

Soviet and Japanese Aerospace Literature

Throughout 1989 the *AIAA Journal* will carry selected abstracts on leading research topics from the Soviet 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 Aircraft Engines from the USSR and Aircraft/Spacecraft/Rocket Engines from Japan.

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Soviet Aerospace Literature This month: Aircraft Engines

A88-49511 A study of the effect of stepwise velocity and temperature profile inhomogeneities in the initial cross section of a jet on its acoustic characteristics (Issledovanie vlianiia stupenchatoi neravnomernosti profilei skorosti i temperatury v nachal'nom sечenii strui na ee akusticheskie kharakteristiki). S. I. KRASHENINNIKOV and M. N. TOLSTOSHEEV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 39-43.

The effect of the gasdynamic and geometrical parameters of a bypass nonisothermal jet with velocity and temperature profile inhomogeneities on its acoustic characteristics is investigated experimentally, with gas temperature in the internal and external flow varying from 273 to 773 K and the full pressure at the nozzle inlet varying from 1.2 to 1.9 kg/sq cm. It is shown that the acoustic power of a bypass jet (with both normal and reversed velocity profiles) can be calculated from the parameters of the initial cross section of an equivalent jet whose area, flow rate, and full impulse are the same as those of the bypass jet.

A88-43123 Using the finite element method for studying the stress-strain state of the rotors of gas turbine engines (Primenenie metoda konechnykh elementov dlia issledovaniia napriazhenno-deformirovannogo sostoiianiia rotorov GTD). V. G. BAZHENOV and I. I. TROSTENIUK, *Problemy Prochnosti* (ISSN 0556-171X), May 1988, pp. 88-92. 7 Refs.

A finite element algorithm designed for problems of high dimensionality is presented which makes it possible to determine the stress-strain state of the rotors of gas turbine engines and to evaluate their load-bearing capacity. Based on calculations for assembled rotors, it is possible to determine clearances in seals with sufficiently high reliability. It is shown that the flexural deformations of cantilever disks can be significantly reduced by using slanted disks and disks with a crown that is asymmetric with respect to the hub.

A88-17742 Variable-cycle engines for boosting-cruising vehicles. N. I. ROTMISTROV and M. M. TSKHOVREBOV, 39th IAF International Astronautical Congress, Bangalore, India, Oct. 8-15, 1988. 15 pp. 5 Refs. (IAF Paper 88-249)

The present consideration of variable-cycle airbreathing booster vehicle engines for operation at Mach 5-6 gives attention to a variable-cycle engine with ramjet duct whose optimum energy transfer value into the duct is optimized. The thermodynamic and kinematic parameters of powerplant configurations of this type are presented, the boosting instantaneous overall efficiency is used to estimate these configurations' efficiencies at representative flight regimes.

A88-32746 Synthesis of a complex control system for gas turbine engines using orthogonal Legendre polynomials (Sintez kompleksnoi sistemy upravleniia GTD s ispol'zovaniem ortogonal'nykh mnogochlenov lezhandra). I. U. M. GUSEV, V. N. EFANOV, V. G. KRYMSKII, and N. F. KUL'NEVICH, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1987, pp. 79-81.

The paper is concerned with the problem of designing a complex controller capable of the coordinated control of all the principal transient and stationary processes associated with the operation of gas turbine engines. The control synthesis problem is solved by using a linear multimode engine model based on the linearization of the initial nonlinear engine models along the throttle (static) characteristic. To relate the model to the time characteristics of the control system, the time characteristics are expanded into a series in terms of orthogonal Legendre polynomials. The synthesis algorithm proposed here is illustrated by an example.

A88-53954 Deformation and damage of the material of gas turbine engine blades during thermal cycling in gas flow (Deformirovanie i povrezhdenie materiala lopatok GTD pri teplosmenakh v gazovom potoke). G. N. TRET'YACHENKO and V. G. BARILO, *Problemy Prochnosti* (ISSN 0556-171X), Aug. 1988, pp. 39-42. 8 Refs.

The thermodynamic processes of energy dissipation in the material of wedge-shaped zones of gas turbine blades are investigated analytically. A procedure for determining that part of energy dissipated in the blade material which corresponds to damage accumulation is proposed. It is shown that, by using the entropy increment resulting from irreversible material deformation as a fatigue life criterion, it is possible to predict the service life of gas turbine blades.

A88-49509 An analytical study of the flow rate characteristics of multistage fan-spool turbines of bypass engines (Raschetnoe issledovanie raskhodnykh kharakteristik mnogostupenchatykh turbin ventilatorov TRDD). M. M. KAMOTSKAIA, B. I. MAMAEV, and T. A. SANDIMIROVA, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 33-36.

Results of an analytical study are presented for two multistage (2 and 3 stages, respectively) fan-spool turbines, which are commonly used in turbofan engines with bypass ratios of 1.5-4.5. It is shown that, in turbines with subsonic ratios, the opening of the blade rims has only a slight effect on the efficiency, while flow swirling at the exit is prevented through the correction of the last rim. Changes in design load distribution over the stages play only a minor role from the standpoint of the possibility of increasing the normalized gas flow rate.

A88-50144 Probabilistic estimation of the exhaustion of gas-turbine-engine disk service life under low-cycle fatigue (Veroyatnostnaia otsenka ischerpaniia rabotosposobnosti diskov GTD pri malotsiklovoi ustaloosti). T. V. BALEPINA, *Problemy Prochnosti* (ISSN 0556-171X), July 1988, pp. 40-43.

This paper describes a procedure for estimating the service-life of gas-turbine disks under low-cycle fatigue. The approximation procedure is based on a method for random-argument function linearization and the Manson formula to express the relationship between the disk strain and its service life. An example is presented for calculating the probability of service-life exhaustion of a turbine disk and the probability of its cracking from a set number of service cycles of the gas-turbine engine.

A88-49473 A method for analyzing natural vibrations of turbine blades, based on a three-dimensional model (Metod analiza sobstvennykh kolebaniy lopatok turbomashin na osnove trekhmernoi modeli). I. U. S. VOROB'EV, Z. V. SAPELKINA, and A. I. SHEPEL', *Problemy Prochnosti* (ISSN 0556-171X), June 1988, pp. 81-86. 13 Refs.

This paper describes a method for the analysis of natural vibrations in complex-shape turbine blades. The method is developed on the basis of a three-dimensional model, with the three-dimensional continuum approximated by means of curvilinear hexahedral elements of the Serendip family. The problem of natural vibrations is reduced to the solution of the generalized eigenvalue problem. The validity of the method was tested experimentally on a turbine blade with an elongated foot and a fir-tree root.

A89-21573 Optimization of the parameters of multistage axial-flow compressors (Optimizatsiia parametrov osevykh mnogostupenchatykh kompressorov). I. N. EGOROV and V. N. FOMIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1988, pp. 89, 90.

A stochastic approach of the Monte Carlo type for the optimization of multistage axial-flow compressors is described. The approach involves statistical testing of a mathematical model of the compressor which allows for the characteristics of each blade crown at the mean radius. The compressor model is treated as a 'black box', which is subjected to a computer experiment. The advantage of the approach is that the computational effort in this case depends only slightly on the dimensionality of the problem.

A89-21571 A study of flow characteristics in models of gas turbine engine Laval nozzles in stationary and nonstationary regimes (Issledovanie osobennostei techeniia v modeliakh sopel Lavalia GTD na statsonarnykh i neustanovivshikhsia rezhimakh). I. U. I. TSYBIZOV and V. V. ZAGVOZDKIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1988, pp. 85-87.

Test results are presented for Laval nozzle models representing the nozzles of gas turbine engines operating with low expansion ratios. It is shown, in particular, that the shape of the subsonic section and the rate of change of the operating conditions have a noticeable effect on flow characteristics, pulsations, structural vibrations, and noise level. The test procedure and the test equipment used are described.

A89-21564 Effect of meridional profiling in a nozzle ring with a small angle of flow deflection on the stage characteristics (Vliianie meridional'nogo profilirovaniia v soplovom apparate s malym uglom povorota potoka na kharakteristiki stupeni). A. I. ARKHIPOV, M. K. MAKUTOVA, and V. N. TARASOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1988, pp. 60-62. 5 Refs.

In earlier studies, meridional profiling has been proposed as an efficient method of improving the gasdynamic characteristics of nozzle rings with a small relative blade height. Here, results of comparative experimental studies of stages with meridional profiling are presented to show that, in the case of nozzle rings with a small angle of flow deflection, meridional profiling does not produce the desired effect.

A89-21556 Changes in the characteristics of gas turbine helicopter engines with the accrued operating time (Izmenenie kharakteristik vertoletnykh GTD po narabotke). A. I. BELOUSOV, I. U. N. MAL'TSEV, and V. A. ZRELOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1988, pp. 26-29.

The performance of gas turbine helicopter engines is investigated experimentally in an effort to establish a relationship between the throttle characteristic of an engine and the accrued operating time. Empirical expressions are obtained which relate changes in engine power to a derivative function describing the throttle characteristic; the region of a sharp decrease in engine power is determined.

A88-49532 The effect of alcohol in the jet fuel on the emission of pollutants from aircraft gas turbine engines (Vliianie spirta i ego dobavok v reaktivnoe toplivo na vybros zagriazniushchikh veshchestv aviatsionnykh GTD). V. P. SVINUKHOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 105-108.

The paper presents an examination of the influence of the addition of ethanol to jet fuel on the emissions of the following pollutants from gas turbine engines: CO, unburnt hydrocarbons, nitrogen oxides, and smoke. It is shown that the use of alcohol as the main fuel for gas turbine engines as well as mixtures of alcohol with hydrocarbon fuels can significantly reduce the emission of nitrogen oxides and the smoking of the engine. Meanwhile, the emission level of CO and unburnt hydrocarbons remains roughly the same.

A89-13178 Prediction of the service lives of aviation gas turbine engine oils (Prognozirovaniie srokov sluzhby masel dlia aviatsionnykh gazoturbinnnykh dvigatelei). E. P. FEDOROV, V. V. GORIACHEV, and O. A. ZAPOROZHSKAIA, *Khimiia i Tekhnologia Topliv i Masel* (ISSN 0023-1169), No. 9, 1988, pp. 38-41.

A method is presented for predicting the service lives of oils for aviation gas turbine engines from laboratory test results. It is noted that the service lives determined by this method are approximate and should be corrected in the process of bench testing and service. The discussion is illustrated by results obtained for a variety of turbine engine oils, including MK-8p, MS-8p, IPM-10, B-3V, LZ-240, 36/1Ku-A, VNII NP 50-1-4f, and experimental oils.

A89-21555 Pulsations and vibrations in a turbine resulting from the interaction between nozzle vanes and rotor blades (Pul'satsii i vibratsii v turbine, obuslovlennnye vzaimodeistviem lopatok soplovoogo apparata i rabochego kolesa). A. N. ANTONOV, B. I. BOROVSKII, L. A. TOLSTIKOV, V. L. KHITRIK, and A. I. CHUCHEROV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 3, 1988, pp. 22-25.

Expressions are obtained for analyzing the relative amplitudes of pulsations and vibrations in a turbine which result from the interaction between nozzle vanes and rotor blades. To assess the validity of the model proposed here, a comparison is made between the model predictions and experimental data. The two sets of results agree to within 15 percent.

A88-49518 Selection of the efficient dimensionality and working process parameters of a unified bypass engine for a class of subsonic aircraft (Vybor ratsional'noi razmernosti i parametrov rabochego protessa unifitsirovannogo TRDD dlia semeistva dozvukovykh samoletov). E. D. STEN'KIN, V. S. KUZ'MICHEV, M. A. MOROZOV, and O. M. ZHUKOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 67-71.

A concept is described which provides an approach to the selection of the efficient dimensionality and working process parameters of a unified gas turbine engine for a class of aircraft. The approach is based on the analysis of the effect of bypass engine dimensionality on the efficiency of the aircraft. The approach is illustrated by a specific example involving the Tu-154 commercial aircraft.

A88-49512 Cooling efficiency of porous wafflelike materials (Effektivnost' okhlazhdeniia pronitsaemykh vafel'nykh materialov). V. I. LOKAI, M. K. FAIZULLIN, and A. V. SHCHUKIN, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 43-47. 5 Refs.

Experimental data are presented on the cooling depth of porous wafflelike materials and on the efficiency of the film cooling of a wall behind a section of such a material. The data, which have been obtained for test specimens of 12Kh18N10T stainless steel, are grouped in accordance with three types of the internal structure of the porous material: a structure with straight flow of the cooling air, a structure with looped flow of the coolant, and a structure with looped flow without coolant injection onto the protected surface.

A88-49508 The problem of jet noise reduction in the near acoustic field of a gas turbine engine (Problema snizheniia shuma reaktivnoi strui GTD v blizhnem zvukovom pole). I. S. ZAGUZOV, E. V. VLASOV, and K. V. KAKHOVSKII, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1988, pp. 29-33.

The paper is concerned with the problem of reducing jet noise in aircraft gas turbine engines which constitutes a source of high-intensity low-frequency acoustic loads on the fuselage surface of passenger aircraft and, consequently, noise inside the cabin. A tubular jet noise suppressor is examined as a possible way of solving this problem. The efficiency of this approach is illustrated by test results.

A88-48148 Equipment for studying the thermal stressed state of rotating gas turbine components (Apparatura dlia issledovaniia teplonapriazhennogo sostoiianiia vrashchaiushchikhsia detalei gazovykh turbin). E. P. DYBAN, V. N. KLIMENKO, V. I. U. KHAVIN, and S. L. POLUKHIN, *Promyshlennaia Teplotekhnika* (ISSN 0204-3602), Vol. 10, No. 3, 1988, pp. 77-80. 5 Refs.

A tensometric device using wire strain gauges has been developed which provides for the correction of errors introduced by the contact resistances of current collectors during the measurement of the deformations of the rotating components of gas turbines. With the device described here, the level of noise introduced by the current collector resistors does not exceed 1 mV for a signal of 1 V.

A88-43612 A numerical method for calculating turbulent flows and heat transfer in the engines of flight vehicles (Chislennyi metod rascheta turbulentnykh techenii i teploobmena v dvigateliakh letatel'nykh apparatov). A. M. LIPANOV, I. F. KISAROV, and I. G. KLIUCHNIKOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 1, 1988, pp. 49-53.

A method is developed for the numerical modeling of turbulent flows of a viscous compressible gas and heat transfer in flight vehicle engines in the stationary operation region. The method, which uses finite difference calculations, makes it possible to evaluate the effect of the geometrical dimensions of the engine and rotation speed on the flow and heat transfer parameters. Results of calculations are presented for two engine configurations.

A88-37549 Life of gas turbine engine disks with cracks (Zhivuchest' diskov GTD s treshchinami). N V STEPANOV, V N SHLIANNIKOV, V V OMEL'CHENKO, and I N SHKANOV, *Problemy Prochnosti* (ISSN 0556-171X), April 1988, pp 108-111 8 Refs

Results of a study of the deceleration of critical cracks in gas turbine disks of VT3-1 titanium alloy under conditions of low-cycle fatigue are reported. In the experiments, cracks were arrested by holes located in areas that were less stressed than the areas where the initial cracks grew from the disk grooves. It is shown that the method of crack arrest described here makes it possible to extend the life of disks by 36-60 percent.

A88-43616 An experimental study of the nozzle vane cascades of gas turbines with counterrotating rotors (Eksperimental'noe issledovanie reshetok soplovykh apparatov turbin GTD s protivopolozhnym vrashcheniem rotorov). B A PONOMAREV and I V SOTSENKO, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 1, 1988, pp 64-67 5 Refs

Experimental data are presented on the performance characteristics of guide vane cascades with large and small angles of flow deflection designed for turbines with corotating and counterrotating rotors, respectively. A comparison of three cascades shows that the transition to the counterrotating scheme reduces the number of vanes by 40 percent, with a total reduction in the vane surface area of 21 percent. This results in a reduction of the flow rate of the cooling air.

A88-43611 Modal synthesis in the study of the dynamic behavior of complex aircraft gas-turbine engine systems (Modal'nyi sintez v issledovanii dinamicheskogo povedeniia slozhnykh sistem aviatsionnykh GTD). M K LEONT'EV, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 1, 1988, pp 44-48

The main concepts and the general equations of the methods of modal synthesis for determining the vibration characteristics of complex elastic-inertial systems of aircraft gas-turbine engines are presented. The equations are written in a form convenient for their direct implementation on a computer. Some problems associated with the use of modal synthesis for evaluating the dynamic behavior of complex elastic-inertial systems are identified.

A88-40317 Thermal state of a turbofan rotor (Teplovoe sostoiianie koleasa turboventilatora). B D BILEKA, A M DIACHENKO, and I S ORINICHEV, *Promyshlennaya Teplotekhnika* (ISSN 0204-3602), Vol 10, No 2, 1988, pp 49-55

Results of an experimental study of the thermal state of a combined turbofan rotor consisting of a peripheral turbine stage and a central fan stage are reported. In particular, attention is given to the effect of gas temperature, air flow rate, and rotation speed on temperature distributions at characteristic points of the rotor. The relative dimensionless temperatures of the turbofan rotor are shown to be constant under all the regimes investigated. An approximate method is proposed for calculating the temperature of the rotor elements, and the results of calculations are compared with experimental data.

A88-53996 Corrosion and protection of gas turbine blades (Russian book) (Korroziia i zashchita lopatok gazovykh turbin). VALENTIN IL'ICH NIKITIN, *Leningrad, Izdatel'stvo Mashinostroenie*, 1987, 272 pp 252 Refs

The characteristics of the damage of gas turbine blades resulting from sulfide-oxide corrosion, the mechanisms of this type of corrosion, and its various forms are reviewed. Different types of anticorrosion coatings and methods for depositing such coating on the blades of gas turbines are then discussed. In particular, attention is given to the possibility of extending the life of gas turbine plants by using corrosion-resistant alloys, fuel additives, and surface and bulk alloying of the blades.

A88-52117 Studies aimed at increasing the efficiency of sound-absorbing structures in the duct of an aircraft engine (Issledovaniia po povysheniiu effektivnosti zvukopogloshchayushchikh konstruktov v kanale aviatsionnogo dvigatelya). A F SOBOLEV, TsAGI, *Uchenye Zapiski* (ISSN 0321-3429), Vol 18, No 6, 1987, pp 41-50 9 Refs

Approximation formulas are obtained which make it possible to determine the direction of the maximum radiation of a given mode relative to the duct axis for various ratios between flow velocities inside and outside the duct. Two characteristic cases are considered: (1) continuous transition from flow inside the duct to external flow and (2) the presence of a tangential discontinuity between the jet issuing from the duct and the coflow. The possibility of increasing noise attenuation in the duct by optimizing the attenuation of the principal modes is investigated experimentally.

A88-32732 Thrust reversal utilization factor and its importance from the standpoint of the current theory of the use of reverse-thrust devices (for jet passenger aircraft) (Koeffitsient ispol'zovaniia reversa i ego aktual'nost' dlia sovremennoi teorii primeneniia reversnykh ustroystv). A G GILERSON and A V TALANTOV, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 3, 1987, pp 22-26

The concept of the thrust reversal utilization factor is introduced. The thrust reversal utilization factor is defined as the ratio of the maximum reverse thrust obtainable in an engine with a reverse-thrust device to the take-off thrust of the engine. It is shown that knowledge of the reverse thrust utilization factor is essential for determining the number of powerplants with reverse-thrust devices required on an aircraft.

A88-41822 Powerplants with in-flight thrust vector deflection (Russian book) (Silovye ustanovki s povorotom vektora tiagi v polete). VIKTOR FEDOROVICH PAVLENKO, *Moscow, Izdatel'stvo Mashinostroenie*, 1987, 200 pp 37 Refs

Various types and schemes of powerplants with thrust vector deflection designed for VTOL, STOL, and STOVL aircraft and also for improving flight control characteristics are reviewed. The discussion includes the design and principle of operation of thrust vector deflecting devices and the aerodynamic effect of exhaust jets on the aircraft, powerplant, and airfield pavement. The performance characteristics of powerplants with thrust vector deflection are presented.

A88-44903 Aircraft engines (Russian book) (Dvigateli letatel'nykh apparatov). ANATOLII ANDREEVICH GAR'KAVYI, ALBERT VIKTOROVICH CHAIKOVSKII, and SEMEN ISAAKOVICH LOVINSKII, *Moscow, Izdatel'stvo Mashinostroenie*, 1987, 288 pp 8 Refs

The general design, principles of operation, and the main components of aircraft engines are discussed with emphasis of gas-turbine engines. In particular, attention is given to the fundamentals of thermodynamics, working processes in aircraft engines, the principal types of aircraft engines and their applications, and the performance characteristics and limitations of gas turbine engines. The discussion also covers the design and operation of air intakes, compressors, and combustion chambers; design and operation of turbojets, bypass, turboprop, turbofan, and compressorless engines, and auxiliary systems.

A88-50778 Operation processes in the cooled perforated-blade turbines of gas turbine engines (Russian book) (Rabochie protsessy okhlazhdaemykh turbinakh gazoturbinnnykh dvigatelei s perforirovannymi lopatkami). EVGENII NIKOLAEVICH BOGOMOLCV, *Moscow, Izdatel'stvo Mashinostroenie*, 1987, 160 pp 36 Refs

Methods are presented for calculating the principal parameters of the perforated-blade cooling systems of gas turbines with convective-film cooling (e.g., gas screen efficiency, heat conductivity of the perforated wall, and optimality of the injection system). An exergic method is proposed for selecting the parameters of systems for feeding the coolant to the turbine blades. The thermodynamic and aerodynamic characteristics of processes in turbines with coolant injection through perforations are examined.

A88-32734 A method for calculating the reverse thrust of a cascade-type thrust reverser (Metodika rascheta obratnoi tiagi reversnogo ustroystva reshetchatogo tipa). V A GOLUBEV, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 3, 1987, pp 30-32

The general design and principle of operation of a cascade-type thrust reverser are briefly described, and a method is presented for calculating the reverse thrust of the reverse-thrust device. It is shown that in the case of engines with large exit pressure gradients, gas expansion in the span section of the deflecting cascade significantly contributes to the thrust reversal coefficient.

A88-32733 An experimental study of the gasdynamic effect of a nozzle cascade with injection at the side surface (Eksperimental'noe issledovanie gazodinamicheskoi effektivnosti reshetki soplovykh lopatok pri vduve na tortsevoi poverkhnosti). A V GOLOVANOV, O N EMIN, and S M PIOTUKH, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 3, 1987, pp 26-29

The objective of the experiments reported here was to determine the effect of the release of the cooling air through perforations in the end wall in front of a plane nozzle cascade on the gasdynamic efficiency of the cascade. Results are presented for $Re = 1.3 \times 10^6$ to 6×10^6 , $Mach = 0.72$, and a temperature ratio of 0.88. It is shown that the injection of cooling air at flow rates not exceeding 1 percent, reduces the inhomogeneity of the flow at the exit section of the nozzle ring without any increase in total losses.

A88-27742 Multifrequency nonlinear vibrations in a gas-turbine engine (Russian book) (Mnogochastotnye nelineinye kolebaniia v gazoturbinnom dvigatele). IOSIF L'VOVICH PIS'MENNYI, *Moscow, Izdatel'stvo Mashinostroenie*, 1987, 128 pp 14 Refs

The book focuses on theoretical and experimental studies of oscillatory processes in gas-turbine engines, including subharmonic and superharmonic surge phenomena. Particular attention is given to methods of protection against dangerous oscillatory regimes. Formulas and characteristics of two- and three-frequency harmonic linearization are presented for the most typical nonlinear elements. The discussion also covers protection against vibrational combustion in the afterburner and some manifestations of the nonlinear effects of vibrations.

A88-25628 A study of the autorotation regimes of gas-turbine engines (K voprosu issledovaniia rezhimov avtorotatsii GTD). V V DAINKO, *Aviatsionnaya Tekhnika* (ISSN 0579-2975), No 4, 1987, pp 72, 73

The autorotation of a gas turbine is investigated experimentally using a full-scale 750-kW aircraft gas turbine engine with a seven-stage axial-centrifugal compressor (six axial stages and one centrifugal stage). It is found that, under conditions of steady-state autorotation, at air flow rates up to 0.2 of the nominal value and flow velocities less than $M = 0.5$, the compressor uses mechanical energy and offers resistance to the incoming air flow, which results in a partial loss of pressure. The torque at the turbocompressor shaft is created by the turbine.

A88-24801 The study of the properties of rocket and jet fuels (Russian book) (Khimicheskaya i reaktivnykh topliv). ANATOLI ANDREEVICH BRATKOV, EVGENII PETROVICH SEREGIN, ANATOLI FEDOROVICH GORENKOV, ALEKSANDR MIKHAILOVICH CHIRKOV, ALEKSANDR ALEKSANDROVICH ILINSKII et al. Moscow, *Izdatel'stvo Khimiia*, 1987, 304 pp.

The principles of operation and the general design of liquid-propellant rocket and jet engines are examined. A classification of rocket and jet fuels is proposed, and their composition and properties are discussed. In particular, attention is given to the physicochemical and performance characteristics of fuels, their production, storage, transportation, and efficient use. The discussion also covers the principles of safe handling of fuels and fuel testing. A brief summary of the properties of rocket and jet fuels manufactured in other countries is included.

A88-24789 Fundamentals of aviation engine assembly (Russian book) (Osnovy sborki aviatsionnykh dvigatelei). ALEKSANDR IOSIFOVICH IL'YANKOV and MIKHAIL EFIMOVICH LEVIT, Moscow, *Izdatel'stvo Mashinostroenie*, 1987, 288 pp. 16 Refs.

The principles, technology, and typical processes of the assembly of aircraft and rocket engines are covered in this textbook. Topics discussed include general information on aircraft and rockets, the general design of jet, turbojet, turbofan, and rocket engines, quality control at aviation engine-building plants and general data on the reliability of aviation engines. Attention is also given to the automation and control of engine assembly processes, the use of industrial robots in engine assembly, testing of aviation engines and safety engineering at engine assembly plants.

A88-24775 Development of a surge protection device for a gas turbine engine with allowance for flow inhomogeneity in the gas-air path (Razrabotka ustroystva dlia zashchity gazoturbinogo dvigatelya ot pompezhov s uchetom neravnomernosti potoka v ego gazovozdushnom trakte). M. M. SHAKIR'YANOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1987, pp. 90, 91.

The paper presents the theoretical basis for the development of an electronic surge protection device for a gas turbine engine with allowance for flow inhomogeneity at the compressor exit. The analysis is based on the results of pressure monitoring at three points in the compressor exit section. A block diagram of an implementation of the device is presented, and its principle of operation is briefly described.

A88-27730 Data processing and analysis during the automated testing of gas turbine engines (Russian book) (Obработка i analiz informatsii pri avtomatizirovannykh ispytaniakh GTD). RAVIL' ISKANDEROVICH ADGAMOV, VLADLEN ONISIMOVICH BOROVNIK, SERGEI VASIL'EVICH DMITRIYEV, IU. V. KOZHEVNIKOV, and G. P. SHIBANOV, Moscow, *Izdatel'stvo Mashinostroenie*, 1987, 216 pp. 24 Refs.

The book is concerned with various aspects of data processing and analysis during the automatic computerized bench testing of gas turbine engines. In particular, attention is given to the structure and software and hardware implementation of the automatic testing process; types and sources of data in gas turbine engine testing, determination of the characteristics of gas turbine engines using a mathematical model, and the validity of the test-bench performance characteristics of gas turbine engines. The discussion also covers the organizational aspects of the computerization of experimental studies.

A88-24772 Effect of the nozzle ring blade passage angle on the efficiency of a radial-inflow microturbine with full delivery of the working fluid (Vliianie ugla naklona osei mezhlopatochnykh kanalov soploвого аппарата na ekonomichnost' tsestroremitel'noi mikro-turbiny s polnym podvodom rabocheho tela). V. N. MATVEEV, N. T. TIKHONOV, and A. A. TROFIMOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1987, pp. 83-86. 6 Refs.

The effect of the nozzle ring blade passage angle on the efficiency of a radial-inflow turbine is investigated experimentally in the blade passage range 4-21 degrees. It is found that, for a constant passage width (1.42 mm), the nozzle efficiency increases with decreasing blade passage angle over the full M1s range investigated (1.1-1.9).

A88-24770 Gasdynamic stability limit of axial-flow compressor stages with blades of low aspect ratio (Granitsa gazodinamicheskoi ustoychivosti stupeney osevogo kompressora s lopatkami malogo udlineniia). A. D. GRIGA, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1987, pp. 79-81.

The effect of the geometrical parameters of axial-flow compressor stages with blades of low aspect ratio on the transition to unstable operation is investigated experimentally. It is shown that the characteristics of the transition to unstable operation depend to a large extent on the pressure characteristics of the stage. It is also shown that the range of stable operation increases with increasing axial and radial clearances and with decreasing aspect ratio of the blades of a high-pressure rotor.

A88-24759 Combustion processes in a model bypass engine afterburner with inlet flow swirling (Protsesty goreniia v model'noi forsazhnoi kamere TRDDF v usloviakh zakrutki potokov na vkhode). V. N. GRUZDEV, V. M. ZAIZHENNYI, and A. V. TALANTOV, *Aviatsionnaia Tekhnika* (ISSN 0579-2975), No. 2, 1987, pp. 34-38. 10 Refs.

The effect of flow swirling at the inlet of a model afterburner with a stabilizer in the form of a grooved ring on flow dynamics and combustion is investigated experimentally. It is shown that swirling in opposite directions generates higher turbulence and contributes to the formation of a narrower recirculation zone. As a result, the flame front angle increases and the required time decreases, which explains the advantage of bidirectional swirling over unidirectional swirling.

Japanese Aerospace Literature This month: Aircraft/Spacecraft/Rocket Engines

A89-15194 Up to date information on the NS30S Stirling engine. O. MAMORU KUBO, JUNJI MATSUE, and FUSAO TERADA, in *1988 IECEC; Proceedings of the Twenty-third Intersociety Energy Conversion Engineering Conference*, Denver, CO, July 31-Aug. 5, 1988, Vol. 1 (A89-15176 04-44).

American Society of Mechanical Engineers, New York, 1988, pp. 163-169. Japan's Mechanical Engineering Laboratory has conducted efficiency-evaluation tests of a previously developed 30-kW class industrial-applications Stirling cycle engine. It is found that target values of 37 percent for thermodynamic efficiency and low NOx emissions have been achieved. Attention is given to engine heat balance characterization and the compressor and output control systems employed.

A88-40424 Development of liquid apogee propulsion system for ETS-VI. UICHI IMACHI, MASAKAZU SATO, KOICHI MIYOSHI, YUICHI HAYASAKA, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 28 Jan. 1988, pp. 25-30.

ETS-VI (Engineering Test Satellite VI) the Japanese first two-ton-class stationary satellite is scheduled to be launched in 1992 by the H-II heavy launch vehicle. Under the contract with the National Space Development Agency, IHI conducts the apogee stage integration for the ETS-VI. Trade-off study on various possibilities resulted in stage configuration in separable blow-down type with storable propellant, i.e., NTO/N2H4 for the advantages of simplicity, lower program risks and shorter development period and christened LAPS (liquid apogee propulsion system). LAPS has a single 2000N-class engine and four thrusters and capabilities of on-orbit restarting, propellant settling and automatic engine shut-down with command from the satellite. The apogee engine has been fire tested over 500 times including sea-level fire testing with 3500 seconds of duration that simulated flight operation and the possibility of practical use as firmly convinced by the propulsion system.

A88-23319 Development of digital electronic control for aero-engine. TATSUKI SATOH, MINEO KISHIMOTO, MASAHIRO KUROSAKI, and MINORU ARAHATA, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 27, Sept. 1987, pp. 281-287.

Digital electronic control for aeroengines has been advancing from the development phase into practical applications. Integrated flight and propulsion control may improve the control performance of total aircraft systems. In this paper, the performance improvement of engines and propulsion systems due to the introduction of digital electronic control is explained. An outline of the system configuration is presented, and results of tests on FADEC (Full Authority Digital Electronic Control) systems in the XF3-30 turbofan engine and the TF40 reheat turbofan engine are reviewed.

A89-12615 Hydrogen-powered vehicle with metal hydride storage and D.I.S. engine system. JUN HAMA, YOSHITADA UCHIYAMA, and YASUO KAWAGUCHI, SAE International Congress and Exposition, Detroit, MI, Feb. 29-Mar. 4, 1988, 12 pp. 7 Refs. (SAE Paper 880036).

A hydrogen-fueled engine system with spark ignition, low-pressure direct gas injection, and metal hydride as the hydrogen storage medium has been developed. Experimental results show that an engine which directly injects hydrogen gas into cylinders at a low pressure of 0.39 MPa functions well as a power source for driving a vehicle. The metal hydride tank and heat exchange system can supply hydrogen gas responsively to the engine when it is adapted to a vehicle with sudden changes in the hydrogen flow rate. The vehicle can be driven on cold winter days right after starting and idling by using this engine system together with a hydrogen flow path that premixes hydrogen with intake air. An experimental vehicle attained a maximum speed of 108 km/h, a driving distance of 280.3 km, fuel consumption of 12.2 km/l during steady driving at 40 km/h, and an exhaust NO(x) concentration of 5 ppm at 60 km/h.