

A87-41809 The dynamics of the bioenergetics indices under hypercapnia (Dinamika pokazatelei bioenergetiki pri giperkapnii) V. L. MAKAROV, L. A. MOROZOV, and A. I. BORISOV, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 139-143. 21 Refs.

The effect of hypercapnia on contents of ATP, ADP, AMP, LDH isozymes, G6PD, and ATPase in blood was studied in healthy male operators exposed for 5 days to an atmosphere containing 2.0-2.5 percent CO₂. Blood analyses were performed before the exposure, at the end of the 5th day, and 14 days later. It was found that total blood concentrations of ATP and ADP nucleotides remained unchanged during the course of the experiment; this stability is believed to be due to simultaneous decreases in both the nucleotide synthesis and their utilization. Hypercapnia caused increases in the relative activities of LDH-4 and LDH-5 in serum, indicating a metabolic shift towards anaerobic processes. In erythrocytes, concentrations of ATPase and LDH activities decreased, while those of ATP and G6PD increased, indicating a disruption of normal metabolic processes. These changes are considered to be adaptive rather than pathological.

A87-41807 Normal levels of blood lipids in healthy humans (Dolzhnye velichiny lipidov krovi u zdorovogo cheloveka) R. K. KISELEV, R. V. BELEDA, A. P. IVANCHIKOV, and V. I. PLAKHATNIUK, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 109-112. 17 Refs.

A method is proposed for estimating individual norms of blood cholesterol and triglycerides from the data of subjects' age, height, and body weight. Data were collected from 2100 healthy males aged 18-57 and were used to compute linear regressions correlating chemically-analyzed blood concentrations of cholesterol or triglycerides with the three body parameters. Various linear combinations of power and logarithmic functions were considered. It was shown that in healthy subjects actual concentrations of both lipid groups agree within 10 percent with the established lipid norms. Subjects with atherogenic cardiovascular abnormalities displayed lipid cholesterol and triglyceride concentrations that were each more than 10 percent above the established normal levels.

A87-41805 The mechanism of voluntary and involuntary regulation of human activity under extreme conditions (Mekhanizm proizvol'noi i neproizvol'noi regulatsii deiatel'nosti cheloveka v ekstremal'nykh usloviyakh) V. I. MEDVEDEV, E. K. ZAV'IALOVA, and M. V. POLIKARPOVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 90-95. 9 Refs.

A method for assessing the characteristics of the voluntary and involuntary regulation of the learning process in humans was developed and applied to assess the effects of 48 hour-long sleep deprivation and of sydnocarb intake on the type of learning-process regulation. It was found that in rested subjects the prevailing mechanism of learning is the voluntary regulation of the learning process, mediated by word command, while in subjects deprived of sleep the regulating function was transferred

to the orientation reactions; thus, the relative efficiency of involuntary learning was greater in these subjects than in the rested controls. The sleep-deprived subjects committed more errors and signal misses and exhibited slower reactions to light signals (whether or not light signals were accompanied by sound signals) than did the controls. The intake of sydnocarb (four 17.5-mg doses) by sleep-deprived subjects had a beneficial effect, correcting insomnia-induced changes in the learning process.

A87-41802 The responses of the human respiratory system to hypoxic and hypercapnic stimuli during adaptation to high altitude (Otvety dykhatel'noi sistemy na gipoksicheskie i giperkapnicheskii stimuly pri adaptatsii cheloveka k usloviyam vysokogor'ia) T. V. SEREBROVSKAIA and T. G. DUBROVSKAIA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 58-64. 33 Refs.

The sensitivity of the respiratory system to hypoxia and hypercapnia in healthy males living at sea level was compared with the sensitivity of men adapted to high-altitude conditions by living for one year at 1680 or 3650 m. Results of measurements of ventilation and gas-exchange parameters after exposures to experimental hypoxia and hypercapnia indicated that, in the subjects who have lived at the altitude of 3600 m, the ventilatory response to both the hypoxic and the hypercapnic stimuli was higher than in the other groups. These subjects could also tolerate a lower critical level of P(A)O₂ but had a lower maximal level of tolerated hypercapnia. It was also found that subjects who exhibited elevated ventilation sensitivity to hypoxia at high altitude exhibit high work capacity at that altitude, elevated oxygen consumption, and lower levels of anaerobic glycolysis. However, these subjects were less stable to the critical levels of hypoxia.

A87-34404 The role of Vavilov-Cerenkov radiation in visual sensations induced by protons (Rol' izlucheniia Vavilova-Cherenkova v zritel'nykh oshchushcheniakh vyzvannykh protonami) P. V. GRAMENITSKII and I. N. FETISOV, *Biofizika* (ISSN 0006-3029), Vol. 32, Jan.-Feb. 1987, pp. 125-127. 10 Refs.

The mechanism responsible for the detection of ionizing particles by the human eye and for the production of a 'flash' sensation was studied using 1-ms monoenergetic proton beams directed at the subject's eye and recording the location, the features and the moment of the appearance of the 'flash' sensations. In particular, the relative importance in this mechanism of the Vavilov-Cerenkov radiation induced in the vitreous humor, as opposed to the importance of alternative mechanisms (the scintillation of the eye tissues or the direct stimulation of the retina), was investigated by comparing the sensations caused by 460 and 1850 MeV beams and by irradiating the eye from different angles. Bright diffuse flashes were seen with the 1850-MeV beams but not with the 460-MeV beams even when high-intensity 460-MeV beams were used. This evidence and other results (e.g., localization of the flash in the vision field after lateral) indicate that the proton-induced Cerenkov radiation in the vitreous body plays a dominant role in the sensitization of the retina.

Japanese Aerospace Literature This month: Aerodynamics

A88-24508 Shock wave/turbulent boundary-layer interactions induced by a semicone NOBUMI SAIDA and TOMONARI OOKA, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Nov. 1987, pp. 173-185. 12 Refs.

This paper presents an experimental study of shock wave/turbulent boundary-layer interactions induced by a semicone placed on the floor of a wind tunnel. The experiments were carried out in an 8 x 10 sq cm supersonic wind tunnel at free-stream Mach numbers of 1.98 and 2.48. Corresponding unit Reynolds numbers at the test section were in both cases 3.8 x 10 to the 7th/m. Semicone models with half angles varying from 20 to 90 deg were used in this study. Surface static pressure measurements, oil flow studies, and Schlieren photographs of the flow field were made. It was found that, on a flat plate, the shape of the separation line is insensitive to the cone angle of over 40 deg. Furthermore, a secondary separation region embedded in the shock-induced primary separated flow exists along the semicone and plate junction.

A88-22318 Fluctuation of heat transfer in shock wave/turbulent boundary layer interaction MASANORI HAYASHI, SHIGERU ASO, and ANZHONG TAN, AIAA Paper 88-0426 presented at the AIAA 26th Aerospace Sciences Meeting, Reno, NV, Jan. 11-14, 1988. 8 pp. 12 Refs.

A novel method based on a newly developed thin-film heat transfer gage yielding high spatial resolution, and applicable for both shock tunnels and wind tunnels with long flow duration, is presently used to measure fluctuating heat fluxes in the interaction region of shock waves and turbulent boundary layers. Attention is given to experimental results obtained at Mach 4 and Reynolds number of 12.6 million, in both separated and unseparated boundary layer conditions; in the former, significant fluctuations of heat transfer rate are observed throughout the interaction region.

A88-22135 Prediction of three-dimensional turbulent flows in a dump diffuser YASUNORI ANDO, MASAFUMI KAWAI, YUKINORI SATO, and HIDEMI TOH, AIAA Paper 88-0185 presented at the AIAA 26th Aerospace Sciences Meeting, Reno, NV, Jan. 11-14, 1988. 13 pp. 7 Refs.

A finite volume method for the solution of three-dimensional incompressible steady Navier-Stokes equations based on a general curvilinear coordinate system was employed to study the characteristics of turbulent flow in dump diffuser of gas-turbine combustor. The standard k-epsilon turbulence model is used to characterize the effect of turbulence. In order to achieve a saving in CPU time for calculation, present calculation was performed by lending itself to vector computer architecture of the FACOM VP-50 supercomputer. This method is applied to prediction of turbulent flow in a three-dimensional dump diffuser with and without the fuel nozzle. The calculated results are compared with the corresponding experimental data obtained in this work. General features of the flow pattern are adequately predicted, although discrepancies in detail seem to indicate deficiencies in the turbulence model used in present study.

A88-14250 On steady supersonic flow over two-dimensional airfoils HAMDI T. HEMDAN, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Aug. 1987, pp. 111-129. 13 Refs.

The problem of steady supersonic flow over two-dimensional airfoils with attached shock waves is considered. By combining the Newtonian limit with a geometric limiting process, new approximate equations are derived which can be used for a wide range of supersonic flows. Newtonian flow can be recovered from those equations as a special case. The work is restricted to moderate supersonic flow only for which two systems of linearized equations are derived and used to obtain closed-form formulas for the coefficient of surface pressure and other aerodynamic parameters. The results are compatible with the theory of characteristics and experiments and improve over other existing approximate methods.

A88-13546 A design of the cascade for a shock-in-rotor supersonic axial-flow compressor TAKAAKI HASHIMOTO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 403, 1987, pp. 401-404. 6 Refs.

A design method of the cascade for a shock-in-rotor supersonic axial-flow compressor is presented. The inlet flow is uniform and satisfies

simplified radial equilibrium. The flow just before the normal shock is uniform and satisfies simplified radial equilibrium. The supersonic portion between the inlet and the normal shock is designed by using the method of weak wave. In the subsonic portion the flow is quasi-axisymmetric. The shape of mean streamline is assumed to be circular arc. The passage walls are composed of circular arcs. A two-dimensional supersonic cascade which is designed by the method in this report includes the three-dimensional effect by taking into account radial equilibrium conditions.

A88-13544 Numerical solutions of the Euler equations for the flow field around counter-rotating propellers MAKOTO KOBAYAKAWA and MASAHIRO NAKAO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 403, 1987, pp. 389-398. 7 Refs.

In order to investigate the flow field around the ATP through numerical methods for its optimal design, 3D-Euler equations are most prominent. The flow field around counterrotating propellers in advancing 0.8 Mach is obtained. Two spaces including front and rear blades are solved separately. The interaction between both blades are taken into the calculation by the connecting surfaces. The noniterative implicit ADI scheme is used in order to solve Euler equations. The periodic steady and averaged steady solutions are obtained. The latter is simplified by averaging the variables at the connecting surface. This shortens the calculation time to one-third compared with the periodic steady analysis which simulates the relative motion of the blades exactly. Numerical calculations are performed for two counter rotating ATP's with SR-1 and SR-3 blades. Both results show that they are similar to each other, and the propeller efficiencies increase compared with single rotating ATP with same blades.

A88-13079 High-lift-device design and low-speed wind-tunnel test MASANOBU OGAKI, TAKESHI WATANABE, and KANICHI AMANO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 34, no. 394, 1986, pp. 592-599.

The design of high-lift devices for transport aircraft is described, and wind-tunnel-test results are presented. A parametric study of the positioning of the high-lift devices is carried out using a method of two-dimensional boundary layer calculation, and the parameters for flap and slat positions are determined. Reynolds number effects in the wind tunnel are examined.

A88-13078 An aerodynamic design study of transonic transport wings KOHEI TANAKA, MASAOKI NAKADATE, and KANICHI AMANO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 34, no. 394, 1986, pp. 587-591. 7 Refs.

An aerodynamic wing design study for a transonic transport aircraft carrying 150 passengers for relatively short distances is carried out. Two-dimensional transonic airfoil design is described, and wind-tunnel-test results are reported. It is shown that the preferred wing is of the front-and-rear loading type, and that M(DD) control can be achieved by the adjustment of the wing cross-section area distribution.

A88-13077 Wing design with a three-dimensional transonic inverse method TADAYUKI TANIOKA, JUNICHI MIYAKAWA, JUN OGINO, and KANICHI AMANO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 34, no. 394, 1986, pp. 582-586.

Wing design performed using the ISOBAR technique with a three-dimensional transonic inverse method is described, and wind-tunnel test results are presented. The proposed approach was used to design the wings for the next-generation civilian aircraft with a length of 37.5 m, a width of 35.5 m, a wing area of 120 sq m, a maximum takeoff weight of 64.4 tons, and an occupancy of 150 passengers. The air pressure distribution was determined.

A88-10094 The flow visualization on the rotary wing with low aspect ratio TADAHARU WATANUKI, MASAYOSHI MATSUZAKA, HIRO-TOSHI KUBOTA, KOJIRO SUZUKI, KOICHI SAGAWA, et al. *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 402, 1987, pp. 346-352. 5 Refs.

Flow patterns on a rotary wing with a low aspect ratio of 3.3 are experimentally investigated in the Goettingen type low speed wind tunnel. Single rotation propeller blade with a radius of 0.3 m is used as the model wing for the flow visualization. The flow phenomena on the blade are visualized by means of oil flow, tuft, mini-tuft, and china clay methods and recorded by simultaneous photography. The experimental results clearly show that the mini-tuft method is more suitable for visualizing the flow on the rotary wing.

A88-10093 A numerical method for subsonic unsteady lifting surfaces - BIS. III - Some additional numerical results MASAMI ICHIKAWA and SHIGENORI ANDO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 402, 1987, pp. 339-345. 19 Refs.

This paper presents some additional numerical results to previous papers concerning a new computation method for unsteady subsonic lifting surfaces, BIS (box-in-strip). It consists of two parts. One is a comparison between BIS and PCKFM (piecewise continuous kernel-function method); the other is a comparison between BIS and analytical solutions for circular and/or elliptic planform wings in steady incompressible flow. As a result, it is found that PCKFM yields fairly close results to BIS in the case of the rectangular wing with AR = 10 and that correlation between BIS and analytical solutions is much better than in the case of VLM.

A87-52359 Study of the flow visualization on the rotary wing with low aspect ratio SHIGERU SAITO, TADAHARU WATANUKI, YOSHIAKI TAMURA, KOJIRO SUZUKI, KOICHI SAGAWA, et al. *Flow visualization IV—Proceedings of the Fourth International Symposium*, Paris, France, Aug. 26-29, 1986 (A87-52301 23-34), Hemisphere Publishing Co., Washington, DC, 1987, pp. 443-448. 12 Refs.

Flow pattern on a rotary wing with low aspect ratio is investigated in the wind tunnel experimentally. The Goettingen-type low speed wind tunnel with 1.5-m diameter is used to simulate the takeoff and landing operating regimes. Four means (oil flow, china-clay, tuft, minituft) of flow pattern visualization on the rotary wing are applied and compared to each other. Photographs are taken to record the phenomena. To analyze the flow pattern on the blade, boundary layer calculations are carried out by the integral method. External flow around a blade is calculated by means of the vortex lattice method. To judge the separation line on the rotary blade, the limiting streamline is used. Comparison between calculations and experiments shows good coincidence.

A87-52322 Visualization of shock wave and streamline around hypersonic vehicle by using electrical discharge MASATOMI NISHIO, and TAKEYOSHI KIMURA, *Flow visualization IV—Proceedings of the Fourth International Symposium*, Paris, France, Aug. 26-29, 1986 (A87-52301 23-34), Hemisphere Publishing Co., Washington, DC, 1987, pp. 185-190.

The electrical discharge method is used to visualize both cross sectional shock shapes around semicone bodies with a delta wing, and streamlines over a wedge and a circular cylinder, shapes that are typical of hypervelocity vehicles. In the present method, the intersection of the shock wave and the electrical discharge is visualized by the difference of the radiation intensities from the two parts of the discharge, one in the freestream and the other in the shock layer. Results show that, when the semiapex angle of the delta wing is small enough, a single shock pattern appears; when its angle becomes sufficiently large, a double shock pattern including the body shock and wing shock occurs. Good agreement is found between visualized and theoretical streamlines around a wedge.

A87-50011 Two-dimensional focusing of a supersonic free jet by a rectangular orifice KOJI TESHIMA, *Physics of Fluids* (ISSN 0031-9171), Vol. 30, July 1987, pp. 1899-1901. 6 Refs.

Supersonic free jets issuing from rectangular orifices have been observed by using a laser-induced fluorescence technique. Anisotropy of expansion in two directions, the orifice length (z) and width (y), apparently occurs in the jet structure at a large pressure ratio (between reservoir and vacuum chambers); the jet spreads in the y direction whereas it converges in the z direction. This effect is enhanced by interaction of lateral shocks from both ends of the orifice when a small aspect ratio orifice is used. Under a flow condition whereby the shocks reflect normally on the axis, the jet becomes very thin in the z direction.

A87-49324 An experimental investigation of aerodynamic drag of peripheral jet GEM with a forward-facing intake FUMIHARU OTAGIRI, SHIGENORI ANDO, and HIRONARI NOHARA, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 400, 1987, pp. 270-275. 6 Refs.

The 'interference thrust' suggested by Ando et al. (1961) has been confirmed by a series of experimental investigations in the laboratory. However, the models used in those experiments are considerably simplified ones in comparison with existing GEMs in practical operation. The purpose of the present work is to complete a series of experimental investigations by using more practical model configuration. In order to achieve both satisfactory separation of the parasite drag from the momentum drag and a good intake efficiency, a forward-facing intake is adopted. The results of this experiment present a better proof of 'interference thrust'.

A87-49321 Subsonic flow region on blunted cones in supersonic flow TAKASHI TANI, NORIO ARAI, KOETSU TAKEHANA, HIDEO SEKINE, and NAOKI HIROSE, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 400, 1987, pp. 253-259. 6 Refs.

The article investigates both experimentally and numerically the complicated flow around the blunted cone of semiapex angle 20-45 degrees at Mach number 1.4-3.0. Especially emphasized is the structure of the subsonic flow region on the cone surface that is caused by the transition from the overexpanded flow at the nose to the recompression on the cone. Both results are in good agreement with each other. Consequently, it is shown that the numerical analysis of inviscid flow is very practical for such a complicated flow.

A87-45278 Performance calculation of counter rotation propeller S. SAITO, H. KOBAYASHI, K. NASU, and Y. NAKAMURA, AIAA Paper 87-1889 presented at the AIAA, SAE, ASME, and ASEE 23rd Joint Propulsion Conference, San Diego, CA, June 29-July 2, 1987. 9 pp. 12 Refs.

A newly developed aerodynamic code, named Local Circulation Method (LCM), was applied to high-speed counterrotation propellers (CRPs) to investigate the potentials of these highly skewed/swept blade systems operating in high subsonic or transonic range. The calculations of CRP performance in a wide range of geometrical and operational rotor variables provided the design data base for CRPs, including efficiency

maps parametered by blade pitch angles of front and rear rotor. It was shown that, compared with SRP, the CRP has a potential of higher efficiency with several percentage points.

A87-45094 Study on the interference between the local separation on a wing surface and outer flow-field KENJI YOSHIDA, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 399, 1987, pp. 197-203. 10 Refs.

This paper presents a theoretical consideration on the interference between the local separated region and its outer flow. To simplify the analysis, a straight wing with an infinite span is assumed to have locally nonuniform distribution of transition points. Using the boundary-layer theory and lifting-line theory, the influence of such local disturbances on the boundary layer and its outer flow is investigated in detail. From this, three-dimensional characteristics of the local separation are deduced. Once the local separation occurs, the thickness of separated region is increased by the effect of trailing vortices, and the thickness of the boundary layer near its region is decreased. The effect of three-dimensional boundary layer is opposite to that of trailing vortices. Moreover, the separated region is localized by the influence of induced cross flow as well as trailing vortices.

A87-42621 Application of discrete vortex method to analysis of separated flow around aerofoils MASASHI SHIGEMI, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 29, Feb. 1987, pp. 207-219. 14 Refs.

The discrete vortex method was applied to the calculation of a separated flow around aerofoils. A new approach was formulated, in which the strength of the vortex, which is shed off at the separation point, was included into the unknown variables. In order to save the computational cost, simplifications were introduced in the formulation: e.g., clusters of drifting vortices were treated as concentrated single vortices. Because the total pressure in the separated region is less than that in the other regions, the pressure distribution around the aerofoil, which is obtained from the velocity distribution through Bernoulli's formula, has to be evaluated individually for the nonseparated and separated regions. To define the relativity between the two pressure distributions, a method to estimate the amount of the total pressure loss in the separated region was introduced. The Blasius formula, which is generally used to derive the forces acting on an obstacle, was modified to include the influence of the total pressure loss upon the lift and the drag forces.

A87-32568 Transonic turbulent flow around two-dimensional airfoils YASUNORI OHMORI, *Proceedings of the 15th International Symposium on Space Technology and Science*, (Vol. 2), Tokyo, Japan, May 19-23, 1986, (A87-32276 13-12), Agne Publishing, Inc., Tokyo, 1986, pp. 2185-2193. 9 Refs.

The LU-ADI scheme is used to solve the flow around two-dimensional airfoils using the thin-layer Navier-Stokes approximation. The results are obtained in short CPU time and show good agreement with experimental data and with the Beam-Warming computational results. The local time step and the fourth- plus second-order numerical dissipation are found to play an important role in the computation time and the convergence. (C.D.)

A87-32357 Axisymmetric turbulent boundary layer on the cylindrical portion of an afterbody test model V. KRISHNAN, *Proceedings of the 15th International Symposium on Space Technology and Science*, (Vol. 1), Tokyo, Japan, May 19-23, 1986, (A87-32276 13-12), Agne Publishing, Inc., Tokyo, 1986, pp. 621-626. 6 Refs.

This paper describes the results of experiments conducted to study the characteristics of an incompressible axisymmetric turbulent boundary layer on the cylindrical portion of an afterbody test model having a circular arc forebody and an afterbody in the presence of a high pressure cold air jet issuing from its base. Tests were conducted on an 80-mm maximum diameter model at the freestream velocities (jet off) of 12.8 and 21.5 m/sec and at jet pressure ratios of 1.0 (jet-off), 1.26 and 1.54. Measurements include boundary layer profiles at four stations on the central cylindrical portion, and pressure distribution on the afterbody. The boundary layer grows in the axial direction, and the boundary layer parameters depend upon the test conditions and the measurement station. The variation of the shape factor is small. There is a slight decrease of the skin friction in the flow direction. The velocity profiles show substantial amount of the logarithmic region when plotted in the two-dimensional wall law and the defect law co-ordinates. The slope 'A' is approximately equal to 5.5, but the intercepts B and D depend upon the test conditions and the measurement station. The wake factor decreases in the presence of the jet.

A87-32355 Experimental investigation of pressure distribution on a slanted top N. ARAI, T. TANI, H. SEKINE, and J. NODA, *Proceedings of the 15th International Symposium on Space Technology and Science*, (Vol. 1), Tokyo, Japan, May 19-23, 1986, (A87-32276 13-12), Agne Publishing, Inc., Tokyo, 1986, pp. 605-611. 5 Refs.

An experimental investigation of the surface pressure distribution on the cylindrical body with a slanted top in a supersonic flow is presented with emphasis on the separation region, which is observed on the cylindrical surface (body side). According to the results of both the surface pressure distribution and the Schlieren photograph, it is clearly shown that the separation region is complicatedly influenced by the Mach number, the angle of attack, and so on. In particular, the peripheral surface pressure distribution is very complicated and does not change monotonously

because of the influence of the separation of flow at the shoulder of the slanted top. Also the existence of a secondary shock was confirmed on the windward side of a cylindrical body. The flow on the slanted surface changes from a subsonic flow to a supersonic one when the angle of attack is changed from positive to negative.

A87-32352 Wind-tunnel free-flight test of cone dynamics at hypersonic speeds KOICHI HOZUMI and TADAO KOYAMA, *Proceedings of the 15th International Symposium on Space Technology and Science*, (Vol. 1), Tokyo, Japan, May 19-23, 1986, (A87-32276 13-12), Agne Publishing, Inc., Tokyo, 1986, pp. 583-592. 16 Refs.

Free-flight tests at a Mach number of 7.1 were conducted on ten-degree half-angle sharp and blunted cones at a longitudinal oscillation amplitude within + or - 15 degrees. Instead of the vertical drop technique, a simplified gun-launch technique was developed to achieve many more oscillation cycles of the model during a short test time. This makes it possible to obtain sufficient data to determine more accurate dynamic stability derivatives. In the process of iterative parameter estimation with the Chapman-Kirk algorithm, more efficient and accurate integration of equations of motion are possible using the Runge-Kutta-Fehlberg 7(8) formulas with step-size control. Comparison of the present data with the inviscid Embedded Newtonian theory showed that there was a relatively large viscous interaction effect on the longitudinal stability derivatives. This is caused by the effects of the leeward boundary layer on the damping stability derivatives of the oscillatory body at hypersonic speeds.

A87-32105 Calculation of transonic potential flow through a two-dimensional cascade using AF1 scheme KENJI INOUE, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 29, Nov. 1986, pp. 171-183. 12 Refs.

A method is presented for calculating the flow field about a cascade of arbitrary two-dimensional blades. A conformal transformation is used to generate a finite-difference grid. An implicit approximate factorization (AF) scheme is used for the solution of matrix equations resulting from a finite-difference approximation to the full potential equation in conservation form. For transonic flows, an artificial viscosity, required to maintain stability in supersonic regions, is introduced by an upwind bias of the density. This allows the simple matrix form of the scheme to be retained over the entire flow field. Supercritical test cases are considered. Blade Mach number or pressure distributions have been computed and found to be in good agreement with independent results.

A87-30233 A new numerical method of subsonic lifting surfaces - BIS SHIGENORI ANDO and MASAMI ICHIKAWA, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 29, Aug. 1986, pp. 101-118. 29 Refs.

A new numerical method is formulated which belongs to discrete methods, in contrast to mode methods, of unsteady subsonic lifting surfaces. This is a final form of the DSM (Doublet Strip Method). After integrating spanwise the kernel function across a narrow chordwise strip, there appear just singular terms similar to those in the 'DLM-C' (2-D code). Thus Mangler's principal value type of integral can be avoided. The subsequent chordwise quadrature may be carried out efficiently as in the DLM-C. This new method is designated as 'BIS' (Box-in-Strip) method, the original of which is refined to give a much more efficient version BIS-QS. Numerical results of BIS-QS are compared with those of DLM (Doublet Lattice Method) and DPM (Doublet Point Method). The convergence and accuracy of BIS-QS are remarkably superior to DLM and DPM, without increasing computation cost.

A87-24963 A numerical study of viscous transonic flows using RRK scheme (Rational Runge-Kutta) KOJI MORINISHI and NOBUYUKI SATOFUKA, AIAA Paper 87-0426 presented at the AIAA 25th Aerospace Sciences Meeting, Reno, NV, Jan. 12-15, 1987. 10 pp. 13 Refs.

An efficient numerical solution has been developed for viscous transonic flows. The thin-layer Navier-Stokes equations are solved by using the rational Runge-Kutta time-stepping procedure combined with the usual central finite difference approximations. The residual averaging and multigrid techniques are incorporated into the method, so that the rate of convergence to a steady state solution is improved. The algebraic two-layer eddy viscosity model proposed by Baldwin and Lomax (1978) is used to simulate turbulent flows. Numerical results for all mandatory cases of the NACA 0012, RAE 2822, and Jones airfoil are included. The results for the RAE 2822 airfoil cases are compared with experiments of Cook et al. (1979). The present numerical method is confirmed to be stable and efficient over a wide range of viscous transonic flow conditions.

A87-23729 Dynamic characteristics of peripheral jet ACV. IV Characteristics of fan and duct TOSHIKAZU MORI and HIROSHI MAEDA, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 34, no. 392, 1986, pp. 499-508. 13 Refs.

During the dynamic motion of an air-cushion vehicle (ACV), the flow rate of the jet varies and the total pressure at the outlet of the fan changes with the flow rate. Moreover, the flow in the duct is unsteady, so the difference of pressure on both sides of the duct is different from that of the steady flow condition. Dynamic motions of ACV are induced by oscillations of the ground board and they are analyzed numerically. Taking account of the characteristics of the fan and the duct, the dynamic motions are investigated, and the results are compared with those obtained under the condition of the constant total pressure of the jet.