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MECHANICAL AND THEORETICAL ENGINEERING

P. D. Balakin, I. P. Zgonnik, L. V. Krasotina
Universal method of elimination of power parametric excitation in mechanical systems of general type

A universal method for converting general mechanical systems into rotational ones with a constant reduced inertial characteristic is proposed. The reception is based on joining the link of the alignment of the kinematic chain with programmatic variation of the inertial characteristic, which, in addition to the basic one, forms a link of reduction with a constant reduced moment of inertia. This modification of the mechanical drive eliminates the parametric power drive excitation, reduces the level of dynamic loading of links and drive connections, which leads to an increase in the reliability and resource of the system.

Keywords: mechanical system, built-in circuit, program change of inertial characteristic, constant reduced moment of inertia, rotative system.

V. I. Surikov, V. R. Vedruchenko, V. S. Shcherbakov, V. Ye. Shcherba, A. Yu. Ovsyannikov
Increasing the efficiency of volumetric piston power machine with gas volume for suction by using a pressure fluctuation in lower cavity of pump section

The article is devoted to the problem of increasing the efficiency of a volumetric piston-type power machine. The main purpose of the work is to improve the intensity of the flow, including in the automatic mode. To achieve this goal, a mathematical model of working processes has been compiled, describing the flow of liquid in the jacket space, as well as changing the gas parameters in the cavities of the machine.

Keywords: piston compressor, hybrid power machine, working processes, working cavity, jacket, liquid cooling.

E. B. Bochektueva, V. E. Rogov
The analysis of cracker resistance of rolled rollers of quartet rolling

The main elements of any rolling mill are rolls, which carry out the rolling of sheets, the production of which is a laborious process. The main part of cold-rolled rolling rolls is purchased abroad. The task of making Russian rolling rolls and assessing their fracture toughness is becoming topical, allowing us to make the correct conclusion about the terms of roll change. The article presents the results of calculating the quartet rolling rolls for durability in the process of operation taking into account residual thermal stresses. The calculation is presented for circular internal defects located perpendicular to the roll axis, representing the greatest danger. As a result, it is found that the maximum danger is represented by cracks located in the marginal zone of the necks.

Keywords: rolling rolls, crack resistance, stress intensity factor, durability.

S. B. Skobelev, V. F. Kovalevskiy
Change in wear resistance of steel 35 with shock-acoustic treatment with introduction of solid lubricant

The results of experimental studies of the influence of shock-acoustic treatment regimens on the wear resistance of samples made of steel 35 are given. Rational processing regimes are determined under which minimal deterioration of the samples is achieved. Based on the results of experimental studies, the values of the overlap and processing coefficients for steel 35 were calculated. A computer program for calculating the rational modes of shock-acoustic processing is presented.

Keywords: wear resistance, surface quality, shock-acoustic treatment, solid lubrication, processing regimes, overlap coefficients, processing coefficients.

E. A. Shibeev, I. P. Moskvina, Yu. E. Tanakova
The effect of compliance of the mixture at casting defect in the form of cracks

The aspects of the occurrence of hot cracks in steel castings depending on the composition and configuration of forms and cores, as well as their degree of compliance are considered. Theoretically and practically it is proved that in the casting of alloy steel from the pliability of the rods and forms directly

depends on quality of the product. These insights and techniques can be used to fight against marriage and for the detail with the different configuration of the foundry.

For the Omsk region scientific development it is useful improving the quality of manufactured products, a growing number of orders from other regions, thereby increasing the income of the enterprise and the Omsk region.

Keywords: pliability, shrink, rod, crack, defect, steel casting.

E. V. Vasilyev, P. V. Nazarov, A. G. Koltsov, D. A. Blokhin, I. A. Bugai, M. A. Totik, I. K. Chernykh
Calibration of axes of experimental CNC grinding machine for contouring plates on back surface with laser interferometer

In the article deals with the process of calibration and modernized machine MSh 289 with the CNC-system «Mayak». The device and layout of the experimental grinding machine is described. With the help of a laser interferometer, the accuracy of positioning of the linear and rotary axis is investigated. As a result, the main reasons that influenced the deviation of the actual displacements from the specified ones are identified and eliminated. Compensation of the error of reduction and backlash in the CNC system is introduced.

Keywords: CNC grinding machine, laser interferometer, CNC-machine tools accuracy, upgrading of the machine.

D. D. Primak, I. A. Volkov, V. B. Masyagin
The method of calculation of dimensional analysis of constructions for details like axially symmetrical bodies using geometrical models of details

In this article the method of calculation the dimensional analysis of construction consisting of details like axially symmetrical body based on geometrical models of details is applied. Usage of the geometrical models in contrast to real details, considerably simplifies the task of performing sized analysis. This method allows to eliminate quickly actually all sized and precision errors and mismatches that allows to provide high quality of construction at the initial stage of its creation, and also realizes automatic design of technological build process, and provides a transition to the display of the assembly image.

Keywords: dimensional analysis, geometrical model, sized circuit, closing links, technological process, assembly.

P. A. Sen'kin, N. I. Prokopenko, A. M. Smirnov, V. V. Mallyi
Calculation of optimum parameters for tank power-package with sustained power engine

The article considers optimum parameters of a turbo-charged diesel engine, ensuring functioning under sustained power. The authors define optimum combinations of boost pressure, excess air ratio, compression ratio and engine pressure ratio under fuel combustion. They draw conclusions and give recommendations for further improvement of diesel turbo-charged engines.

Keywords: sustained power engine, optimum parameters, turbocharging.

A. A. Shargaev, N. G. Makarenko, S. A. Mamey, E. N. Shitakov
Durability improvement of rolling-contact bearings in internal combustion engine by electrochemical and mechanical processing

The article suggests a technique for increasing the durability of rolling bearings with electrochemical-mechanical treatment with a non-contact electrical component. The analysis of the reliability of rolling bearings of internal combustion engines (ICE) has shown that when 75 to 80 % of the service life is reached, the radial clearance in the roller-support interface exceeds the permissible values, resulting in reduced engine life. The purpose of the work is to increase the life of rolling bearings, by applying protective coatings on the working surfaces, which makes it possible to reduce the gap in the roller-bearing connection. The processing of rolling bearings is performed, the results confirming the increase in the resource are presented. This technique can be used to improve the durability of rolling bearings in internal combustion engines.

Keywords: a technique, reliability, an internal combustion engine (ICE), a rolling bearing (RB), wear, electrochemical and mechanical processing (ECMP).

V. V. Kharlamov, D. I. Popov,
S. O. Rumenko

Features of process simulation tests of asynchronous traction motors by method of mutual loading in software product Multisim

The article presents simulation in the Multisim program of process tests of induction machines by method of mutual loading application circuits with two frequency converters. There are identified problems arising in the modeling. It shows the inefficiency of using some of the standard elements of the program Multisim, and standard G-shaped equivalent circuit for modeling the generator mode the induction motor in test circuits.

Keywords: asynchronous traction motor, the method of mutual loading, frequency converter, generator mode, electric machine, simulation model.

Yu. A. Arutyunov, O. N. Borodin, A. A. Drobyazko,
E. A. Chashchin, P. A. Shashok

Designing power transformers using methods of topological optimization

The author explains and presents the method of topological optimization of magnetic circuit of transformers based on application of the criterion of the level of losses in the magnetic core used in practice to determine the rational design parameters of the magnetic circuit with constraints on the choice of types of electrical steel. It describes the features and it is shown that when determining the main dimensions and topology of the magnetic circuit of the transformer plays an important role in achieving a given level of relationship of no-load losses due to the uneven distribution over the cross section of the magnetic circuit of the magnetic flux, which allows to find the rational solution given the numerous functional limitations. In the approximation that the load losses are directly dependent on the mass of the magnetic circuit, considered the problem of finding the minimum mass of the magnetic circuit in the transformer in regulated modes.

Keywords: transformer, magnetic, optimization, topology, loss, efficiency.

I. V. Belitsyn, D. V. Rysev

Problems of control and analysis of quality indicators of electrical energy and ways of their solution

The article is devoted to the review and analysis of the existing energy quality control problems. The influence of energy quality on the efficiency of the use of electrical equipment and the energy undercounting was studied. The electromagnetic and optical instrument transformer's metrological parameters are compared. The shortcomings of the discrete Fourier transform are shown. A wavelet analysis-based time series processing method is proposed.

Keywords: energy quality, instrument transformers, time series processing, wavelet analysis.

P. V. Belyaev, D. A. Podberezkin, R. A. Em

Studies of the impact of changes in hydrogen concentration on the output characteristics of the fuel cell proton exchange membrane

In the article the mathematical modeling of fuel cell proton exchange membrane (PAMTA) is developed. There are analyzed effects of changing parameters of the fuel cell proton exchange membrane on its output characteristics. The analysis of data obtained in the modeling data will allow to draw conclusions about the nature and extent of influence of each of the editable parameters. There is considered volt-ampere characteristic POMTE and its main region. The mathematical model describing the electrical properties of the fuel element is developed. For our simulations there is developed the simulation model in software environment Matlab/Simulink. Using the model investigated the reaction of the output characteristics POMTE to change one of the main input parameters.

Keywords: fuel cell, PEMFC, modeling.

A. A. Bubenchikov, N. G. Demidova, A. G. Komarov,
V. V. Gorbachev, T. V. Bubenchikova

The possibility of using alternative sources in the Omsk region

An analysis of the feasibility of using alternative sources of electricity in the Omsk region is carried out. The characteristics of systems based on alternative sources of electricity are presented. A study is made of the applicability of renewable energy sources in solving consumer problems.

Keywords: alternative power sources, photovoltaic station, wind power station, diesel-generator set, autonomous hybrid electrical installation.

A. A. Bubenchikov, N. G. Demidova, D. V. Avdeev,
A. G. Komarov, V. V. Gorbachev, T. V. Bubenchikova
Assessment of energy and economic efficiency of alternative energy sources in the Omsk region

A study is made on the possibility of using alternative sources of electricity in the Omsk region. The composition, the method of selecting the main source of electric power and the calculation of the cost of each system based on alternative sources of electricity are considered. Economic evaluation of the feasibility of using alternative sources of electricity in the Omsk region is made.

Keywords: alternative power sources, photovoltaic station, wind power station, diesel-generator set, autonomous hybrid electrical installation.

Ye. M. Kuznetsov, A. Yu. Kovalev, V. V. Anikin
Method of determining the parameters of induction motor without pairing with loading device

There are determined by the initial current and time constant exponents approximating a gentle, cool and super transition plots the envelope of the digitized transient response $i_1(t)$ decay of the stator current and the integral and the value of the derivative $(di_1/dt)_{t=0}$ at the beginning of the transition process. There are measured and calculated data of certain equivalent parameters of induction motors (IM). The results of experimental verification of the method proving its effectiveness and suitability for repair shops of electrical equipment and oil wells are presented.

Keywords: transient response, current of the stator active winding resistance, leakage inductance.

O. A. Lysenko, A. V. Simakov

Simulation of power characteristics of synchronous and induction submersible motors

The article questions the simulation and calculation of electromagnetic torque submersible induction motors and permanent magnet motors of submersible centrifugal pumps in oil production installations are considered. The relevance of the issues discussed is confirmed by the growing demands for oil production technology, including in terms of energy efficiency. The main design features of submersible motors are presented. The software for constructing a mathematical model of a submersible motor is selected. The results of the simulation are the patterns of the power lines in the section of the asynchronous and magnetoelectric synchronous submersible motors. The adequacy of the models is confirmed by the correspondence between the distribution of the magnetic flux in the section of the machine and the correspondence within the error of the analytical and empirical values of the torque. The simulation results, taking into account the assumptions made and the method of calculation and design error and means for calculating the model is correct.

Keywords: oil production, centrifugal pump, submersible electric motor, mathematical model, finite element method.

T. A. Novozhilov

The current sensor on reed switch for relay protection

A new design is developed of the current sensor on the reed switch for relay protection, which is performed in the form of a reed switch with the control and measuring windings mounted on a printed circuit board and placed in a protective enclosure made of porcelain, rubber or plastic. In this case, the housing of dielectric material is designed for reliable protection of the current sensor from mechanical and electrical damage. Management coil when powered it with AC or DC current makes it possible to increase the sensitivity of the device and to determine the direction of the measured current. The measuring winding is used to control the tension and the spectrum of the magnetic field at the point of placement of the magnetic system current sensor from the tire of the protected element of the power system and the control coil. For the implementation of the proposed protection methods for the determination of the magnetic field of the actuation of the reed switch currents in the tire and the coil control and method of correction parameters of the reed switch.

Keywords: current sensor, the housing of the current sensor, reed switch, control and measurement coil.

I. S. Sukhachev, S. V. Sidorov, V. V. Sushkov

The method of assessment energy effecting electrical equipment insulation an oil well at impulse overvoltages

The paper relates to the field of electrical engineering and downhole equipment, namely, to the assessment energy effecting electrical equipment insulation an oil well at impulse overvoltages. The substitution scheme and its mathematical description are developed on the example of the «transformer-supply cable-SEM» system. The frequency response of impulse overvoltages at the input of a transformer, cable and submersible electric motor is constructed

and analyzed. The energy and frequency of the stresses in the nodes of the substitution circuit are determined, where the energy of the action on the insulation has the maximum value.

Keywords: impulse overvoltage, energy, electrical equipment insulation, transformer, cable, submersible motor, protection equipment.

Ch. P. Mongush, Yu. Ch. Ondar, A. V. Sat, S. N. Chizhma
Analysis of energy losses and ways to reduce them in the electrical networks of the Republic of Tyva

At present, the electric power industry is characterized by a high degree of deterioration of the material and technical base, which does not meet modern requirements and, in combination with increasing volumes of electricity consumption and network load, contributes to the growth of electricity losses in the power grid. This article considers the structure of the power system of the Republic of Tyva, the main indicators are analyzed: the annual volume of electricity generation, the volume of release, consumption and loss of electricity for the last six years, the technical condition of the equipment, etc. The ways of reducing power losses are considered.

Keywords: power system of the Republic of Tuva, energy losses, measures to reduce energy losses.

N. S. Troshina
The modeling of optimization efficiency of cogeneration gas turbine cogeneration plants taking into consideration the operational costs and indicators of harmful emissions

There is considered combined production of heat and electric energy cogeneration. Classification of cogeneration technologies is given and their advantages are highlighted over the separate generation of energy. The bulk of the work includes a model of efficiency that should be used when solving problems of optimization of cogeneration plants.

Keywords: cogeneration, cogeneration plant, the efficiency, heat balance, the internal combustion engine.

E. S. Flek
Development of physical model of combustion of droplet of coal-water fuel

In the article there is considered one of directions of increase of efficiency of use of coal — burning coal-water fuel (CWF). A review of research on the production and combustion of CWF is done. There is developed a physical model of the combustion of droplets of CWF c division of the process into a sequence of repetitive stages of evaporation and burning out of the solid phase.

Keywords: coal-water fuel, ignition, combustion, devolatilization, evaporation, physical model.

A. S. Martianov, V. V. Sushkov
Comparison of ride-through solutions for electric submersible pump units

In this paper, our main objective is developing ride-through solution for the electric submersible motors with adjustable speed drive. This paper considered the main ride-through solutions for the ESM. The most preferred ride-through solution are HSTD, DVR, and increase the power supply of the load node at the time before voltage reduction (using flywheels or ultra-capacitors). We propose the rational ride-through solution with supercapacitor energy storage to decrease unacceptable trips of ESM with ASD.

Keywords: ESP, energy storage system, ride-through solutions.

A. I. Pavlov, O. A. Savotin, P. I. Sukhanov
Software and hardware complex for selection of schemes for the assembly and installation of high-speed power transmission lines

In this paper we propose the description of the software developed by RDCPE- subsidiary of «The Siberian Research and Development Institute for Electric Power Industry» in fulfilment of Research and Advanced Development «Elaboration of quickly mounting power towers (emergency reserve power towers) for overhead power towers 220–500 kW emergency restoration». This software allows to optimally determine the variant of power tower assembly schemes and their poling on an emergency or overhauled overhead line section. Using the kit for quickly mounting power towers assembly work and installation together with the software would enable great reduction of emergency restoration.

Keywords: overhead transmission lines, temporary tower, quickly mounting power towers, selection assembly tower configuration software.

INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

**A. A. Kuznetsov, A. S. Bruykhova,
K. V. Usacheva,
D. V. Muraviev**

Improving the accuracy of spectral analysis tools while ensuring identical test conditions

The paper considers allowance methods for external conditions examined by example of video content analysis and statistical analysis of the results by spectrum analysis of materials. The object is accuracy increase and reproducibility of the results in conditions of changing influencing factors. A block diagram of a spectrometer equipped with sensors to monitor changes in external factors is proposed. Experimental data confirming the effectiveness solutions is proposed.

Keywords: spectral analysis of materials, sensors for experimental conditions, control of plasma parameters, processing of video images, increasing the accuracy of analysis results.

**V. L. Khazan,
M. N. Kovaleva**
Communication channels with linear distortion

The theory «paired-echo» is the universal mathematical device for the analysis of the linear and nonlinear phenomena in radio engineering circuits and liaison channels. In the given article is analyzed only linear distortions which can occur in the environment of propagation and in paths of radio equipment. Liaison channels with variable parameters and radio engineering circuits with nonlinear distortions it supposed analyzed separately. Below we study the influence of distortions of the amplitude-frequency and phase-frequency characteristics of the communication channel in view of its impulse response and Vice versa, the influence of impulse response to form the amplitude-frequency and phase-frequency characteristics. In the modern scientific literature on radio these questions are not found worthy of the light. Discussed in the article, specific examples show that the distortion of the amplitude-frequency and phase-frequency characteristics lead to multipath in the communication channel and Vice versa — multipath leads to distortions of the amplitude-frequency and phase-frequency characteristics of the communication channel.

Keywords: amplitude-frequency characteristic, phase-frequency characteristic, impulse response, multipath, leading signal, lagging signal.

E. V. Leun
The construction of multi-channel hybrid 3D measuring heads for high-precision contact and non-contact coordinate measurements of product sizes

The article is devoted to multichannel hybrid 3D measuring heads (MH) for contact and contactless coordinate measurement on coordinate measuring machines (CMM). In such a head inside a hollow spherical ruby tip radius r_t with multi-channel fiber-optic transducer (FOT), consisting of n fiber channels that form the central and the surrounding q rows of optical fibers with a total beamwidth of $\pm 95^\circ$ with a 5° overlap for two adjacent sectors. The work of the MH in the contact mode, measurements are made traditionally by mechanical contact ruby tip with the surface. It describes the work of the MH in case of contactless measurements of sequential switching fiber channels. The article discusses the design issues of creation of elements of MH, firstly for FOT, through the use of modern advances in fiber-optic technology too.

Keywords: coordinate measuring machine, coordinate measuring, measuring head, touch head, fiber-optic transducer, microlens, low-coherence interferometer.

**A. Yu. Tetter,
V. Yu. Tetter**
Definition of technical condition of units of railway technics in conditions of non-stationary modes of operation

The necessity of diagnostics of a rolling stock during its operation and maintenance is shown. Insufficient elaboration of the question of diagnosis under transient conditions is considered. Examples of the use of non-stationary modes of operation of equipment for electrical parameters, vibration and temperature are given. The conclusion about the economic viability of the systems diagnostic in dynamics is done. There are identified promising areas of research.

Keywords: rolling stock, diagnostics, non-stationary modes, dynamic modes, transients, vibration, temperature.

R. D. Karabtsov, L. A. Denisova
Automated design of fuzzy control systems using genetic algorithms

The problems of the design of automatic control system (ACS) are realized using fuzzy information technologies. Fuzzy regulators with different number of membership functions are optimized using the genetic algorithm. The choice of fuzzy ACS, which provides better regulation by the accepted quality indicators, has been carried out. Model studies of ACS are performed in an environment of MATLAB/Simulink/Fuzzy logic Toolbox/Global Optimization Toolbox.

Keywords: automatic control system, digital controller, mathematical model, fuzzy logic, genetic algorithm.

D. A. Pankov, L. A. Denisova
Development and research of routing algorithm in communication system

This paper proposes communication complex routing algorithm that optimizes the process of information transfer by increasing the rate of exchange between nodes. The best set of intermediate nodes and interfaces formed dynamically allows to increase the speed. The algorithm is compared with well-known routing algorithms. We have defined a set of requirements and additional components necessary to implement the algorithm.

Keywords: communications complex, routing algorithm, optimization of information transmission, design of algorithm.

O. V. Batenkina, K. V. Inozemtseva
Method for recognizing emotions of preschool children using mimic expressions

The article presents a description of pattern for emotion recognition, which are sets of control points for determining the

emotions of preschool children according to Paul Ekman's coding system for facial movements, taking into account the features of emotion through facial expressions in childhood. Also, the article presents the developed algorithm for comparing data on the classification and identification of children's emotions.

The algorithm will create a software module for assessing the level of emotional development and expressiveness of the child and understand the problems that the preschooler had while testing for early detection and determining the level of mental ability and emotional state and can be used both in specialized preschool institutions and at home.

Keywords: recognition of emotions, facial expressions, expression of emotions, algorithm of emotion identification, preschool age children.

A. L. Tkachenko, O. G. Sheveleva, G. N. Boyarkin
Application of logistic approach in prediction of implementation of investment project

In this article application of logistic approach in prediction of implementation of the investment project is considered. The logistics role in financial activities of firm and influence of logistics on prediction of results of firm and receiving further profit is specified. Also, it is described how by means of application program packages it is possible to make measure calculations of a logistics system and to predict results of financial activities of firm.

Keywords: information logistics, investment process, investments, logistics system, trend of temporary benefits, logistic approach.