

MECHANICAL AND THEORETICAL ENGINEERING

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Evaluation of effect of leakage in cylinder-piston seals on working process of low-speed long stroke piston units

The theoretical analysis carried out in this paper shows the relevance of the topic of determining the dependencies of conditional gaps in long-stroke units on the discharge pressure for various designs of the compression stage. Significant errors in the performance of calculations, especially for large diameters of the steps, make it unacceptable to use the values of the gaps obtained for the existing structures of piston units. In the future, it will be necessary to carry out field tests to determine the dependencies of the gaps on pressure and the design of the unit.

Keywords: long stroke piston compressor, piston pump, working processes of a piston compressor and pump, cylinder strength calculation, leakage in a cylinder-piston seal, temperature deformations.

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Investigation of reasons for decrease in mechanical characteristics of hot-rolled steel 09G2S bends

In this paper, the causes of the drop in the mechanical properties in the process of manufacturing the «bend-out» part are investigated. On the basis of the obtained results, nonstandard heat treatment is proposed allowing to increase the mechanical characteristics to the initial values. Experimental data showing the validity of the proposed heat treatment regimes are given.

Keywords: restored austenitic grain, the principle of orientational and dimensional correspondence, Widmanstatt structure, structural heredity of austenite grain.

I. A. Kyzmenko, A. B. Yakovlev

Investigation of properties of system of automatic control of liquid-propellant rocket propulsion system with integrating regulator

There are considered the dynamic properties of the system of automatic control of the unitary fuel supply to a singlecomponent gas generator of a liquid rocket engine. There are obtained differential equations describing the operation of the comparison element, the throttle valve, the hydraulic amplifier, and the processes in the gas generator. The final equation of the mathematical model of the system operation is proposed, which allows to reveal the main regularities of the influence on the static error and the static accuracy of the external action and the command value. The results presented in this paper make it possible to obtain static and dynamic properties of the elements of the automatic control system based on the controller with integrating properties.

Keywords: liquid rocket engine, unitary fuel, liquid gas generator, control system.

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Special features of friction stir welding dissimilar joints

In this article, there is some special features of obtaining dissimilar butt-welded and lap-welded joints for various material systems. The scheme for obtaining butt-welded joints of aluminum to steel with tool displacement is analyzed. The analysis of quality and structure of welds that were manufacturing using this scheme is being conducted. The transverse micro-section of obtained specimen of the weld of aluminum alloy AMG6 to stainless steel 12H18N10T of 2 mm thickness at a welding speed of 50 rpm and a transverse speed of 50 mm/min with a tool displacement of 0,2 mm to steel part are investigated. Mutual invasion of metals to a depth of 3,2 mm and steel inclusions in an aluminum alloy of up to 0,3 mm in size are observed in the weld seam.

Keywords: friction stir welding, dissimilar welds, aluminum alloys, stainless steel, structure of a weld.

ELECTRICAL ENGINEERING

E. S. Kinev, A. A. Tyapin, E. A. Golovenko, Yu. S. Avdulova

Controlling aluminum casting from stationary furnace

The features of the combined induction device designed for transporting, pumping or mixing aluminum alloys with the possibility of its heating are considered. Heating is capable of melting aluminum plugs at the start, as well as compensating for heat losses during casting or melt mixing. The device is one of the varieties of linear MHD machines with a core and windings with a variable number of pole pairs and the sequence of switching windings is determined by the algorithm of the control unit modules. Due to the open configuration of the magnetic circuit of the MHD inductor asymmetry of the magnetomotive forces of the windings occurs, which leads to a distortion of the low-frequency running magnetic field. Evaluation of the asymmetry of the electromagnetic mode of the shortened machines for switching on the windings of six-zone inductors can be conveniently performed according to the vector diagrams of magnetic fluxes. Regulation of the force and intensity of heating of the induction MHD device is performed by redistributing the linear current load between the phases of the inductor or programming algorithms for separate control of the three-phase IGBT phase modes of the inverter operating at lower frequencies. With the correct choice of the winding connection scheme, the proposed device provides a continuous circular raster of flows in the cores, creating uniform traction forces and increasing the efficiency of electromagnetic effects.

Keywords: longitudinal magnetic field inductor, three-phase induction MHD machine, triangle switching into a star, magnetic flux vector diagram, running magnetic field, nonlinear multiphase magnetic circuit model, asymmetry of the three-phase frequency inverter mode.

E. A. Krotenko

Overvoltage in medium voltage networks

The causes of overvoltages in medium voltage networks can be not only atmospheric discharges and switching processes, but also certain operational states. The purpose of the study is to analyze overvoltages in medium voltage networks with atmospheric discharges into or near electrical systems switching in the system often leading to switching overvoltages. The application of the proposed measures will reduce the frequency of internal overvoltages, reduce the likelihood of isolation overlapping and correctly select its protection.

Keywords: atmospheric overvoltage, internal overvoltage, current cut, frequency overvoltage.

A. N. Kalyakulin

Method and device for detection of insulation breakdown on hull in power circuits of locomotives

One of the significant problems of modern locomotives is to ensure their electrical and fire safety. A method is described that allows to quickly determine the number of the traction motor in the power circuit, the state of isolation of which is emergency. The disadvantage of the existing protection method is that it only provides information about the loss of insulation integrity in the positive or negative circuit. The proposed method is based on the use of changes in electrical capacitance and insulation resistance in the circuit. The results of mathematical modeling and experimental research confirm the possibility of practical application of the breakdown detection device built on the basis of this method. In the course of the experiments, insulation breakdowns in the power circuit are successfully localized and emergency devices to be replaced are found.

Keywords: the power circuit of the locomotive, control of short circuits to the body in the circuit, changing the insulation capacity of the windings of traction motors, breakdown detection device

INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

V. I. Guzhov, I. O. Marchenko, G. A. Pozdnyakov, E. E. Serebryakova

Expansion of phase uniqueness of projection methods when illuminated by sinusoidal pictures with different periods

The article describes a method for eliminating phase ambiguity in the use of a series of measurements with different periods. The choice of the period of sinusoidal patterns with given periods can be carried out using the structured illumination of the object. The phase information is obtained by the stepwise phase shift method. For this, three or more sinusoidal patterns with a given phase shift are projected onto the object. As a result of the decoding of the intensity patterns recorded, a field of phase quantities is obtained with a period determined by the magnitude of the period of the projected sinusoidal pattern. The same phase distribution can also be obtained with a different period. As a result of subtraction of phase pictures, the period of difference will be greater than the initial periods. The resulting period is determined by the equivalent period. The value of the equivalent period is inversely proportional to the difference of the initial periods. To increase the region of phase uniqueness, it is necessary to choose close periods. However, in this case, the error in determining the profile increases. The method proposed in the article obtains three or more series of sinusoidal pictures with different periods for illuminating the object. Reduction in error is provided by combining the phase values obtained for a minimum period with the values of phase transitions for the extended range, which allows to eliminate the effect of increasing the error and, accordingly, to reduce the overall phase error. Areas of phase transitions are automatically determined as a result of subtraction of the profile of the object obtained during measurements with different periods. Since the regions of phase transitions are homogeneous, we can propose a simple averaging procedure. Adding to the obtained field of phase transitions the measurement results with a minimum period, we obtain measurements with a minimum error. In this case, the periods of projected pictures do not need to be close. This choice of periods ensures the stability of the proposed method.

Keywords: structured lighting, equivalent period, step-by-step phase shift, phase ambiguity, profile definition, phase methods, measurement error.

A. I. Blesman, R. B. Burlakov

Photocells based on silicide Schottky barrier contacts PtSi-*n*-Si and PdSi-*n*-Si

Task of studies is a development of the structure and way of fabrication of a photocell capable to take a radiation or in near infrared range of the spectrum (0,9–1,4) micron, or in the field of (0,5–1,4) micron. Way of fabrication and results of studies of photoelectric features of two spectrum photocells based on two Schottky barrier contacts PtSi-*n*-Si (or PdSi-*n*-Si), situated on opposite parties silicon plate, are considered. It is shown that the explored photocell can be used for the transformation of the energy of the radiation in the electrical energy at room temperature in two ranges: or in near infrared region of the spectrum (0,9–1,4) micron, or in the field of (0,5–1,4) micron. This characteristic of the designed photocell will allow to increase its application. Photocell possesses a simple structure and technology with a time of its fabrication in the interval (2,5–3) of the hour.

Keywords: method of fabricating the photocell, n-type silicon, Schottky barrier contacts PtSi-*n*-Si (or PdSi-*n*-Si).

E. V. Leun

Questions of construction of jet-drop optical measuring systems: registration of acoustic emission signals and temperature measurement in the cutting zone during turning, drilling and milling

The article deals with the use of jet-drop optical measuring systems (JDOMS) on machine tools for recording acoustic emission (AE) signals and pyrometric temperature measurement in the cutting zone. The work of JDOMS is considered on the examples of metal working with the supply to the cutting zone of cutting coolant directed by a jet or through the internal through-holes of the cutting tool. It is shown that the coolant flow is used for directional transmission from the cutting zone of AE signals to the hydrophone as a sound guide and light of the infrared range to the pyrometer as a light guide. In the first case, AE signals are recorded to control the metal working conditions in the cutting zone, and in the second case, its temperature is measured.

Keywords: jet-droplet stream, acoustic emission, hydrophone, pyrometer, light guide, waveguide, cutting area, cutting tool.

V. I. Kirnos, A. V. Zubar', I. V. Kunaev

Method and system development of external target designation with target indication for armoured weapons samples

When conducting scientific research, the authors solve the problem of implementing a multi-purpose and accurate external target designation in real time, for the targets and critical facilities along the line of sight and beyond it. They achieve minimal dependencies of the external target designation result on the complexity of the target environment, the intensity of the battle, as well as the skills and the training of the crew of the combat vehicle. The peculiarity of this method is the use of a mathematical model of a digital video camera to describe the optical-electronic channels of modern sights of armored weapons.

Keywords: target designation, target search, digital image of the object, information processing, sight, digital video camera.

Ngoulou-A-Ndzeli, V. Yu. Tetter, V. G. Shakhov

Diagnosis experience of traction engines of locomotives

Authors propose a method and algorithms for the rapid diagnosis of locomotives traction engines based on duplication of main frequency channel by additional wavelet analysis and decision — making on the methodology of fuzzy logic. The method and corresponding algorithms are uses for programming controllers of vibrodiagnostic systems.

Keywords: diagnosis of locomotives traction engines, sensors, diagnostic experiment, quality criteria for a diagnostic experiment, adequacy, reliability, diagnostic system, technical condition, rolling stock.