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# Russian and Japanese Aerospace Literature

**During 1996 the *AIAA Journal* will carry selected abstracts on leading research topics from Russian aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Aeroelasticity, Flutter, and Vibration from Russia and Composite Structures from Japan.**

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## Russian Aerospace Literature
## This month: *Aeroelasticity, Flutter, and Vibration*

**A96-13549 Refinement of a numerical solution for aeroautoelasticity problems (Utochnenie chislennogo resheniya zadach aehroavtouprugosti).** M. F. GARIFULLIN (Kazanskij Gosudarstvennyj Tekhnicheskij Univ., Kazan, Russia), *Aviatsionnaya Tekhnika* (ISSN 579-2975), No. 2, 1995, pp. 82–84. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

A numerical method for solving aeroautoelasticity problems is examined which allows a detailed study of the effect of various factors on the behavior of an elastic flight vehicle with an automatic control system. The method can be integrated into an iteration procedure for the simultaneous design of a flight vehicle and automatric control system synthesis.

**A96-12077 Effect of damping forces on the postcritical behavior of essentially nonpotential systems (O vliyanii dempfiruyushchikh sil na poslekriticheskoe povedenie sushchestvenno nepotentsial'nykh sistem).** V. V. BOLOTIN, A. A. GRISHKO, and A. P. PETROVSKIJ, *Rossijskaya Akademiya Nauk, Izvestiya, Mekhanika Tverdogo Tela* (ISSN 0572-3299), No. 2, 1995, pp. 158–167. In Russian. 12 Refs. Documents available from Aeroplus Dispatch.

A study is made of the behavior of essentially nonpotential mechanical systems in the presence of flutter-type instability. The effect of damping forces on the postcritical behavior of the systems, including regions far from the stability boundary, is analyzed. Since stability conditions for this class of systems depend on the ratios of the partial damping coefficients, particular attention is given to the analysis of the effect of these ratios on the amplitudes and spectral composition of steady state vibrations in the flutter region. The analysis is based on the results of a computational experiment for a wide range of system parameters.

**A95-45142 Effect of the support conditions of a cylindrical shell on the critical flutter velocity in axial supersonic gas flow (Vliyanie uslovij zakrepleniya tortsov tsilindricheskoj obolochki na kriticheskuyu skorost' flattera v aksial'nom sverkhzvukovom potoke gaza).** I. N. MALYGIN and S. B. FILIPPOV, *Sankt-Peterburgskij Universitet, Vestnik, Seriya 1—Matematika, Mekhanika, Astronomiya* (ISSN 0024-0850), No. 3, 1994, pp. 81–88. In Russian. 6 Refs. Documents available from Aeroplus Dispatch.

Sufficiently simple explicit formulas for determining the critical flutter velocity of a cylindrical shell in supersonic axial flow of a gas is obtained for different support conditions by using an asymptotic method. The support conditions considered include hinged support at both ends of the shell; rigid support at both ends; and mixed hinged-rigid support conditions. Calculation results are presented, and the accuracy of the formulas is estimated.

**A95-33485 Engineering methods for estimating the transonic flutter characteristics of aerodynamic control surfaces (Inzhenernye metody otsenki kharakteristik transzvukovogo flattera aehrodinamicheskikh poverkhnostej upravleniya).** A. V. SAFRONOV and V. A. SAFRONOV (Kievskoe Vysshee Voennoe Aviatsionnoe Inzhenernoe Uchilishche, Kiev, Ukraine), *Problemy Prochnosti* (ISSN 0556-171X), No. 6, 1994, pp. 78–85. In Russian. 14 Refs. Documents available from Aeroplus Dispatch.

Based on an analysis of the results of theoretical and experimental studies of transonic gas flows past airfoils, engineering methods are proposed for estimating the flutter characteristics of control surfaces with allowance for their interaction with shock waves. The calculated hinge moments of an aerodynamic control surface are found to be in satisfactory agreement with the values based on flight tests.

**A94-29297 Predicting the flight vibrations of the thin-walled structures of flight vehicles (Prognozirovanie poletnykh vibratsij tonkostennykh konstruktsij letatel'nykh apparatov).** Y. N. MAKAROV and R. V. SIDEL'NIKOV, *Issues of the durability of aircraft design elements* (A94-29287 09-39), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, pp. 56–61. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

A procedure is proposed for predicting the level and spectral composition of flight vibrations of thin-walled structures of flight vehicles using two methods. The finite element method is used in the frequency region where the natural vibration density of structural elements is low, whereas the statistical energy method is used in the region of higher frequencies. The procedure has been implemented in a set of software. Predictions of vibrational loads on a compound shell of revolution exposed to noise in a turbulent boundary layer are found to be in good agreement with flight test data.

**A94-29294 A numerical study of lifting surface flutter (O chislennom issledovanii flattera nesushchej poverkhnosti).** V. A. PAVLOV and V. G. GAJNUTDINOV, *Issues of the durability of aircraft design elements* (A94-29287 09-39), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, pp. 42–45. In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

An algorithm for the numerical analysis of the dynamic instability of a compound lifting surface is proposed which is based on a refined scheme allowing for the three-dimensional nature of the deformation of structure components. A variational-matrix method for obtaining the general stiffness matrix of the compound surface is described. The validity of the algorithm proposed here is supported by calculations and experimental results.

**A94-29293 Vibrations of linear systems with small nonconservative forces (Kolebaniya linejnykh sistem s malymi nekonservativnymi silami).** T. V. GRISHANINA and F. N. SHKLYARCHUK, *Issues of the durability of aircraft design elements* (A94-29287 09-39), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, pp. 36–41, In Russian. 4 Refs. Documents available from Aeroplus Dispatch.

For an autonomous linear system with small nonconservative forces, formulas are obtained for determining the dynamic characteristics of the system using the perturbation method in the first and second approximations. The accuracy of the formulas is estimated, and their validity is demonstrated for several nonconservative systems, including a cantilever bar loaded by a follower force, a pipe with fluid outflow, and an all-moving tailplane in supersonic flow.

**A94-29280 Characteristics of the vibration spectra of asymmetric rotor blades (Osobennosti spektrov kolebanij lopatochnykh koles s asimmetriej).** A. Y. BEREZKIN and A. I. ERMAKOV, *Design and adjustment of aircraft gas-turbine engines* (A94-29278 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, pp. 21–27. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

Some characteristics of the vibrations of blade wheels of turbomachines with deviations from exact rotational symmetry are examined. The laws governing the frequency spectra and vibration modes of blade wheels with nonidentical blades are determined as a function of the extent and nature of the asymmetry and stiffness characteristics of the wheel structure as a whole.

**A94-29277 A method for determining the dynamic characteristics of gas turbine blades in transient regimes (Sposob opredeleniya dinamicheskikh kharakteristik lopatok GTD na perekhodnykh rezhimakh).**

V. K. SEMENYCHEV and A. N. TYRSIN, *Vibrational durability and reliability of aircraft engines and systems* (A94-29268 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut 1989, pp. 91–97. In Russian. 8 Refs. Documents available from Aeroplus Dispatch.

A method for determining the dynamic characteristics of gas turbine blades is examined which is based on representing blade vibrations by a linear discrete model. The method allows for limits on the signal duration and coloration of the noise spectrum. A method is proposed for detecting resonance blade vibrations from changes in the statistical characteristics of the signal. Stability against variations in distribution laws and noise spectra is ensured both in detecting resonance vibrations and in determining dynamic characteristics.

**A94-29276 Relationships between undesirable phenomena in multirotor gas turbine engines, their vibration characteristics, and rotor rpm ratios (O nalichii svyazej mezhdu nezhelatel'nymi yavleniyami v mnogorotornykh GTD, ikh vibratsionnymi kharakteristikami i sootnosheniyami chastot vrashcheniya rotorov).** I. L. PIS'MENNYJ, *Vibrational durability and reliability of aircraft engines and systems* (A94-29268 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, pp. 77–84. In Russian. 2 Refs. Documents available from Aeroplus Dispatch.

In the context of the theory of multifrequency nonlinear vibrations, it is hypothesized that an increase in the vibration level occurs in multirotor gas turbine engines at certain rotor rpm ratios. The hypothesis is supported by an analysis of experimental data. The analysis also supports the hypothesis that there exists a relationship between undesirable phenomena in operation and vibration characteristics.

**A94-29275 Results of a study of the fatigue strength of the bellows compensators of gas turbine engines under vibrational loading (Rezul'taty issledovaniya ustalostnoj prochnosti sil'fonnykh kompensatorov GTD pri vibratsionnom nagruzhenii).** A. I. KRYUKOV, A. A. SIDORENKO, and F. S. KHUSAINOV, *Vibrational durability and reliability of aircraft engines and systems* (A94-29268 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, pp. 51–58. In Russian. 6 Refs. Documents available from Aeroplus Dispatch.

Fatigue curves and fatigue life distributions of bellows have been obtained experimentally for the case of high-cycle vibrational loading. An analytical description is presented for a bellows fatigue curve which makes it possible to determine their vibration survival capability (number of cycles to failure) under induced vibration for a specified stress level. Stresses in the bellows are calculated by using nonlinear Reissner equations as a function of the induced vibration amplitude. An illustrative example is included.

**A94-29269 Selection of the dependent and governing parameters of the hydrodynamic dampers of gas turbine engines (Vybor opredelyaemykh i opredelyayushchikh parametrov gidrodinamicheskikh dempferov gazoturbinnykh dvigatelej).** V. B. BALYAKIN, *Vibrational durability and reliability of aircraft engines and systems* (A94-29268 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, pp. 5–11. In Russian. 5 Refs. Documents available from Aeroplus Dispatch.

The dependent and governing parameters of the hydrodynamic dampers of gas turbine engines are obtained by using the dimensionality and similarity theory. Variability limits are determined for the dimensionless governing parameters for the dampers of aircraft gas turbine engine rotors. Expressions for the dimensionless hydrodynamic force as a function of the governing parameters are presented for the case of a short hydrodynamic damper with turbulent flow of the fluid in the damping layer.

**A94-29268 Vibrational durability and reliability of aircraft engines and systems (Vibratsionnaya prochnost' i nadezhnost' dvigatelej i sistem letatel'nykh apparatov).** A. I., BELOUSOV, ED., Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, p. 143. In Russian. Documents available from Aeroplus Dispatch.

The papers presented in this volume provide an overview of current research related to the vibration sources, vibration loading, and vibration survival capability of the principal elements of aviation gas turbine engines and methods for diagnosing and suppressing dangerous vibrations. Specific topics discussed include selection of the dependent and governing parameters of hydrodynamic dampers for gas turbine engines; results of a study of the fatigue strength of the bellows compensators of gas turbine engines under vibration loading; a method for determining the dynamic characteristics of gas turbine engine blades in transient regimes; and designing pipeline clusters with structural damping.

**A94-28152 Vibration diagnostics of powerplant components using the engine vibration control system (11) (Vibrodiagnostika agregatov silovoj ustanovki s pomoshch'yu sistemy kontrolya vibratsii dvigatelya).** V. S. BAKLANOV and V. M. VUL', *Vibrational stability and reliability of aircraft engines and systems* (A94-28151 09-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, pp. 11–15. In Russian. 2 Refs. Documents available from Aeroplus Dispatch.

A method is described for using the data supplied by the existing engine vibration control systems to evaluate the condition of the accessory gear box mounted on the engine. The identification of the vibration spectra of the casing of a medium-thrust bypass engine has made it possible to determine the dependence of some of the spectrum components on the operating conditions of the gear box. An algorithm is proposed for determining the dependence of individual spectrum components, characterizing a specific system, on the vibrational state of this system.

**A94-28151 Vibrational stability and reliability of aircraft engines and systems (ME) (Vibratsionnaya prochnost' i nadezhnost' dvigatelej i sistem letatel'nykh apparatov).** A. I., BELOUSOV, ED., Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1988, p. 93. In Russian Documents available from Aeroplus Dispatch.

The papers presented in this volume provide an overview of recent theoretical and experimental research in the field of the vibration survival capability and reliability of gas turbine engine components and flight vehicle systems. In particular, attention is given to the vibration diagnostics of powerplant components using the engine vibration control system; organization of vibration process input into a computer; and hydraulic losses in cylindrical wicks of MR materials. Papers are also presented on a study of a spectral model of pressure pulsations in an axial-flow compressor for diagnosing gasdynamic instability; an analysis of the efficiency of a parametric diagnostic method for the bench testing of gas turbine engines; and selection of functions for the distribution of displacements and transverse stresses over the thickness of layered anisotropic plates and shells.

**A95-14491 A new statement of the flutter problem for a shallow shell (Novaya postanovka zadachi o flattere pologoj obolochki).** A. A. IL'YUSHIN and I. A. KIJKO, *Prikladnaya Matematika i Mekhanika* (ISSN 0568-5281), Vol. 58, No. 3, 1994, pp. 167–171. In Russian. 11 Refs. Documents available from Aeroplus Dispatch.

The panel flutter problem for a shallow shell of arbitrary planform and arbitrary orientation relative to the flow velocity vector is stated under the assumption that the excess pressure of the gas flow over the shell can be determined from the linearized (piston) lifting surface theory. The general formulation of the problem is then adapted to several specific examples.

**A95-12871 Acoustic resonance in turbomachines due to aerodynamic cascade interaction in subsonic gas flow (Ob akusticheskom rezonanse v turbomashinakh pri aehrodinamicheskom vzaimodejstvii reshetok v dozvukovom potoke gaza).** V. L. KHITRIK, *Prikladnaya Mekhanika i Tekhnicheskaya Fizika* (ISSN 0869-5032), Vol. 35, No. 4, 1994, pp. 78–85. In Russian. 12 Refs. Documents available from Aeroplus Dispatch.

A simple mathematical formalism is used to compare the conditions leading to acoustic resonance in the blade passages of a stationary cascade (which govern the choice of stationary/nonstationary blade ratios) and similar conditions leading to hydrodynamic nonequilibrium (i.e., nonstationary periodic forces and moments acting on stationary turbine blades at the blade frequencies of the rotor during aerodynamic cascade interaction). An expression is obtained for estimating the maximum stationary/nonstationary blade ratios and the condition for preventing the amplification of acoustic pressure oscillations at the blade frequency harmonics of the rotor.

**A94-35273 Blade vibration damping as an example of resource-saving technology during the conversion of gas turbine engines (Dempfirovanie kolebanij lopatok kak primer resursosberegayushchej tekhnologii pri konvertirovanii GTD).** O. V. KURAKIN, N. I. STARTSEV, and A. V. PISAREV, *Design and development of aircraft gas-turbine engines* (A94-35266 12-07), Kuibyshev, Russia, Kujbyshevskij Aviatsionnyj Institut, 1989, pp. 51–54. In Russian. Documents available from Aeroplus Dispatch.

Damping is investigated as a more cost-effective alternative to blade frequency tuning during the conversion of gas turbine engines. The damper should be capable of energy dissipation within small volumes: it should not affect blade interchangability or the gasdynamic parameters of a stage. Examples of such dampers are presented.

**A94-27720 Calculation of the natural modes and frequencies of the flexural-torsional vibrations of a rotor blade with a swept tip (Raschet sobstvennykh form i chastot izgibno-krutil'nykh kolebanij iopasti vertoleta so strelovidnoj zakontsovkoj).** I. A. LEVIN, *Problems in the design of helical-wing flight vehicles* (Problemy proektirovaniya vintokrylykh letatel'nykh apparatov), Moscow, Russia, Moskovskij Aviatsionnyi Institut, 1992, pp. 87–101. In Russian. 12 Refs. Documents available from Aeroplus Dispatch.

A study is made of the effect of a swept tip on the dynamic characteristics of a rotor blade, with the natural modes and frequencies of the blade calculated by the finite element method. The model used employs Hermite polynomials for the linear approximation of point displacements within an element in terms of element end displacements. The vector of the node degrees of freedom is used to account for the twist and its derivative along the element length as well as displacements and their derivatives in the rotation plane. The calculation results are compared with the results of frequency tests on a nonrotating bench.

**A94-25711 Adaptive algorithms for damping the short-period motions of aircraft—Lateral motion (Adaptivnye algoritmy dempfirovaniya korotkoperiodicheskikh kolebanij samoleta—Bokovoe dvizhenie).** P. D. KRUT'KO, A. A. MALAKHOV, and V. G. CHERNYSHOV (Moscow State Technical Univ., Moscow, Russia), *Moskovskij Gosudarstvennyj Tekhnicheskij Universitet, Vestnik, Seriia Priborostroenie* (ISSN 0236-3933), Vol. 1993, No. 2, 1993, pp. 15–33. In Russian. 3 Refs. Documents available from Aeroplus Dispatch.

The paper deals with the synthesis of adaptive algorithms for the damping of yawing and rolling motions which can be implemented with a minimum amount of measured data. Four versions of the algorithm structure are considered. The algorithm structure is determined by solving the problem of minimizing the instantaneous values of a function characterizing the motion energy of the plant in the vicinity of the trajectory of a reference model. The algorithms synthesized in this manner provide for the low sensitivity of the system to changes in the aircraft parameters. Results of the mathematical modeling of the control processes for various flight conditions are presented.