STUDYING THE PECULIARITIES OF BALANCING OF FLEXIBLE DOUBLE-SUPPORT ROTORS BY TWO PASSIVE AUTOMATIC BALANCERS PLACED NEAR SUPPORTS (p. 4-9)

Valery Goncharov, Gennadiy Filimonikhin, Kostyantyn Dumenko, Mihail Lychuk

A discrete N-mass model of a flexible double-support rotor with two passive automatic balancers of pendulum, ball or roller type was constructed. Automatic balancers are placed near supports. The system of differential equations, which describes the motion of a rotor machine, is obtained.

The primary (sustained) motions of a system as the motions, in which automatic balancers eliminated displacements of a rotor in supports, were found. It is shown that on the primary motions, the total imbalances of a rotor and AB, reduced to two correction planes (supports), equal zero.

It was proposed to examine the stability (of the family) of sustained motions by generalized coordinates, which set the displacement of a rotor in the supports and by dynamic variables that equal total imbalances of a rotor and AB in two correction planes. We obtained differential equations, which describe the change in these variables that describe the process of self-balancing.

By the analysis of differential equations of the motion of a system it was established that:

– on the primary motions, AB eliminate rotor deflections and vibrations in elastic viscous supports, but do not remove shaft deflections in non-supporting points;

– on the primary motions elastic viscous supports are conditionally converted into hinge supports;

– shaft deflections in non-supporting points and the primary motions change with the change in angular speed of rotation of the rotor;

– primary motions exist at a certain distance of the speed of rotation of the rotor from the critical speeds of flexible rotor rotation with the hinge supports instead of elastic viscous supports;

– at the speeds of rotation of a rotor shaft close to any of these speeds, the conditions of existence of the primary motions are disrupted because shaft deflections theoretically grow to infinity and the balancing capacity of AB is not sufficient for the compensation for the imbalances of the rotor;

– in practice these deflections are limited and, therefore, proper selection of the balancing capacity of AB can ensure existence of primary motions at all speeds of rotation of rotor.

Keywords: flexible rotor, automatic balancer, self-balancing, primary motion, critical speed, resonance speed.

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ANALYTICAL STUDY OF THE BENDING OF ISOTROPIC PLATES, INHOMOGENEOUS IN THICKNESS (p. 10-16)

Volodymyr Plevako, Volodymyr Potapov, Viktor Kucenko, Ighor Lebedinec, Iryna Pedorych

A three-dimensional problem of bending the plate, in which the parameters of elasticity of the material vary by thickness and are arbitrary integrable functions, was examined. And the plate itself is exposed to the action of mass forces while the action of surface loads is studied as a separate case.

An analytical solution to the boundary problem by the operator methods was obtained in a case when the boundary conditions are satisfied exactly on the flat surfaces of the plates and on the lateral surface – in the Saint Venant approximation.

It was theoretically proved that the exact, in the sense of Saint Venant, analytical solutions may be obtained if the plate is exposed to the action of the mass and surface forces, distributed on the plate and on its surface by the two-dimensional polyharmonic law. In this case, the thinner the plate, the more exact the solution will be, since the corresponding solutions represent the series that contain a finite number of members.

It was demonstrated that the obtained formulas for the calculation of bending the thin plates in the case of homogeneous material transfer to the classic formulas of the theory of bending thin plates.

The obtained solutions allow using them as the approximate, "technical" theory for engineering calculations of the stressed and deformed state of non-homogeneous plates.

Keywords: theory of elasticity, isotropic bodies, non-homogeneous materials, bending of plates, stresess and deformations.

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ANALYSIS OF ORIGIN OF SHEAR BANDS IN A REINFORCING ELASTIC-PLASTIC BODY (p. 17-22)

Yurii Chernyakov, Artur Shevchenko

The area of the line of localization of plastic deformation in the section of reinforcement is presented in the form of a band of finite length for the case of plane strain. The banks of the band can slide freely, but in this case they must stay in contact. The theory of microdeformation, which leads to the singular surface of fluidity is used for describing mechanical behavior, which is very important in the problems of localization.

We built a closed analytical solution of the problem of building the fields of rates of displacements and changes in stresses in the vicinity of apex of the assigned line of discontinuity of the speeds of displacements. It was established that three different forms of the solution, depending on the results of the solution to the problem of localization, are possible. The point of localization is defined as the point of intersection of the curve defining the dependency of parameters of material on the parameters of load according to the theory of microdeformations, with the curve that defines the boundary between elliptic and hyperbolic regime of the solutions. The field of rates of change in stresses has a root peculiarity.

The criterion for ductile fracture (advance of line of discontinuity) was formulated based on the approaches, accepted in the Novozhilov criterion of brittle fracture. In this case it was taken into account that with the ductile fracture we deal

with the occurrence of a localized flow, in which the development of line of discontinuity will be determined by average rates of change in stresses in the vicinity of a singular point. The orientation of the line of discontinuity of the rates of displacements and the fields of rates of change in stresses and displacements were defined. The dependence of the length of the line of localization on subcritical stresses is obtained from the limitation of the angle of fracture of the trajectory of load. It was established that the line of localization in the initial state can have dimension comparable with size of the grain. It was shown that localization in the form of the slip line of finite length precedes the localization at the point.

Keywords: theory of plasticity, micromechanics, shear bands, theory of microdeformations, bifurcation, polycrystal, critical load.

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MODELLING A THROTTLING DEVICE DURING SEPARATION OF MOISTURE FROM GAS FLOW (p. 23-29)

Georgiy Kulinchenko, Petro Leontiev

The need to design a model of a throttling device, which is used in the process of low temperature separation (LTS) of moisture from the gas flow, is predetermined by the necessity to coordinate the modes of functioning of the throttle with the modes of the heat exchanger and the separator that are included in the installation of separation. Proceeding from the task of efficient management of the process of the LTS of moisture from the gas flow, we analyzed a channel of control of the flow of gas under throttling. The peculiarity of managing the process of separation of moisture is in the contradiction between the productivity of the gas flow and the conditions of moisture removal. In order to study the influence of parameters of a throttle on the formation of the modes of passing flow, a distribution of the field of the flow velocities is obtained in the software environment of ANSYS Workbench. Visualization of the flow stream allows analyzing the level of turbulence of the flow under throttling and forecasting the trajectory of moisture droplets formed at throttling. By comparing the data obtained from the experimental installation with the data of numerical calculations, carried out in accordance with well-known mathematical models of the flow under throttling, we conducted the assessment of the adequacy of the description of the object of control. It is shown that the assumption of incompressibility of natural gas when evaluating the rate leads to significant errors. As a result of the identification of the parameters of a throttling device, its simulation was implemented in the

environment of MatLab Simulink. Block construction of the model allows performing simulation under conditions of arbitrary nature of the change in the parameters of the process over time. The assessment of the adequacy of simulating a throttle device allows using the studied model for constructing a model of an installation of moisture separation from gas flow.

Keywords: subcritical flow mode, supercritical flow mode, throttle valve, pipeline hydraulic resistance, dew point temperature.

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DEVELOPMENT OF GAS DYNAMIC LINEAR SYSTEMS FOR SETTING LOW PRESSURES (p. 30-36)

Ihor Dilay, Zenoviy Teplukh, Roman Brylyns'kyy, Ivan-Roman Kubara

The results of research into the schemes of serial connection of capillaries – pressure dividers, both two- and multi-capillary, were presented, with a linear dependency of change in inter-throttle pressures on supply pressure. Based on the analysis of the results, the schemes for multi-range pressure setting devices are built – a cascade connection of dividers and with binary ramification of pressure dividers.

For each of these schemes, the corresponding setting of dimensions of passable capillary channels can set such pressure drops in capillaries, at which the division pressure coefficients will vary by several orders of magnitude and remain constant. The designed schemes provide one direction and proportionality of all inter-throttle pressures (drops) of a scheme when changing the input supply pressure, but the scheme with binary branches of dividers enables setting the drops of pressures at the level of pascal particles.

The built four-decade device for setting the drops of pressures was explored by the obtained mathematical models under the action of impact factors (change in supply pressures of the setting device, temperature of throttled gas) on the coefficients of division. It was found that the influence of pressure changes in the designed scheme is practically absent while the temperature change of the gas flow by ± 5 K does not exceed 0,2 %.

Application of the tools of pressure reproduction, based on the designed schemes, opens up the prospect of building high precision devices for one-stage preparation of complex gas mixtures with micro-concentrations of components, the devices for setting low and micro-rates of gases, as well as for testing the tools for measuring pressures.

Keywords: pressure reproduction, capillary, combiner and divider of flows, linear divider of pressures.

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FORMATION OF A RATIONAL CHANGE IN CONTROLLING CONTINUOUSLY VARIABLE TRANSMISSION AT THE STAGES OF A TRACTOR'S ACCELERATION AND BRAKING (p. 37-44)

Vadim Samorodov, Andrey Kozhushko, Eugene Pelipenko

We formalized the criteria for evaluation of indicators of a wheeled tractor with continuously variable hydrovolumetric-mechanical transmission from the point of view of loading a hydraulic branch of hydrovolumetric transmission in direct and reverse power flows. The given description of the criteria is used for the formation of change in parameters of adjustment of hydraulic machines (hydraulic pump and hydraulic engine) in the process of acceleration and braking of a wheeled tractor.

We formed a rational change in parameters of adjustment of a hydraulic machine at the stages of acceleration and braking for a wheeled tractor with continuously variable hydrovolumetric-mechanical transmission that is made by the scheme of the differential at the output. In the study of the obtained dependency of parameters of adjustment of hydraulic machines, we determined the change of such indicators as the time of acceleration and braking; braking distance of a wheeled tractor; coefficient of performance of hydrovolumetric drive and hydrovolumetric-mechanical transmissions; the difference of working pressure in hydrovolumetric drive. It was found that when applying the rational change in the parameters of adjustment of hydraulic machines instead of the linear one at the stages of acceleration and braking, the zone of the highest value of the coefficient of performance of hydrovolumetric-mechanical transmission narrows, which, in turn, points to the loading of the hydraulic branch of a hydrovolumetric transmission.

Keywords: hydrovolumetric-mechanical transmission, rational change in parameters, hydraulic branch of transmission, coefficient of performance, evaluation criteria.

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REDUNDANT INFORMATION PROCESSING TECHNIQUES COMPARISON FOR DIFFERENTIAL VIBRATORY GYROSCOPE (p. 45-52)

Valerii Chikovani, Olha Sushchenko, Hanna Tsiruk

Advantages of differential Coriolis vibratory gyroscope of the new type with two measuring channels of angle rate with opposite signs that provides redundant measuring information about angle rate are analyzed. Comparative analysis of four different techniques of redundant signals processing including technology of "virtual" gyro signals processing in application to the differential vibratory gyroscope is carried out.

Importance of creation of redundant information processing techniques is caused by distinction of the differential vibratory gyroscope from other micro-electro-mechanical gyros, for example, tuning fork gyro, in that it has two output signals, which come from the single resonator and correspond to angle rates with opposite signs.

As a result redundant output information processing techniques were obtained. This information comes from the differential vibratory gyroscope output and is formed by subtracting of two measuring channel signals. The algorithm of "virtual" gyro redundant output information processing was modified. The algorithm differs from known ones by calculation of inter-channel correlation matrix in on-line manner. This leads to decrease of angle rate measuring random error and to decrease overshoot in conditions of abrupt change of angle rate.

The obtained results are important and useful for application of differential vibratory gyroscopes in stabilization systems and angular motion control. This is caused by high requirements to accuracy and ability to function in hash environment.

Keywords: differential vibratory gyro, "virtual" gyro technology, bias, correlation matrix.

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