

**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 Khimii*, 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 ILANKOV 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 gazovozдушnom trakte).** M. M. SHAKIR'IANOV, *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 DMITRIEV, 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 rabocheго 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 ustoiichivosti stupenoi 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.

**A89-10661 Numerical approach of advanced turboprop with three-dimensional Euler equations.** SHIGERU SAITO, HIROSHI KOBAYASHI, YASUHIRO WADA, and YUICHI MATSUO, *IN Proceedings of the International Pacific Air and Space Technology Conference*, Melbourne, Australia, Nov 13-17, 1987, (A89-10627 01-01); Society of Automotive Engineers, Inc., Warrendale, PA, 1988, pp 415-424 31 Refs (SAE Paper 872448)

Numerical analysis by solving the three-dimensional Euler equations has been performed in order to investigate the complicated flow patterns or aerodynamic characteristics of the advanced turboprop (ATP) propeller with two types of spinner configuration. The governing equations are written for a rotating Cartesian coordinate system in terms of absolute flow variables. The solution algorithm used is an implicit approximate factorization method and resultant matrices are efficiently solved by a LUADI scheme. This solver has been applied to study the effect of interference between highly swept blades and axisymmetrical spinner on the aerodynamic performance of the ATP propeller. Numerical results show that the selection of an area-ruled spinner is important for the aerodynamic design of an efficient turboprop.

**A88-31191 A concept of CO<sub>2</sub>-breathing propulsion engine for planet use.** SABURO YUASA and HIROSHI ISODA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol 36 No 409, 1988, pp 16-22 11 Refs

The purpose of this paper is to assess the feasibility of a CO<sub>2</sub>-breathing engine using metal fuels for planetary use. The heats of reactions between metals and CO<sub>2</sub> were reviewed. Equilibrium compositions and temperatures of the metal-CO<sub>2</sub> flames were calculated. It was confirmed experimentally that Al and Mg could burn in CO<sub>2</sub>. Thermodynamic cycle calculations were carried out to evaluate the performance of a CO<sub>2</sub>-breathing turbojet engine. With these results, it is concluded that metal-fueled CO<sub>2</sub>-breathing turbojet engine with a practicable performance can be developed.

**A88-44459 Enhancement of matrix/filler adhesion in HMX/AP/HTPB composite propellant.** KEIICHI HORI, AKIRA IWAMA, and TAKAOKI FUKUDA, *IN Technology of energetic materials: Manufacturing and processing - Valuation of product properties, Proceedings of the Eighteenth International Annual Conference of ICT Karlsruhe*, Federal Republic of Germany, July 1-3, 1987 (A88-44451 18-28). Pfinz, Federal Republic of Germany, Fraunhofer-Institut fuer Treib- und Explosivstoffe, 1987 pp 38-1 to 38-13 14 Refs

Dihydroxyethylidimethylhydantoin (DHE) is examined as a possible HMX/HTPB propellant system. Adding DHE is found to improve the adhesion for HMX/HTPB, the optimum content of DHE is determined. Fourier transform infrared spectroscopy shows that interfacial bonding force between AP and the bonding agent arises from the hydrogen bonding force in the case of aziridine derivatives and from ionic force in the case of alkyleneopolyamino derivatives. The solidification of aziridine derivatives is found to be due to homopolymerization by imine ring opening.

**A88-28954 Design and performance tests of a low power dc arcjet thruster.** MICHIO NISHIDA, KEIJI KAITA, and KAZUO TANAKA, *Kyoto University, Faculty of Engineering Memoirs* (ISSN 0023-6063), Vol 49 Oct 1987 pp 358-369

This paper describes a quasi-one-dimensional flow model which can be used for the design of an arcjet thruster. Owing to the simplicity of the model, the performance characteristics of the thruster can be calculated easily for finding an optimum configuration suitable for various missions. In order to verify adequacy of the model, a thruster was fabricated and its performance characteristics were measured. The experimental results were compared with the calculation predicted with the model. Both are in satisfactory agreement, and it is concluded that this flow model is a useful tool for the design of the arcjet thruster.

**A88-23272 Research in computational fluid dynamics at National Aerospace Laboratory, Japan.** H. NAGASU, *IN Computer applications in aircraft design and operation, Proceedings of the First International Conference on Computer Aided Design, Manufacture and Operation in the Aeronautics and Space Industries*, Paris, France, June 16-18, 1987 (A88-23259 08-01). Billerica, MA, Computational Mechanics Publications, 1987, pp 195-208 7 Refs

The development of computational fluid dynamics (CFD) software and its applications at the Japanese National Aerospace Laboratory (NAL) are discussed. Two-dimensional and three-dimensional CFD codes for designing aircraft, cascades and nozzles, and transonic wings are addressed. The use of a new numerical simulator system at NAL is briefly discussed.

**A88-15994 Performance of advanced engine cycles in future launcher.** H. TANIGUCHI and D. MANSKI, 38th IAF International Astronautical Congress, Brighton, England, Oct 10-17, 1987 10 pp (IAF Paper 87-288)

Earth-to-LEO SSTO booster engine cycle performance has been investigated for the cases of staggered combustion, gas-generator dual-throat, and gas generator/staged combustion cluster propulsion system configurations. The propellant combinations considered are hydrogen/oxygen, propane/oxygen, and methane/oxygen. The results obtained indicate that the dual-throat engine employing propane/hydrogen/oxygen as propellants possesses the highest payload capability among the present engine cycles.

**A88-44836 Swept frequency type of ultrasonic inspection method for liner-propellant separations of the H-I upper stage motors.** MORIO SHIMIZU, KATSUYA ITOH, TSUTOMU FUJIWARA, YUKIO FUKUSHIMA, MICHIO TAKAHASHI et al., 24th AIAA, ASME, SAE, and ASCE Joint Propulsion Conference, Boston, MA, July 11-13, 1988 10 pp 9 Refs (AIAA Paper 88-3356)

This paper describes the swept frequency type of ultrasonic inspection method which is usable for inspecting not only case-liner separations but liner-propellant separations of solid motors, and successful application of the method to the H-I upper stage motors. Unfortunately, the liner-propellant separations have never been inspected practically with usual ultrasonic inspection methods over the past quarter of a century. The new method for inspection of the liner-propellant separations has been developed in NAL and NASDA from 1968, and the inspection technique is based on the quarter wavelength resonance principle for the liner thickness under one free edge and the other fixed edge boundary condition. Since the motor cases have curved (spherical or cylindrical) surface, some curved contact surface type of probes were developed and successfully applied.

**A89-17745 Conceptual study of turbo-engines for horizontal take-off and landing space plane.** HIROYUKI NOUSE, MITSUHIRO MINODA, RYOJI YANAGI, TEIICHI TAMAKI, and TETSUJI FUJIMURA, 39th IAF International Astronautical Congress, Bangalore, India, Oct 8-13 1988 7 pp (IAF Paper 88-253)

A Hotol SSTO vehicle that employs an airbreathing powerplant for acceleration from takeoff to Mach 6, whereupon scramjet, and then rocket powerplants supply thrust for acceleration to orbital velocity, is presently evaluated in light of the capabilities of air turbo ramjet or turbo ramjet airbreathing propulsion systems. Higher specific thrust scramjets and lower weight airbreathing engines generally are identified as prerequisites for successful SSTO vehicles of this type.

**A89-24325 Measuring technique of heat transfer on turbine airfoils using boundary element method.** KEN-ICHI FUNAZAKI, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol 28 Sept 1988, pp 327-332 7 Refs

A new technique using the BEM is proposed for measuring heat transfer distribution on air-cooled turbine airfoils exposed to high-temperature gas flow. In this technique, these turbine airfoils are considered as a kind of heat-flux meters. The numerical accuracy of the BEM was checked using three types of boundary-elements (constant, linear, and quadratic). Comparing with exact solutions of simple test cases, it is found the BEM using the quadratic element gives most accurate results with no difficulty in the program coding. Application of this method to heat transfer measurement on a turbine airfoil shows some scatterings near the trailing edge which get worse in the case of a constant-element BEM.

**A89-19950 Fan acoustic modes measuring system.** KOSUKE ISOMURA, YOSHIYA NAKAMURA, and ICHIRO ISHIKAWA, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol 28, July 1988, pp 244-250 5 Refs

The fan acoustic modes detecting system has been developed to separate fan rotor-stator and rotor-struts interaction noise to evaluate the low-noise fan design method. To measure the data, two devices were developed. One is the Induct Acoustic Modes Measuring Device to detect acoustic modes in the intake duct. The other is the Radiated Acoustic Modes Measuring Device which detects acoustic modes radiated from the duct lip to free field. To analyze the data, the Noise Data Automatic Analyzer has been developed. This can analyze multiple points of noise data automatically by utilizing the multiplexer system while the measuring device is rotating slowly with some microphones on it. The system with all these devices enables detection of dominant acoustic modes within 5 dB of accuracy.

**A89-20639 The exhaust flow field of the H-II rocket engine LE-7.** RICHIE MATSUZAKI, NORIAKI HIRABAYASHI, and TATSUO TANAKA, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663), Vol 36, No 416 1988, pp 440-442

Performance of the LE-7 engine, the first stage engine of the Japanese H-II launch vehicle, is estimated around its design point in a quasi-one-dimensional framework. The result shows that the gas dynamic properties are nearly in equilibrium at a high combustion pressure such as that in this engine. The exhaust flow pattern, the properties in the exhaust gas, and the flow rate of the cooling water to cool down the exhaust gas are estimated.

**A87-40847 Development of the F3-IHI-30 turbofan engine.** *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol 27, Jan 1987 pp 36-41

The F3-IHI-30 turbofan engine developed for the XT-4 intermediate trainer is described. The engine is a two-spool, low-bypass-ratio turbofan engine with a thrust of 16.38 kN. The engine was designed and tested in accordance with the modified MIL-E-5007D so that requirements of the intermediate trainer and environmental conditions in Japan are reflected. Through both the preliminary flight rating and qualification tests, it has been demonstrated that the engine can withstand bird and ice ingestion, low-cycle-fatigue, endurance, inlet distortion tests, etc. The flight test of the XT-4 powered by two XF3-30 engines is being successfully conducted. The engine is qualified for series production.

**A88-11979 Study on linear elements for Stirling engine regenerators.** NAOTSUGU ISSHIKI, HIROICHI WATANABE, SHIGEO TSUKAHARA KENJI HASHIMOTO and KATSUJI YOSHIKAWA, IN *IECEC '87, Proceedings of the Twenty-second Intersociety Energy Conversion Engineering Conference*, Philadelphia, PA, Aug. 10-14, 1987 Vol. 4 (A88-11776 02-20) New York, American Institute of Aeronautics and Astronautics 1987 pp. 1847-1852

With a view to the improvement of Stirling engine performance, research has been undertaken into novel regenerator element designs featuring fewer 'dead' spaces and lower flow resistance without counterbalancing compromise of heat transfer rates. Attention is given to linear elements such as tubes, wires, and twisted wires that are packed parallel to the direction of flow; these possess fewer dead spaces than wire meshes, while having lower flow resistance. Pressed wires, iron strips, steel spheres, and wound fine wire pellets are also considered.

**A89-19948 Development of small LOX/LH2 rocket engine.** TAKASHI MORI, KOICHI SUZUKI, KAZUYUKI HIGASHINO, KOICHI MIYOSHI, and NOBUMI OHNARU, *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 28, July 1988, pp. 225-230. 7 Refs.

Test on a small liquid oxygen (LOX) and liquid hydrogen (LH2) expander cycle rocket engine was successfully conducted at the IHI Aoi Testing Center in March, 1987. The rocket engine is considered to be applicable to a one-ton class upper stage and an orbit transfer vehicle (OTV). This study had been continued by IHI with its own fund since 1983. The test results showed the validity of the design and fabrication of the small engine. Data of start-up characteristics, stable condition and performance were also obtained from the tests conducted under a certain vacuum condition. The current design of the engine can also meet necessary increase of thrust and power as well as higher performance corresponding to requirements of upper stage engines, OTV engines and so on. The study will continue on further improvement of the engine for several more years.

**A89-24498 Navigation and guidance of Japanese deepspace probes encountering Halley's comet.** T. NISHIMURA, H. MATSUO, T. TAKANO and J. KAWAGUCHI, IN *Automatic control, Proceedings of the Tenth Triennial World Congress of IFAC*, Munich, Federal Republic of Germany, July 27-31, 1987 Vol. 6 (A89-24476 08-63) Oxford, England and Elmsford, NY, Pergamon Press 1988, pp. 199-204.

The techniques used by ISAS in the guidance of the Sakigake and Suisei probes, which encountered Comet Halley in March 1986, are reviewed. Consideration is given to the guidance of the last rocket stage in the direct ascent phase, midcourse maneuvers, tracking systems and communication links, the tracking strategy, trajectory-generation and orbit-determination software, and orbit-determination accuracy. Diagrams, drawings, graphs, photographs, and tables of numerical data are provided, and the ISAS positions of both probes during the first 10 days after launch are shown to be within 100 km in distance and 1 m/sec in velocity of NASA coordinate estimates.

**A89-10545 Plasma jet ignition of lean hydrogen-air mixtures.** SHINSUKE ONO, EIICHI MURASE, KUNIHICO HANADA, and SHOJI NAKAHARA, *Kyushu University, Faculty of Engineering Memoirs* (ISSN 0023-6160), Vol. 48, March 1988, pp. 1-15. 17 Refs.

In order to confirm the performance and characteristics of plasma jet ignition quantitatively, combustion tests of lean hydrogen-air mixtures are carried out with varying governing parameters of plasma jet igniter (plasma cavity size, orifice diameter, and discharge energy). From the series of tests, the combustion enhancement by the plasma jet ignition is revealed only in the initial stage of combustion. Then a comparing parameter of the performance of plasma jet ignition in its initial stage of combustion is proposed by comparing the pressure diagram of plasma jet ignition and that of conventional single-point center ignition. The performance and the characteristics of plasma jet ignition are revealed quantitatively by the comparing parameter.

**A89-22027 10 kW steady-state MPD thruster.** AKIHIRO SASOH, ANDERS E. SOLEM, and YOSHIHIRO ARAKAWA, *Tokyo University, Faculty of Engineering Journal, Series B* (ISSN 0563-7937) Vol. 39, March 1988, pp. 275-296. 19 Refs.

A 10 kW steady-state MPD thruster with a permanent magnet was constructed. This thruster delivered a specific impulse of 7700 sec and a thrust efficiency of 25 percent for a hydrogen propellant. The results suggest that in order to obtain a high thruster performance at larger thrust/power ratios, positive control of current distribution may be effective.

**A89-22627 The influence on total performance for varying the stator setting angle of multi-stage axial compressor.** YOH KAKEHI, *Japan Society for Aeronautical and Space Sciences Journal* (ISSN 0021-4663) Vol. 36 No. 418, 1988, pp. 505-511. 11 Refs.

In the development phase of an aircraft gas turbine, the required performances of the gas turbine components are decided after general consideration of the engine total performance. For accomplishing the required performance, the tedious and expensive works of design for modification, production and tests were laboriously repeated. This paper introduces the practical and useful method describing the relation between component performances of the compressor and the combination of the stator setting angle analyzing by statistical methods based on the experimental data.

**A88-54337 Structural design and its improvements through the development of the XF3-30 engine.** HIDEKATSU KIKUCHI and KIYOSHI ISHII, *ASME Gas Turbine and Aeroengine Congress and Exposition*, Amsterdam, Netherlands, June 6-9, 1988. 7 pp. (ASME Paper 88-GT-261)

The XF3-30 engine has been successfully completed its Qualification Test at March 1986 and the production has started as the powerplant for Japan Self Defence Force's intermediate trainer T-4. The first flight of the T-4 powered by two XF3-30 engine was made on July 29, 1985. More than 500 test flights have been made in these two years and engine flight time has accumulated to over 1500 hours. Strict structural integrity requirements have been imposed on this XF3-30 engine to meet the MIL-E-5007D specification. This paper describes the structural features of this engine and some structural problems encountered through the development. The improvements for these development problems are covered.

**A88-19735 The vibration of a vertical cylindrical shell partially filled with liquid, induced by longitudinal excitation.** S. KOBAYASHI and T. NAGASHIMA, *Journal of Fluids and Structures* (ISSN 0889-9746), Vol. 1, Oct. 1987, pp. 415-429. 7 Refs.

As a fundamental research problem relating to the amplitude of Pogo oscillations of liquid propellant launch vehicles, an experimental study was conducted in which a vertical cylindrical shell partially filled with liquid was longitudinally excited. The vibration of the shell wall was induced at exciting frequencies close to the fundamental natural frequency of longitudinal vibration of the system. It was a phenomenon of parametric excitation, i.e., the longitudinal motion of the liquid excited the transverse wall vibration. A nonlinear theoretical analysis has been carried out in order to model this phenomenon, including the study of existence and stability of this wall vibration. Good agreement was observed between the analytical and the experimental results.

**A88-10988 Development of the XF3-30 turbofan engine.** HIDEJIRO YAMADA, HIROSHI HAMATANI, and KAZUHIKO ISHIZAWA, 32nd ASME International Gas Turbine Conference and Exhibition, Anaheim, CA, May 31-June 4, 1987. 7 pp. (ASME Paper 87-GT-26)

The XF3-30 is the low-bypass-ratio turbofan engine which has been developed to power the XT-4 intermediate trainer for the Japan Air Self Defence Force. All of the qualification tests including endurance tests, low cycle fatigue test, altitude test, foreign object ingestion test, and environmental icing test were successfully completed by March 1986. A flight test of the XT-4 trainer aircraft powered by two of the XF3-30 engines has proceeded without any engine-related problems.

**A87-44776 Recent advances in spark-ignition engine combustion research.** KAZUO IINUMA, *JSME International Journal* (ISSN 0913-185X), Vol. 30, April 1987, pp. 553-559. 34 Refs.

This paper presents an overview of the current trend of combustion research in spark-ignition engines. The subject of greatest and continuing interest is the elucidation of the mechanism of turbulent flame propagation and/or the flame structure. Although there remain some problems as yet, the goal may not necessarily be so far away, considering the remarkable progress in diagnostic techniques during the last decade. Advances in numerical aerodynamics have made it possible to simulate the flow phenomena in an engine. The field of numerical aerothermochemistry, however, is still immature. Also, the investigation into knock has recently become a subject of growing interest. This review covers the above subjects, in some depth.

**A89-19949 CAD/CAM/CAE application for design of LE-7 LOX/LH2 turbopump - CADLEX system.** AKIRA OKAYASU, TOYCHIKO OHTA, SHOGO WARASHINA, TOSHIHIDE OHKI, YUKIE TAKOH et al., *Ishikawajima-Harima Engineering Review* (ISSN 0578-7904), Vol. 28, July 1988, pp. 231-235.

This paper introduces the CAD/CAM/CAE system applied to designing the LE-7 LOX/LH2 turbopump. LE-7 is the first stage engine that has been developing for the H-II rocket. CADLEX meeting with the production engineering section and the aerospace engineering system group was held to design the system suited for LE-7 development. Subsequently, application of the CAD/CAM/CAE system started and several interface and mesh-generation programs have been developed. The CADEGA system, developed for the V2500 fan jet engine, was employed to produce CAD drawing. The 3D design models were made with CATIA and passed to CAM actively to assure accuracy and to decrease production cost. As a result, with CAD/CAM/CAE application, the design period was shortened and cost were down 50 percent compared with the old system.

**A88-11974 Development of five cylinder double acting Stirling engine.** H. KOJIMA, K. HASHIMOTO, and N. ISSHIKI, IN *IECEC '87, Proceedings of the Twenty-second Intersociety Energy Conversion Engineering Conference*, Philadelphia, PA, Aug. 10-14, 1987 Vol. 4 (A88-11776 02-20) New York, American Institute of Aeronautics and Astronautics, 1987, pp. 1823-1827.

Results are presented from extended studies of the performance of a novel, five-cylinder double-action Stirling engine configuration employing He as the working gas and intended for heat pump applications. The output power and efficiency of the engine are noted to be most directly influenced by the compound-type regenerators, which are composed of linear tubes and wire meshes. Thermal efficiency is found to be insufficient, due not only to various mechanical losses but to incomplete preheating and poor performance matching between the burner and heaters.