JPRS L/9620

20 March 1981

. . . FBIS 40TH YEAR: 1941-81 . . .

USSR Report

ENGINEERING AND EQUIPMENT

(FOUO 2/81)

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26 February 1981

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USSR REPORT

ENGINEERING AND EQUIPMENT

(FOUO 2/81)

CONTENTS

AERONAUTICAL AND SPACE

UDC 629.7.051(075.3)

FLIGHTCRAFT EQUIPMENT

Moscow OBORUDOVANIYE LETATEL'NYKH APPARATOV in Russian 1979 signed to press 23 May 79 pp 2-4, 151-152

[Annotation, preface and table of contents from book "Flightcraft Equipment", by Igor' Valentinovich Kolchin, Valentin Ivanovich Kochetkov and Anatoliy Vasil'yevich Tumanov, Izdatel'stvo "Mashinostroyeniye", 5000 copies, 152 pages]

[Text] The book presents the principles of design and instrumentation of equipment carried on flightcraft including flight control systems, on-board digital computers, automation for propulsion units, telemetry systems, electric power supply and so on. An examination is made of methods of checking and testing on-board equipment and ensuring its reliability.

Preface

Present-day flight vehicles (aircraft, missiles, spacecraft) require a variety of complex equipment. They have a flight control system that solves problems of navigation, guidance, orientation and stabilization, propulsion control equipment, science and telemetry equipment, electric power supplies and other systems and instruments.

The modern flightcraft handles a variety of complicated scientific and national economic jobs with an effectiveness that depends to a considerable extent on the technical characteristics of the on-board equipment, and in particular on the type of flight control system, the dynamic, energy and accuracy characteristics that determine the complexity and quality of the jobs that can be handled by a given flightcraft.

One of the important areas of development of flightcraft equipment is characterized by widespread introduction of airborne digital computer equipment that by its organizational and computational functions unifies all equipment into a single complex. This has had a strong influence on principles of design of airborne equipment as a whole, and its individual instruments and devices.

The authors have made an effort to systematize the material of the book in accordance with an instructional program, and to present it in a form accessible to the students of technical schools. In this connection, the book goes into detail on the essence of physical processes that take place in equipment devices and systems, and the presentation is accompanied by numerous diagrams and graphs.

Considerable emphasis is given to the design of flight control systems. Therefore most sections of the book that deal for instance with airborne digital computers, actuating elements, navigational, telemetric and radio equipment involve the description of instruments and devices that are either directly part of the flight control systems or are used for testing during development and checking in the process of operation.

The textbook is based on open-source Soviet and non-Soviet materials listed at the end of the book. These references can be utilized by readers for an in-depth study of individual questions in graduate and undergraduate courses, or in laboratory work.

The material of the book is divided by authors as follows: chapters 1, 3, 6, 8 and the preface were written by V. I. Kochetkov; chapters 2, 4 -- by I. V. Kolchin; chapters 5, 7, 9 -- by A. V. Tumanov.

The authors take this occasion to express sincere gratitude to V. B. Degtyareva and Candidate of Technical Sciences A. V. Skripitsin for constructive advice and comments made during review of the manuscript.

All comments on the book and suggestions for improvement should be addressed to: Moscow, GSP-6, 1-y Basmannyy per. 3, izdatel'stvo "Mashinostroyeniye".

[132-6610]

6610
CSO: 1861

UDC 629.7.036.3:533.697.2(088.8)

AIR SCOOP FOR AN AUXILIARY ENGINE

Soviet Patient No 195896 filed 24 Jul 65, published 25 Jan 80

ANISHENKO, V. G., BAYEV, O. K., BALANDIN, V. V., GUSEV, Yu. I., ZAKHAROV, V. D., RYZHIK, Ya. I., SERDECHNYY, Yu. P., TAPEL'ZON, S. B. and TURCHANIKOV, I. I.

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 8, 1980 Abstract No 8.34.55]

[Text] A patent has been granted for an air scoop for an auxiliary engine. The device contains a plug air channel with radial blades. To maintain optimum characteristics without increasing head drag of the flightcraft, the inlet part of the air channel is located in a chamber equipped with controllable pod flaps or fuselage flaps, and a spherical screen that equalizes airflow is installed at the inlet to the air channel.

[11-6610]

6610
CSO: 1861

UDC 621.45.2

ON STUDYING AGGREGATES OF AUXILIARY HOT GAS POWER SOURCES

Khar'kov GAZOVAYA DINAMIKA DVIGATELEY I IKH ELEMENTOV in Russian No 1, 1979 pp 123-125

GOLDAYEV, I. P., IL'INSKIY, V. V. and SKVORCHEVSKIY, Ye. A.

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 10, 1980 Abstract No 9.34.94]

[Text] An examination is made of questions associated with studying the aggregates of on-board hot gas systems of flightcraft. An evaluation is made of the suitability of a two-component liquid gas generator for this purpose. Tests are done that show the range of gas generator parameter control. Figure 1; table 1; references 2.

[10-6610]

6610
CSO: 1861

MARINE AND SHIPBUILDING

UDC 629.12

PRINCIPLES OF DESIGN OF SUBMERSIBLE SYSTEMS FOR UNDERWATER VEHICLES

Moscow PRINTSIPY POSTROYENIYA POGRUZHNYKH SISTEM PODVODNYKH APPARATOV in Russian 1979 signed to press 13 Jul 79 pp 2, 128

[Annotation and table of contents from book "Principles of Design of Submersible Systems for Underwater Vehicles", by Vyacheslav Semenovich Yastrebov, Aleksey Vladimirovich Smirnov and Vladimir Alekseyevich Chelyshev, Izdatel'stvo "Nauka", 1000 copies, 128 pages]

[Text] The book deals with problems of designing and studying submersible (oil-filled) systems that operate on underwater vehicles under conditions of the influence of high hydrostatic pressure. An examination is made of characteristics and versions of design modifications for underwater conditions of passive (electric drive) and active (hydraulic drive) submersible systems. An examination is made of the major elements of compensating subsystems -- working fluids, compensators, seal units. Principles and designs are proposed for the components of submersible systems that ensure stable characteristics regardless of the depth of immersion.

The book is intended for engineers and technicians engaged in the research and development of underwater equipment.

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CSO: 1861

NON-NUCLEAR ENERGY

ENERGY ACCUMULATORS

Moscow NAKOPITELI ENERGII in Russian 1980 signed to press 17 Apr 80 pp 2, 151

[Annotation and table of contents from book "Energy Accumulators," by Doctor of Technical Sciences Nurbey Vladimirovich Gulia, Izdatel'stvo "Nauka", 24,500 copies, 153 pages]

[Text] The solution of many present-day problems in power, fuel, transportation, environmental protection and others that involve energy production and consumption is impossible without using a variety of storage units -- energy accumulators. And they will be still more extensively used in future. This book tells about all known forms of energy accumulators, demonstrates their current capabilities and future outlook, and gives examples of their application.

Doctor of Technical Sciences N. V. Gulia is the author of more than 150 scientific papers (including 70 inventions) in the field of energy storage, mainly flywheel storage units. A great deal of practical work on storage of mechanical energy that is now in progress in our nation is being done under his direction or with his participation.

Contents

[128A-6610]

6610
CSO: 1861

NAVIGATION AND GUIDANCE SYSTEMS

UDC 629.7.05:681.5

AUTOMATION OF UNSTEADY FLIGHT CONDITIONS OF AIRCRAFT

Moscow AVTOMATIZATSIYA NEUSTANOVIVSHIKHSYA REZHIMOV POLETA SAMOLETOV in Russian 1980 signed to press 13 Feb 80 pp 2-4, 139-140

[Annotation, preface and table of contents from book "Automation of Unsteady Flight Conditions of Aircraft", by Yevgeniy Germanovich Smenkovskiy, Izdatel'stvo "Mashinostroyeniye", 1550 copies, 144 pages]

[Text] The book examines problems of automating control of an airliner on stages of takeoff, landing, and transition to a holding pattern. A method of refined linearization is proposed that improves accuracy of solution on the time interval of interest, when a priori information is available on the nature of the process to be studied. Considerable emphasis is given to the characteristics of ground-based and airborne landing and takeoff support facilities.

The book is intended for engineering and technical workers engaged in designing airborne flight control systems, and also for students majoring in the pertinent fields in colleges and universities.

Preface

In recent years the problems of increasing regularity and safety of civilian airline flights have aroused considerable interest in problems of automating such flight stages as takeoff, leveling in the landing process and transition to a holding pattern. A general distinguishing feature of these flight stages is the use of unsteady (transient) modes resulting from introduction of large controlling actions into the aircraft-autopilot system. Such actions bring the system out of the region of small deviations for which linearized equations are valid. At the same time, the theoretical analysis of initial nonlinear equations that describe the behavior of the system in the general case presents nearly insurmountable difficulties. In analyzing the motion of an aircraft at low altitudes typical of the processes of takeoff and leveling during landing, additional complications make it necessary to take consideration of the changing influence of the ground.

To some extent these difficulties that arise in the design of control systems are overcome by using facilities of digital technology. In the latter case it is usually a matter of sorting through a large number of variants, which prolongs the planning stage and moreover fails to guarantee that the chosen solution is optimum. On the other hand, the possibilities for optimizing the solution with respect to certain quality criteria cannot always be used because of the difficulties that

arise in synthesizing the criteria themselves. For example the difficulties of formalization usually do not permit use of a single generalized criterion to account for not only such requirements as minimum mass, volume and equipment cost, maximum reliability, but also the quantitative constraints on these factors.

The method of refined linearization of nonlinearities considered in chapter 1 enables us in solving many problems to use the simple apparatus of linear differential equations with constant coefficients even in the case of large controlling actions on the system. The additional simplifications of the mathematical description of the motion of the aircraft in these processes are determined by the known possibilities of distinguishing special kinds of motion and realizing conditions of autonomy and invariance of the parameters to be controlled.

Simplifications of the mathematical description of the aircraft that enable detection of the main laws of control lead to the necessity of subsequent refinement of recommendations by computer techniques. For example recommended laws of control of long-period processes may be supplemented by terms of a correcting nature with respect to conditions of short-period fluctuations. However, it is quite important that on the first stage of the work when using analytical methods the problem of substantiating the decisive terms of the control laws is more rigorously solved. Thus the analytical and computer methods are not mutually exclusive, but rather complement one another.

In accordance with the main idea of simplification of the mathematical apparatus, the book examines only linear control laws. This establishes the maximum correspondence between processes that take place in conventional (visual or instrumental) and automated control, making it easier for the pilot to change from one kind of control to the other. We are assuming that the pilot realizes nonlinear control algorithms only in extreme situations that are completely excluded in normal operation of the automated system.

Some attention is given in the book to problems of decision making both when landing under conditions of limited visibility, and when taking off in the case of engine failure or an unfavorable combination of parameters that influence the length of the takeoff distance. In this connection, consideration is given to the characteristics of ground-based and airborne landing support facilities, including on-board airstrip imaging equipment, and also the possible principles of operation of takeoff indicators (chapter 2).

The book attempts to systematize the presentation of topics relating to automation of the important flight stages.

The author thanks Candidate of Technical Sciences V. N. Prosypalov for constructive remarks made during review of the manuscript.

Please address suggestions and comments to: 107886 Moscow, GSP-6, 1-y Basmannyy per. 3, izdatel'stvo "Mashinostroyeniye".

Contents

[139-6610]

6610
CSO: 1861

UDC 358.4(24)

OBJECTIVE CONTROL OF PRECISION IN AERONAVIGATION

Moscow OB"YEKTIVNYY KONTROL' TOCHNOSTI SAMOLETOVOZHDENIYA in Russian 1980 signed to press 28 Sep 79 pp 3-5, 126-127

[Annotation, introduction and table of contents from book "Objective Control of Precision in Aeronavigation", by Georgiy Fedoseyevich Molokanov, Voyenizdat, 9500 copies, 128 pages]

[Text] The author, an eminent scientist in the field of aeronavigation, outlines in this book the physical essence of major errors in flightcraft navigation, precision and reliability indices, and gives the mathematical substantiation of objective control and suggests a technique for processing the results.

The book will be of use to the manegerial and flight staff, students of aviation academies and all who are involved in air traffic control, simulation of vehicle motion and automation of objective control of the accuracy of vehicle motion.

Introduction

The crew of a vehicle, be it in the air, on the land, in the water or under the water, handles a variety of problems: research, national economic, military and so forth. Success in carrying out these jobs depends to a great extent on precise organization of vehicle traffic. As a rule, ground-based transport is confined to a system of roads, for ocean-going vessels and aircraft the routes are indicated on maps; by using navigational instruments, the crews ensure adherence to the schedule and safety of travel on these routes.

Traffic will be organized (and in military terms this means coordination of strikes with different kinds of troops, guaranteeing the maximum fighting effectiveness of their combined efforts) only if the crew follows the indicated route and control agencies at each instant know the location of the vehicle and its exact time of arrival at a designated point. It is most difficult to organize traffic in the air where the motion of aircraft takes place in three dimensions at very high velocities and frequently at night and in clouds.

Under these conditions it is especially important to set up continuous monitoring of the actual motion of flight vehicles and their relative locations in order to be of assistance to a crew in trouble at any time, as well as to analyze the patterns that characterize the particulars of flightcraft movement. To do this, appropriate airborne or ground-based equipment can be used for continuously recording the

actual flight trajectory of the aircraft for subsequent analysis. Such equipment is called a control system, and the process of recording and analysis is called objective control of aircraft flight.

The result of objective control of aircraft flight is automatically recorded information or data obtained after additional processing on the actual flight path, altitude, flight velocity and certain other parameters that are of objective assistance in evaluating the work of the crew in the air.

The main content of this book is given over to methods of processing the results of objective control, analysis of data in the interests of improving accuracy of aeronavigation, and also (especially important to organization of socialist competition), recommendations to the managerial staff of aviation departments whose job it is to organize objective control of flight crews.

Chapter 1 is devoted to a brief description of given flight trajectories typified by a constant increase in the fraction of curvilinear segments. A regorous mathematical definition is given of a method of comparing trajectories that is based on the conventional mathematical definition of the distance between two curves. A disclosure is made of the physical essence of the major indices of accuracy and reliability of flightcraft navigation over a given trajectory and within the limits of a delineated strip of the route. The same method is used to check the accuracy and reliability of the flightcraft in reaching a goal at a designated time, maintaining an assigned altitude and flight speed.

Chapter 2 gives the theoretical substantiation of algorithms for automatic processing of the results of objective control by the method of least squares, and also presents requirements for a rational rate of determination of parameters that are recorded by technical facilities. The analysis is based on the correlation theory of random processes (normalized correlation function, its derivatives, spectral density and so forth), but the calculations are reduced to simple final formulas and their physical essence is disclosed.

Chapter 3 gives a method of processing the results of objective control of aircraft flight over a predetermined trajectory in order to explain the meaning of thorough in-depth analysis of a completed flight, and to demonstrate the feasibility of automated processing of the results of analysis. The method is based on a quantitative evaluation of the number of excursions of the random process and their duration. However, with adequate accuracy for practical purposes a simpler method can be used to process the results of objective control that consists in introducing an average time interval that elapses between intersections of the predetermined flight trajectory by the aircraft as it deviates periodically from the route. The physical essence of the final formulas is explained.

Chapter 4 presents a method of rational processing of the results of control of the accuracy of aeronavigation using two of the most common computers: the small MIR-2 and the large YeS-1030, that give the results in convenient form, and an analysis is made of computations*.

*The examples of processing results of objective control of precision of aeronavigation were done on the MIR-2 and YeS-1030 computers at the Yu. A. Gagarin Military Air Academy.

With the processed results of objective control at hand, one can carefully analyze the quality of a completed flight, objectively evaluate the work of the crew in the air, their level of training, find the errors that have been made and suggest ways to prevent recurrence. It is necessary to have a clear idea of the nature of major errors of navigation of flight vehicles over a given route, and to know the method of analyzing them.

Computer equipment should be extensively used to shorten the time for statistical analysis of a group of flights. If the conditions under which each flight was completed are specified (type of aircraft, altitude, weather conditions, flight classification of the crew and so on), then the computer itself can automatically form data files with respect to a given feature for subsequent analysis. This will help in finding the way that aeronavigational accuracy depends on flight conditions, level of training of the crew, type of aircraft and so on.

The detailed breakdown on quality of each completed flight should be supplemented as statistical data are accumulated with an analysis of the aggregate, which will reveal new and important patterns characterizing improvement in maturity of the flight crew, their training in the air, and will uncover reserves for improvement of this training, and for flight safety and efficiency.

A complete understanding of methods of processing the results of objective control is also necessary for properly selecting facilities to get the necessary characteristics of accuracy in flightcraft navigation that will be conducive to the best analysis of a forthcoming flight.

The author considers it his duty to thank the chief navigator of the Air Force, Lieutenant-General of Aviation V. P. Bulanov and Professor V. G. Tarasov for constructive criticism that was taken into consideration in completing the manuscript.

Contents

[140-6610]

6610
CSO: 1861

UDC 621.438-55(088.86)

GAS TURBINE ENGINE CONTROL SYSTEM

Soviet Patent No 726360 filed 9 Nov 77 published 5 Apr 80

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 9, 1980 Abstract No 9.34.75 P]

YASTREBOV, I. A., KOCHETOV, A. Ye., Sovinskiy, B. I. and BEZCHASTNYY, V. A.

[Text] A gas turbine engine control system is proposed that contains sensors, an automatic control and monitoring module, AND circuits, a program module, a recorder and series-connected OR circuits, switching and actuating elements. To prevent a false command from being sent upon failure of any of the channels of the automatic control and monitoring module, as well as to provide automatic monitoring of this module, the system is modified by adding a stimulating signal unit, a commutator, a memory unit and a failure signal shaper. The outputs of the program module are connected to the inputs of the commutator, the AND circuits, the memory unit and the first input of the failure signal shaper. Connected to the other inputs of this signal shaper are the outputs of the automatic monitoring and control module, while the inputs of the AND circuits and the recorder are connected to the shaper outputs. The sensors and stimulating signal unit are connected through the commutator and the automatic control and monitoring module to the inputs of the AND circuits. The outputs of these circuits are connected to the OR circuits both directly and through the memory unit. Figure 1.

[10-6610]

6610
CSO: 1861

FLUID MECHANICS

K. E. TSIOLKOVSKIY AND PROBLEMS OF AVIATION AND AERONAUTICS

Moscow TRUDY TRINADTSATYKH CHTENIY, POSVYASHCHENNYKH RAZRABOTKE NAUCHNOGO NASLEDIYA I RAZVITIYU IDEY K. E. TSIOLKOVSKOGO in Russian 1979 pp 90-91

[Front Matter and Table of Contents from the collection of papers delivered in the Aviation and Aeronautics Section of the Thirteenth Lectures Dedicated to Elaboration of the Scientific Heritage and Development of the Ideas of K. E. Tsiolkovskiy held in Kaluga, 12-15 September 1978, USSR Academy of Sciences, 330 copies, 91 pages]

[Text] The following organizations took part in preparation of the lectures:

The K. E. Tsiolkovskiy State Museum of the Histroy of Astronautics;
The Committee of the USSR Academy of Sciences on Elaboration of the Scientific Heritage of K. E. Tsiolkovskiy;
The Institute of the History of Natural Science and Technology, USSR Academy of Sciences;
The Institute of Medical and Biological Problems of the USSR Ministry of Public Health;
The Yu. A. Gagarin Astronaut Training Center
The Committee of Astronautics of DOSAAF SSSR

Editorial staff of the lectures:

B. M. Kedrov (chairman), V. V. Balashov, N. G. Belova, Yu. V. Biryukov, L. M. Vorob'yev, N. K. Gavryushin, V. V. Dobronravov, V. P. Kaznevskiy, I. S. Kozlov, I. S. Korochentsev, A. A. Kosmodem'yanskiy, F. P. Kosmolinskiy, Ye. I. Kuznets, V. B. Malkin, I. A. Merkulov, Ye. K. Moshkin, A. N. Ponomarev, S. A. Popytalov, V. P. Senkevich, V. N. Sokol'skiy (deputy chairman), A. D. Ursul, Ye. T. Faddeyev, A. S. Fedorov, V. I. Florov, I. M. Khazen, O. A. Chembrovskiy, N. A. Cheremnykh, Yu. A. Shkolenko, I. I. Shuneyko and S. A. Sokolova (secretary-in-chief)

Editors-in-chief of the collection:

Doctor of Technical Sciences A. N. Ponomarev, N. A. Cheremnykh and Doctor of Technical Sciences S. A. Popytalov

Contents

In addition, a lecture was delivered by B. I. Kozlenko and Yu. B. Oskret, "Lateral Controllability of an Airplane with Takeoff and Landing Gear that Operates on an Air Cushion in Case of Engine Failure when Taxiing".

The collection was prepared for publication by N. I. Mizyulina, Tsiolkovskiy State Museum of the History of Astronautics.
[143-6610]

6610
CSO: 1861

UDC 621.438-253.5-71:51-7

CALCULATING THE TEMPERATURE FIELD OF A COOLED GAS TURBINE BLADE

Kuybyshev VIBRATSIONNAYA PROCHNOST' I NADEZHNOST' DVIGATELEY I SISTEM LETATEL'NYKH APPARATOV in Russian No 6, 1979 p 18

MIKHEYYENKOV, Ye. L.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 2, 1980 Abstract No 2.49.43]

[Text] The temperature field in the cross section of a blade is treated as a system of heat flows into the coolant with boundary conditions of the third kind on the gas side. The problem of thermal conductivity and stressed state in the cross section of the blade is linearized. A linear programming system is worked out for optimizing the heat state in the cross section of the blade. The criterion functional is taken as the minimum value of the overall heat flows into the coolant. Figure 1; references 6.

[8-6610]

6610
CSO: 1861

UDC 621.51

CONCERNING THE MUTUAL INFLUENCE OF RUNNER VANES AND GUIDE VANE ASSEMBLIES ON FLOW IN AN AXIAL GAP

Khar'kov GAZOVAYA DINAMIKA DVIGATELEY I IKH ELEMENTOV in Russian No 1, 1979 pp 12-30

ANYUTIN, A. N.

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 9, 1980 Abstract No 9.34.30]

[Text] Based on the theory of an active disk an investigation is made of a method of accounting for the change in flow parameters due to the mutual influence of runners and guide vane assemblies on off-design modes. The flow-in angle in the design mode is taken as equal to zero. A solution in quadratures is found in some special cases, and the results of calculation are given. Figures 6; references 4.

[10-6610]

6610
CSO: 1861

UDC 621.438:629.7

EXPERIMENTAL INVESTIGATION OF FLOW AROUND PERFORATED TURBINE CASCADES WITH ADMISSION OF AIR ONTO THE SURFACE OF THE VANES IN THE VICINITY OF THE INTAKE EDGE AT DIFFERENT ANGLES OF ATTACK

Khar'kov GAZOVAYA DINAMIKA DVIGATELEY I IKH ELEMENTOV in Russian No 1, 1979 pp 114-118

YEMIN, O. I., KUZNETSOV, V. I. and MILOVANOV, V. K.

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 9, 1980 Abstract No 9.34.47]

[Text] Experimental materials are presented on a perforated nozzle cascade under isothermal conditions. An investigation is made of the influence that the angle of attack has on the static pressure curve on the blade profile to determine certain principles that govern the behavior of losses in cascades with regard to the intensity of air blow-out onto the profile surface. Figures 3; references 4.

6610
CSO: 1861

UDC 621.438:629.7

INVESTIGATION OF THE INFLUENCE THAT COOLANT RELEASE AND ANGLE OF ATTACK HAVE ON THE DISCHARGE CHARACTERISTICS OF PERFORATED TURBINE CASCADES

Khar'kov GAZOVAYA DINAMIKA DVIGATELEY I IKH ELEMENTOV in Russian No 1, 1979 pp 118-123

MILOVANOV, V. K.

[From REFERATIVNYY ZHURNAL, AVIATSIONNYYE I RAKETNYYE DVIGATELI No 9, 1980 Abstract No 9.34-48]

[Text] Experimental data are given on the flowrate characteristics of a perforated turbine cascade, and also of the perforation channels. A method of calculating flowrate characteristics is proposed that is based on the results of experiments done under isothermal conditions. Results are given that are associated with the distribution of coolant flowrate between the perforated back and trough. The author introduces the concept of the lower limiting working mode with respect to coolant flowrate. Figures 3; references 4.

6610
CSO: 1861

UDC 629.78.015:535.6.011.55

AERODYNAMIC CHARACTERISTICS AND FLOW AROUND BLUNT BODIES IN A STRONG BLAST

Moscow TRUDY MOSKOVSKOGO VYSSHEGO TEKHNICHESKOGO UCHILISHCHA IMENI N. E. BAUMANA in Russian No 326, 1980 pp 16-30

ZAKHARCHENKO, V. F.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.94]

[Text] A method is presented for calculating flow around blunt solids of revolution in a hypersonic stream under conditions of strong blow-in of gas, and an estimate is made of the effect that the intensity of blow-in (one of the decisive parameters of surface mass exchange) has on flow around the bodies and their aerodynamic characteristics at different Mach numbers M_∞. Figures 9; references 5.

6610
CSO: 1861

UDC 629.78.015:533.6

SUPERSONIC FLOW AROUND BLUNT BODIES IN A STRONG BLAST

Moscow TRUDY MOSKOVSKOGO VYSSHEGO TEKHNICHESKOGO UCHILISHCHA IMENI N. E. BAUMANA in Russian No 326, 1980 pp 31-39

BOROVSKIY, Ye. E.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.95 by T. A. Ye.]

[Text] An analysis is made of the results of an experimental study of the effect that intense blow-in has on the configuration of a head shock wave, and a study is done on the spectra of pressure on the surface of a permeable blunt body under conditions of intense mass exchange. Calculations showed a considerable increase in the wave drag coefficient with increasing flowrate of the blow-in air. The results were confirmed by strain gage measurements showing that the total drag with intense blow-in is determined chiefly by the drag from pressure. Figures 6; references 2.

6610
CSO: 1861

UDC 629.78.015:6.011.5

INVESTIGATION OF GAS FLOW AROUND SOLIDS OF REVOLUTION

Moscow TRUDY MOSKOVSKOGO VYSSHEGO TEKHNICHESKOGO UCHILISHCHA IMENI N. E. BAUMANA in Russian No 326, 1980 pp 49-54

DANILOV, A. N., OVCHINNIKOV, V. M. and KITAYEV, A. A.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.96 by T. A. Ye.]

[Text] The paper gives the results of an experimental study of supersonic air flow around solids of revolution. The bow end of the investigated models was a sharp cone with an angle of 0.367 radian (21°) at the tip. The cylindrical part of the body terminated in a reverse cone with half-vertex angle β having a flat base. The results of the studies showed that reverse cones with angle β of 0.262 and 0.349 radian have the minimum base drag. However, the total drag is greatest on the model with β = 0.349 rad. Thus the research shows that a gain in drag is realized for models with reverse cones having small angles (less than 0.262 radian). Figures 4; references 2.

[9-6610]

6610
CSO: 1861

DC 629.78.015:533.6.011.5

DRAG OF A BLUNT PERMEABLE WEDGE IN A SUPERSONIC FLOW

Moscow TRUDY MOSKOVSKOGO VYSSHEGO TEKHNICHESKOGO UCHILISHCHA IMENI N. E. BAUMANA in Russian No 326, 1980 pp 98-104

POLYAYEV, V. M. and TSVETKOVA, M. V.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.97 by T. A. Ye.]

[Text] Blow-in of gas along all or part of the permeable surface of a body in a supersonic flow leads to a change in the nature of flow and redistribution of pressure on the surface, which causes a change in the aerodynamic characteristics. Experimental studies of a blunt permeable wedge in a supersonic air flow with blow-in of air through its surface were done at different angles of attack α and at Mach and Reynolds numbers of the oncoming flow equal to 6 and $0.062 \cdot 10^7$ m^{-1} respectively. These studies showed that in the presence of mass exchange at the surface of a blunt

wedge, where $(\rho V)_{unit} \leq 0.02$, the coefficients of wave drag and normal force are practically independent of the nature of distribution of blow-in along the surface and of its intensity, while the coefficient of base drag in this case changes considerably, leading to a change in the total coefficient of axial force. The given results can be used to estimate the influence of blow-in on the drag of flat blunt bodies. Figures 4; references 3.

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CSO: 1861

UDC 629.78.015:533.6

A NUMERICAL METHOD OF SOLVING VARIATIONAL PROBLEMS ON THE MINIMUM WAVE DRAG FOR SLENDER SOLIDS OF REVOLUTION

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA in Russian Vol 11, No 3, 1980 pp 106-108

PERMINOV, V. D.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.98]

[Text] A numerical method is proposed for solving variational problems on minimum wave drag for fairly smooth slender solids of revolution in a supersonic flow at a zero angle of attack. The method is based on using cubic splines to approximate the shape of the required solid. References 6.

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CSO: 1861

UDC 629.78.015:533.6.015.04

ON THE LAW OF CROSS SECTIONS FOR A THREE-DIMENSIONAL BOUNDARY LAYER ON A SLENDER WING IN A HYPERSONIC FLOW AT AN ANGLE OF ATTACK

Ramenskoye UCHENYYE ZAPISKI TSENTRAL'NOGO AEROGIDRODINAMICHESKOGO INSTITUTA in Russian Vol 11, No 3, 1980 pp 113-117

DUDIN, G. N.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 9, 1980 Abstract No 9.41.101]

[Text] An investigation is made of three-dimensional flow on a slender wing in a hypersonic stream of viscous gas at a small angle of attack. It is shown that in the general case for the boundary layer on low-aspect wings the law of cross sections is valid and the error of the zero approximation does not exceed the aspect of the wing. It is shown by numerical calculations that the presence of angle of attack has a considerable effect on friction stress in the longitudinal direction and on heat flow, and has considerably less effect on the friction stress in the transverse direction. Figures 4; references 2.

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CSO: 1861

MECHANICS OF SOLIDS

UDC 629.78.015.4

ON NUMERICAL SOLUTION OF THE PROBLEM OF THERMOELASTICITY OF SANDWICH SHELLS OF COMPLEX SHAPE THAT ARE SHALLOW RELATIVE TO A REFERENCE SURFACE

Kuybyshev VOPROSY PROCHNOSTI I DOLGOVECHNOSTI ELEMENTOV AVIATSIONNYKH KONSTRUKTSIY in Russian No 5, 1979 pp 16-24

PAYMUSHIN, V. N. and SOMOVA, Ye. S.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 2, 1980 Abstract No 2.41.149]

[Text] An examination is made of the problem of calculating sandwich shells of complex shape with a light orthotropic filler. This problem is solved by using an approach in which the middle surface of the filler σ is mapped onto some surface of simple geometry σ_0 normalized to lines of curvature $\alpha_1 = \text{const}\ \sigma_0\varepsilon$, which is called the reference surface. Expressions are derived on the basis of Grigolyuk-Chulkov relations for the strain components of the layers in the case where σ is shallow relative to σ_0. Equations of equilibrium are obtained that correspond to these strain components, and boundary conditions are formulated for shells in which the normal projection of contour lines $\gamma j\varepsilon\sigma$ ($j = 1.4$) coincides with the coordinates of lines $\alpha_1 = \text{const}\ \sigma_0\varepsilon$. Based on the resultant equations, a numerical method is developed for solving the problem of thermoelasticity for open shells of complex shape in which the middle surface is shallow relative to an arbitrary surface of zero gaussian curvature. The technique is based on using a variational modification of an integral-difference method developed in this paper as applied to the investigated class of problems. References 5.

[12-6610]

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CSO: 1861

UDC 629.78.015.4

PREDICTING AND ANALYZING THE PROCESS OF FATIGUE FAILURE OF STRUCTURAL SPECIMENS AND COMPONENTS

Kuybyshev VOPROSY PROCHNOSTI I DOLGOVECHNOSTI ELEMENTOV AVIATSIONNYKH KONSTRUKTSIY in Russian No 5, 1979 pp 124-131

MOSTOVOY, A. S. and PROKHOROV, A. G.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 2, 1980 Abstract No 2.41.155]

[Text] Based on the linear-discrete hypothesis of damage accumulation and the concomitant method of durability calculation, the authors predict and analyze a number of parameters that characterize the process of fatigue failure: the instant of crack inception, stresses, damage and intensity of its accumulation, relaxation of the external load with rigid loading, and the instant of fracture. Figures 5; references 8.

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CSO: 1861

UDC 629.78.015.4

ON DETERMINING EQUIVALENT CONDITIONS OF TESTING AND DURABILITY OF COMPONENTS THAT OPERATE UNDER CONDITIONS OF BENDING AND TWISTING

Kuybyshev VOPROSY PROCHNOSTI I DOLGOVECHNOSTI ELEMENTOV AVIATSIONNYKH KONSTRUKTSIY in Russian No 5, 1979 pp 96-101

KHAZANOV, Kh. S. and CHURAKOV, A. A.

[From REFERATIVNYY ZHURNAL, RAKETOSTROYENIYE No 2, 1980 Abstract No 2.41.161]

[Text] A method is proposed for determining simple harmonic testing conditions that are equivalent with respect to durability to harmonic loads that cause bending with twisting. The assumed criterion of equivalence is equality of the fatigue damages caused by the complex stressed state and by simple loading over equal time periods. The control experiment showed that durability of specimens in bending with twisting agrees quite satisfactorily with the durability under equivalent loading conditions. Figures 5; tables 2; references 2.

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CSO: 1861

UDC 621.438:539.4.01

LONG-TERM STRENGTH OF TURBINE DISKS

Moscow RASCHETY NA PROCHNOST' in Russian 1979 pp 30-40

MALININ, N. and NIGIN, A. A.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 2, 1980 Abstract No 2.49.51]

[Text] A method is presented for calculating long-term strength of turbine disks under unsteady loading. The calculations take consideration of the anisotropy of properties of the material as well as intergrain and intragrain damageability that arises due to strain of the material beyond the elastic limit and under conditions of creep. The calculation is done by the finite element method. An estimate is made of the time to failure of a totally cast disk with blades on "mounts" under cyclic loading. Figures 5; references 13.

[8-6610]

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CSO: 1861

UDC 62-35-251:534.1

EFFECT OF ROTATION ON THE NATURAL FREQUENCIES OF CONICAL SHELLS

Khar'kov UKRAINSKAYA RESPUBLIKANSKAYA NAUCHNO-TEKHNICHESKAYA KONFERENTSIYA. METODY I MODELI V SISTEMAKH AVTOMATIZIROVANNOGO PROYEKTIROVANIYA ENERGETICHESKIKH TURBOUSTANOVOK, GOTVAL'D, 1979. TEZISY DOKLADOV [UKRAINIAN REPUBLIC-WIDE SCIENTIFIC AND TECHNICAL CONFERENCE ON METHODS AND MODELS IN SYSTEMS FOR AUTOMATED DESIGN OF TURBINE POWER PLANTS, Gotval'd, 1979. Abstracts of the Papers] in Russian Part 2, 1979 pp 11-12

VOROB'YEV, Yu. S. and DETISTOV, S. I.

[From REFERATIVNYY ZHURNAL, TURBOSTROYENIYE No 2, 1980 Abstract No 2.49.77]

[Text] An expression is derived for the potential energy of a shell (elements of the rotors and disks of turbomachinery) with consideration of transverse shear deformations. The kinetic energy of a nonrotating shell from work of centrifugal and Coriolis forces is determined. Equations are derived for oscillations of a conical shell rotating about its own axis. The method of finite elements is used to get

the influence that the frequency of rotation and geometry of the shell have on its natural frequencies of oscillations. It is shown that rotation has a considerable effect on natural oscillations of shells.

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CSO: 1861

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