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## MECHANICAL AND THEORETICAL ENGINEERING

**I. V. Boyarkina**

**The specific energy consumption for processes of soil digging by digging machine bucket**

The connection of the physical parameters of the specific resistance to digging with a specific energy of the process of digging materials and soils by the bucket is observed. Tables of resistivity soil digging and cutting, which is a generalization of the statistical results of numerous studies are presented. There are refined ranges of resistivity soil digging buckets in accordance with the number of strokes dynamic densitometer; there is obtained average resistivity to digging for different categories of soil. There is completed research allowed to establish a connection resistivity digging materials with specific energy process. On the energy intensity of the process of digging the soil affects the strength of the soil category, chip thickness, disintegration rate and other parameters are obtained.

Keywords: resistivity, strength, specific energy.

**S. A. Korneyev, V. S. Korneyev, D. A. Romanyuk**

**The energy method for calculating load characteristics of rubber-cord flat coupling in view of misalignment of shafts**

Rubber-cord flat coupling design FNPC «Progress», protected by patents of the Russian Federation, have a number of advantages, foremost among which are small axial dimensions and the ability to compensate for large radial, axial and angular shaft displacements of the connected drives in a wide range of values of the transmitted torque. The article uses a thermodynamic approach to describe the load characteristics of the elastic coupling element at arbitrary offsets mounting the coupling halves and twist angles. Defining relations obtained in the quadratic approximation of the potential function, taking into account temperature.

Keywords: rubber-coupling, shaft misalignment, thermodynamics of deformation, constitutive relations, load characteristics.

**S. V. Korneev, S. V. Pashukevich, D. S. Rybalskiy, V. D. Bakulina, R. V. Buravkin,**

**N. Yu. Machekhin, I. I. Shirlin**

**The influence of diesel fuel quality on engine performance**

The paper presents the analysis of the indicators of diesel fuel quality that affect the performance and durability of engines, such as sulfur content, ash content and others. There is conducted fuel analysis for gas chromatography-mass spectrometer, which revealed that the sulfur content of the obtained samples is unacceptably high. This leads to disturbances in the operation of diesel engines, as illustrated by real examples of carried out research allowed to draw conclusions about the necessary requirements for fuels and motor oil, what is achieved by improving their production.

Keywords: diesel fuel, motor oil, internal combustion engine, the sulfur concentration.

**V. N. Tarasov, G. N. Boyarkin**

**Improving exciters theory**

The theory of centrifugal unbalance vibration exciters at which an inertia element with the unstable revolved mass is supplied supports wobbling is considered. Dependence of power of electric motor is investigational on forcing force of unbalance. Analytical expression of dynamic forcing force is got, the parameters of vibroexciter are investigational. The new formula of centre-of-mass unbalance is got, mass of unbalance, forcing forces and powers.

Keywords: unbalance, vibration exciter, the driving force, power.

**S. P. Bobrov, V. A. Baranov, T. V. Selyavina, D. A. Ustinov, I. Yu. Efimov**

**The improvement of efficiency in production of ring rubber without impairing strength of linkage products**

It is shown the effect of use of glues instead of mandreling technological operation for production of rubber-metal rings. The final and element models of a product and a volume diagram of deformations are provided. Techniques and programs of testing

of a product are given. The result of improved manufacturing techniques of rubber-metal rings application is described.

Keywords: Rubber-metal rings, durability of connections, vulcanization of rubber, the magnitude of the displacement.

**E. V. Krivonos, I. K. Chernykh, E. N. Matuzko, E. V. Vasilev**

**Analysis of defects caused by friction welding with stirs**

In modern machinery is widely used a relatively new welding technique — the friction stir welding. Most often this method is used in the manufacture of missiles to weld shells. The aim of the study is to analyze the defects arising from the use of this welding method. The study is conducted on the vertical milling machine equipped for friction stir welding. Checking the welds is performed using ultrasonic fault detector. The result of the research is the development of design tools, the use of which eliminates one of the most frequently occurring defects — «formation of burr».

Keywords: friction stir welding, defect, burr.

**V. Yu. Putintsev, A. A. Novikov, D. A. Negrov,**

**O. Yu. Burgonova, K. N. Pantyukhova, A. R. Mulyukova**

**Influence of heat treatment on coefficient of acoustic losses in material ultrasonic tool**

In this article we consider improvement of process of heat treatment and its influence on structure and properties the ultrasonic tool of material. The use of ultrasound in production gives the opportunity to improve processing of various materials. The analysis of the relative resistance of losses in exemplars from various steels is carried out. Heat treatment by the ultrasonic to develop process for various technological processes is an urgent task.

Effectiveness of power transmission of ultrasonic fluctuations in the processed zone directly it is bound to the right choice of parameters of a heat treatment of the ultrasonic tool which forms its mechanical and operational characteristics. To ensure quality of the ultrasonic tool operation the rational modes of hardening and annealing of the steel 30HGSA applied to manufacture the ultrasonic tool which has to have visco-elastic behavior, low coefficient of wave losses as well as high fatigue resistance.

The stand by means of which tests of exemplars with different types of a heat treatment for a research of coefficient of wave losses in material are carried out is developed of which the ultrasonic tool is manufactured.

As a result of the conducted research of steel 30HGSA it is established that the coefficient of wave losses significantly depends on the modes of heat treatment. After the annealing at 500 degrees Celsius coefficient of wave losses makes 1,32 units that is 14,28% less than when annealing 540 degrees Celsius (1,54 units). It is revealed that the structure significantly influences coefficient of wave losses in material of the ultrasonic tool.

Keywords: ultrasound, ultrasound tools, heat treatment, vacation, wave loss factor.

## ELECTRICAL ENGINEERING. POWER ENGINEERING

**A. V. Bubnov, G. V. Malgin, V. D. Rovkin**

**Optimizing control principle at start of asynchronous electric drives with phase-wound rotor based on simulation of its dynamic operational modes**

The paper describes an approach to optimizing the parameters of the control system for asynchronous electric drives with a phase rotor by means of numerical simulation of the electrical complex. The researchers have implemented a numerical model of the electrical complex called "Asynchronous motor with a phase-wound rotor — A production mechanism." The model is implemented in a software product AdFr in Delphi visual programming environment. A specialized numerical method and algorithm in the form of MIntegr and MVisual visual components are used as a calculating tool. The author has considered the specific features of analyzing the dynamic modes, taking into account the discrete-continuous nature of the control system. The simulation result allows generating transient modes of the required quality. In the paper the author also compares the

developed method of calculating the control system parameters with the classical method of generating transient modes.

Keywords: relay-contact control system, asynchronous electric drive, phase-wound rotor, numerical modeling, numerical methods, mathematical model, software product.

**V. R. Vedruchenko, V. V. Krainov,  
E. S. Lazarev, P. V. Litvinov**  
**The indication as method for adjusting and diagnostics of diesel engine working process parameters**

The requirements for diesel engine indicator diagram using as a base material in experiments with different fuels are formed. The classification of indicators and recommendations for their selection in particular experimental conditions are shown. The different indicator diagram configurations of a diesel engine working process and their correlations with the working process adjustment details for different fuels are examined. The modern measure complexes for a diesel engine working process diagnostics and visual observing are analyzed.

Keywords: working process, indicator diagram, experiment, alternative fuel, gases pressure, fuel supply, injection advance angle.

**V. K. Fedorov, V. V. Fedyanin, D. V. Fedorov**  
**Algorithm for formation of pulse width modulation with carrier frequency mode deterministic chaos**

In the article the question of reducing harmonic distortion associated with the growth of the non-linear load in the form of variable-speed induction motors, switching power supplies, inverters sine wave voltage, power factor correctors are considered. There is method of investigation. We use the simulation and experimental research method. Simulation method is based on the use of algorithmic models implemented on computers to study the functioning of the process systems. The method of experimental research is to analyze the received waveform and comparing the results of simulation and physical model.

Results. The study suggested pulse width modulation with randomly changing carrier frequency. Such an approach has reduced the level of higher order harmonic amplitudes, electromagnetic interference and improves the quality of the generated output voltage. The investigations can be used at the stage of the design of power electronics devices, as well as for further research directed at the use of deterministic chaos in electrical engineering.

Objective: To improve the quality of spectral composition and voltage in switching power supplies by means of random assignment of the carrier frequency pulse-width modulation.

Keywords: pulse width modulation, power electronics, frequency converters, deterministic chaos.

**S. S. Girshin, A. S. Shiryayev,  
A. A. Lyashkov, A. T. Kalimullin**  
**The choice of measures aimed on reduces energy losses in linear grid taking into account temperature of conducting part**

Techniques to improve the efficiency of introduce measures aimed on optimization of the value of electricity losses for examples of a power simple grid are considered. The comparative results of calculations of power losses without considering and taking into account the temperature of the network elements (overhead lines, transformers). The estimation error of calculation of the payback period and the reduced costs resulting from not taking into consideration the thermal processes is produced. Based on the results obtained in this paper, there can be developed methods aimed on minimization power losses value in distribution system.

Keywords: the complex measures aimed on reduction of the energy losses value, temperature dependents of resistance, thermal processes, overhead line, transformers, electrical grid.

**E. M. Kuznetsov, D. O. Pavlov**  
**Direct measurement of rotational rate of asynchronous electrical submersible motors for oil production**

The article considers the measurement of the rotation rate of the asynchronous submersible electrical motors (SEM) by placing on its shaft on dielectric beams located at the two end sides of k non-magnetic intermediate bearings of the rotor of 4k four-pole magnets with radially magnetized zones of different polarities, oriented strictly to the same direction. Measuring information is generated directly by SEM stator winding and is transmitted to the surface via a power cable and is removed through the current transformer and a bandpass filter from the cable line phase. The results of circuit simulation are presented in software package confirming the validity of the measuring data.

Keywords: highly coercive magnets, synchronous and in-phase rotation, EMF.

**A. D. Ernst, D. Yu. Rudi, A. A. Ruppel, A. I. Antonov,  
V. I. Kleutin, K. V. Khatsevskiy,  
T. V. Gonenko, S. I. Petrov**  
**Features dynamic transients generators distributed generation**

Modern development of distributed sources of energy efficiency in Russia is impossible without the development of tools to increase the supply of dynamic stability. An important condition for reliable operation of the own sources of electricity is the stability of synchronous generators. This paper presents the characteristics of dynamic transients in gas turbines. The relevance of the study is related to the fact that currently in Russia distributed energy sources have little power. Related to this is the loss of inventory dynamic stability at fault or significant overloads.

Keywords: Transients, dynamic stability, particularly the stability, distributed generation, generators sustainability.

**A. V. Ded**  
**To a problem of levels of indicators of asymmetry of tension and currents in networks of 0,4 kV**

In the article results of measurements of indicators of quality of electric energy are presented to the most problematic from the point of view of quality of the electric power distributive networks of 0,4 kV. The results of measurements executed in networks of the organizations of various fields of activity are given in a type of temporary charts. It is defined that in networks of 0,4 kV the value of coefficients of asymmetry of currents on the return and zero the sequences can be up to 30 %. Data of measurements confirm existence of modes of asymmetry of currents and tension.

Keywords: power quality, unbalanced load, the power loss.

**A. V. Ded, E. G. Andreeva**  
**The solution of task for definition of dependences of losses of power in asymmetrical modes by method of the smallest squares**

Results of the solution of the task of finding of dependence of losses of power in the asymmetrical mode from the set parameters of loading and coefficients of the currents characterizing asymmetry on the return and zero sequence are presented in the article. On the basis of skilled calculations for required dependence polynomial approximation of the third degree is defined. By means of the developed algorithm by calculation of losses of power at asymmetrical loading in distributive networks of 0,4 kV dependences of losses of power on asymmetry coefficients on the return and zero sequence with amplitude asymmetry of currents are received.

Keywords: power quality, unbalanced load, the power loss.

**V. K. Gaak, V. M. Lebedev, M. S. Sherstobitov**  
**Problems of use of slag materials of thermal power plants**

In the article problems with warehousing of slag materials in Russia, on the example of Omsk are considered. The analysis is made and the main reasons for low level of processing of slag materials are established. Authors of article have defined priority tasks which solution, will allow to lower significantly an environmental pressure from large coal power sources due to use of slag waste in the construction industry of the region.

Keywords: waste, ashes, construction materials, use, pollution, accumulation.

**S. S. Busarov, V. K. Vasilev, I. S. Busarov, A. V. Nedovenchany,  
D. S. Titov, K. V. Shcherban, A. Yu. Gromov**  
**Static blowdown of valves in long stroke low-speed lubricant-free piston compressor stages**

In accordance with known methods of determining the mass flow rate when the static vent on the designed test bench are calculated the values of the conditional clearance for the valves applied in studies of low-speed compressor stages.

The obtained results allowed to clarify the method of calculation of working processes of slow long stroke of piston stages and take into account the real magnitude of the leaks.

Keywords: long stroke piston compressor, workflows, conditional clearance, gas leakage.

#### INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

**A. D. Byalik**  
**Engineering calculation method of transforming function of fiber optic pressure sensors**

In this paper engineering calculation method of transforming function of fiber optic pressure sensors is described. This calculation method is a simplified step-by-step approach to

defining transforming functions. This greatly facilitates the design of fiber-optical sensors, which convert the measured value is carried out in several fundamentally different mathematical descriptions of stages.

However, the proposed methodology takes into account the main parameters of the transforming function (sensitivity and non-linearity) and their dependence on structural characteristics of fiber-optic sensors.

As an example calculation method of transforming function of amplitude fiber optic pressure reflective sensors are considered.

Keywords: engineering calculation method of transforming functions, amplitude fiber optic pressure sensors.

**G. M. Sidelnikov, S. A. Morozov, V. I. Slastukhina**  
**Comparative analysis of noise immunity of signals PSK and DPSK in channels with different structure**

In the work the task based on the apparatus of vector algebra and statistical computer modeling to get of probabilities distribution function of intersymbol interference signals and phase difference modulation in the channels with different structures. The obtained probability characteristics allow to determine the effectiveness of signals in different channels, as well as an analysis of noise immunity at various levels of additive noise, and will determine the possibility of applying such channels as diversity reception, and the transmission.

Keywords: additional phase shift, the probability of error, integral function of probability distribution.

**I. A. Kirovskaya, A. V. Yureva, S. N. Pogodin, R. V. Ekkert, I. Yu. Umanskiy, E. N. Eremin, Yu. I. Matyash, S. A. Korneyev**  
**Features and regularities of change in acid-base status of semiconductor surfaces A<sup>III</sup>B<sup>V</sup>-ZnSe systems-materials for sensors**

Using complex methods studied acid-base properties of solid solutions of GaAs-ZnSe, InSb-ZnSe systems are compared with the initial binary compounds and among themselves. The nature, strength, heterogeneity of the acidic (active) centers has been established. The general characteristics and regularities of change in the acid-base properties, largely due to the influence A<sup>III</sup>B<sup>V</sup> compound — ZnSe are revealed. It is shown determining the role coordinatively unsaturated atoms as the active centers of adsorption of H<sub>2</sub>O, NH<sub>3</sub>-type molecules. Semiconductors of studied systems with relatively acidic surface (pH<sub>izo</sub> < 7) are recommended as materials for sensors for detecting impurities of basic gases (NH<sub>3</sub> type).

Keywords: semiconductors, solid solutions, acid-base properties, acid (active) centers, regularities, sensors.

#### INFORMATION TECHNOLOGY

**V. N. Zadorozhnyi, E. B. Yudin**  
**About inhomogeneous structure of social networks**

Methods for the calibration of non-homogeneous random graphs for modeling social networks are developed. Graphs are calibrated by distribution of the vertex degree distribution and edge degree distribution. The theory of random graphs with nonlinear preferential attachment, and the theory of Erdos-Renyi graphs constitute the mathematical basis of the developed methods.

Keywords: random graphs, vertex degree distribution, edges (arcs) degree distribution, nonlinear preferential attachment.

**V. I. Potapov**  
**Development of mathematical model of multistage dynamic technical system recovers from breakdown in the course of conflict**

The mathematical model is based on the probabilistic nature of the functioning of the system in a conflict situation, taking into account the fact that the attacking side in the conflict tends to reduce its reliability, the impact of its resources attacks on the increase in failure rates of its components involved in the implementation of the appropriate technological operation, and to reduce the intensity of the recovery of failed components. The behavior of the considered technical system is approximated by Markov process. The developed model is a system of differential equations with time variable coefficients, the solution which is easy to obtain, using an approximate numerical method based on the method of sampling and integer programming. Formulas for evaluating operational readiness of the system in the course of the conflict and to assess the average losses from false alarms, hidden failures of system components and system recovery time after a component failure.

Keywords: mathematical model, multioperational dynamic system, a conflict situation, reliability, failover, and differential equations.

**V. I. Potapov, O. A. Gorn**  
**Mathematical model, algorithms and software for computer research of parameters of reliability in the process of conflict hardware-redundant dynamic system**

There is developed a mathematical model of the hardware-redundant dynamic system that is involved in a conflict situation taking into account the features of the backup units to replace a failed key in the process of the conflict and the ultimate reliability of control system operation of the system. There are developed numerical algorithms for the approximate evaluation of the probability of failure-free operation and average time of «life» of the system. There is developed software that implements the computational algorithms using computer research to optimize the parameters of the dynamic system that is involved in a conflict situation depending on the strategy of attacking the enemy.

Keywords: mathematical model, numerical algorithm, reliability, dynamic system, redundancy, conflict, software.

**A. S. Dudoladov, E. T. Gegechkori**  
**On synthesis of business process reengineering and expert systems**

This article describes the ability to share business process reengineering and the establishment of expert systems, to achieve the most effective expert system and reduce its development time. It is also considered a joint management development analyst and developer on the basis of their purpose for doing more productive work and achieve high development results. The article is a diagram combining their work on the basis of stages of reengineering business processes and stages of development of expert systems.

Keywords: business process reengineering, expert systems, information technology.