cooled zones and the corresponding design parameters of the cooling jacket, which makes it possible to ensure the permissible temperature of the injected gas at minimum overall dimensions and mass.

Keywords: working process, cooling system, slow-speed stage.

D. A. Kalashnikov, A. S. Pugachuk, E. O. Chudotvorova, A. V. Chernyshev

Determination of power loss in compressor stage of turbogenerator in dynamic experiments

A mathematical model for the interaction of a gas environment with the surfaces of the impeller of turbogenerator compressor is developed. The study of the characteristic of power losses at various rotational speeds of the rotor is provided. Recommendations for testing the impeller of turbogenerator compressor is given.

Keywords: turbogenerator plant, compressor stage, compressor impeller, power loss, balancing of the rotor, flow channel of the impeller, gasdynamic calculations, computation domain of a mathematical model.

AVIATION AND ROCKET-SPACE ENGINEERING

V. N. Blinov, A. I. Lukyanchik, V. V. Shalay

Mathematical model for the parametric study of ammonia propulsion system in microsatellite platform by random search method

A large number of basic design parameters of the ammonia propulsion system makes the task of their search by the method of random search urgent. The aim of the research is to create a mathematical model that is adapted to the chosen method. Mathematical model for random design parameters provides the choice of the optimal reduced mass of the propulsion system, taking into account the complex relationships of the investigated parameters, which provides the solution of the given tasks of microsatellite maneuvering.

Keywords: ammonia, correcting propulsion device, microsatellite, random search method, basic design parameters.

A. V. Sedelnikov, Yu. Ya. Puzin, A. S. Filippov

Method of flight operation of software and hardware for controlling parameters of the rotational motion of small spacecraft of the Aist series

The paper presents a methodology for flight operation of firmware intended for monitoring the parameters of the rotational motion of a small spacecraft. The developed technique is aimed at improving the quality of the primary information on the state of the parameters of the rotational motion of the small spacecraft and the quality of the implemented algorithms for controlling the electromagnets. This facilitates both the creation of favorable conditions for the implementation of technological processes on board of the small spacecraft, and a significant improvement in the quality of telemetric information transmitted from the small spacecraft to Earth. The technique can be applied to the operation of small spacecraft of other series that do not contain large elastic elements of the structure.

Keywords: small spacecraft, software and hardware, operating procedure, continuous control procedure, magnetic actuators, rotational motion parameters.

V. I. Gorbunkov, V. V. Kositsin, V. I. Ruban, V. V. Shalay

Arcjet plasma temperature estimation in thruster device

The kinetic theory of gases methods has been used to evaluate plasma arc parameters in the arcjet thruster device.

It greatly means the compression process in adiabatic character and gas temperature increasing for excited atoms Boltzmann distribution over the energy levels.

Using argon gas for arcjet working process carrying out, the way of gas temperature evaluation is offered.

The results of the study can be use in the spacecraft arcjet development.

Keywords: arcjet thruster, high pressure argon plasma, specific impulse, gas and electron temperature, the adiabatic character of the compression process, local thermal equilibrium, the Boltzmann distribution, emission spectroscopy.

I. Yu. Gudkova, D. B. Lempert

The energy potential of some hypothetical nitrosubstituted tetrazoles derivatives

The energy abilities of solid composite propellants based on some nitrosubstituted tetrazole derivatives, which are still hypothetical but they are promising for create on their basis rather powerful propellants, have been considered. It is confirmed by the thermodynamic calculations.

Keywords: tetrazole derivatives, solid composite propellants, specific impulse, oxidant, binder.

D. B. Lempert, E. M. Dorofeenko, S. I. Soglasnova

The energy potential of some high-enthalpy N-oxides as oxidizers

The energy abilities of solid composite propellants based on a couple of new high-enthalpy N-oxides (furazano-terazine-dioxide and tetrazino-tetrazine-1,3,6,8-tetraoxide) have been considered, it is found that these two compounds show record energy characteristics – specific impulse up to 273 s (at pressure in the combustion chamber and at the nozzle section 4,0 and 0,1 MPa respectively) at the combustion temperature not higher than 3700 K. Formulations based on these two compounds are very powerful if any binder (an active binder or a hydrocarbon one) is used.

Keywords: high-enthalpy polyazotic compounds, solid composite propellants, specific impulse, oxidant, binder.

ENGINEERING GEOMETRY AND COMPUTER GRAPHICS**K. L. Panchuk, E. V. Lyubchinov**

Elements of spatial cyclography

In modern CAD / CAM systems and in CAGD (Computer Aided Geometric Design), models of geometric objects (lines, surfaces) of space R^4 in space R^3 and vice versa are used. The analysis of geometric models used in such systems allows us to conclude that research is relevant to the development in R^3 of analytical models of lines and surfaces of the space R^4 .

In this paper, we show the possibility of obtaining of constructive-analytical model using the three-dimensional drawing of the space R^4 , proposed by N. V. Naumovich. Based on this drawing, a constructive interpretation of the proposed analytical model is given and its implementation is realized in a virtual electronic 3D-space.

The model of the R^4 space curve proposed in this paper is based on the theoretical positions of the spatial cyclography realized in Naumovich's three-dimensional drawing. This proposed model differs from existing ones using the analytical method of modeling.

The essence of the proposed constructive-analytical modeling consists in the geometric representation and interpretation in the three-dimensional drawing of the cyclographic images of points, lines, the set of points and lines of the space R^4 .

The constructive-analytical modeling of the R^4 space curve on the basis of the cyclographic mapping and the possibility of its realization on Naumovich's three-dimensional drawing allow to get a full picture of the interrelation and mutual influence of all the elements of the model. Such a representation is based on the implementation of a 3D-drawing in virtual electronic 3D-space with the means of modern graphical CAD and allows solving the optimization of the developed models of geometric objects in relation to the requirements of modern CAD / CAM systems and CAGD.

Keywords: cyclography, lines and surfaces, geometric modeling, multidimensional space, three-dimensional Naumovich's drawing, channel surface.

F. N. Pritykin, V. I. Nebritov

Determination of spherical curve defining the angle of service of android robot arm by method of small motions synthesis

A generalized method for determining the angle of service based on the synthesis of motions in the specified directions of the gripper's axis with immobile center is presented. As an example, the angle of the android robot's arm is defined, formed by the longitudinal axis of the gripper. The essence of the method is based on the study of position's sets of configurations defining the extreme positions of the points of a sphere of unit radius that specifies the angle of the service. On the basis of this, a spherical curve defining the shape of the desired angle is defined.

Keywords: manipulators mechanisms, service angle, robot motion synthesis, maneuverability, robotics, output link.