advanced degrees, and I am given opportunities to present my research ideas at international conferences. If I were working for a U. S. company, however, I would not have a similar position because I do not have an advanced degree. The difference rests with how each country defines the word 'research'. In the U.S., research represents the quest for a very fundamental understanding of nature - discovering a certain phenomenon and then determining the 'why and how' of that phenomenon. In Japan, research (Kenkyu) includes, and is oriented toward, the search for applications. It thus bridges science and engineering. In a U.S.-type research/science environment, one needs highly specialized knowledge, which is usually gained through an advanced degree. In Japan, advanced degrees are not as necessary because a majority of kenkyu follows an applications route, which calls for general, collective knowledge".

Hiring Approach

"In the U.S. and Japan, engineering students in their final year of school seek out the perfect company. The qualifications for perfectness, however, vary between our two cultures. For a U.S. engineering graduate, one of the most important factors in choosing an employer is the type of work he/she will be performing. The position and responsibilities are well understood by both the company and applicant before a work agreement is finalized. In Japan, graduates choose an employer primarily based on its name and prestige--factors also important to U.S. graduates--but Japanese graduates have only a vague idea of what type of job they will do once they join the company. In Japan, the prospects for employment stability (i.e., lifetime employment) take precedence over any other factor in selecting a company and job assignment decisions are left almost entirely to company administration officials. By contrast, Americans believe that only we as individuals, and not our employers, are able to determine the best job for us".

Business Management and Personal Life Style

"Japanese people in general are devoted to their companies. Whether or not this is by their own will, I cannot answer. From what I hear and read in the news most people are in one way or another induced to spend excess time at their offices. Naturally, people who wish to advance in a company must spend more time, and quality time that is, at their job and at other work-related activities (such as golf). That is a universally accepted rule for career success. But for those who have goals for life that fall outside of the career realm, devotion to a company is not optional here in Japan as it is in the U.S.

The Japanese practices of management may surprise new comers from abroad: wearing a company uniform, singing a company song, and participating in an annual undokai (athletic meeting) of one's company to name a few. In return, this disciplinal (or so-called "family-like") management approach contributes, I believe, to the efficient productivity of Japanese manufacturing concerns, but I feel that it hampers individual creativity needed in a research environment. A good manager must use tools other than discipline to obtain maximum results from researchers and engineers. What is required in a sense can be described as creative management: encouraging people to perform beyond their own expectations. In career development lingo, this is called 'growing people'".

Meeting Calendar

1991

8.29-31 International Symposium on Fluid Control, Measurement and Visualization (San Francisco, U.S.A.)

9.13-14 Korea-Japan FA Joint Seminar (Seoul, Korea)

11.4-7 1st JSME/ASME Joint International Conference on Nuclear Engineering (ICONE-1) (Tokyo, Japan)

11.12-14 The 2nd Joint Japan-US Conference on Adaptive Structures (Nagoya, Japan)

11.23-29 The JSME International Conference on Motion and Power Transmission (MPT '91) (Hiroshima, Japan)

11.25-29 ASIA-Pacific Vibration Conference '91 (Melbourne, Australia)

1992

4.9-12 ASME/JSME Joint Conference on Electrical and Electronic Packaging (San Jose, U.S.A.)

5.17-21 5th International Conference on CREEP (Orlando, U.S.A.)

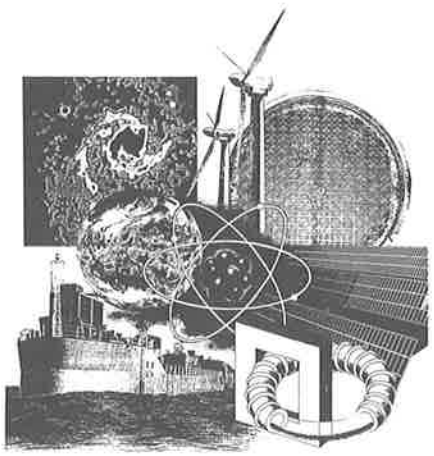
6.9-13 SEM International Conference on Experimental Mechanics (Las Vegas, U.S.A.)

9.1-3 International Workshop on Robot and Human Communication (Tokyo, Japan)

9.7-11 The 1st International Conference on Motion and Vibration Control (1st MOVIC) (Yokohama, Japan)

1993

11.22-25 International Conference on Speedup Technology for Railways and Maglev Vehicle (Yokohama, Japan)



RECIPIENTS of JSME MEDAL for 1990

For the Development of New Techniques

(For details, see page 6)

For the Best Papers

• A Nonisothermal Constitutive Model of Plasticity (Formulation Based on Bounding Surface and Transformation to Multisurface Model)
Nobutada OHNO and Jianding WANG (Nagoya University)

• A Characteristic Study of Particle Beam Skimmed from Plasma Ionized Flow Fields with Neutral Argon Charges Using the Time-of-Flight Mass-Spectrometer Technique
Seizo KATO (Mie University), Manabu KATAGIRI (Nippon Telegram and Telephone Corp.),
Shinji ITOH (Kyohsera Corp.)

• A Study on the Fine Structure of Propagating Turbulent Flames in Premixed Mixtures (An Analysis of the Schlieren Images Based on a Flame Structure Model)
Hiroyuki KIDO, Kenshiro NAKASHIMA and Shuwei HUANG (Kyushu University), Koji KITANO (Toyota Motor Corp.)

• Damping Characteristics of a Passively Stabilized Rotor Suspended by Magnetic Bearing
Kazuo TSUCHIYA (Osaka University), Sadao AKISHITA (Ritsumeikan University),
Masao INOUE (Mitsubishi Electric Corp.), Atsuki NAKAJIMA and Yoshiaki OHKAMI (National Aerospace Lab.)
Chikara MURAKAMI (Tokyo Metropolitan Institute of Technology)

• Unsteady Aerodynamic Analysis of Two-Dimensional Subsonic and Supersonic Cascades Oscillating with Chordwise Displacement or Non-Rigid Deformation
Kazuhiko TOSHIMITSU and Masanobu NAMBA (Kyushu University)

• Measurement of the Thermal Diffusivity of Liquids by the Forced Rayleigh Scattering Method (2nd Report, Analysis of error factors)
Yuji NAGASAKA and Akira NAGASHIMA (Keio University), Takuya HATAKEYAMA (Canon Inc.)

• Turbulent Lubrication Theory Considering the Surface Roughness Effects (1st Report, Modified Turbulent Lubrication Equation)
Hiromu HASHIMOTO (Tokai University), Sanae WADA (Waseda University)

• Effect of Flaw Size on Elevated Temperature Static Fatigue Limit of Silicon Nitride
Takashi MACHIDA and Saburo USAMI (Hitachi, Ltd.),
Ichiro TAKAHASHI (Kanagawa Institute of Technology)

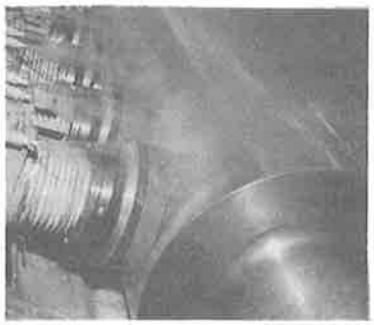
• Moire Analysis of Strain by Fourier Transform
Yoshiharu MORIMOTO and Yasuyuki SEGUCHI (Osaka University),
Toshihiko HIGASHI (Kansai Electric Power Co., Inc.)

• Analysis of Dynamical Characteristics of Middle Ear (Theoretical Study of Three-Dimensional Tympanometry)
Hiroshi WADA and Toshimitsu KOBAYASHI (Tohoku University)

DEVELOPMENT OF ON-LINE ROLL GRINDER FOR WORK ROLL OF HOT STRIP MILL

Tomio AZUMI — Mitsubishi Heavy Industries, Ltd.
Ken-ichi YANAGI — ditto
Hidehiko TSUKAMOTO — ditto
Yoshiki MITO — ditto
Kanji HAYASHI — ditto

The on-line roll grinder (ORG) is installed in a rolling mill and grinds the work roll surface during rolling to maintain its profile. It is a new technology which is highly acclaimed by the iron and steel industry. The ORGs reduce restrictions on rolling imposed by wear of the work rolls and improve the quality of products and productivity. They make schedule-free rolling possible, extend the roll change period and reduce manpower requirements.



We have developed a new ORG based upon our original design which has "non-driven rotary cup grinding wheels".

The grinding wheels rotate along with the rotation of the roll when the grinding wheels are pushed against to an outside circumference surface of the roll with a specified force under the relative position relations.

Thus, this ORG needs no complicated driving device and has a simple and compact construction which enables it to be installed in various types of rolling mills. The Mitsubishi ORG has the following grinding characteristics.

(1) The grinding direction of each point along the line at which the grinding wheel comes into contact with the roll is not in the same direction. Thus, when the grinding wheel axially moves along the roll, it grinds the roll surface in many different directions, thereby achieving higher grinding performance.

(2) The contact lines of the grinding wheels with the roll surface change constantly. Therefore, it is less susceptible to seizing and dulling.

(3) Because of (1) and (2), the grinding wheel maintains stable grinding. Consequently, a grinding wheel of smaller grain size can be used. Such a grinding wheel grinds the roll surface to a desired roughness and has a longer service life.

The ORGs installed in hot strip mill equipment achieved remarkable results. Uneven wear and roughening of the work rolls which had limited the rolling operation were eliminated. As a result, restrictions on the rolling schedule were reduced and the quality of products was improved. It is expected that besides the hot rolling mills, the ORGs will be applied to cold rolling mills and to the rolls of other types of equipment.

Photo 1 shows an ORG grinding for the total length of a roll. All the grinding wheels grind stably while rotating in unison with the roll.

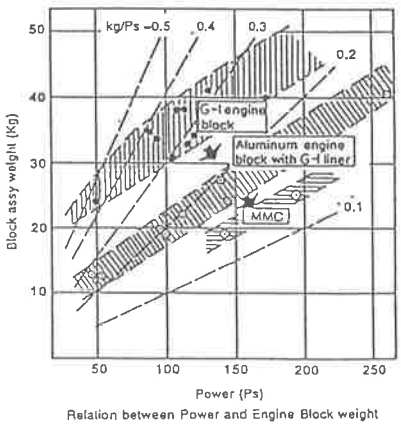
DEVELOPMENT OF LIGHTWEIGHT AND COMPACT ENGINES USING METAL MATRIX COMPOSITE

Yoshio ANDOH — Honda Engineering Co., Ltd.
Tadayoshi HAYASHI — Honda R&D Co., Ltd.
Masuo EBISAWA — Honda Engineering Co., Ltd.
Takashige HARA — ditto
Takashi SAKURA — ditto

In the wake of the international awareness of possible global warming due to the upsurging Greenhouse Effect caused by carbon dioxide gas, strong cries are being heard for improved fuel efficiency to reduce the damaging emissions released from automobiles. Reducing an automobile's overall weight and size as well as the procurement of high performance engines through weight reduction have proven to be effective measures for improving fuel efficiency. So we would like to introduce the production technology for the metal matrix composite (MMC) engine blocks used in the development of lightweight and compact engines.

Fig. 1 shows the power-to-weight ratio of various engines. This provides a visual comparison of three different engine blocks. The three different zones represent a gray-iron (G-1) engine block, an aluminum engine block with gray-iron liners and the MMC engines block.

Assuming that each engine generaters 150 PS, the MMC engine block



Relation between Power and Engine Block weight

Fig.1, Relation between Power and Engine Block weight

achieves a weight reduction of 25% when compared to an aluminum engine block with gray-iron liners, and 50% when compared to a gray-iron engine block.

In order to clearly show the characteristics of the MMC engine block, we compare it with an aluminum engine block with gray-iron liners. Both were in-line 4-cylinder engines with a displacement of 2,000 cc. The thickness between the cylinder bores is reduced by 2mm in the MMC engine block. As a result, the overall length of the MMC engine block is 6 mm shorter than that of the aluminum engine block with gray-iron liners.

In addition to this, weight was reduced 2.5kg by replacing the gray-iron liners with liners procured using MMC material. Thus, the weight of the MMC engine block was reduced by a total of 4.5kg. Even though the bore pitch remains unchanged, an increase in the bore diameter can produce a larger displacement. The excellent cooling characteristics of the MMC material makes it possible to maintain the engine block temperature approximately 10℃ lower.

Then we will go into the outline of production technology used for the MMC engine block. Mass production of the MMC engine block was achieved by incorporating these five technological developments.

1. A production technology to produce a composite material consisting of alumina and carbon fibers.

An MMC material consisting of only alumina fibers passed all the in-house tests without any problems.

However, extended exposure to extremely low temperatures resulted in minute scuffings of 2-to-3 microns in depth on the cylinder bore surface at the very beginning of operation. The addition of carbon fibers produced a hybrid material with sufficient strength.

2. A precision preform production technology using the aspiration-press method. Obtaining a hint from a traditional paper manufacturing technology, the aspiration-press method was developed. As a method, there were three optional perform methods in addition to the aspiration-press method chosen. They were the press method, the extrusion method and the centrifugal method. All three of these methods failed to satisfy the criterion for accuracy in fiber fraction ratio, compounding ration and precision.

3. A casting technology for the composite material using low-speed pressurized casting.

The aluminum alloy used for the common aluminum engine block must be injected into the hybrid preform using uniform penetration. There are several requirements that are vitally important to this process. Our studies revealed that temperature, injection speed and pressure requirements have a large effect on penetration. We choose the New-Die-Casting method that we developed for the production of the MMC engine block.

4. A machining technology for the composite material using reciprocal bore machining.

Minimizing the machining depth of the boring and the honing process, a quality machined surface was successfully achieved without dam-

aging the fibers.

5. A non-destructive inspection technology using the simultaneous application of eddy-current and ultrasonic inspection methods. This inspection tool was designed to be incorporated into the machining line.

The combined technologies made it possible for HONDA to develop an MMC engine block appropriate for responding to the need for a lightweight, compact and high performance engine.

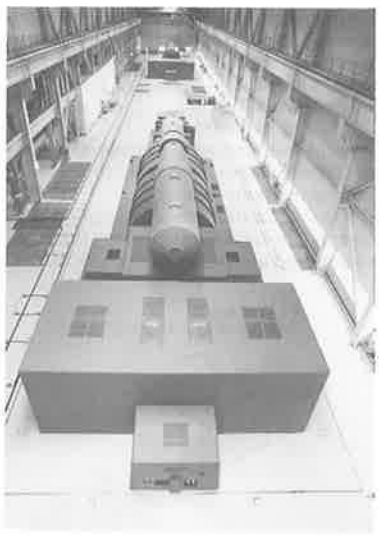
HONDA has produced more than 50,000 MMC engine blocks since mass production began in December 1989.

DEVELOPMENT OF THE FIRST LARGE-SCALE COMMERCIAL STEAM TURBINE OPERATING UNDER ULTRA SUPER CRITICAL PRESSURE CONDITION

Takashi IKEDA Toshiba Corp.
Tomikazu FUSHIMI Chubu Electric Power Co., Ltd.
Shoichi HISA ditto
Kano AIZAWA ditto
Masayoshi KAKISHIMA ditto

1. Summary

The newly-developed 700 MW steam turbines have been successfully operated under so-called "Ultra Super Critical" initial steam condition of 31.1 MPa at Kawagoe power station of Chubu Electric Power Co. in Japan.



The first and second unit started commercial operations respectively in 1989 and 1990. This is a remarkable improvement upon the machines heretofore in use. Since, the initial pressure level of large-scale steam turbines has been remained at 24.2MPa for about 30 years. This improvement on the initial pressure raises the thermal efficiency of the plant more than 2% in absolute value.

Main items of the turbine design specifications were decided based on the general engineering of the plant, as follows; rated output 700MW, 3,600rpm, main steam 31.1MPa/566℃, double reheat 566 ℃ / 566℃, tandem-compound of 4 cylinders, 4 exhaust flows with 33.5 last stage blade length. The more important requirement for the development was to keep the same high reliability and operability as the usual design in spite of the very severe design conditions. So the various tests and analysis of the turbine components had been systematically carried out to improve the existing technique. Innovative technique was, however, not adopted intentionally with less experience, because it is difficult to manufacture and test a whole machine on trial. Adequate material selection, optimization of the size and shape, and confirmation tests/analysis of the parts under the simulated operating condition were made in design and development process. Among them, the following three themes were the most important and representative; Wide application of 12 Cr alloy steel for the high pressure turbine cylinder, rotor dynamics design to prevent the steam-whirl problem, and reliable design of the high-loading first stage moving blades.

These developed techniques were sufficiently confirmed by the reliability test during operation, and were also confirmed at the first overhaul inspection after one year's commercial operation.

Especially the thermal efficiency was proven to be good to the planned level by the performance test.

These established design and techniques can be applied to any thermal power plant to improve the performance. Encouraged by the success of this plant, the trend to improve the thermal efficiency due to the elevation of steam conditions will again prevail around the world as one of the main countermeasures against the energy and environment problems.

2. Technical Details

a) Wide applications of 12 Cr alloy steel

12 Cr alloy steel have been commonly used as heat-resistance alloy for turbine blades. It has also good experience of more than 15 years as the turbine rotor material. For stationary parts such as casing shell, valve chest and nozzle diaphragm, however, low-Cr Mo V alloy steel have been applied. On the other hands, 12 Cr alloy steel with higher rapture-strength can reduce the thickness of the most stationery parts of the high pressure turbine. It is very effective not only to decrease the thermal stresses during start and stop, but also to reduce the thermal expansion difference between rotating parts and stationary parts.

b) Prevention of steam-whirl problem

The high pressure turbine rotor with elevated initial steam conditions has inevitable tendency under such condition that the ratio of steam force and rotor bending stiffness is higher. This means higher possibility of steam-whirl occurrence. This problem is generally considered as the most difficult barrier against the elevation of initial pressure and output. To prevent this phenomenon, new technique of rotor-stability evaluation has been established by the steam-whirl simulation test. Based on this analysis, the configuration and sizes were decided, these are, single-flow first stage, the rotor of larger diameter, the shorter bearing-span as far as possible, and so on.

c) Vibration test of the first stage blade

To reduce the steam induced exciting force, the existing large-scale turbine has double-flow type at the first stage. As above mentioned, the single-flow first stage design was adopted. It means more severe design condition for the first stage blade. Therefore, to confirm off-resonance characteristics of the moving-blade at rotating condition the exciting vibration test were carried out by rotating the actual size test wheel.

THE DEVELOPMENT OF DIESEL OUTBOARD MOTORS

Tadao OBATA Yanmar Diesel Engine Co., Ltd.
Koichi AMEMORI ditto
Susumu NISHI ditto
Genshi YASUMA ditto

A new series of diesel outboard motors has been developed and settled on the market since 1987 in Japan and since 1988 outside Japan.

Fig. 1 shows the sectional view of diesel outboard motor model D27 and their main specifications are shown in Table 1.

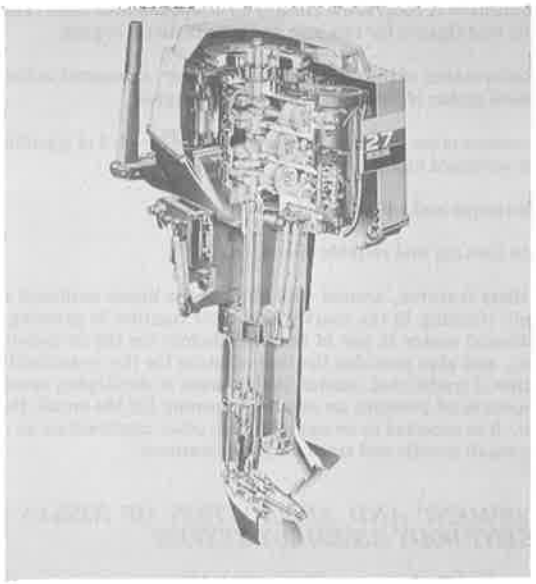


Fig. 1, Diesel Outboard Motor: Model D27

Table 1 SPECIFICATIONS

Model	No. Cyl.	Bore× Stroke mm	Stroke Volume cc	Max. Power KW(PS)	Engine Speed rpm	Outboard Weight kg
D27	3	70×70	808	19.9 (27)	4500	90
D36	3	82×70	1109	26.5 (36)	4500	116

Note: Max. Power, at propeller shaft end.
Outboard Weight, for electric start model with transom height L.

The diesel engines for these units were specially developed for outboard use and incorporate several innovative design features and new concepts.

In the early stage of the development, basic research was conducted on the engine structure and injection/combustion system in order to overcome the weight barrier of the diesel and even so to maintain its durability and reliability for marine use. The result is a unique structure, incorporating an integrated aluminium cylinder head-block with

cast iron cylinder liners casted in, a high speed direct injection combustion system using a mini unit injector, a timing belt driven OHC, direct sea water cooling, a vertical crank-shaft, etc.

The integrated aluminium cylinder head-block features;

* The weight is around 1/5 of conventional cast iron cylinder block, cylinder head and head bolts.

* No gasket trouble, caused by no gasket structure.

* Without the strain of tightening head bolts on the cylinder bore, good lubricating oil control is achieved at high speed.

* A small scatter range of the piston top clearance in mass production, for more even engine performance.

The unit injector features;

* Higher injection pressure (80 MPa; around double that of the conventional system), for finer fuel droplets and faster burning.

* No injection delay at high speed, for smooth running without injection timing advance gears.

* No irregular injection over all load and speed ranges, and freedom from cavitation erosion.

And the power heads achieve 4500 rpm operation for the first time ever with this kind of small direct injection diesel engines, and are also the lightest diesels in this horsepower range with a weight power ratio of about 1.2 kg/KW.

The specific fuel consumption is 260g/KWh (191g/PS) at rated output.

The minimum is 200g/KWh (162g/PS) at around 3000 rpm. These are some of the best figures for this size and type of diesel engine.

The performance of the diesel outboard motor, compared to the gasoline outboard motor of the same horsepower range is;

* Fuel consumption of diesel fuel is around 1/2 ~ 1/4 of gasoline on a gasoline outboard motor.

* Higher torque and safety cruising.

* Certain starting and reliable operation.

With these features, around 4000 units of the diesel outboard motors are already working in the market and their number is growing. This diesel outboard motor is one of the best choices for the propulsion of a small boat, and also provides the best solution for the motorization and dieselization of traditional coastal fishing boats in developing countries.

The powerhead provides an excellent opening for the small diesels of the future. It is expected to be used for such other applications as marine inboards, small mobile and stationary applications.

DEVELOPMENT AND APPLICATION OF NISSAN'S INTELLIGENT BODY ASSEMBLY SYSTEM

Kaoru OKUYAMA	Nissan Motor Co.
Hiroshi SASAOKA	ditto
Hiroshi INOUE	ditto
Masamichi SAKAINO	ditto
Kazuhiko YAZAKI	ditto

1. Introduction

Automobile manufactures have been attempting to instill a higher of flexbility in their production facilities in order to be more responsive to diversified customer needs and to make production adjustments quicker when sales volumes fluctuate.

Flexible body assembly processes were established early on, through the introduction of robots and other automated systems, because of the time and cost that had been required to construct new lines for each model change. However, the main facilities remained rigid, only capable of producing 1 or 2 models on the same line. At Nissan, therefore, we have developed IBAS (the Intelligent Body Assembly System).

2. Technical Highlights

2.1 Development aims for IBAS

The following three development aims were set for IBAS.

(1) To achieve a programmable manufacturing system capable of producing any type of vehicle by simply changing the relevant data on the body shape.

Such a system would make it possible to build a variety of vehicles, ranging from a compact car (March) to luxury model (Infinity Q45), on the same line at any of the company's plants.

(2) To assure high quality levels and operating rates by incorporating in the system automatic error correction functions and self-diagnostics for dealing with equipment failures.

(3) To support complementary manufacturing arrangements on a global scale including domestic plants through the use of an off-line CAD simulation system. Such a system would enable simulations of production conditions to be executed on an engineering work-station (EWS) during the development of a new model. Robot teaching data prepared in this way could then be transmitted via a communications network to all plants including offshore manufacturing facilities.

To achieve these aims, IBAS has been developed around the basic concept of a programmable system in which data provide the basis for the control and operation of the system.

2.2 Construction of IBAS body-main line

The IBAS body-main line has an overall length of approximately 65 m and maximum width of 10m. It can complete one car body roughly in 45 seconds and is capable of producing more than 20,000 units a month.

The work flow on the line begins with the successive introduction of body panels at the first station by an automatic loader. Seven body panels, including the floor, body sides and roof, are input and temporarily assembled without being welded. They are then conveyed by a transfer system to the positioning and welding station, which is called the NC locator and corresponds to an assembly jig in a conventional manufacturing system. The robots that make up the NC locator position and spot weld the body panels.

The provisionally welded body skeleton is then transported to an in-line body accuracy measuring unit, where measuring robots measure the assembly accuracy at key points on the body. The measured data are sent to the EWS for display on a monitor.

After that, the body is transported to the re-spot welding station where robots execute the additional spot welds needed to give the body its required strength. The construction of the IBAS body-main line is shown in Fig. 1.

2.3 Benefits of IBAS

(1) Mixed production of different models. The conventional body-main line was limited to mixed production of one or two models. In contrast, IBAS makes it possible to build various types of vehicles concurrently on the same line.

(2) Quick facilitation of complementary production between plants. Preparations for complementary production between different plants can be completed quickly by taking the IBAS operational data from one facility and inputting it in the IBAS control system at another plant. In the past, it took approximately six months to complete the retooling work for launching production. Thanks to IBAS, Nissan has actually completed retooling in about three months, enabling one plant to help out another by assuming part of the production load.

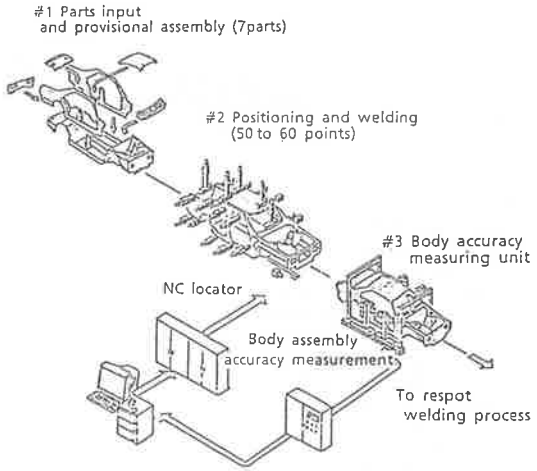


Figure 1 Basic Configuration of IBS Body Main Jig

The following three benefits are also expected to be obtained in the future.

(3) Global production complementation. Nissan plans to build a worldwide network linking its manufacturing facilities around the world including those in Japan. As a result, it will be possible to achieve production complementation on a global scale by simply transferring the relevant data on the vehicles to be built.

(4) Lead time reduction and computer-based prototyping.

Because the control system is based on the use of data, various types of CAD simulations can be performed to reduce substantially the lead time needed to retool for a model change. In addition, it will also be possible to perform computer-based prototyping using CAD data before a physical prototype of a new model is actually built.

(5) Extension of IBAS concept to other processes. The concept of IBAS will be applied to develop similar systems for other processes in automobile manufacturing including stamping, painting and final assembly. This will lead to the creation of totally intelligent manufacturing system in which data serve to link all production operations at all plants throughout the world.

DEVELOPMENT AND PRODUCTION OF INTEGRATED CONTROL SYSTEM OF ACTIVE CONTROL SUSPENSION AND FOUR WHEEL STEERING

Ryohei KIZU Toyota Motor Corp.
Hiroshi KAWAGUCHI ditto
Yuji YOKOTA ditto
Kaoru OHASHI ditto
Hiroyuki OHNO ditto

1. Abstract

With the recent increase in the speed, the vehicle performance, and the desire for higher class of automobiles, there is a great demand for the ty ability, as well as insulation of vibrations and noise, ride comfort. To fulfill all these requiremennts simultaneously, the active suspension has been studied since earlier times than semi-active suspension. However, the active suspension has not actually been used for cars except when it was used for F1 racing cars in 1987.

The Toyota Active Control Suspension has been developed by adopting electronic control technology for optimizing the suspension characteristic according to the road conditions, the vehicle speed, and the driver's operations, for the 1989 CELICA. (Fig. 1)

This system integrally controls the active hydropneumatic suspension and the speed-sensitive type four-wheel steering (dual-mode 4WS) system to improve the total performance of the vehicle motion.

2. Contents of Technology

1) Vehicle Attitude Control

Attitude Control for pitching and rolling directions decreases low-frequency vibration. Acceleration in the longitudinal and lateral directions of a vehicle during acceleration, deceleration and turning is detected by the acceleration sensor and the control signal is given to the linear control valve of each wheel to control the cylinder pressure. As the result, the vehicle attitude is kept constant.

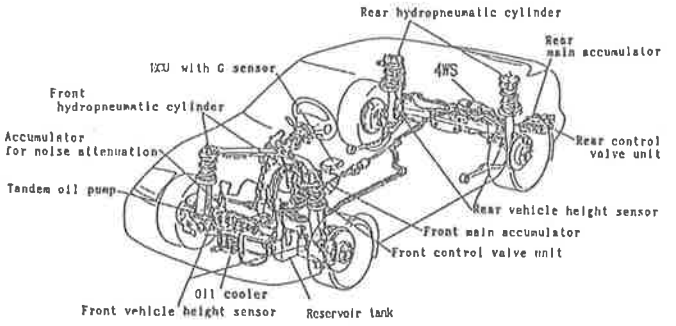


Fig.1 Parts disposition diagram for the 1989 CELICA's active control suspension + 4WS

2) Vehicle Height Control

The set vehicle height (three levels) will be kept even if the number of passengers or loaded weight changes. When the vehicle speed exceeds 80 km/hr, the vehicle height is lowered by one step(-20mm) to improve the high speed stability.

3) Ride Comfort Control

The Ride Comfort Control is devided into three control ranges to improve the reduction of power consumption and the flat and soft riding.

① Low frequency range (1 to 2Hz)

The bouncing, pitching and the other vertical movements of the vehicle caused by road surface irreguralities, are detected by the vehicle height sensors on each wheel and the acceleration sensor. The ride comfort is controlled by PID-controlling the deviation signal to control the cylinder pressure.

② Medium frequency range (about 7Hz or less)

In the frequency range where the linear pressure control valve can respond, the pressure changes in the cylinder, caused by road surface irregularities, are detected by the linear pressure control valve. Then the pressure in the cylinder is kept constant by the mechanical servo mechanism, and the input loads to the body are reduced.

③ High frequency range

Since the response of the linear pressure control valve in this range cannot follow the movement of the vehicle, the vibrations are reduced by a passive hydropneumatic system with gas springs and damping force valves.

4) Stability & Controllability Control

The transition state from running straight to turning movement is detected by the steering angle sensor and the estimated control value determined by the vehicle speed and the steering angular velocity is given to the rear side. As the result, the rear roll stiffness is increased and the vehicle controllability at the start of turning is improved. In addition, during turning, the front roll stiffness is increased and the vehicle stability is improved.

5) Integrated Control of Active Control Suspension And Dual-Mode 4 WS

Use of 4WS, permitting direct control of movement in yaw direction by changing the tire turning angle, is still more effective for steering control in the steady state. Thus the roll stiffness distribution control by the active suspension is set in a range where the ground contact load distribution is not changed so wide and a high critical lateral acceleration can be obtained, and the superiority of each system is much improved by direct control for the 4WS rear steer. The lateral acceleration again of the roll control and the lateral acceleration gain of the presumed control determined by steering angular velocity and vehicle velocity are changed according to the 4WS front and rear wheel steering angle ratio.

6) 4WS Speed Sensitive Function

At a low speed, controllability is improved because the rear wheel is steered in the opposite direction (reverse phase) to the front wheel. At a high speed, traveling stability is improved because rear wheel is steered in the same direction (same phase) with the front wheel.

7) 4WS Dual - Mode Function

The driver can select two modes (Normal mode, Sport mode) with the map for the phase and steering angle of the rear wheel to the steering angle of the front wheel by selecting the switch.

8) 4WS Canceling Function For Backward Movement

To provide the driver with natural feeling for backward movement of the vehicle and to allow the driver to easily move the vehicle aside in a tandem parking lot, the driver can cancel 4WS only for backward movement by selecting the switch.

R&D of AIR-COOLED SMALL-TONNAGE GAS-FIRED ABSORPTION CHILLER HEATER

Toru HAYAMA Hitachi, Ltd.
Giichiro UCHIGASAKI ditto
Shoji YOSHIDA Tokyo Gas Co., Ltd.
Tomosaburo MORI Osaka Gas Co., Ltd.
Junichi KIMURA Toho Gas Co., Ltd.

1. Abstract

Absorption-type chillers are very popular because they do not require CFCs as a refrigerant and consume very little electric energy. Especially double-effect machines have a higher COP value and until now have been water cooled. It is important now to replace the water-cooled system with an air-cooled system.

The key point of the air-cooled system lies in the air cooling of the absorber itself. If the current water-cooled absorbers are air cooled without changing the system, absorption temperature will rise in the Li-Br solution resulting in crystallization, thus rendering the cycle ineffective. To overcome this difficulty, the heat exchange between the absorption tubes and cooling air was done by four pass cross-counter type exchangers. The absorber tubes have a spirally-grooved inside and the outside cooling fins are elevated strip-type. Correctly placing the absorber and condenser achieves compactness and preserves all the advantages of a water-cooled absorption chiller. Thus, the world's first air-cooled double-effect absorption chiller using water as a refrigerant is achieved.

2. Details of Technology

Difficulties in air cooling: The coefficient of heat-transfer drops to 1/100 th if water cooling is replaced by air cooling. In water cooling, for an inlet temperature of water of 32 ℃, outlet temperature rises to 37℃. In air cooling, an inlet temperature of air of 35℃ rises to 43℃, which is 6℃ higher than the previous case. Thus, the absorbent LiBr solution crystallizes and the cycle ceases to work. This is the most difficult problem to overcome in air-cooling systems.

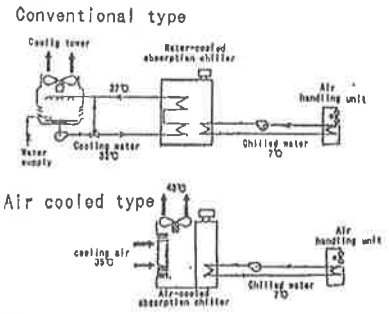


Fig.1 Comparison of the Conventional system to the Air Cooled Type

Breakthrough technology in an air-cooling system:

(a) Redesigned absorber: Present water-cooled absorbers consist of absorption tubes where absorption takes place outside the tube and cooling water flows inside. Conversely, in air-cooled systems, absorption occurs inside the tube and cooling air flows outside.

(b) Improved heat-transfer surface:

(i) Coefficient of heat transfer within the absorption tube: Vertical absorption tubes with a spirally-grooved inner surface enhance mass transfer by creasing turbulence within the flowing solution film. This enables a 30% increase in the coefficient of heat transfer.

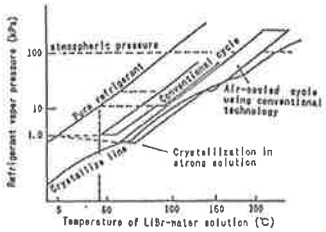


Fig.2 Difficulties of realizing air-cooled double-effect absorption refrigerating cycle.

(ii) Air-cooling fin: An elevated-type strip fin has been developed to improve heat-transfer properties by preventing the development of a thermal-boundary layer. In this process, elevated fins with various inclinations and varying resistance to air flow have been realized thus improving the coefficient of heat transfer more than 2.5 times that of the flat fin.

(c) Construction based on a new system of heat exchange between solution and cooling air:

(i) A method of heat exchange to achieve a lower outlet temperature of the solution than that of the air outlet temperature, cross-counter flow has been realized along with the special arrangement of the vertical absorption tubes.

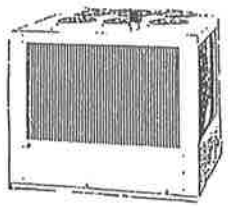


Fig.3 70 kW Air-Cooled Gas-fired Absorption Chiller Heater

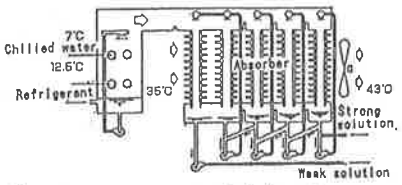


Fig.4 Structure of 4 pass vertical air cooled absorber

(ii) Matrix of the absorption tubes: Tubes are arranged so that cooling air goes through four passes and creates a cross-counter heat exchange during its flow from the downstream point to the most upstream point. To ensure proper mass absorption at each tube, the bottom side of each tube has a receiver and pump. Between receivers there are an overflow section and connecting tubes. All these changes aided in maintaining and increasing the absorption capability of the system.

(d) Arrangement of air-cooled absorber within the system: Considering the temperature gradient within the cooling air, tubes are arranged in five rows along the direction of flow. In this way, the first three rows down constitute the three passes. The fourth and fifth rows formed the fourth pass. Condensing tubes are positioned along with the fourth and fifth rows i.e., the fourth pass of the absorbing tubes. Thus for an inlet air temperature of 35 ℃ and outlet temperature of 43 ℃, the solution temperature at the inlet of the absorber cools down to 40℃ at the outlet. It has been possible to achieve the same performance from an air-cooled system as that from a water-cooled one. Hence, air-cooled absorption chillers became a reality.

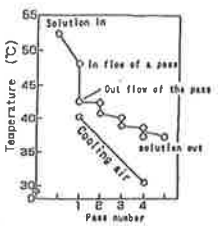


Fig.5 Change of solution temperature

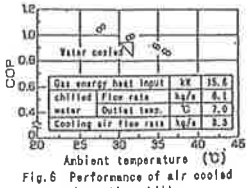


Fig.6 Performance of air cooled absorption chiller

3. Conclusion

The world's first air-cooled double-effect absorption chiller heater has became a reality. In this age of CFCs elimination and energy conservation, the impact of this machine as freezer, air conditioner or heater, is of much significance. From now on, rapid development and increased application is expected.

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Editor,
Hideo Okamura, Kiyoshi Sogabe, Takezo Nonami, Masahisa Takashi
Manasaaki Kawahashi, Toyoaki Yoshida, Ysuhiro Daisho,
Kensuke Usui, Kimiyuki Mitsui

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