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**VERSATILE DESIGN OF A SEED DISK FOR DOTTED AND MIXED SOWING OF ROW CROPS**

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One of the promising sowing methods is combined sowing and growing several crops on the same field. The authors have revealed the shortcomings of the existing designs of serial row sowing machines, which do not fully comply with the requirements of mixed crop patterns, including the design features of the seed disk and economic cost-estimation indicators of its manufacturing. Federal Agroengineering Centre VIM is designing seeders with an original seed dispenser based on new metering pneumatic systems. This paper presents a sowing machine with a universal seed disk of a new collapsible design used for dotted and mixed sowing of calibrated and uncalibrated seeds of different crops. Laboratory tests have experimentally determined the parameters of a cone-shaped cell of the seed disk, which ensures uniform dispensation of seeds without gaps in a row: the diameter of through holes on side walls of the cone-shaped cells – 3 mm; the lower diameter – 6 mm; depth – 18 mm; the upper diameter – 24 mm. The authors have also studied the effect of excess pressure in a seed chamber (from 2.5 kPa to 4.5 kPa) on the quality of the metering unit as exemplified by maize seeds of the "Dobrynya" variety in Krasnodar Krai. They have determined the optimum value of excess pressure (3.0 kPa) for the considered design of a pneumatic device, which ensures single-seed sowing without gaps with a total number of 98,5%, which corresponds to agrotechnical requirements. The authors have experimentally determined the capabilities of the universal seed disk of a new design, providing reliable sowing of seeds with both dotted and mixed methods with a reduction in metal intensity of a unit by 20% as compared to analog units.

**Key words:** sowing machine, hopper, air nozzle, seed disk, cone-shaped cell, coulter, ejector seeds.

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**STUDYING METHODS OF OBTAINING AND DIGITAL PROCESSING OF SENSOR SIGNALS OF WHEEL TURNS OF FARM TRACTORS**

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The author proves the necessity of determining the slipping of farm tractor wheels during testing with the purpose of determining their functional characteristics and gives account of the operating principle and design of an inertial sensor of the driving wheel turning angle ИП-291, based on the sensor of the inertial navigation system MPU-9250. The main existing mathematical methods for nonlinear filtering of the initial data of 9-axis inertial orientation sensors have been analyzed for this purpose. A software has been developed to implement various variants of mathematical models for processing data of inertial orientation sensors. The bench design and the software for testing the ИП-291 sensor are described with the purpose of determining the accuracy and stability of the indications in the range from 0 to 360° with various variants of mathematical models of digital filters. The author presents the implementation and test results of the sensor IP-291. The main advantages of the inertial sensor ИП-291 are the ease of its mounting on a tractor wheel, as well as no need in power and information cables. It has been established that in order to select the optimal mathematical filter it is necessary to meet the following criteria: measurement error – no more than 1%, standard deviation of indications – no more than 0,5°, and an operating range of measurements – from 0 to 360°. Proceeding from the test results, the authors have chosen the best accuracy measurement (the main full-scale error of 0.678%) and the stability of indices (standard deviation of 0.117°) for the extended Kalman filter based on the Jacobian calculation. The selected mathematical model of the filter allows using the inertial navigation technology to calculate the change in the rotation angle of the driving wheel of a tractor with subsequent calculation of speed and skidding.

**Key words:** digital processing, mathematical methods, mathematical model, inertial wheel rotation sensor, orientation filter, Kalman filter.

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### **THEORETICAL STUDY OF THE CONTACT BETWEEN SHAPED PEGS AND CORN GRAIN IN A THRESHING CHAMBER**

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For effective threshing of corncobs, the working elements of modern threshing devices are equipped with steel pegs of various shapes. The design parameters of these studs are determined experimentally, without previous theoretical studies. In this paper, the authors propose the design of a new shaped peg for a corncob threshing device. The design of the new-shaped stud has been obtained on the basis of the analysis of design features of biological prototypes of the studs. It differs from the widely spread round stud by the curvature of its working surface. Mandibles of granary pests (elements of the mouthpiece of insects eating corn kernels) were taken as a biological prototype. The study involved 3D modeling of the contact of a corn grain shell with steel pegs of a widespread round shape and new shaped studs. It has been established that the contact area of the round stpeged and the corn grain shell is an ellipsoid, and the contact area of the new shaped peg and the corn grain shell is a complex figure consisting of an ellipsoid and an elliptical paraboloid. Theoretical studies have been carried out, as a result of which expressions have been obtained for determining the volumes of a grain shell pressed into the inside by a round and a new shaped peg. The contact areas of grains and round and shaped studs have been analyzed in terms of the contact area size and the penetration depth of the peg into the grain. As a result, relative equality of the pressed volumes of a grain shell with both a round and a new shaped peg has been determined and a significant difference in the contact area size has been revealed: for the round peg, the contact area with the corn shell is 3,12 mm<sup>2</sup>, and the new shaped peg, it amounts to 5,17 mm<sup>2</sup>. Therefore, when using pegs of a new design, threshing force is spread over a larger area, which reduces the probability of small and large deformations of grain.

**Key words:** corn grain, threshing, shaped peg, biological prototype, grain deformation.

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### **IMPROVING TECHNOLOGICAL PROCESSES AND TECHNICAL MEANS BASING ON INDIVIDUAL CONTROL OF ANIMAL PARAMETERS ON FARMS**

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The authors propose technical solutions for improving technological processes on dairy farms based on individual control of animal parameters. A set of technical means and systems of local forced ventilation has been developed, basing on the organization of a controlled air flow vector directed at animals in their areas, taking into account their clinical and physiological parameters under thermal stresses. With the application of the developed device, the clinical-and-physiological indices of animals, in the hot season, come back to normal values 2...4 times faster; the rate of moisture evaporation from skin the surface grows 1.8...2.3 times faster; milk production increases by 13...15%; energy consumption for ventilation is reduced in 2...3 times. A set of technical tools for locating animals in a barn has been developed on the basis of measuring the location of animals for their quick detection, controlling their motor activity and their sorting out into groups. During the production check, the measurement error of the current coordinates of animals inside the barn and on the walking platform was less than 0.22 m. the authors have developed a set of technical means for recording the time point of the onset of calving, frequency, duration and time of defecation and urination based on voltage monitoring muscle strain of the root of an animal's tail. With the use of technical means, an increase in the profit of a dairy farm by 100

animals is more than 6%, the payback period of investments is 85 days, which is due to the low cost of technical means relating to the cost of material losses.

**Key words:** technical means for controlling cows' parameters, local ventilation systems, cow screening and locating systems, systems for determining the beginning of calving.

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## **FEASIBILITY OF APPLYING GREEN STAR NAVIGATION EQUIPMENT FOR SOIL CULTIVATION**

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The authors present the experience of using the navigation equipment Green Star 2 2600 installed on the John Deere 8430 tractor used for soil cultivation on the fields of the "Integratsiya" training centre of Orel State Agrarian University named after N.V. Parakhin. It has been established that the system of black fallow makes it possible to actively combat weeds, and reduces the number of methods for chemical treatment of winter crops in the subsequent year. The research results have shown that when using the free corrective SF1 signal, the deviation from the specified trajectory does not exceed 15 cm. Comparative figures are given for soil treatment with the John Deere 8430 tractor equipped with a disk harrow Catros 7500 unit with navigation equipment and without it. It has been established that for a disk-operated area of 12,000 hectares, at a price for diesel fuel of 45 rubles per liter, fuel consumption of 6 liters per hectare, and with the use of navigation equipment, the economic effect on fuel alone will amount to 193,104 rubles for the season. With an average capacity of 10 hectares / h for cultivating an area of 12,000 hectares without the use of navigation equipment, it will take 71.5 hours more. In addition, navigation equipment provides for 24-hour operation of a machine under conditions of high dust content, which has a positive effect on the time frame of field works. The research results have shown that navigation provides not only for the most effective use of money invested in the equipment, but also to shorten the operating time, increase productivity, while ensuring fuel economy and reducing labor and production costs.

**Key words:** navigation equipment, soil cultivation, automatic driving, AutoTrac Universal 200.

## **TECHNICAL SERVICE IN AGRICULTURE**

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## **TECHNOLOGY OF VIBRATION-ARC HARDENING WITH FERRO ADDITIVES AS APPLIED IN THE REPUBLIC OF CUBA**

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The paper contains information about the necessity and relevance of the process of restoration of parts by the method of vibration-arc hardening as exemplified by the experience of the Republic of Cuba. The authors have studied ways and methods of strengthening of working bodies of agricultural machines, so they can offer a more economically feasible option of treatment based on the use of metal-ceramic powders. The sequence of implementation of the hardening technology is presented and a number of full-scale experiments are carried out as compared with non-fixed working bodies. The experiment was carried out on rocky soils of the province of Pinar del Rio of the Republic of Cuba on the tractor New Holland TT-4030 with the ИМПАГ-6 cultivation unit. Metal-ceramic powder ПГ-10N-01 was used as wear-resistant

coating of chisels. To estimate the wear rate of chisels, use was made of the mass loss parameter measured in grams. The authors have made its depreciation scheme and established that treatment of tillage equipment tools with this method will allow to reduce wear by 25% in processing of 100 ha, and by 35% in processing of 200 ha. The experiment results have shown that it is possible to increase the service life of soil processing tools with the help of vibration-arc hardening and the use of metal-ceramic powders. The authors have made some conclusions about the effectiveness of this operation in relation to the conditions of the Republic of Cuba.

**Key words:** wear, friction, metal-ceramic powders, vibration-arc hardening, hardness, composite.

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## **CHOOSING MODES FOR WELDING OF METALLIC POWDERS BASED ON NICKEL AND IRON WITH A COMBINED METHOD OF BRONZE BUSHING RESTORING**

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The greatest difficulty in electric contact welding of powders based on iron and nickel systems are caused by the difference in melting temperature. In practice, a conductive graphite shell and a special electrode are used to solve this problem. However, their use has led to some difficulties in the selection of temperature modes of welding. On the basis of preliminary studies, bushings made of bronze O5C5S5 were chosen, powders PH-30 and PR-N80H13S2R were chosen for welding. The welding parameters for the powder PR-N80H13S2R were as follows: the range of welding – 1000...1300°C; the welding duration – 40-120 s; the electrode resistance – 0.7 mOhm; specific heat of the powder – 430J/kg °C; specific heat capacity of the restored part is 370 J/kg °C; powder weight (bulk) – 6g; thickness of the layer to be welded (on the side) is 2 mm; roughness of the surface to be restored is 10...15 µm. For powder PH-30: temperature range of welding – 1100...1400°C; treatment time – 120-250 s; (specific) heat capacity of the powder – 450 J/kg °C; powder weight (bulk) – 8g. The other parameters remain the same. As a result of the conducted studies it has been established that the best quality indicators are achieved for the powder PR-N80H13S2R at a welding temperature of 1160°C, and for the PH-30 powder based on iron, the best performance is achieved at 1280°C with a holding time of 100 s at 1100°C. As a result of the conducted studies, it has been established that when the PR-N80H13S2R is welded at a temperature of 1100°C, no reliable sintering of the powder occurs. The best quality indicators are achieved at a welding temperature of 1160°C, at temperatures above 1200°C, pores are formed. For iron-based PH-30 powder, at temperatures in the sintering zone 1100...1200°C, there is no welding of the bronze bushing, at 1300...1400°C the bushing is melted. The best performance is achieved at 1280°C with an equalizing time of 100 s at 1100°C.

**Key words:** combined recovery method, electric contact welding, metal powders, bronze bushings, temperature electric-welding.

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## **METHODS OF PREVENTING CORROSION OF HEAT-AND-POWER EQUIPMENT OF BOILER AND HEAT SUPPLY SYSTEMS IN AGRICULTURE**

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In the process of operation, the heat and power engineering equipment of boiler stations and heat supply systems are subject to corrosion, which leads to a decrease in the generation of thermal and electric energy and even to emergency shut-downs. The paper presents methods of corrosion control applied at various sections of the heat and power system. Water for heat supply systems is subjected to stabilization treatment with various reagents depending on the composition of impurities and pH. Water is treated with phosphates, phosphonates, various chelating agents, etc. To remove aggressive gases, decarbonators and thermal deaerators are used. The use of floating sealing liquid in storage tanks with hot water protects water from evaporation and excessive aeration. Various coatings and cathodic protection of metal are used to protect tanks from corrosion. It is noted that the conservation of shut-down heat and power equipment allows to avoid downtime corrosion.

**Key words:** heat-and-power equipment, corrosion, corrosive gases, storage tanks, methods of corrosion protection.

## ECONOMY AND ORGANIZATION OF AGRICULTURAL ENGINEERING SYSTEMS

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### EXPORT OF RUSSIAN AGRICULTURAL MACHINERY: IS IT HIGH TIME OR TOO SOON FOR IT?

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The authors consider the fleet, volumes of production and export of Russian agricultural machinery, and analyze the measures of state support to stimulate domestic demand, manufacturing of new product types, modernization of enterprises that help Russian producers of agricultural machinery successfully develop exports. They claim that it is necessary to develop exporting because the domestic market is saturated. Exports confirm that the products are competitive, thus stimulating investments in the development of new designs, provide for a quicker update of a model range, stabilize, and contribute to the uniform development of an enterprise. The exports of Russian agricultural machinery in 2016 increased by 1.43 times as compared with 2012. In 2016, products were exported to 47 countries. "The strategy for the development of agricultural machine industry in Russia for the period until 2030", "The strategy of export development in the agricultural machinery industry for the period until 2025", state support measures aimed at stimulating domestic demand, manufacturing new products, modernizing enterprises etc., help Russian producers of agricultural machinery to successfully promote exports.

**Key words:** agricultural machinery industry, machinery, export.

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### PECULIARITIES OF INTENSIVE POTATO PRODUCTION IN TULA REGION

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The author has made an analysis of potato growing in the Tula region for 2012-2016, identified the regional features of the industry and determined the main factors of the total potato yield change for all categories of farms. In the region, 59% of total potato production is concentrated in farm enterprises, peasant farms and farms run by individual entrepreneurs. Farm enterprises of the Tula region have established channels for potato selling to wholesale and retail chains. Marketable preparation processing (washing and packing) and processing of potato products are developing in the region. The main factor in increasing the gross potato output in farm enterprises is an increase in yields. The high dependence between the potato acreage and its yield (correlation coefficient – 0.79) has been revealed, the determination coefficient indicates that 63% of the potato yield variation is associated with a change in the potato acreage. It is shown that in the Tula region the development of potato farming goes along an intensive path, which makes potato production a promising and profitable industry. The author lists the main conditions for intensive development of potato production: the availability of certified seed material, high-yielding special-purpose varieties; the compliance of agrotechnical requirements; the use of high-performance and low-injuring equipment; the availability of irrigation system and sufficient amount of mechanized storage facilities.

**Key words:** Tula region, potato growing, intensive production, commercial potato production, profitability of potato growing.

## POWER SUPPLY AND AUTOMATION OF AGRICULTURAL PRODUCTION

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### ESTIMATION OF ENERGY INDICATORS OF ROBOTIZED LAWN MOWERS

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The paper describes the main technical characteristics of an experimental robotic lawn mower. The lawn mower is designed to mow vegetation in small areas without an operator's involvement. All control functions of the lawn mower, including the selection of the trajectory, the change in the cutting height and the response to an emergency situation are carried out by the on-board processor. In addition, the current information about the operating modes of the mower, as well as its location, is transmitted to the control panel. It is possible to manually adjust the operating modes or provide priority instructions from the same remote control. The lawn mower is driven by two electric motors, and mowing is carried out in an unsupported way. The nature and characteristics of energy consumption by electrified lawn mower devices are analyzed in the paper: an electric motor of the cutting working body drive, traction electric motors, a processor, operating mechanisms and receiving and transmitting communication facilities. The total power of the energy users of the experimental robotic lawn mower at a speed of its forward motion of 0.3 m/s and a radius of cutting working bodies of 0.125 m amounts to 620 W. It has been established that the following consumers determine the energy consumption of an experimental robotic lawn mower (in a decreasing importance order): 80.6% of the motor of the cutting tools, 10.4% of the traction motors, 4.8% of the on-board processor, operating mechanisms (2.9%), radio communication facilities (1.3%). As the radius of the cutting device of a lawn mower increases, the fraction of the on-board processor, operating mechanisms and receiving-transmitting communication facilities decreases exponentially. The capacity of the nickel-cadmium battery has been calculated as well. The authors have come to a conclusion about the feasibility of using batteries that provide continuous power to electrified lawn mowing devices within 20-30 minutes.

**Key words:** robotized lawn mower, unsupported mowing, energy consumption, power consumption, accumulation of electrical energy.

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### **MODERNIZATION OF POWER SUPPLY SYSTEMS OF RURAL CONSUMERS BY INTRODUCING DISTRIBUTED GENERATION**

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Recently, in the conditions of the automation of processes and wider application of high-tech power receiving devices, the task of ensuring reliable and uninterrupted power supply of agricultural facilities has become especially relevant. The main feature of farm power supply is the low density of loads (5-15 kW/km<sup>2</sup>). This predetermines significant costs of the construction of 0.4 and 10 kV distribution grids, which account for 70% of the total costs of rural power supply. In many rural grids, the voltage in a grid with a phase voltage of 0.23 kV fluctuates at the level of 0.18 kV, which does not correspond to the requirements of GOST-32144-2013. The past few years have shown that the total connected capacity of power receiving devices in different regions of Russia is much less than the power of all applications submitted by consumers to utility organizations. To solve the problems listed above, it is possible to attract the consumers of electricity themselves. The paper considers the importance of using distributed generation installed in the immediate proximity to the areas of power consumption. The use of distributed generation will make it possible to select the necessary levels of reliability and the quality of power supply for consumers, to attract private investments into the development of Russia's electric power industry, to reduce electricity tariffs for consumers by establishing a competitive environment not only for producers but also for power consumers and making conditions for optimizing the structure and operating modes of generation, distribution grids and consumers.

**Key words:** power distribution grids for rural purposes of 0.4-10 kV, centralized generation, distributed generation, electricity tariff, reliability of power supply, quality of electricity.