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В статье выявлена природа аэрогидродинамического сопротивления вращению зубчатых колес и предложены относительно простые аналитические выражения, дающие возможность определять энергетическую эффективность высокоскоростных зубчатых передач. На основании уравнения массового баланса определена плотность масловоздушной смеси во впадинах зубчатого колеса и установлено граничное число Эйлера, определяющее достижение ее критического значения. Определены пределы влияния торцевых зазоров на потери мощности и эффективности применения смазкой окулированием.

Ключевые слова: зубчатые передачи, зубчатое колесо, потери мощности, аэрогидродинамическое сопротивление, масловоздушная смесь, торцевой зазор, ширина зубчатого венца.

УДК 621.833

Определение возможности профилирования исходных контуров цилиндрических прямозубых передач кривыми второго порядка / П.Н. Ткач // Вестник НТУ "ХПИ". Серия: Проблемы механического привода. – Х.: НТУ "ХПИ", 2015. – №34(1143). – С.135-144. – Библиогр.: 17 назв. – ISSN 2079-0791.

В статье рассмотрена возможность применения эллипса, параболы и гиперболы для образования профиля исходного контура. Определены предельные параметры профильного угла и коэффициента высоты профиля, при которых возможно применение указанных кривых. Разработаны рекомендации по выбору параметров исходного контура таких передач, установлена связь между ними. Предложен общий алгоритм выбора параметров. Проверена возможность применения гиперболического исходного контура вместо традиционного и исходного контура для авиационных зубчатых колес. С использованием результатов данной работы можно проводить дальнейшие исследования геометрии таких передач.

Ключевые слова: исходный контур, прямой зуб, профильный угол, зубчатая рейка.

УДК 621.833; 62.652

Моделирование показателей жесткости эпицикла планетарного колесного редуктора / А.Н. Чачин // Вестник НТУ "ХПИ". Серия: Проблемы механического привода – Х.: НТУ "ХПИ", 2015. – №34(1143). – С.144-153. – Библиогр.: 6 назв. – ISSN 2079-0791.

На основе разработанных аналитических моделей деформированного состояния эпицикла в составе планетарных колесных редукторов троллейбусов получено функцию приведенной удельной жесткости, отражающую не только упругие деформации зубьев обода эпицикла под действием нормативных нагрузок, но и размеры усталостной трещины в процессе ее развития. По данным анализа эксплуатационных повреждений исследована кинетика усталостных трещин на ободу эпицикла. Установлено, что при наличии трещины показатель приведенной жесткости эпицикла уменьшается пропорционально размерам трещины, что способствует возникновению параметрического резонанса в условиях виброударных режимов колебаний и подтверждает возможность однозначной вибродиагностики усталостных трещин на ободу эпицикла в условиях троллейбусных депо.

Ключевые слова: эпицикл, упругие деформации, усталостная трещина, спектр вибраций.

УДК 621.9.04

Исследование спектра главных частот тренажера-гексапода / В.П. Яглинский, Г.В. Козерацкий, А.С. Обайди, Н.Н. Москвичев // Вестник НТУ "ХПИ". Серия: Проблемы механического привода. – Х.: НТУ "ХПИ", 2015. – №34(1143). – С.153-158. – Библиогр.: 11 назв. – ISSN 2079-0791.

В статье разработаны аналитические зависимости определения главных частот динамического тренажера экипажей боевых мобильных машин. Определены резонансные режимы функционирования по шести обобщенным координатам. Встановлено, что отклонение платформы от горизонтального положения уменьшает первую, вторую и четвертую главные частоты, а третья и пятая главные частоты возрастают. По результатам численного моделирования построены диаграммы зависимости главных частот от пространственной конфигурации платформы гексапода. Полученные аналитические модели дают возможность выбирать условия функционирования тренажера в диапазоне допустимых значений резонансных частот.

Ключевые слова: частотное уравнение, матрица Якоби, резонанс, жесткость.

ABSTRACTS

Novikov Mikhail Leont'evich in the memories of the candidate of technical sciences Yakovlev A.S. / A.S. Yakovlev // Bulletin of NTU "KhPI". Series: Problems of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.4-9. – Bibliogr.: 7. – ISSN 2079-0791.

The article is devoted to the 100th anniversary of the birth of Doctor of Technical Sciences, Professor M.L. Novikov, founder of circular-helical gearing system. The author, who personally knew M.L. Novikov,

recalls his meetings with them, analyze the achievements and challenges in implementing of Novikov gears. Considered part in the development of M.L. Novikov gearing by leading Soviet scientists who continued to study after his death: A.I. Petrushevich, V.A. Gavrilenko, V.N. Kudryavtsev, R.V. Fedyakin and V.A. Chesnokov, E.G. Roslivker, V.I. Korotkin and others. Also briefly discussed the possibility of forming M.L. Novikov gearing by classical methods Willis and Olivier. This proposal by G.G. Baranov – to form tooth profiles used in the Olivier method two incongruent curves with the inner point touch; proposal by Y.S. Davydov – used for the same purpose incongruent producing pairs. The author also shows that the cylindrical gear pair with a point mesh may be created of a single basic rack by Olivier (Camus) method.

Keywords: gear, Novikov mesh, contact strength.

Wear simulation for involute tooth profile of the bush-roller chain drive / S.V. Andrienko, A.V. Kuznetsova, A.V. Ustinenko, R.V. Protasov // Bulletin of NTU "KhPI". Series: Problems of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.10-15. – Bibliogr.: 14. – ISSN 2079-0791.

When using chain drives in dusty conditions, and for sprockets of the drive wheels for tracked vehicles, to the forefront the problem of accelerated abrasive wear of working teeth profiles. It is proposed to solve this problem using involute chain mesh, which can ensure the reduction of sliding velocities and contact pressure. A method for the synthesis of tooth form by constructing Bobillier. The solution of the differential equation that describes the profile stars, obtained numerically by the Runge-Kutta method in the system MathCAD using the built-in function Rkadapt. Approximation of the profile with the help of a third-order Bezier curve was made. The methods are developed: determining sliding velocities in the chain engagement; calculating the curvature radius of the tooth profile based on differentiating the Bezier curve; determination of contact stress by H. Hertz formula. Mathematical model of the sprocket tooth wear is developed. Method of evaluation of the resource chain drive on the criterion of wear resistance of the tooth profile is proposed.

Keywords: chain drive, sprocket, tooth, involute profile, wear.

Possibilities of using AutoCAD in the design of new mesh profiles / Miroslav Božanský, Radoslav Orokocký, Rastislav Janček // Bulletin of NTU "KhPI". Series: Problems of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.15-19. – Bibliogr.: 15. – ISSN 2079-0791.

Modern engineering places high demands on machine parts (increase of loading capacity and resource, low the weight, reducing design time), which are often contradictory. Therefore, the task of finding the optimal parameters of the items is very difficult. All this fully applies to the gears. Promising is mesh with the convex-concave tooth contact. This type of mesh is described by complex functional dependencies. The existing top-level software (CATIA, Pro/ENGINEER, ANSYS) allow for a full cycle of synthesis and analysis of gears. However, the products of the lower level (AutoCAD) with extension programming language AutoLISP allow synthesis of tooth profile and conduct geometric analysis. The article describes the implementation of a geometric synthesis and analysis of gears with convex-concave tooth contact in AutoCAD system with the AutoLISP extension. This software implementation can create gears in 2D and 3D, edit the synthesized profile and output control sizes of gears.

Keywords: AutoCAD, AutoLISP, CATIA, convex-concave contact, modification of convex-concave mesh.

Features of the load capacity calculation of open gearings/ B.V. Vinogradov, D.A. Fedin // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.19-25. – Bibliogr.: 7. – ISSN 2079-0791.

The article analyzes the current trends in heavy machinery drive production. It is shown that the main trend is the increase of the drive power and the use of drives with two motors. Open gearing – the main type of gearing in heavy machinery. It is shown that the errors occurs during manufacture, installation and operation of open gearing. There is always a non run-out component of gearing error. Gearing errors lead to non-uniform distribution of the load along the length of the contact lines. Gears open gearings have a complex structure. Gears deform under the load. This leads to non-uniform distribution of the load along the length of the contact lines. The results of experimental studies of non-uniform distribution of the load in open gearing of tumbling mills are presented. It is shown that the distribution of load along the length of the contact line is linear. One of the ways to reduce the non-uniform distribution of the load in open gearing is the use of self-aligning pinion. The finite element method was used to investigate the stress-strain state of self-aligning pinion in the absence of gearing errors. It is shown that the gear is in the essentially three-dimensional stress-strain state. Unlike standard methods ISO6336, DIN 3990, AGMA finite element method allows to obtain reliable data for the calculation of the strength of the open gearings of heavy machinery.

Keywords: open gearing, finite element method, stress calculation, self-aligning pinion.

УДК 621.833

Creating a normative base tests of mechanical drives engineering application / V.N. Vlasenko, I.V. Dobrovolskaya // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.25-29. – Bibliogr.: 7. – ISSN 2079-0791.

Reviewed the work of LLC "Institute "Gear" and TC 47 "Mechanical drives" when creating the regulatory framework testing the mechanical actuators of planetary type. Program and methods of testing PM-121 was developed and implemented for distribution on prototypes and mass-produced gearboxes and geared motors Planetary single- and multistage, including block constructed from modules with a planetary gear-building applications) tests are carried at the testing center LLC "Institute" Gear "and machine-building enterprises producing mechanical drives planetary type. permitted testing of the present PM special planetary gear and gear motors, appointment and conditions of use which are similar to parts of general machine. PM installs the procedure for obtaining at acceptance, qualification, periodic and typical tests of reliable information on the actual values of the technical characteristics of products. Some provisions of the PM can be used to conduct research tests. The technique is also suitable for certification testing.

Keywords: test methods, the mechanical drive of the planetary type.

Changing the kinematics of gear hobbing machine for gear cutting by radial-circular method / S.I. Gromnjuk, L.Je. Grycaj // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.30-34. – Bibliogr.: 11. – ISSN 2079-0791.

The article viewed directions upgrading serial gear manually controlled gear's cutter machine under for radial- circular way. Changing gear kinematics conventional machine is as follows. Rotating disk mill provided by servomotor controlled controller or computer. Speed cutters of the mill take depending on mechanical properties of the cog-wheel's material and its diameter. Periodic mill's motion in the radial direction has a frequency equal to the number of teeth and wheels by means of servomotor. Instrumental carriage with a cutter installed on ball bearings in double guides. Manage servomotor carriage is also carried out by the controller or computer. Set value displacement, depending on the module. Simultaneous control of two working movements – cutting speed and radial displacement cutters cut serrated surfaces allows any profiles- involute, sinusoidal, Novikov gearing, arch, asymmetrical, stars and others.

Keywords: gear's cutter machine, radial-circular way, CNC-cutting, Mekhatronik, effectiveness.

Calculation of distribution of loads on width of teeth, a sag of shafts, the forces operating on legs, and deriving of signals for preliminary treatment of gears in system ASGEARS / V.L. Dorofeev, D.V. Dorofeev, V.N. Zhuravlev, A.B. Edinovich // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.35-40. – Bibliogr.: 6. – ISSN 2079-0791.

This article describes the use of the software complex ASGEARS for calculation of load distribution across the width of the teeth, the shafts bending and of the forces acting on the supports transmissions. Was used a special finite element model calculation, the function form of which is fully consistent with the differential equation of bending. The number of stages shaft having different diameters, has no limitations. The angular or radial fixing nodes, radial forces or bending moments was taken into account. ASGEARS has fifteen-level relational database, which stores information about the sizes of the shafts. The calculation results are displayed in numerical and graphical form. The results of the calculation of the bending of the shafts are transmitted to the system calculation of gears, where the calculated distribution of the contact and bending stresses across the width of the teeth, the stiffness of the system elements, radial and torsional vibration. The article shows examples of input data calculation results.

Keywords: ASGEARS, shaft, transmission, form function, distribution of loadings on width of teeth.

The impact of surface layers state formed by additives at friction surfaces on the nature of conjugation materials deformation / A.V. Zakharchenko // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.41-48. – Bibliogr.: 41. – ISSN 2079-0791.

The analytical review of solution tracks for a problem to choose the lubricant conforming to specific conditions of exploitation in accordance with the triboconjugation surface layers state and deformation nature on the basis of state-of-the-art tribological sources. The requirements are systematized for determining the threshold values for the outcome of joint action of thermal and mechanical load when the friction surfaces become chemically and catalytically active that is needed for the intensification of an effective chemically modified layer formation processes. In general the friction couples on the surface of which more homogeneous structure has been formed within the friction process are characterized with better tribo-engineering features. If on the friction surface there is a combination of topographical elements that are typical for diverse structures, then it testifies to the tribological unit unstable operation. A great number of some deficiencies on the surfaces testifies to the tribological unit unstable operation too.

Keywords: a package of additives, chemically active substances, friction surface, superficial layer, chemisorption, and a chemically modified layer, secondary structure.

The task solution of searching rational parameters of mine locomotive transmissions by methods of direct optimization/ I.Yu. Klymenko, I.A. Taran, M.N. Trubitsin // Bulletin of NTU "KhPI".

Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.49-58. – Bibliogr.: 6. – ISSN 2079-0791.

The main (maximum efficiency) and auxiliary tasks (approximation of experimental data) of optimizing the parameters of hydromechanical transmission of mine locomotives using the modified simplex method of Nelder-Mead are considered. The possibility of finding local extremums on the basis of the preliminary probing space: evenly busting the initial simplex (using LP- τ grids) and localization of extremums found with the introduction of additional restrictions on the N-dimensional space of arbitrary objective function. Further refinement of the algorithm is supposed to be carried out in the direction of balance account for simplex vertices, to reduce the number of iterations carried out – considering the second best and the worst peaks. Also stopping criterion for calculating, on the principle of full coverage zones OOTSF localization, ie receiving a total of its examination developed.

Keywords: mine diesel locomotives, hydromechanical transmission, methods of direct optimization, the simplex method of Nelder-Mead, local extremums, probing N-dimensional space, the LP- τ grids, localization region of extremum, punitive restrictions.

About one a reserve of increase the load capacity of the Novikov gearing with basic rack profile according to GOST 30224-96 / V.I. Korotkin // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.58-63. – Bibliogr.: 9. – ISSN 2079-0791.

This article considers the possibility of reducing the bending and contact stresses as well as increasing the load capacity of cylindrical Novikov gearing made on the basis used in practice standard basic rack profile according to GOST 30224-96 due to the increase of module. Job of transmission is expected in the real world, i.e. in the presence of manufacture and assembly errors and taking into account the compliance of the teeth and drive components. With increasing module remain unchanged radial and axial overall dimensions of gear transmission. When processing the results of modeling received the working formula for the calculation of effective contact and bending stresses, as well as tables and graphs. It is shown that with increasing module one step reduces the effective contact stresses up to 30%, and bending up to 60%, wherein effect increases with decreasing degree of Accuracy for Transmission. Taking into account the non-linear relationship between stress and load load capacity of the transmission is increased, respectively, to 1.5 times for contact and up to 2 times by bending.

Keywords: Novikov gearing, module engagement, bending stresses, contact stresses

Development of the concept, structure and principles of the establishment and functioning of a new technical system for gears synthesis / A.V. Krivosheya, M.G. Storchak, Yu.M. Danilchenko, N.E. Ternuk, B.S. Vorontsov, A.V. Ustinenko // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.64-74. – Bibliogr.: 28. – ISSN 2079-0791.

In the article the necessity, the technical and economic feasibility of creating a new technical system synthesis gears and its support of mathematical models and information technology, taking into account the life cycle of gears. These information technologies through support for the lifecycle of products can be used not only to improve efficiency, productivity and profitability of the processes of business, but also to create new mechanisms or radical improvement of the known. The article made an analysis and presents particular technical system development and information technology to support it on the example of the synthesis of gears as one of the most complex and mass higher kinematic pairs. The structure of the technical system, concepts, principles of creation and functioning. Considered system will enable synthesize gears with higher quality performance and provide validation of all stages of its life cycle.

Keywords: gear, synthesis, concept, structure, principles of creation, life cycle.

Experimental studies on the production of globoid gears / N.N. Kuzmenko // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.75-79. – Bibliogr.: 6. – ISSN 2079-0791.

Major geometric and kinematic parameters of produced globoid teeth wheels are as follows: relative sliding speed; total speed of contacting surfaces displacement; angle between vector of relative speed and direction of contact lines; transformed curvature of contacting surfaces; specific slides at the instrument tooth and teeth wheel being treated; the length of contact line. Analysis of these parameters allowed to increase precision of globoid teeth wheel due to perfection of heir shape formation scheme. Estimation of precision of globoid teeth wheels treatment by the suggested method of shape formation has been investigated in comparison with existing shape formation schemes. The total area of contact for kvazi-globoid contact gears is defined.

Keywords: kvazi-globoid gear-wheel, instrumental wheel, gear cutting, shaping.

Comparative analysis of accuracy of autor's and preresonance methods of measuring rotor unbalance / A.V. Mamontov // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.79-84. – Bibliogr.: 12. – ISSN 2079-0791.

The paper estimates metrological accuracy the author's method of measuring static disbalance of rigid rotors compared to preresonance one. Formula are derived for calculating component of relative measurement error caused by linear friction. Also, the calculated data were obtained in the form of diagrams. The result of analysis is indicative of the fact that by measurement accuracy the author's method has an advantage over preresonance one and can be used in technological operations of rotor balancing of various machines and mechanisms. Scientific novelty consists in the derivation of formulas for calculating the component of the relative error of the imbalance via partial preresonance o for methods and copyright caused by linear friction. The practical significance of this study is to confirm the possibility of establishing more precise and easier to manufacture and maintain the equipment to determine the static unbalance of rotors.

Keywords: balancing, unbalance, rigid rotor preresonance, relative error, free oscillations, linear friction.

Optimization of main design factors highly economical precessional drives with rolling elements / M.V. Margulies, Y.O. Gordienko // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.85-92. – Bibliogr.: 9. – ISSN 2079-0791.

One of primary goals of the trend of intensive development of modern engineering sets is a continuous increase of power and decrease of mass and dimensional characteristics of drives of the machines and mechanisms. This makes the development of improved drives with progressive harmonic drives with rolling elements an actual task. In this article method of optimization of main design factors for minimization of mass and dimension parameters is given. The article is based on the analysis of scientific researches on calculation of deflected mode of machine elements at a local compression and publications about harmonic drives with rolling elements, and competed analytical researches and experimental data which are obtained during test prototype of mechanism. Dependencies that consider the influence of curvature of race grooves and rolling elements and nutation angle on values of contact stress which occur in workloads transfer process are given.

Keywords: harmonic drive, principal curvatures, periodic race groove, rolling elements, nutation angle, optimization, precession.

Evolution of loading ability of optimal on mass construction of planetary mechanism of type $2 \times \overline{AI}$ from conditions of contact balances / V.A. Matusevich, U.A. Sharaban, A.V. Shehov, V.T. Abramov // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.93-102. – Bibliogr.: 6. – ISSN 2079-0791.

Research of dependence evolution of the loading ability of the mass optimal structure of planetary mechanism of type $2 \times \overline{AI}$ on the chosen his design data is given. Structural properties set the numerical values of coefficients which determine properties of objective function of minimization of mass of mechanism. The minimum of mass of structure is found from a condition of contact strength balances of gear gearings. Estimation of the loading ability structure of mechanism takes into account the different variants of execution of his structure. The variant of execution of structure of mechanism is determined by the type of objective function of minimization of his mass. The problem of choice of optimum on mass structure of power mechanism associated with the implementation of the theoretical values obtained by the gear ratio of one stage mechanism is considered.

Keywords: planetary mechanism of type \overline{AI} , loading ability, optimal structure of the mass, analog of the mass, contact balances of gear gearings.

New type of herd alloy sprig-plate worm shavers and possibility of their manufacturing / V.A. Nastasenko // Bulletin of NTU "KhPI". Series: Problems of the mechanical drive – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.103-108. – Bibliogr.: 6. – ISSN 2079-0791.

The work deals with the realm of worm gear cutting tools in particular with assembled worm shavers made from high speed steels and hard, alloys intended for machining worm gear manufacturing process. Its implementation is connected with the need to improve the worm gear and tools to make them. One solution to this problem is finishing worm gear shaving. The analysis of known spring plate worm cutting tools was done, their merits and drawbacks were shown, and new designs eliminating these drawbacks were suggested: a preferable realm of their application was shown, and their manufacturing process was developed. Analyzed the technical and economic parameters of the proposed designs of shavers. Material consumption and complexity of manufacturing the proposed shavers reduced by 10%. The sum total of research done allows to recommend the instruments of question for high-productive and high-precision finish machining of worm wheels.

Keywords: worm gear, worm gear cutting tools, shavers.

Dynamics of the stress-strained state elements of a chain drive in in metal and polymeric implementation / O.I. Pilipenko, A.V. Poluyan // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.109-115. – Bibliogr.: 10. – ISSN 2079-0791.

A new approach to the calculation of the dynamics of the stress-strained state of chain transmissions are shown, which takes into account the real dynamic processes occurring during operation of chain drives. Maximum stress of a monolithic elastic polymeric link is less than the internal metal plate of the chain link. In the event of the maximum (peak) stress occurs and the corresponding maximum (peak) resulting elastic movement in the nodes of elements of the chain investigated. During these moments there is a reduction of the minimum safety factor of the material investigated elements of the chain. In addition, the obtained average value of the minimum safety factor plates metal chain corresponds to the traditional high value for such chains, and for the polymer chain, this value is placed within the machine-building norms. The existence of emerging vibration loads that multiple act on the sprockets and chain contour during operation of transmission. They are concentrated in the areas of microshock interaction roller chain with sprockets and, as a result of such influence, there are large localized stresses and elastic displacements in the material, which in most cases is the reason for breaking the plates of the chain links.

Keywords: stress-strained state plates of the chain links and the elastic polymer monolithic link.

Contact strength of toothed gearings with bevel-cylindrical gears / A.P. Popov, L.A. Popova // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.116-124. – Bibliogr.: 11. – ISSN 2079-0791.

The materials on the novel toothed gearing with spatial spot gearing of the straight evolvent teeth of the bevel-cylindrical gears have been presented. In this gearing the teeth of the pinion were turned by a small angle θ relatively of the gear teeth. In connection with this and taking into account the angle θ , the pinion presents itself bevel whereas the gear remains cylindrical. By that the axis of rotation of the pinion and gear remain parallel each other. The given gearing is characterized by high load capacity on contact stresses. The proposed gearing has been created on the basis of the new theory of contact strength worked out by prof. Popov A.P. To determine the maximum values of contact stresses under consideration gearing spatial contact problem is solved, providing not only finding contact stresses, but also the size of the elliptical contact area, and the minimum values of the rotation angle θ with respect to pinion teeth of the gear teeth.

Keywords: gearing, stresses, load capacity, turned teeth, bevel-cylindrical gearing.

Experimental research of contact interaction of complex rough bodies in view of compliance including compliance / N.B. Skripchenko, N.N. Tkachuk, A.A. Atroshenko, N.A. Tkachuk // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.124-129. – Bibliogr.: 6. – ISSN 2079-0791.

Important task is to determine the possible application of the developed, adapted or improved methods for the numerical investigation. Accuracy of numerical solutions by varying the parameters of numerical models is also an important task. The boundary element method is used for numerical solution of the contact problem. The article describes the method and results of experimental research of contact interaction complex-shaped bodies. The technology of pressure-sensitive films, which are placed between the contacting bodies, was used; they serve as indicators for the determination of the contact areas and sensors for measuring the contact pressure distribution. The correspondence used model with Winkler elastic foundation was shown. The magnitude of the compliance of the intermediate layer was obtained experimentally. Possibility of modeling contact interaction of complex-shaped bodies with the elastic layer using variants of the method of boundary integral equations has been demonstrated.

Keywords: contact interaction, complex body, Winkler elastic foundation, contact prints.

Analysis of key factors that influence aerodynamic friction in high-speed gear transmissions / V.V. Stavitskyy, P.L. Nosko, D.N. Marchenko, P.V. Fil, V.M. Kravtchenko // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.130-134. – Bibliogr.: 17. – ISSN 2079-0791.

This paper presents a discussion of the nature of windage and churning power losses. Relatively straightforward analytical mathematical expressions are offered to determine the energy efficiency of high-speed gears. A series of formulas which enable accurate prediction of windage and churning power losses for one pinion characteristic of gear transmission geometry and prediction of physical properties of lubrication are presented. Presented dependencies allow to calculate energy efficiencies of high-speed gears with minimum calculation efforts not only taking into account mechanical friction losses, but also taking into account windage and churning power losses. Specific gravities for different kinds of power losses are presented. Analytical dependencies of oil-air density on gear transmission geometries (rotational speed, tooth face width, radial and axial clearances, helix angle) are obtained based on mass balance. Influence limits are studied for the effect of the end gaps on the power losses, and for the effectiveness of lubrication by immersion in an oil bath.

Keywords: high-speed, transmissions, gears, windage and churning power losses, oil-air mixture, tooth face width, gear pitch radius, axial clearance.

Determining of opportunity of the cylindrical spur transmissions basic rack's profiling by curves of the second order / P.M. Tkach // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.135-144. – Bibliogr.: 17. – ISSN 2079-0791.

The opportunity of application of second order curves, such as ellipse, parabola and hyperbola is considered at a profiling of a cutting rack's teeth which is applied to manufacture of cylindrical spur transmissions. Limiting values of parameters of ellipse, hyperbola and parabola which make possible application of these curves as profiles of cutting rack's teeth are defined. In particular, for factor of height of the profile $h=1,25$ at a pressure angle on the initial direct $\alpha_n < 17,43^\circ$ profile will be circumscribed by an ellipse, at $\alpha_n > 17,43^\circ$ – a hyperbola, and at $\alpha_n = 17,43^\circ$ – a parabola. Synthesis algorithms of gearings are offered on the basis of cutting rack's teeth, delineated by second order curves – ellipse and hyperbola (common algorithm), and also for parabola. Control calculation which has confirmed an opportunity to find alternative for traditional involute transmissions with a pressure angle 20° and for aviation gears with a pressure angle 25° and $30,5^\circ$ is executed. With use of results of the given operation it is possible to make the further researches of geometry of such transmissions.

Keywords: cutting rack's tooth, a straight tooth, a shape angle, teeth rack.

Modeling stiffness values of epicycle planetary wheel gear / A.N. Chanchin // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KPI", 2015. – №34(1143). – P.144-153. – Bibliogr.: 6. – ISSN 2079-0791.

On the basis of developed analytical models of an epicycle as a part of planetary wheel gear of trolleybus it is received a function of the specific rigidity considering the crack sizes, elastic deformations of teeth and of a rim of an epicycle under the influence of operational loadings. According to the analysis of operational damages the kinetics of fatigue cracks in a rim of epicycle is investigated. It is established that in epicycles with rather thin rim the kinetics of a fatigue crack totals three stages. The crack arising in a hollow between teeth is directed on a normal to a hollow surface, and after an exit to an external surface turns in thickness of a rim where under the influence of sign-variable flexural tension develops parallel to an axis. Final destruction of a rim is observed on a site of spline connection of an epicycle with the gearbox casing in section at an angle $25...40^\circ$.

Keywords: epicycle, elastic deformations, fatigue crack, spectrum of vibrations.

Research of a range of the main frequencies of exercise machine-hexapod / V.P. Yaglinsky, G.V. Kozratsky, A.S. Obaydi, N.N. Moskvitchev // Bulletin of NTU "KhPI". Series: Problem of mechanical drive. – Kharkiv: NTU "KhPI", 2015. – №34(1143). – P.153-158. – Bibliogr.:11. – ISSN 2079-0791.

In article analytical dependences of determination of the main frequencies of the dynamic exercise machine of crews of fighting mobile vehicles are developed. Exercise machines on the basis of a hexapod machine out real overloads on crews of cars, model the movement of the vehicle in the conditions of difficult maneuver, an adverse condition of the road, case vibration, at refusal of systems of the car or its partial destruction. In emergency situations of maneuver of the car there are difficult spatial movements and overloads which become defining at working off of professional skills of maneuvering. Therefore research of a range of the main frequencies of free fluctuations of system of the exercise machine-hexapod is an actual task. At the movement of the exercise machine its spatial orientation and respectively oscillatory parameters changes. At fluctuations of the exercise machine round this configuration Yakobian systems can be considered invariable. The generalized coefficients of rigidity and inertia thus are constants. The resonant modes of functioning of the exercise machine are determined from the frequency equation by six generalized coordinates: to three coordinates of a pole of a platform and three corners of Euler-Krylov. By results of numerical modeling charts of dependence of the main frequencies on a spatial configuration of a platform of a hexapod are constructed. At a platform deviation from horizontal situation the first, second and fourth main frequencies decrease and the second and fifth – increase. Value of the sixth main frequency fluctuates at the level of $3000s^{-1}$ and almost doesn't depend on a corner ($-20...+20^\circ$) turn of a platform. The set of spatial configurations of a platform with low values the main frequencies is defined. The knowledge of a range of the main frequencies facilitates a choice of a trajectory of possible maneuver of the exercise machine when training crews of cars. The received analytical models give the chance to choose exercise machine operating conditions in the range of admissible values of resonant frequencies.

Keywords: frequency equation, Jacobi's matrix, resonance, rigidity.