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14 April 1981

# Japan Report

(FOUO 23/81)



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JAPAN REPORT

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APPLICATIONS OF TRANSFER ROBOTS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 11-15

[Article by Makoto Iida, chief, Automation Promotion Section, Technical Department, Toshiba Seiki Co., Ltd.]

[Text]

1. Introduction

It is ironic that the present trend in industrial robot development is heading away from the direction of their initial development into exclusiveness, that is, specific robots for specific purposes. From the perspective of robot development, this trend naturally makes us think twice about its desirability. From the point of view of whether the trend is helping meet the purposes of robots, however, the trend is seen as a natural consequence of our country's industrial level. The transfer robot introduced in this article follows the aforementioned trend. It is a fixed sequence robot that has simple mechanisms. Its main use purpose is the transfer of materials in press work, but it can also be used in assembly, processing, and transfer work involving a small number of stations.

2. Outline of RHP Series

The majority of present-day industrial robots have their operating space defined by cylindrical coordinates, with their operating territory restricted to within the space of their rotation. Because of this, they are not suited for operation in a linear work space. The RHP series was developed to operate in a linear work space, and to accommodate this, they have their operating space defined by rectangular coordinates. Their profiles are shown in Fig. 1.

An RHP series robot consists of a drive system and an operation system. The load transfer weight is 1.4kg/operation system, and one drive system can drive up to two operation

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systems. There are two types of arm movement: 2-arm independent drive (D type), and transfer arm (DT type). Profiles and specifications of each are shown in Figs.2 and 3, respectively.

In Fig.4, the D type's right and left arms are driven independently of each other by two sets of cams in the drive system. The cam diagrams are drawn such that in travelling from A to B and B to C, the arms can follow the paths that enable them to reach their positions in minimum time. The robot's can process the arm's horizontal transfer movement of 210mmx2 in 1.5 seconds, as shown in the specifications, because of the cam system.

In the case of DT type robots, they have a set of cams, and their operations are C→A, A→B, and B→C for A→B transfer. The arm waits at the middle point "C" for the work to finish. This operation is available for use not only in press jobs but can also be used as a direct flow transfer device. It is considered a simple and low-priced linear-type base MC.

Introduced here are actual cases where RHP series robots have been used for processing.

**3. Introduction of D-Type Robots**

**3-1. Processing of Chain Sprockets (See Fig.5)**

This is the simplest operation for a robot in press work where chain sprockets (110φ-220φ) are made. The machine used was an RHP-7D robot, and the work involved feeding pieces to and taking them out of a 35-ton press. The cycle time was 2 seconds. By attaching an escapement to the tip of the loading conveyor, a gross feed precision of ±0.2mm was maintained.

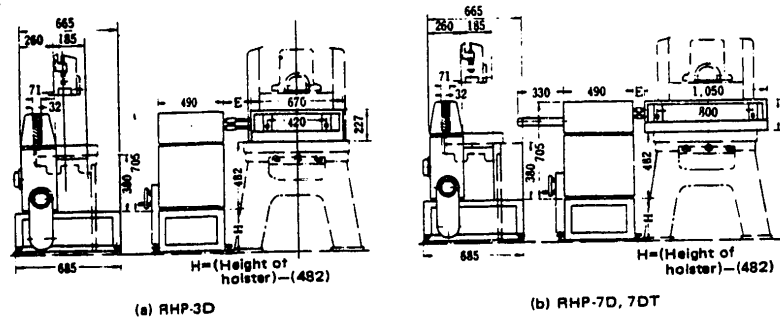


Fig. 1. Shapes of RHP Series

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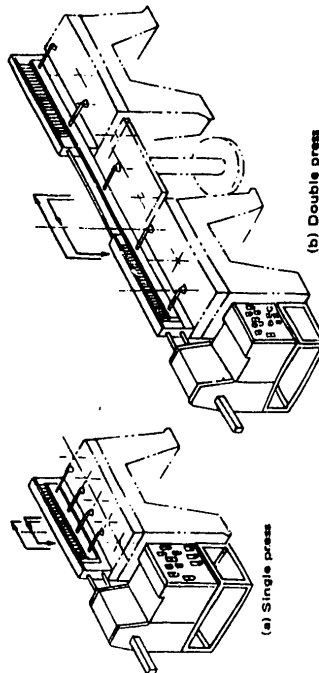
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	RHP-3D	RHP-7D
Transfer load	300g	700g
Horizontal traverse (slide)	210mm (Max)	400mm (Max)
Up and down movements	40mm (Max)	40mm (Max)
Cycle time	1.5 seconds	3 seconds
Precision of stop position	±0.3mm	±0.3mm
Motive power source	200V/AC 0.75kW	3φ motor

- Left (feed) arm
  - (1) Descend (adsorption)
  - (2) Ascend
  - (3) Slide: right
  - (4) Descend (release)
  - (5) Ascend
  - (6) Slide: left
- Right (take out) arm
  - (1) Slide: left
  - (2) Descend (adsorption)
  - (3) Ascend
  - (4) Slide: right
  - (5) Descend (release)
  - (6) Ascend

"Start" signals to the press at the original point.

Fig. 2. Shape and Specifications of Two Independent-Type Arms (D Type)



- (1) Slide: left (1/2 pitch)
  - (2) Descend (adsorption)
  - (3) Ascend
  - (4) Slide: right (1 pitch)
  - (5) Descend (release)
  - (6) Ascend
  - (7) Slide: left (1/2 pitch)
- Start signals to the press at the original point.

Transfer load	Total weight 1.4kg
Horizontal traverse (slide)	400mm (Max)
Up and down movements	40mm (Max)
Cycle time	2 seconds
Precision of stop position	±0.3mm
Motive power source	200V/AC 3φ 0.75kW motor

Fig. 3. Shape and Specifications of Transfer Arm (DT Type)

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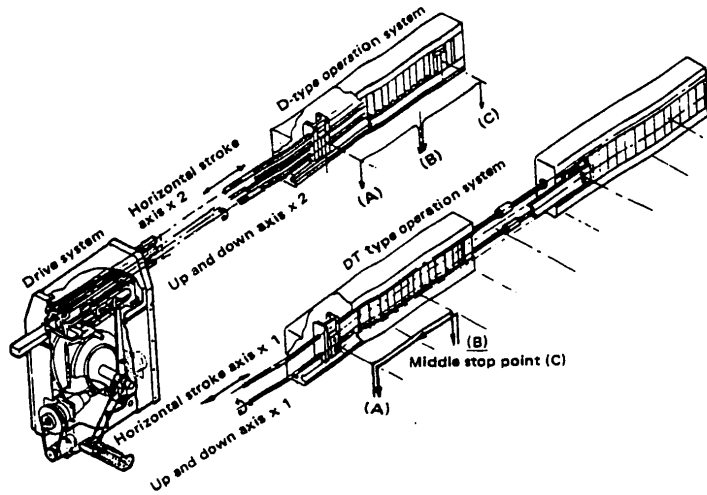


Fig. 4. Motions of D-Type Robot's Arm

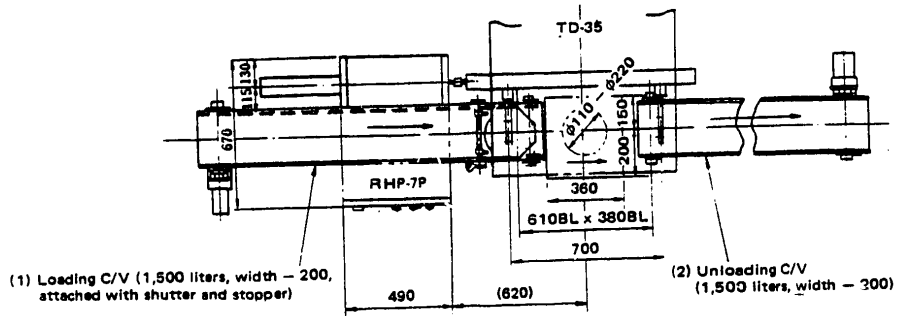


Fig. 5. Processing of Chain Sprockets

For control, emphasis was placed on the control of the robot itself, and the robot was designed to start functioning upon receiving a "press start signal" or "escapement start signal" and become internally interlocked upon receiving a completion signal.

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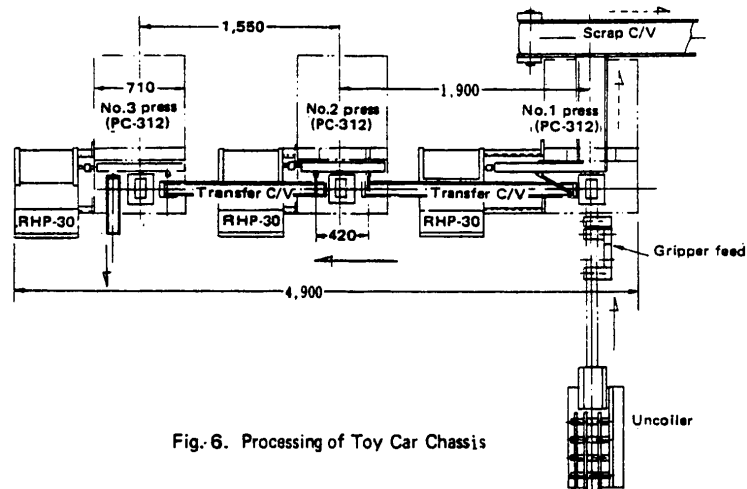


Fig. 6. Processing of Toy Car Chassis

3-2. Processing of Toy Car Chassis (See Fig. 6)

- 1st process: Blanking, punching of holes
- 2nd process: Reduction of area, punching of holes
- 3rd process: Reduction of area

This case involved automatic processing of the above three processes using three presses. The raw material was supplied by a gripper feed to the holster of the press in the first process at a right angle after going through the uncoiler and labeler. The metallic mold has a mechanism to remove scraps while the material is being processed into a chassis, and the scraps are removed by a scrap ejection conveyor through a chute. The plank is one-arm (used only for taking out) D type, and scraps are ejected onto the conveyor. The conveyor also works as a storage, and an escapement is installed in the supply position in the 2nd process. When it is to be removed after completion of processing in the 2nd process, the work is turned over by gravity and forwarded to the 3rd process. This conveyor also works the same as the previous conveyor. After completion of processing in the third process, the work is ejected through the chute in the front. The cycle time is 1.5 seconds plus 0.7 seconds (press work time), and each workstation has its own control system that works independently of the other control systems. The workstation is designed to start processing of the work independently, on the "work in place and ejection completed" signal. Such a control system is used because the press work process can be freed from being too rigidly fixed, and more flexibility can be given to it so that it can cope with changes in the number of processes. As a result, the press line can be partitioned off at any position and it can also be fed with two or three types of products.

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The foregoing are just two cases where D-type robots have been applied, and robots of this type may be used as supply and ejection devices for independent machines, such as presses.

4. Introduction of DT-Type Robots

The DT Model robots come in several varieties. Several operation systems can be operated by a single drive system. In this case, the total transfer weight is 1.4kg to an operation system, regardless of the number of arms. However, when there are more than 3 operation systems, the total transferrable weight per operation system must be reduced.

4-1. Area Reduction Processing, Such as Processing of "The Cover of a Pressure Cooker"

As shown in Fig.7, the work involved feeding of blank material by a push-up device, and area reduction processing by a C-frame press with a wide head. Up to seven workstations can be established. Ordinarily, there are only five stations. With 5 stations, the work is processed in station No.1 for blanking and the scraps are ejected from the lower side of the metallic mold.

When the work must be turned over in station No.2 (for sheared-off surfaces), the blank is turned over by a turn-over device and work proceeds to the No.3, No.4, and No.5 processes. The product is removed by the unload chute. Because of eccentric loads, the idle stations in front and in the rear inside the holster can be used for light work. In this case, two operation systems are used because the holster is more than 2,000mm across, but one operation system is enough when the total width of transfer of the work for processing is narrow.

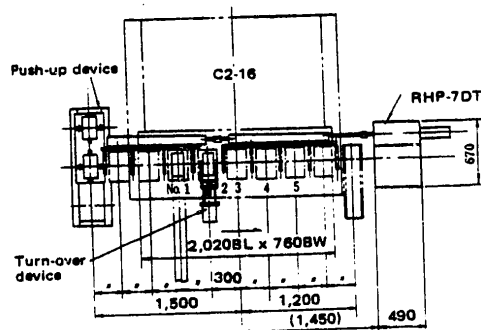


Fig. 7. Example of Area Reduction Application

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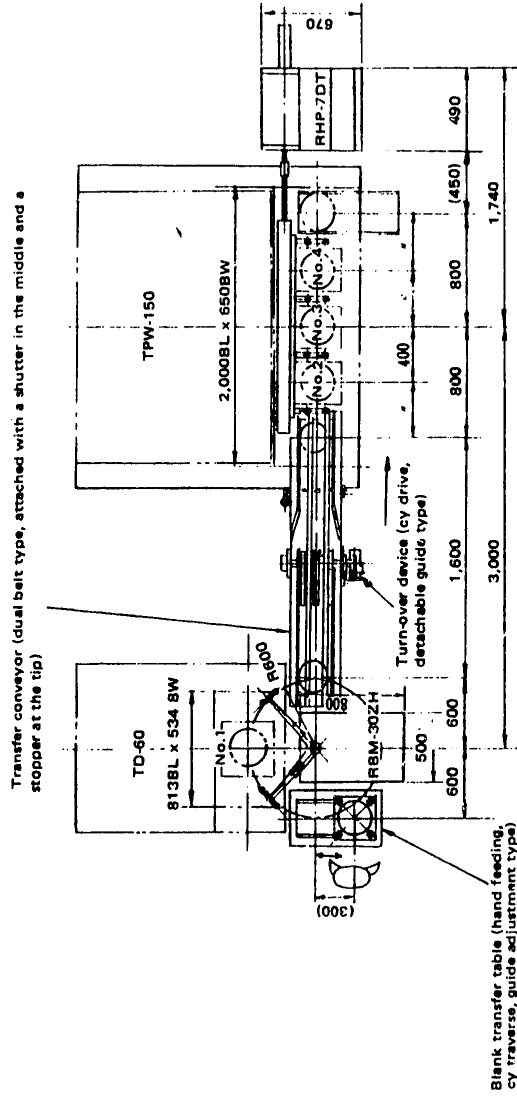


Fig. 8. Where the Width of Transfer for Processing is Small

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Fig.8 shows an example where blanking is conducted by using a separate press. Here the two presses are made to work in synchronization with each other. In the first process the RBM-30Z (cylindrical coordinates system robot) is used for the functions of a lifter, and the RHP-7DT is used in the 3rd process. An RHP-7DT robot is used to carry out the remaining three processes. In this case, a turn-over device is installed in the middle to turn over the work when necessary. For control, as stated before, each has its own independent control system.

#### 4.2. Robot Introduced in a Job Involving More Than Two Presses

In the processing of medium-size parts (about 200), the transfer bar system has conventionally been used, but this system is cumbersome for changing metallic molds and a single mold cannot be used. The line shown in Fig.9 is a transfer line formed by installing two presses that work in synchronization with each other. It can be considered as a two-dimensional transfer bar. The characteristic feature of this system is that a transfer line can be formed easily. The system's principles are almost the same as those of the previous case; the only difference being that with this system the horizontal transfer stroke tends to be longer and at present the maximum stroke length is 1,200mm.

#### 5. Incorporation in An Automatic Assembler

Some of the readers may have already noticed from the previous article that introduced the application of a DT-type robot to a press line, that attempts are being made to use DT-type robots as a transfer device for linear-type, middle level assembly lines. In Fig.10, there are four routes established at present, and route (1) is for exclusive use by presses. (2) is a path established from the necessity of lowering the arm in connection with the press's interference with the metallic mold, and by taking advantage of this route the robot can be used in an assembler. That is, it uses point C'. Suppose point C' is a supplier of assembly components, and parts are chucked at point C' and moved to other parts at point C for transfer to point B. In other words, all it needs is to supply parts located at point C to the body at point A, and to move them all to point B for final work. Such cases are still rare and there is much room for exploration in this field. In work involving linear feeding, it will enable the user to devise a system of his own without purchasing an expensive base MC provided the feeding mechanism can be fitted with some sort of temporary storage.

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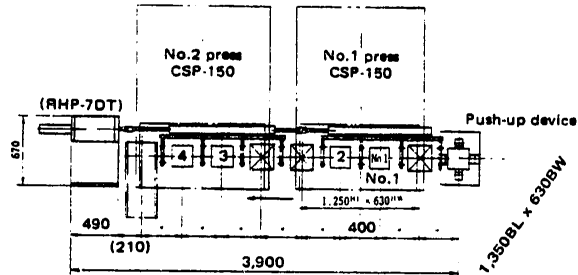


Fig. 9. Where a Robot is Introduced to More Than 2 Presses

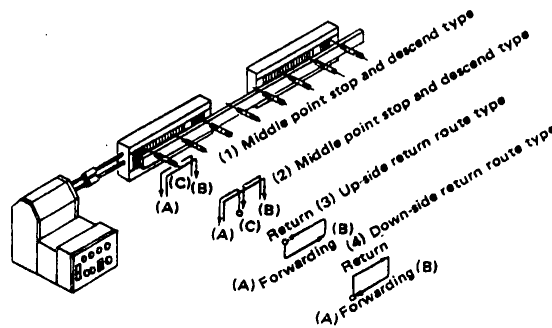


Fig. 10. Operating Routes in Automatic Assembler

(3) and (4) are ordinary operations of a transfer bar system and (4) is the most common route and the easiest to use. With (3), the work can be grasped and transferred, so it is suited for assembly of parts shaped like a chassis.

The writer has elaborated on the introduction of PHP series, but we are obliged to the users for the cooperation they extended to us in the development of the rectangular coordinates series of robots for use in press work. As the writer stated in the closing part of this article, exploration in the use of this series of robots as the base MC for simple and linear type operations has opened a broad field of application for them. With the growing trend among users to develop specialized machines using standard units, we would appreciate their feedback and suggestions on our attempts.

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PRECISION SMALL ROBOTS, THEIR APPLICATIONS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 16-22

[Article by Shigeru Iwai, chief, Device Technology Section, Electronics Department, Daini Seikosha Co., Ltd., and Satoshi Shigeno, MAC Giken Co., Ltd.]

[Text]

**1. Introduction**

Development to automate labor-intensive manual jobs, industrial robots are aimed mainly at automating the transfer of objects. Today, industrial robots come in various types and forms, ranging from the very simple to the highly sophisticated. They do not, however, always perform at the level expected by the user, and with respect to their multi-purpose features, there is a large gap between the maker's assertions and the user's expectations. This difference stems in part from the hand functions being constructed as a separate part of, or as an add-on to, the main robot. The hand functions of an industrial robot are the most important element in work involving the transfer of objects. Most such functions are performed by exclusive hands (or exclusive manipulators) manufactured to meet the specific work requirements of each task.

Industrial robot makers claim that separating the function of the robot proper from its hand function makes the robot more versatile, and thus it can be used in a wider range of applications. On the other hand, the users wonder whether the multi-purpose features and added versatility of robots are advantages since they must devise countermeasures each time they introduce a robot to a new task. What is needed is a mechanical hand that has all the functions of the human hand, but this dream is far from realization. A more plausible solution for the present is to carefully analyze the task procedures in dangerous or simple repetitive jobs, and to select the robot most suited to the job.

This article outlines several compact, high-speed, high-precision robots developed by this firm that are used for the transfer of small parts. Examples of their applications are also given.

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2. Outlines of Standard Models

2-1. Model 100 (See Photograph 1)

A pneumatically-operated, compact, high-speed, high-precision supply and ejection unit of the forward-proceeding type, this model was developed for use in assembly operations of small, precision parts, or to supply and eject parts in press work. Major specifications are shown in Table 1.



[Photo 1]

Table 1. Specifications of Model 100

Vertical	45-50mm (variable)
Horizontal	0-200mm (variable)
Cycle time	1 cycle/2s max.
Reproduction precision	±0.01mm
Gripper (including transferrable weight)	1.5kg
Measurements	455 x 153 x 246mm
Weight	20kg
Drive	Normal pneumatic pressure 5kg/cm <sup>2</sup>
Option	Gripper

Features:

- (1) Being very small and lightweight, it requires very little space for installation.
- (2) Being a forward-proceeding type, only a small amount of operating room is needed to supply and/or eject parts.
- (3) Powerful oil dampers on its H and V axes permit high-precision positioning.
- (4) The operation moves to the next step only after confirming that each axis has completed its action, therefore job quality is very high.
- (5) It is easy to operate and the cycle time is short because all operations are performed by pneumatically-operated mechanisms.

2-2. Model 200 (See Photograph 2 and Table 2)

A pneumatically-operated, compact, high-speed, high-precision supply and ejection unit with a whirling handling arm, the Model 200 was developed especially for assembly of miniature high-precision parts, and to supply and eject parts in press work.

Features:

- (1) The handling arm can be installed on either the up or down side of the loading axis of the machine.
- (2) The powerful oil damper permits quick, highly accurate positioning of relatively heavy parts.

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- (3) Since the damper oil is cooled, the oil does not deteriorate as quickly as conventional units, hence the effect of the damper lasts longer (use of the adiabatic expansion of air).
- (4) The operation moves to the next step only after confirming that every axis has completed its action, therefore job quality is very high.
- (5) Since the arm whirls and moves up or down by pneumatically-driven mechanisms, the cycle time is very short.
- (6) When two handling arms are used, parts can be both supplied and ejected in one cycle (see Model 200W in Table 3).

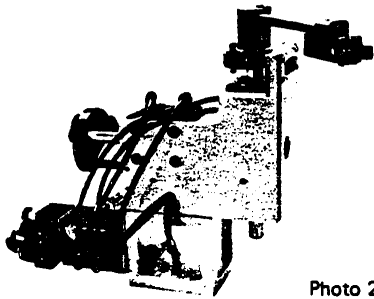


Photo 2. Model 200

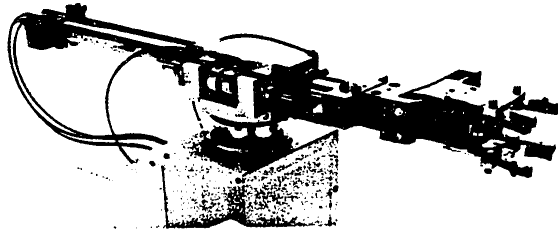


Photo 3. Model 400

Table 2. Specifications of Model 200

Vertical	10-20mm (variable)
Turning	$90^{\circ} \pm 2^{\circ}$ or $120^{\circ} \pm 2^{\circ}$
Cycle time	1 cycle/s max.
Reproduction precision	$\pm 0.01$ mm (with 150mm arm and 150kg load)
Gripper (including transferrable weight)	150g (when speed is slow, 300g)
Measurements	292 x 89 x 318mm
Weight	16kg
Drive	Normal pneumatic pressure 4kg/cm <sup>2</sup>
Option	Arms (150 or 200mm)

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2-3. Model 400 (See Photograph 3 and Table 4)

The Model 400 is a pneumatically-driven, high-speed, high-precision unit developed to automate supply and ejection of parts in press, lathe, grinding, and assembly work.

Features:

- (1) The mounting position of the H axis is variable over a wide range.
- (2) Compared with the Model 100, the Model 400 can transfer heavier objects.
- (3) The mechanical hand division (grip division) can be shifted at a right angle (to left or right) to the H axis.
- (4) Since work proceeds to the next step only after confirming that every axis has completed its action, job quality is very high.
- (5) Since it is pneumatically driven, it can move back and forth, up and down, and right and left.

Table 3. Specifications of Model 200W

Vertical	10-20mm (variable)
Turning	90°±2° or 120°±2°
Reproduction precision	±0.01mm (with 150mm arm and 150g load)
Gripper (in- cluding transferrable weight)	150g (300g at slow speed)
Measurements	292 x 89 x 318mm
Weight	16kg
Drive	Normal pneumatic pressure 4-5kg/cm <sup>2</sup>
Option	Arm (150 or 200mm)

Table 4. Specifications of Model 400

Vertical	20-100mm (100mm/0.8s) (variable)
Horizontal	0-400mm (400mm/0.7s) (variable)
Reproduction precision	±0.025mm
Gripper (including transferrable weight)	4kg
Measurements (measurements excluding arm)	410 x 240 x 410mm
Weight	70.5kg
Drive	Normal pneumatic pressure 5kg/cm <sup>2</sup>
Options	Rotate gripper 2.5kg (180 rotation + gripper) (clockwise and counter-clockwise rotation available) Shift gripper 2.5kg (50mm shift + grip) vacuum chuck 2kg

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2.4. Model 700 (see Diagram 1, Table 5)

The Model 700 was developed for machining and assembly of watch parts. It is particularly suited for precision assembly of miniature parts and supply and ejection of parts. It is also suited for jobs requiring high speed repetition of complex actions.

Features:

- (1) All axes can be driven at the same time because all of the Model 700's mechanisms are pneumatically driven.
- (2) Since it can be connected to electric, electronic, or pneumatic controllers, the Model 700 can be custom fitted to the user's application.
- (3) The machine can be started or stopped by input signals, and the peripheral machinery can be controlled by output signals.
- (4) The Model 700 is divided into blocks which the user can select and combine to match his specific task.

Table 5. Specifications of Model 700

Vertical	40mm (40mm/0.5s)
Horizontal	150°±2.5° or 200°±2.5m (150mm/0.5s)
Rotation	90°±2° or 120°±120°±2 (clockwise and counter-clockwise directions) (90/0.5s)
Reproduction precision	±0.025mm
Gripper (including transferable weight)	500kg (1,000kg at slow speed)
Measurements	280 x 220 x 230mm
Weight	20kg
Drive	Normal pneumatic pressure 4kg/cm <sup>2</sup>
Options	Horizontal axle 250mm; gripper (opened + closed) 300g

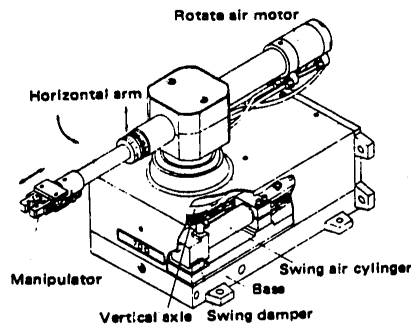


Fig. 1. Model 700

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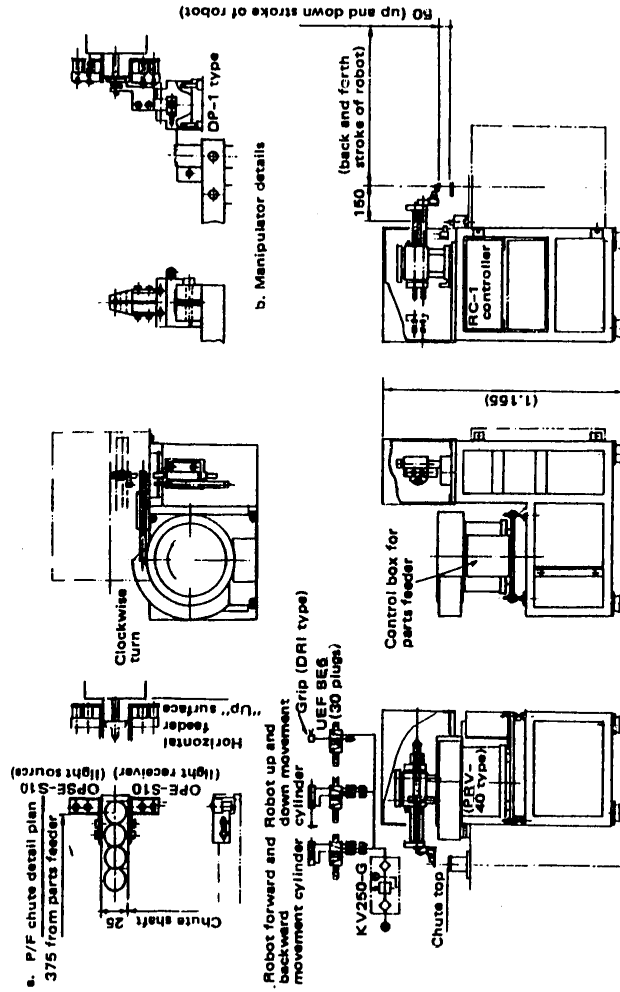


Fig. 2. Automatic Feed and Assembly System

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2-5. Controller RC-1/DC-1

RC-1 is a sequence hard-wired logic controller designed to economically enhance the performance of Models 100, 200, and 400. DC-1 is for Model 700 (see Tables 6 and 7).

Table 6. Specifications of RC-1 Controller

Models that can be controlled	200, 200W, 400, 400L
Weight	4.5kg
Measurements (length x width x height)	210 x 396 x 180mm
Sequence	Fixed sequence
External synchronous signal	Receiving x transmitting 5 x 2
Power source	110VAC 50/60Hz (option 110-240V)

Table 7. DC-1 Controller Specifications

Models that can be controlled	700 (400 and 200 without electro-magnetic valves)
Weight	13.7kg
Measurements (length x width x height)	115 x 355 x 275mm
Sequence	Programmable cam sequence
Step cam	24
Cycle time	50Hz (7.8 10.4) 60Hz (6.3 8.3)
External synchronous signal	Receiving x transmitting 1 x 2
Power source	100VAC/240V 50/60Hz

3. Application Examples

3-1. Automatic Feed and Assembly Unit

Figure 2 shows an example where using Model 100, the process of automatically feeding parts (see Fig.3) forwarded by a parts feeder and clamping them into position is performed as a unit. The H axis stroke is 150mm and the V axis stroke is 50mm. The cycle time is 2 seconds.

This example shows how a parts feeder and the Model 100 can be combined as a single unit.

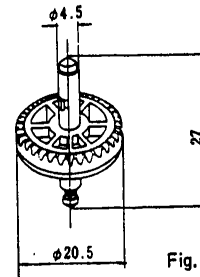


Fig. 3 Work

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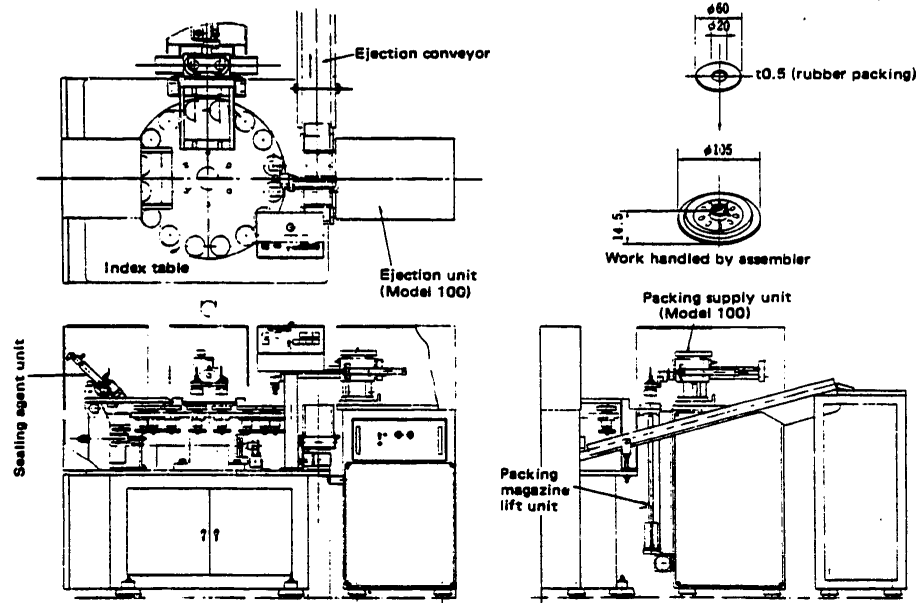


Fig. 4. Example of Model 100 Being Used in Combination with a Rotary Index Assembler

3-2. Example of Automatic Assembler Application

Fig.4 shows an example of a Model 100 acting as a feed, assembly, and eject or unit for rotary index assembler. Photograph 4 shows the overall system. Photographs 5 through 8 show examples of units in use. Table 8 lists the assembler's specifications.

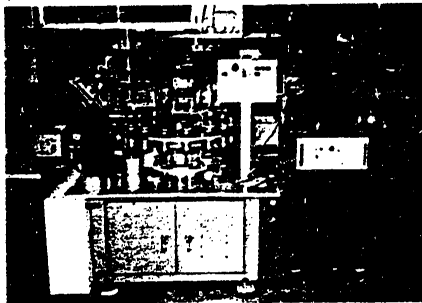


Photo 4. Example of Application To An Automatic Assembler

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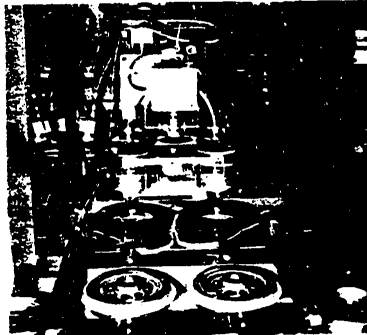


Photo 5.

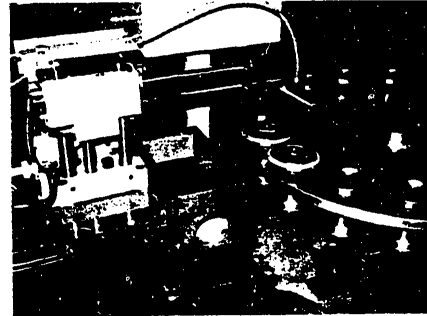


Photo 6.

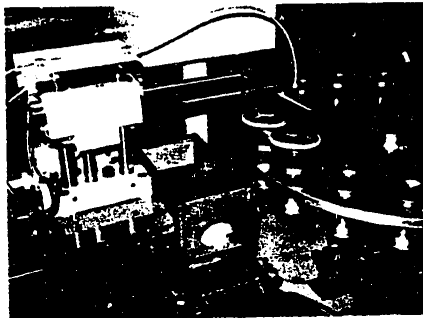


Photo 7.

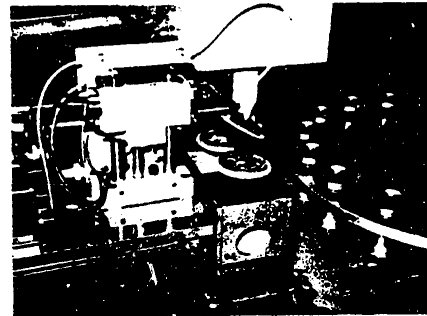


Photo 8.

Table 8. Specifications of Automatic Assembler

Item	Specifications	
Name of item processed	Automobile part (see Fig. 4)	
Cycle time	4-5 1/2 pieces (2-2.5 s/1 piece)	
Index unit	Index number 8, index precision $\pm 30^\circ$ , motive power 0.4kW, structure: barrel cam type	
Sealing agent feed unit	Comprised of a painted head, tank, and work drive mechanism (detail specifications omitted)	
Packing feed unit (Photo 5, Fig.2)	Comprised of a feed robot Model 100 and lift unit	
Feed robot (Model 100)	Drive mechanism	Pneumatic pressure 4-5kg/cm <sup>2</sup>
	Up and down stroke	45-50mm
	Back and forth stroke	0-200mm
	Chuck system	Vacuum system
Lift unit	Ascending speed of lift	Variable
	Descending speed of lift	Fixed
	Number of works (packings) stored	900 pieces/magazine Arranged in two rows, the total is 1,800 pieces/unit (packing thickness 0.5mm) Magazine replaceable
Work-ejection unit (Model 100)	Driving mechanism	Pneumatic 4-5 kg/cm <sup>2</sup>
	Up and down stroke	45-50mm
	Back and forth stroke	0-200mm
	Chuck system	Grip system (Photos. 6, 7, 8)
Conveyor unit	Belt speed	6-6.4m/min
	Motive power	6-25W
Power source used	200VAC, 60Hz	
Machine weight	About 1 ton	



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3-3. Example of An Automatic Feed System for Presses

This example shows a Model 700 industrial robot in a system where cases with their interior surfaces lined with rubber are fed into the cope of a press.

- (a) Details of the system
  - \* Model 700 specifications (see the standard specifications).
  - \* Manipulator (mechanical hand) and parts shape (see Fig. 5).
  - \* System layout (see Fig. 6).
  - \* Operating procedures (see Table 9).
- (b) Program
  - Programs for the Model 700 robot are prepared by using the program sheet shown in Fig. 7.
- (c) Outside connector connecting diagram (see Fig. 8).

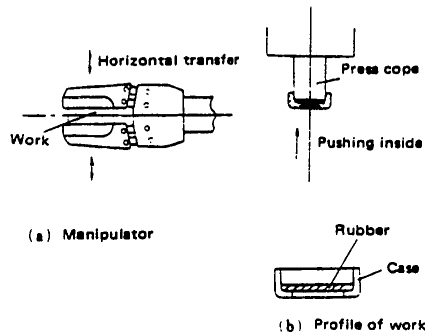


Fig. 5. Manipulator and Work

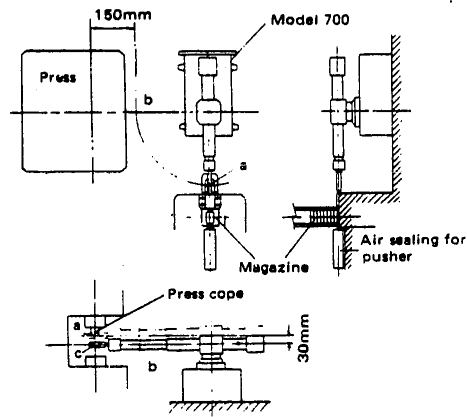


Fig. 6. System Layout

Table 9. Operating Procedure

Step	Movement	Remarks
1	Pusher advances	
2	Grip "on"	
	Pusher moves back	
3	S-axis rotates (clockwise)	a → b
4	H-axis advances	b → c
5	V-axis moves upward	c → d
6	Grip "off"	
7	V-axis descends	d → c
	H-axis moves back	c → b
8	S-axis rotates (counter-clockwise)	b → a, 1 cycle ends

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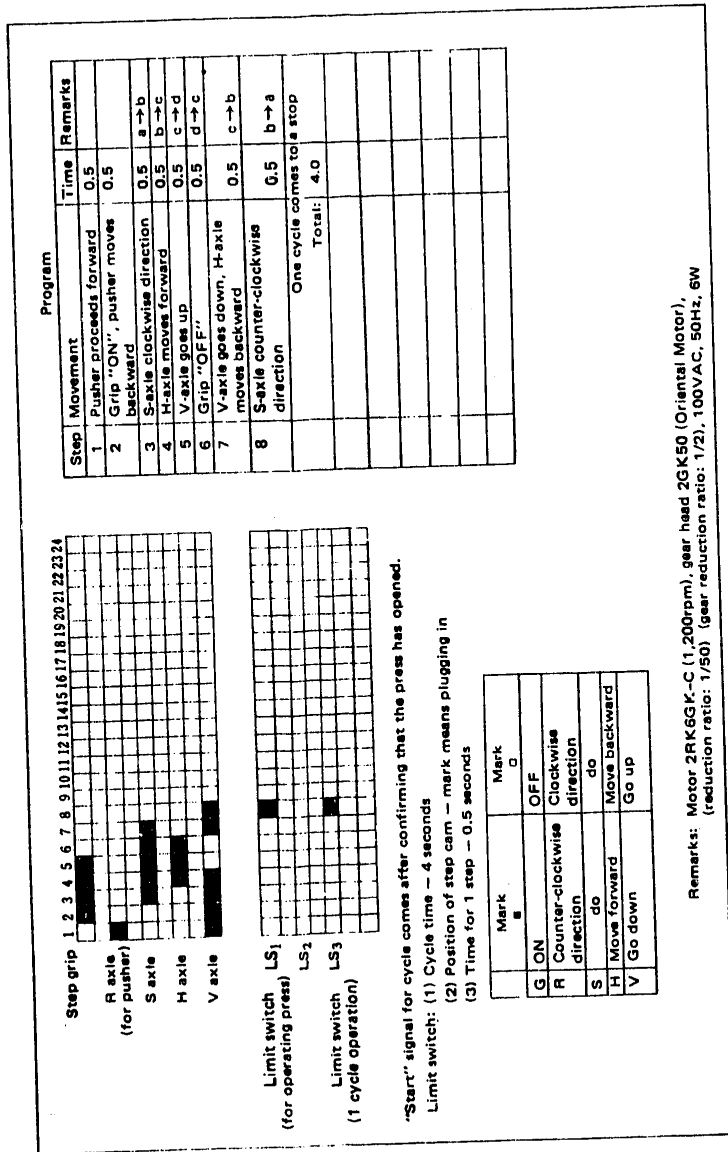


Fig. 7. Program Sheet for Model 700

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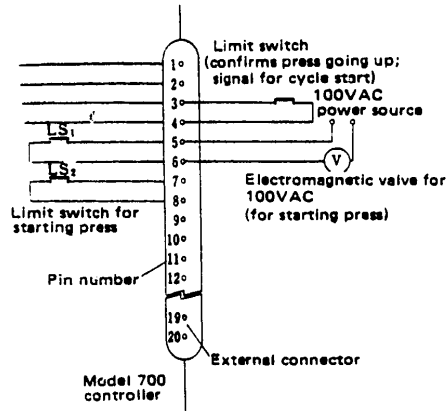


Fig. 8. External Connector Connecting Diagram

#### 3-4. Examples of Mechanical Hands (manipulators)

For an industrial robot to be a full-fledged robot, it must have what amount to human hands. Shown in Figs.9 and 10 are some of the standardized mechanical hands used in industrial robots. The mechanical hand shown in Fig.11 is an exclusive vacuum-type floating manipulator that can grasp (absorb) two parts at the same time and assemble them.

Shown above are various models of compact, high-precision industrial robots, and some examples of their applications. In humans, hand work is done by actually touching the parts, while the brain controls the movement of the hands and wrists to create the desired state. With industrial robots, the hand division is closely related to the type of job it is to perform as well as to the objects it is to handle, and it is very difficult to give it a mechanical function with the versatility of human hands. This is why robot hands are offered by makers as optional items.

However, as long as hands are treated as options, industrial robots will remain exclusive automata, each fitted with a specific purpose, no matter what claims are made about the utility value of giving arms multi-purpose features. The task facing the industry today is to overcome the technical limits inherent when exclusive hands are options, promote the effort to manufacture them as modules, and develop hands with multi-purpose features.

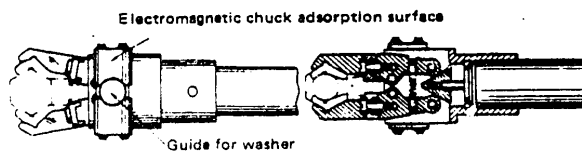


Fig. 9. Double Chuck-Type Handle

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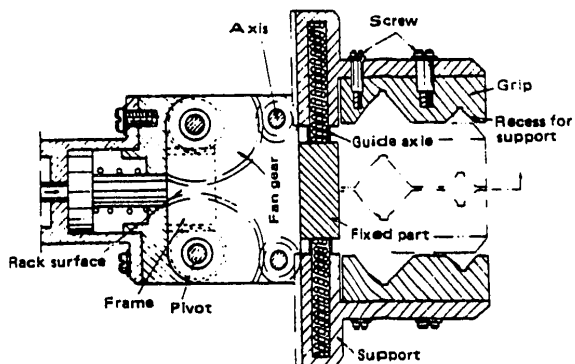


Fig. 10. Finger That Can Be Moved Horizontally

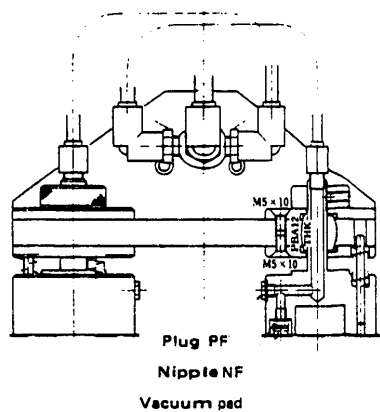


Fig. 11. Vacuum-Type Floating Manipulator for Model 100

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ANTIWEAR COATING BY ION PLATING--ION PLATING FOR CUTTING TOOLS OF HIGH SPEED STEEL

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 32-38

[Article by Akira Kono, product manager, ULVAC Corporation]

[Text]

### 1. Principles and Features of Ion Plating

Ion plating is a method of deposition by the bombardment of evaporated molecules which have been positively ionized in discharge, onto negatively biased substrates. In order to sustain glow discharge, an inert gas ( $10^{-2}$  -  $10^{-4}$  torr) is fed into the system and a voltage of some 100V is applied between the evaporation source and the substrate. These principles are illustrated in Fig. 1.1)

The greatest feature of ion plating is higher adhesion of coatings to substrates than that given by other PVD methods. Adhesion of ion plated films is shown in Table 1 as compared with conventional vacuum vapor deposition. The table indicates that ion plated films have adhesion 50 - 100 times that of ordinary vapor deposited films.

This can be ascribed to the following two factors.

- 1) Prior to evaporation, Ar glow discharge is introduced to the system by negatively biased substrates, and ionized Ar sputters away the surface contaminants of the substrates, consisting of adsorbed gas, fat, oil and oxides. This allows the evaporation on clean surfaces.
- 2) The evaporant, ionized in the glow discharge area is accelerated by an electric field, and clashes violently against the substrates, which produces a thin alloying layer composed of substrates, which enables a thin alloying layer composed out of the substrates and the evaporant between them.

An example of surface cleaning effects by ion bombardment is shown in Fig. 2 and the difference in the interface between ordinary vapor deposition and ion plating in Fig. 3.

The second important feature of ion plating is to easily provide compound films. Reactive evaporation has been attempted by many elaborators. It is the method which evaporates a reactive metal into the reduced active gas atmosphere

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to form a compound film. So far, despite efforts to minimize evaporation rates because of slow reaction, it has been difficult to obtain compound films which are stoichiometrically uniform. Ion plating, on the other hand, is quite easy to provide stoichiometrically uniform compound films by the activation effect of glow discharge.

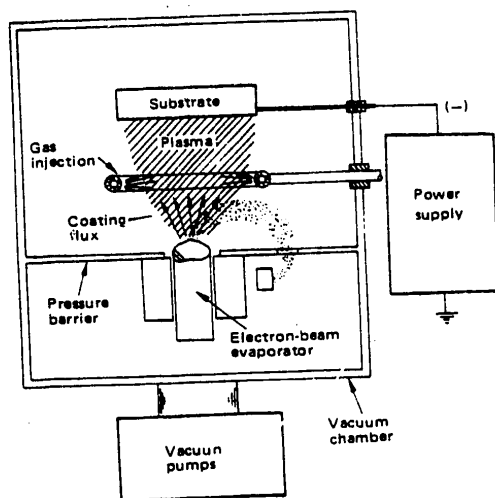


Fig. 1. Schematic of Ion Plating

Table 1. Adhesion of Ion Plated Films on Various Materials

	Evaporant	Matrix (kg/cm <sup>2</sup> )		
		Metal	Ceramics	Plastics
Ion plating	Al	150		100
	Cu	> 300	> 300	120
	Cr	> 300	> 300	> 300
	Al <sub>2</sub> O <sub>3</sub>	70	70	
	SiO <sub>2</sub>	> 300	> 300	
Evaporation	Al	5		< 1
	Cu	5		< 1

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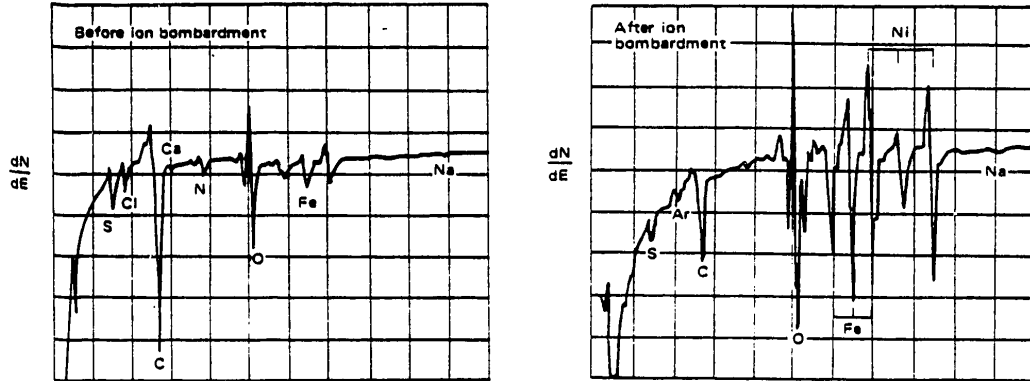


Fig. 2. Auger Electron Spectroscopy of Fe-Ni Alloy Before and After Bombard Cleaning (Before Bombard Cleaning Scarcely Appear Fe or Ni Atoms, but After 10 Min Bombard Cleaning (2,000Å) Impurities on the Surface are Almost Removed)

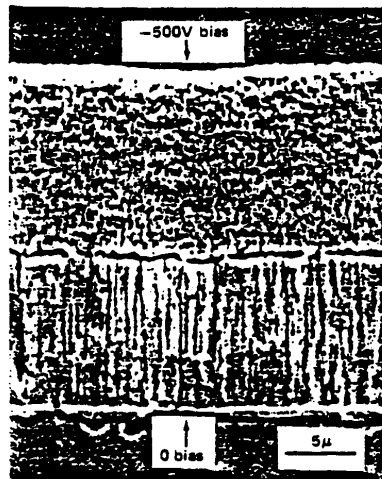


Photo 1. Cross Sectional Micro-Structure of Ion Plated and Vacuum Evaporated Ta Film (Ta is Evaporated without Biasing at First, and Then Evaporated with Biasing-500V)

Some types of compound films obtained by ion plating are shown in Table 2, together with their hardnesses.

The third feature of ion plating is that the films formed have excellent mechanical properties. Photo 1 shows a dendritic structure which is inevitable in the usual vacuum evaporation. In ion plating, the bombardment prevents growth of this structure and instead helps produce a desirable equiaxial crystal structure. At the same time, it increases the density of the formed films.

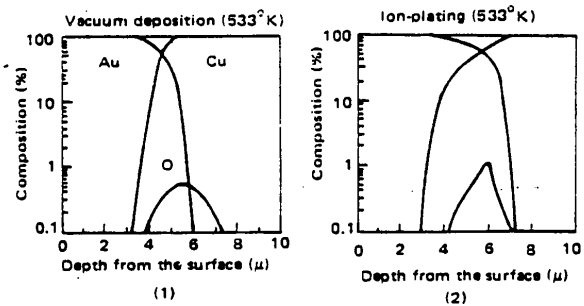


Fig. 3. Depth Profiles of Auger Electron Spectroscopy

- (1) Evaporated Au Film on Cu
  - (2) Ion Plated Au Film on Cu
- (S. Komiya et al; Japan J. Appl. Phys. Supple. 2, Pr 1) (1974) 363

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**FOR OFFICIAL USE ONLY**Table 2. Hardness of Ion Plated Compound Films  
at 500 to 550°C

Kind of coatings	Hardness (ks/mm <sup>2</sup> )
TiC	3,500
TiN	2,800
Cr <sub>3</sub> C <sub>2</sub>	3,500
CrN	2,000
VC	2,500
NbC	2,000
Mo <sub>2</sub> C	2,400

**2. Improvement of Ion Plating**

It has already been mentioned that ion plating owes its main features to evaporated molecules ionized in the Ar glow discharge charge.

DC glow discharge is typically about to ionize molecules up to at most 2 - 3%. In order to promote ionization and make the features of ion plating more prominent, efforts have been made to increase the ionization ratio with several proposed improvements. Conceptual diagrams for such improvements are shown in Fig. 4. The multi-cathode method<sup>2)</sup> aims to promote ionization with the aid of thermal electrons from the hot W filaments placed in the evaporation area. The high-frequency method (RF ion plating)<sup>3)</sup> and I-Gun method<sup>4)</sup> (induction gun ion plating) tries to activate ionization by electrons trapped in a high-frequency magnetic field. The auxiliary probe method is designed to attain higher percentages of ionization ratio of evaporated molecules with an intense discharge sustained by the positively biased probe located close to the evaporation source. There are also some other methods proposed. One is a method which uses a special low-voltage high-current electron gun (a hot hollow cathode discharge gun) instead of the usual high-voltage electron gun, as an evaporation source, to strikingly increase the ionization ratio by this large current.<sup>5)</sup> Another is a cluster ion method<sup>6)</sup> which allows ionized molecules to evaporate in clusters with a number of neutral molecules to create an effect equivalent to the state of increased ionization. These methods generally increase the ionization ratio by a factor of about 10.

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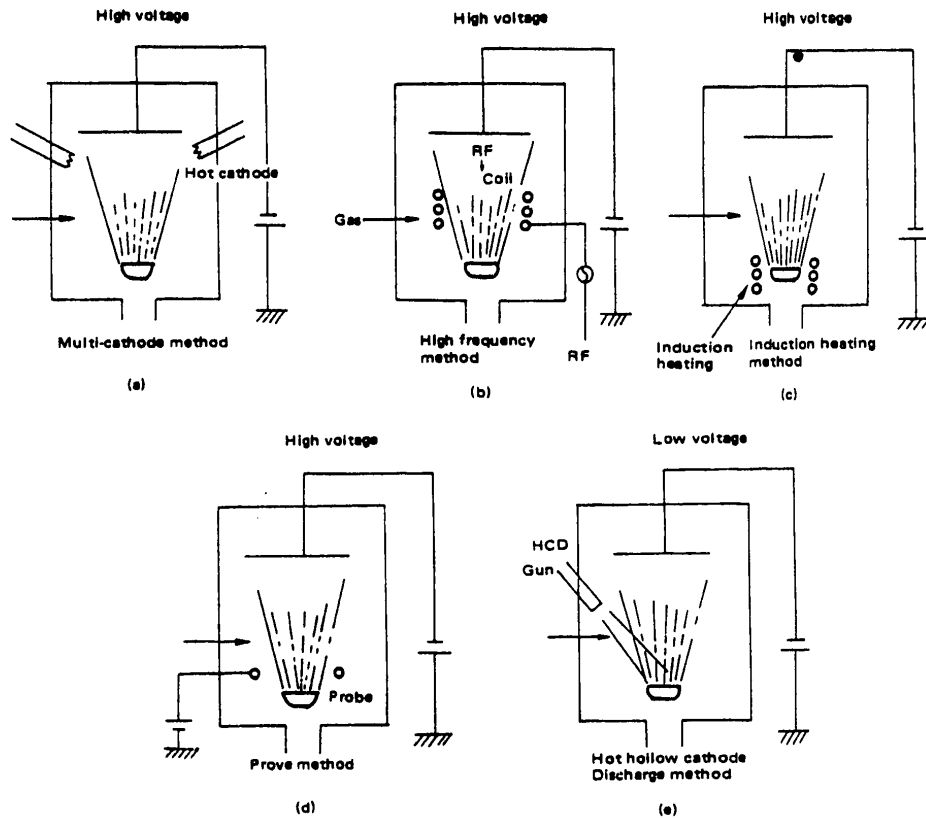


Fig. 4. Some Improved Methods of Ion Plating

3. Applications of Ion Plating

Ion plating was once called "dry plating" as a pollution-free plating method to replace conventional electro plating, and there prevailed an illusion that it would quickly replace electroplating. Today, in practice taking advantage of the above features, it has achieved steady application primarily in forming compound films, which cannot be coated by electroplating. And its application to antiabrasive plating appears to be replacing hard chrome plating, which is the most expensive of all electroplating systems.

3-1. Plating of High-Speed Steel Cutting Tools with Ti C and Ti N<sup>7,8,9,10,11</sup>.

As an ideal surface treatment method for cutting tools made of high-speed steel (which requires two contradictory characteristics, high tenacity and high anti-wear, in addition

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to strict dimensional accuracy), ion plating with nitrides and carbides has achieved practical utilization in the past few years.

Ion plating on high-speed steel has the following advantages:  
 a) It is able to tightly coat highly tenacious high-speed steel with very hard films (TiC: 3,000 kg/mm<sup>2</sup>; TiN: 2,500 kg/mm<sup>2</sup>).

b) The coating temperature is sufficiently lower than tempering temperature of high speed steel (600°C). Therefore, it does not permit substrates to be deformed and transformed during processing. Thus, it is applicable to precision tools.

c) Because compounds such as TiN and TiC have less affinity for ordinary steel than for high-speed steel, ion plated tools with these compounds involves less seizure and are likely to provide smoother finished surfaces.

d) Since coating thickness is allowed to be as small as about 2μ, it will not affect surface roughness. Thus, it will not change the roughness of finished surfaces.

As a result, ion plating is very effective as an anti-wear surface coating method for tools made of high-speed steel, particularly hob cutters and pinion cutters, which especially require dimensional accuracy. In addition, the advantageous situation which results from increased coating costs being small relative to the high unit costs of precision tools is playing an important role in the prevalence of this technology.

An example of a machining test with TiN coated hob cutters is shown in Fig.5. The hob is coated with TiN 2μ thick, which has essentially, a hardness of 2,500kg/mm<sup>2</sup>. Practical use of hob cutters and pinion cutters in a production line is shown in Fig.6. The use of TiN coated hob cutters doubled cutting speed with a substantial reduction in tool wear. In comparison in terms of cycle time, this means that the efficiency of processing was nearly doubled while tool life was substantially increased. Additionally, the technique effected a reduction in shaving time (as a subsequent process) because high speed cutting lift no pluckings on machined gear surfaces. With hob cutters, the effects of matrices and cutting speeds are shown in Fig.7. With matrices of coated tools used in low-speed cutting ranges, tenacity seems to play a more important role than thermal resistance and antiwear. In high-speed cutting, on the other hand, resistance to heat and abrasion is more important for matrices of coated tools than is tenacity. (So, where coating matrices with low tenacity are used, high-rigidity hobbing machines have to be used to prevent tipping.)

An example of coating of endmills with TiN is shown in Fig. 8. It is known that characteristics depend considerably on materials to be cut and the shape of endmills. Also it is generally known that, although it is very effective in dry cutting without cutting oil, this plating is not so effective in low-speed cutting as in high-speed cutting when cutting oil is used.

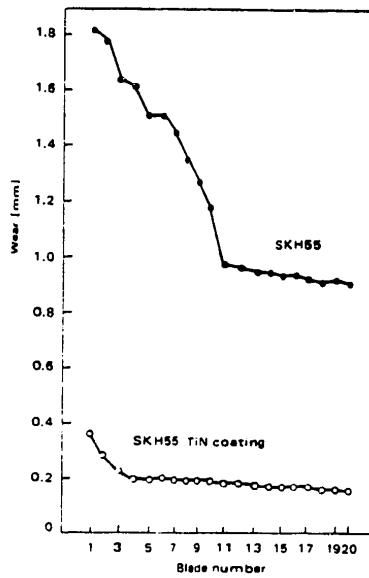
Also, it has been proved that the lives of drills can be prolonged by the use of coatings.

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The factor which is limiting the spread of applications of ion plating to high-speed steel tools is processing cost. In order to process a large quantity of relatively small tools such as drills and end mills, specimens have to be rotated and turned around at a temperature of around 500°C. This causes the problem of manufacturing effective jigs which restricts the uses the plating technology. At the present moment, it seems to be no economical approach to coat drills.

In addition, applications also have been found in press tools of high speed steels and hot die steels. But because they widely vary in shape and service conditions, coating conditions have to be developed in cooperation with users.



Comparison of wear between non-coated hqb and TiN coated hob (with a score 20 at the largest wear)

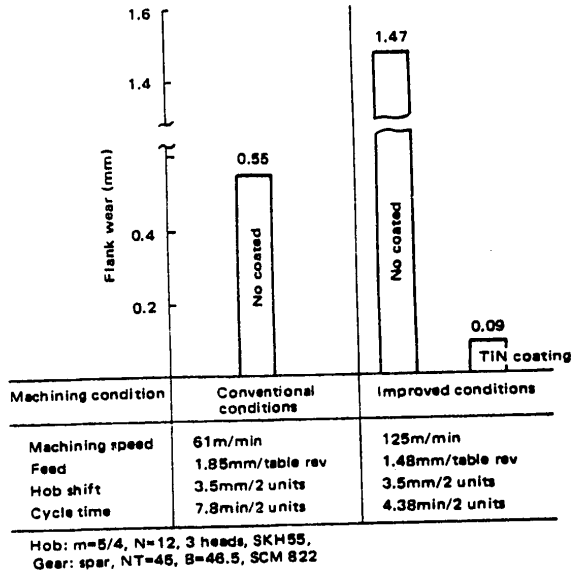
Requirements for hob cutting

Machine: Hobbing machine made by Shinohara Kikai Co.  
 Work material: S45C as forged (HRC 18-25)  
 Cutting speed: 40m/min  
 Feed: 1mm/work-rev.  
 Hob shape:  $\phi 75 \times 75 \times \phi 31.75$   
 Gearing:  $m^2 PA20^\circ; 2=14; 100\text{mm finish}$   
 Shift: 6mm; one point; 10-piece cutting  
 Lubrication oil

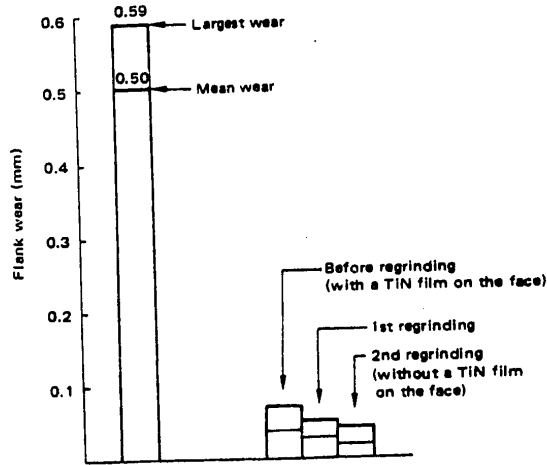
Fig. 5. A Machining Test Data of TiN Coated Hob Cutter<sup>11)</sup>

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(a)  
Hob cutter



Pinion cutter:  $m=2.5$ ,  $NT=54$ , SKM 9, gear: spur,  $NT=37$ , SCM 415,  
cutting conditions: cutter stroke 700/1,050 str/min, cutting speed  
44/66m/min, circumferential feed 0.5/0.24mm/str, radial feed  
0.04/0.01mm/str, number of cuts 120

(b)  
Pinion cutter

Fig. 6. Field Test Data of TiN Coated Hob and Pinion  
Pinion Cutters<sup>8)</sup>

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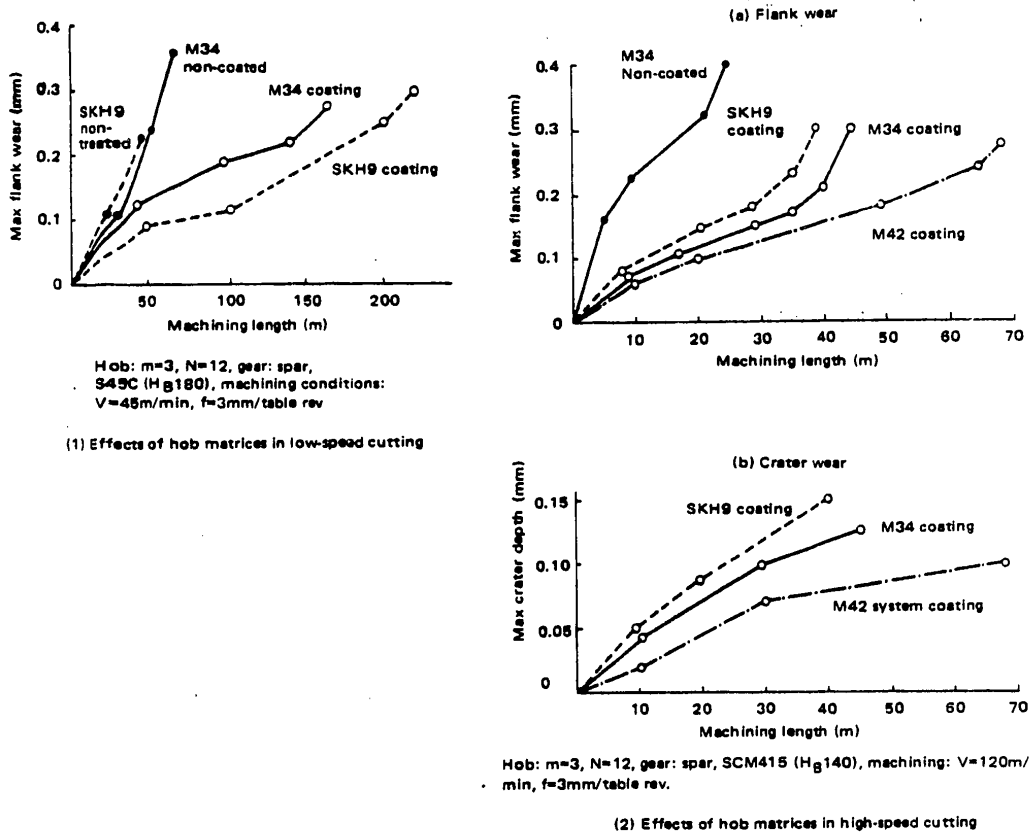
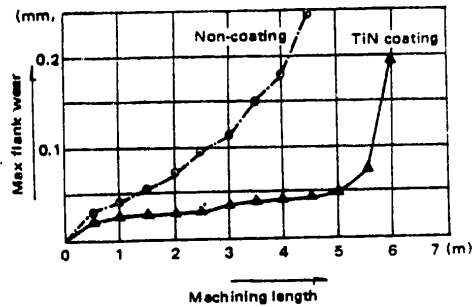


Fig. 7. Effect of Matrix on Wear Resistance of TiN Coated Hob Cutter<sup>8)</sup>

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Tool: endmill  
 $\phi 10 \times 25 \times 75$  KMC2 M series double blade  
 Machining conditions:  $V=18\text{m/min}$   
 $F=130\text{mm/min}$   
 $20 \times 1.0$  step cutting  
 Material to be cut: SKD 4 H<sub>B</sub> 310

Fig. 8. Typical Results of Machining Test with TiN Coated Endmill<sup>7)</sup>

### 3-2. Decorative Antiwear Coatings

As the price of gold rises, increasing attention is being paid to TiN ion plating for coatings golden in color and having greater resistance to corrosion and abrasion than do gold platings. TiN plated watch cases are already on the market and this plating technique is being extended to watch bands.

Color tones are freely variable from whitish gold to reddish gold by varying the flow rates of  $N_2$  in reactive ion plating.

It should be carefully noted that inclusion of carbon and oxygen in coatings will make color tones red-dark.

Coatings approx.  $1.5 - 2.0\mu$  thick will provide far better resistance to scratching, corrosion and sweat than conventional gold plating.

Chrome nitride is also hard ( $H_v: 3,500\text{kg/mm}^2$ ) and its color is mild whitish silver, so, its practical use for decorative coatings on watch accessories can soon be expected.

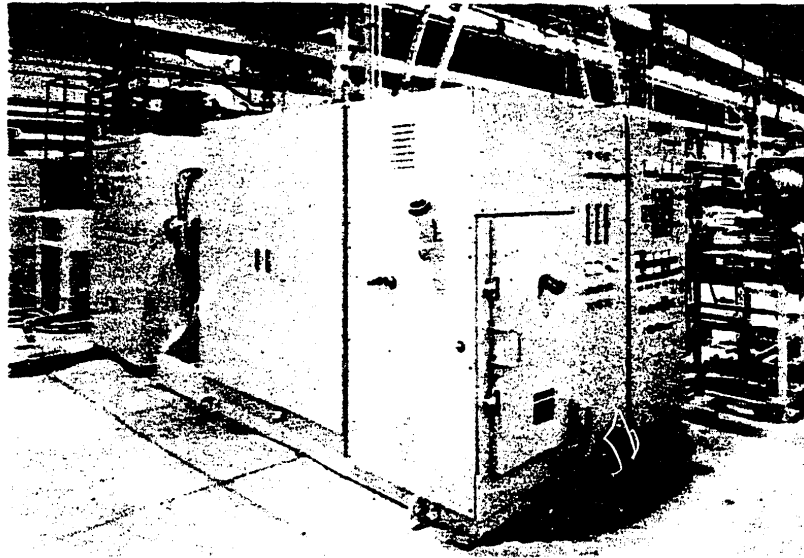
### 3-3. Ion Plating as an Alternative Technology to Hard Chrome Plating

As restrictions on pollution are becoming tighter and it is becoming increasingly difficult to acquire land for disposal of plating sludge, along with increasing costs for antipollution processing, renewed attention is being paid to ion plating as a technological alternative to hard-chrome plating.

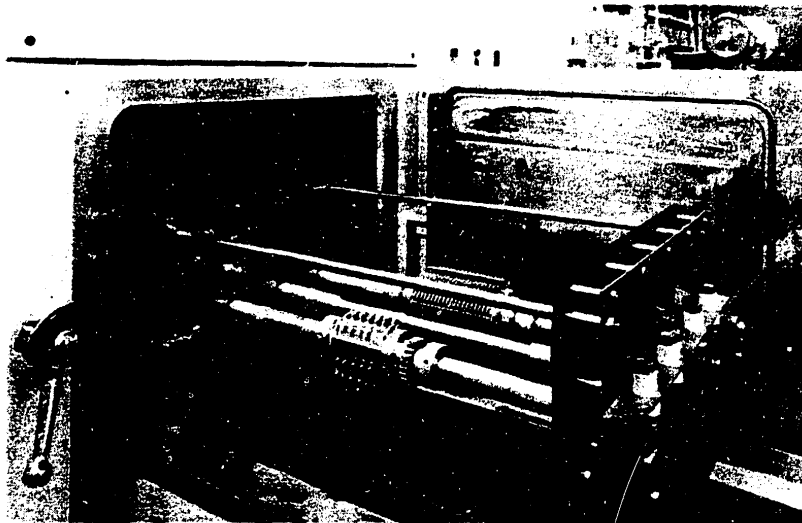
Generally it is desired to replace conventional  $20 - 25\mu$  chrome plating with ion plating with  $2 - 5\mu$  TiN or chrome nitride of greater hardness.

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Ion-Plating Machine (ULVAC Corp.)



Jig Fixture

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Some estimations have been made proving that the application of high-productivity systems (in-line systems) having very high rate evaporation source will be comparable with conventional electrical-plating in terms of cost. Thus, it is expected that ion plating with 2 - 5 $\mu$  compound films may be able to replace conventional plating for parts which do not involve highly concentrated stress.

**4. Conclusion**

Thus far, we have outlined current ion plating technology in Japan.

Although the sputtering method seems to find increasing application in the formation of compound coatings because of its advantages of high operability and easily providing desired compound coatings subject to sintered compound targets, its applications may be confined to those fields where adhesion of coatings is not so important. (A typical such field is electronics.)

As a technology for surface hardening which provides high adhesion to matrices in particular, ion plating seems to find increasingly wider application as its technology matures.

Ion plating has the drawback of poor throwing power because it uses point-like evaporation sources. Also, for matrices having complicated shapes, processing may be impossible or may require fixtures such as complicated jigs for rotation and orbital revolution, contributing to a reduction in productivity and consequent rises in processing costs.

Recently, attention is being paid to the plasma CVD method which adds discharge to the conventional chemical vapor deposition method - in other words, ion plating using volatile halogenated metals (instead of evaporating metals) as sources of evaporants. This method enables conventional processing temperatures by the CVD method to be lowered by 300 - 500°C and is able to form compound coatings such as TiC and TiN at temperatures around 500°C. At present, the lower limit of temperature which ensures sufficient adhesion to for cutting tool applications is 600°C, a short step up from the tempering temperature of high-speed steel.

With ion plating, on the other hand, attempts are being made to develop technology for forming antiwear coatings having high adhesion at a temperature of 200°C (equal to the tempering temperature of alloy steel) by developing pretreatment technology or technology for surface cleaning before plating and encouraging results are anticipated.



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References

- 1) D.M. Mattox; J. Vac. Sci. Technol, 10 (1973) 47
- 2) K. Matsubara; Patent No. 817356
- 3) Y. Murayama; Japan J. Appl. Phys. 13 (1974) 459 Y. Murayama, M. Matsumoto and K. Kashiwagi; "Oyo Butsuri"; 43 (1974) 687
- 4) G.W. White et al.; J. Vac. Sci. Technol 13 (1976) 680
- 5) S. Komiya, K. Tsuruoka; J. Vac. Sci. Technol, 13 (1976) 520 Y. Koh; "Kinzoku Zairyo", 17 (1977) No. 11, 96
- 6) T. Takagi; "Zairyo Kagaku", 12 (1975) 220
- 7) M. Takeuchi; Y. Yamada; "Kobeseiko Kogugihō" No. 27 (1980) 6
- 8) H. Yoshioka; "Seimitsu Kikai"; 46 (1980) No. 5, 9
- 9) Y. Tanozaki, M. Hattori; "Kinzoku" '79/10, 85
- 10) Y. Doi, S. Hori; "Japan Machinist" No. 206, 207 (1978)
- 11) Y. Yoshida; "Kikai Gijutsu", 27 (1978) No. 2, 49

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## HIGH-SPEED AND HARD ANODIZING

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 39-44

[Article by Yoshio Fukuda, National Research Institute for Metals, and Toshiro Fukushima, National Research Institute for Metals]

[Text]

## 1. Introduction

In general, hard anodizing of aluminum has been carried out in sulfuric acid at low temperatures below 10°C.<sup>1)</sup> It is considered that compact films can be obtained at low temperatures because of high formation voltages, and that thick films can be obtained because of the low rate of dissolution of porous layers during the course of anodization. However, this process requires special refrigeration facilities, and films become cracked. A process operating at moderate temperatures is desirable.

For this purpose, either dilute sulfuric acid or an organic acid whose solvent action on the oxide film is weak above ordinary temperatures, are suitable as the electrolyte, because hard films which possess large cells and a small number of pores can be formed at the high voltage. Dilute sulfuric acid is liable to produce pitting,<sup>2)</sup> and organic acids are liable to produce uniform films.<sup>3,4)</sup> However, studies of hard anodizing above ordinary temperatures are few. Although malonic acid yields hard films at 40 to 60°C,<sup>5)</sup> it is liable to decompose into CH<sub>3</sub>COOH and CO<sub>2</sub> at high temperatures<sup>6)</sup>.

Recently, it was found<sup>7,8)</sup> that crack-free films with hardness above Hv 500 are formed in tartaric or malic acid baths at temperatures above 60°C. However, these acids have the disadvantage that the bath voltage is too high (above 150V for high purity aluminum) and uniform films cannot be formed on alloys such as A6063 (Al-Mg-Si). Additives to overcome these difficulty were investigated.<sup>9)</sup> By addition of 0.2 mol dm<sup>-3</sup> oxalic acid to 1 mol dm<sup>-3</sup> tartaric or malic acid, films with hardness Hv 300-420 were obtained on A6063 alloy at 40 to 50°C.<sup>10)</sup> However, the bath voltage was still high (105 to 140V at 5.65 A dm<sup>-2</sup>).

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The bath voltage can be lowered by further addition of oxalic acid, but the dissolution of the cell wall during anodization is accelerated, leading to a decrease in the hardness of the film. Simultaneous attainment of an increase in hardness and decrease in bath voltage is impossible.

With the aim of producing films with hardness above Hv 400 at voltages below 100V, tartaric-oxalic acid electrolyte was improved. The dependence of hardness on the anion content and porous structure of the film was also investigated.

**2. Effect of pH and Oxalic Acid Concentration**

An increase of the pH of the electrolyte is necessary to reduce the rate of chemical dissolution of the porous layer during the course of anodization above room temperature. However, the rise in bath voltage, which follows the rise in pH and induces burning, should be suppressed as much as possible. There are two means for raising the pH, dilution of acid and addition of a base without dilution. In a dilute oxalic acid bath of high pH, the bath voltage is so high that burning is liable to occur, whereas in a bath with high oxalic acid concentration, adjusted to the same pH, the voltage is lower than in the dilute acid bath.<sup>11,12)</sup> The lower the pH and the higher the oxalic acid concentration, the more the oxalate is involved in the film. The chemical dissolution rate of the film is independent of the oxalate concentration of the bath, and the film becomes soluble when the oxalate content of the film is higher and the pH of the bath lower. It seems that the barrier layer formed in a bath with concentrated oxalic acid, adjusted to a high pH, contains more oxalate than that formed in a dilute acid bath of the same pH so that the electrochemical dissolution of the layer is accelerated, lowering the bath voltage at a constant current density. This might occur also in the case of oxalic acid mixed with tartaric or malic acid. In a tartaric or malic acid bath with high oxalic acid concentration, adjusted to a high pH, the bath voltage would be lower than that in a bath with low oxalic acid concentration. Even if the bath voltage were decreased, the rate of dissolution of the cell wall would be relatively low because of a high pH, so hardness of the film would not decrease remarkably.

**3. Experiment**

Plates of extruded aluminum alloy A6063-T5,<sup>13)</sup> 3mm thick and 40mm wide, were cut into 100mm lengths (surface area=88.4cm<sup>2</sup>). Each was racked to a holder made of pre-anodized tantalum wire, 1mm diam., and treated with an aqueous solution of 1.25 mol dm<sup>-3</sup> NaOH at 80°C for 30s. They were then successively rinsed, neutralized with 15%

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$\text{HNO}_3$ , rinsed and anodized. A 5 dm<sup>3</sup> beaker was used as an electrolytic cell, cathodes being made of two plates of carbon (250x50x10 mm).

Tartaric acid which can produce films at lower voltages than malic acid was used as the primary component of the electrolyte mixed with oxalic acid or oxalic acid and triethanolamine<sup>14)</sup> (Table 1). The bath temperature was kept at 30, 40, and 50±1°C. While the solution was stirred with a propeller at about 330 min<sup>-1</sup>, galvanostatic anodization using a three-phase full-wave rectifier was carried out at 2.26 A dm<sup>-2</sup> for 50 min and at 5.65 A dm<sup>-2</sup> for 20 min. Current was controlled to a specified value within 15s after switching on.

The hardness was measured on the surfaces of two anodized specimens at three points each, using a micro Vickers hardness tester with a load of 100g. The average of six readings was taken. The microstructure of the anodized surface was observed with an electron microscope using a one-step carbon replica at an accelerated voltage of 50kV. The carbon content of the film was determined by analysis of CO<sub>2</sub> gas produced by combustion (1,300°C, carrier gas O<sub>2</sub>) of the film.<sup>12)</sup> The film was isolated by the cathodic reduction method.

Table 1 Composition and pH of Electrolytes

Tartaric acid mol dm <sup>-3</sup>	Oxalic acid mol dm <sup>-3</sup>	Triethanolamine mol dm <sup>-3</sup>	pH (at 25°C)
1	0.2	0	0.80
1	0.2	0.13	1.00
1	0.2	0.22	1.25
1	0.4	0	0.67
1	0.4	0.26	1.00
1	0.4	0.34	1.25
1	0.6	0	0.60
1	0.6	0.43	1.00
1	0.6	0.54	1.25
1	0	0	1.28

## 4. Results

## 4-1. States of the Anodized Surface

When anodizing was carried out in a bath with 0.2 mol dm<sup>-3</sup> oxalic acid, adjusted to pH 1.00 and 1.25, at 5.65 A dm<sup>-2</sup>, burning occurred. Under all other conditions uniform films were formed. The thickness of each film was about 35µm. Films were colored, no cracks being observed. The color of the films formed at 2.26 A dm<sup>-2</sup> was grayish yellow and that of the films formed at 5.65 A dm<sup>-2</sup> reddish dark yellow. The lightness of the color increased with increase in oxalic acid concentration and rise in temperature.

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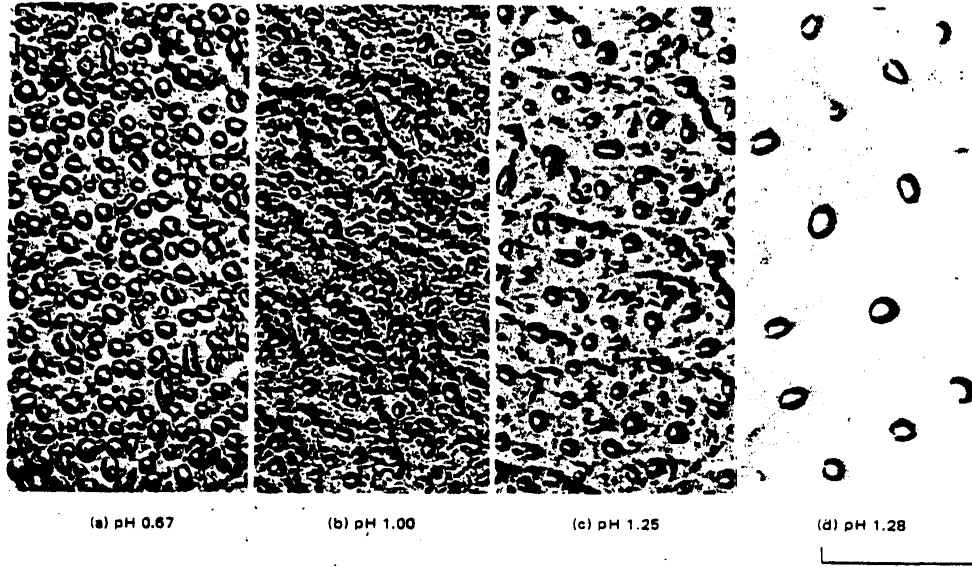


Photo 1. Replica Electron Micrographs of Films Formed in (a)  $1 \text{ mol dm}^{-3}$  Tartaric Acid  $-0.4 \text{ mol dm}^{-3}$  Oxalic Acid, (b)  $(a) + 0.26 \text{ mol dm}^{-3}$  Triethanolamine, (c)  $(a) + 0.34 \text{ mol dm}^{-3}$  Triethanolamine, and (d)  $1 \text{ mol dm}^{-3}$  Tartaric Acid, at  $40^\circ\text{C}$  and  $2.26 \text{ A dm}^{-2}$  for 50 min.

#### 4-2. Bath Voltage

The time dependence of the bath voltage is shown in Fig.1. The voltage dropped after the critical point "c" and then rose gradually. The slope of the voltage-time curve after point "c" decreased with increase in oxalic acid concentration, rise in temperature and lowering in current density.

The minimum bath voltage immediately after the critical point ( $E_{min}$ ) increased with increase in pH and decreased with increase in oxalic acid concentration (broken line, Figs.2a-c and 3a-c). The tendency was recognized also in the case of the final voltage ( $E_f$ , solid line). However, when the oxalic acid concentration was  $0.2 \text{ mol dm}^{-3}$ , the  $E_f$  at pH 1.25 was lower than that at pH 1.00. The bath voltage decreased with rise in temperature and increased with increase in current density.

#### 4-3. Hardness of the Film

As shown in Figs.2d-f and 3d-f, the hardness increased with increase in pH and decreased with rise in temperature. At constant pH and temperature, the hardness decreased with oxalic acid concentration. There was little change in

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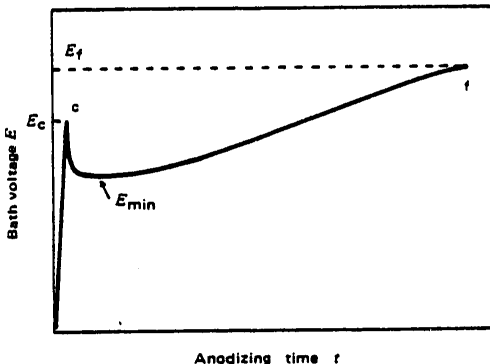


Fig. 1. Time Dependence of Bath Voltage in Galvanostatic Anodizing

the hardness with current density. By comparing the hardness with bath voltage, it was found that films with hardness above Hv 430 are formed in baths consisting of  $1 \text{ mol dm}^{-3}$  tartaric acid with  $0.4$  to  $0.6 \text{ mol dm}^{-3}$  oxalic acid at pH 1.00 and 1.25 with voltage 65 to 85V at  $40^\circ\text{C}$ .

#### 4-4. Carbon Content and Hardness of the Film

The carbon content of the film was determined in order to examine the effect of electrolyte anions on the hardness of the film. The hardness was found to be independent of the carbon content of the film.

#### 4-5. Microstructure and Hardness of Films

Replica images of the film surface are shown in Photo 1. The number of pores in films formed in mixed baths (a-c) is larger than formed in films formed in tartaric acid alone (d). There is a difference in the number and radius of pores in the films, as shown in Photo 1 a-c. The number (surface density,  $\text{m}^{-2}$ ) and radius (nm) of pores were measured on the photographs, and the total area of pores was calculated. The parameters are plotted against the anodizing variables (Figs. 4 and 5) and the hardnesses of the film (Fig. 6). The hardness increased with a decrease in the number and area of pores, but did not correlate with the radius of pores.

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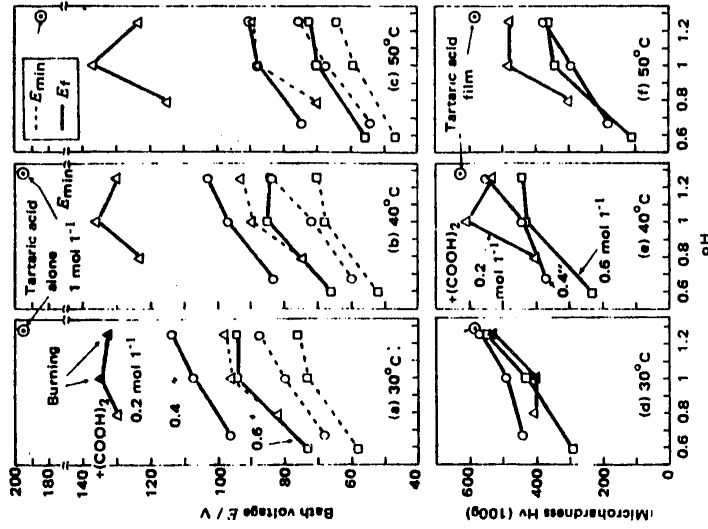


Fig. 3. Dependence of Bath Voltage and Hardness of Films on pH of Electrolytes at Various Temperatures and Oxalic Acid Concentrations (5.65 A dm<sup>-2</sup>, 20 min, A6063 alloy)

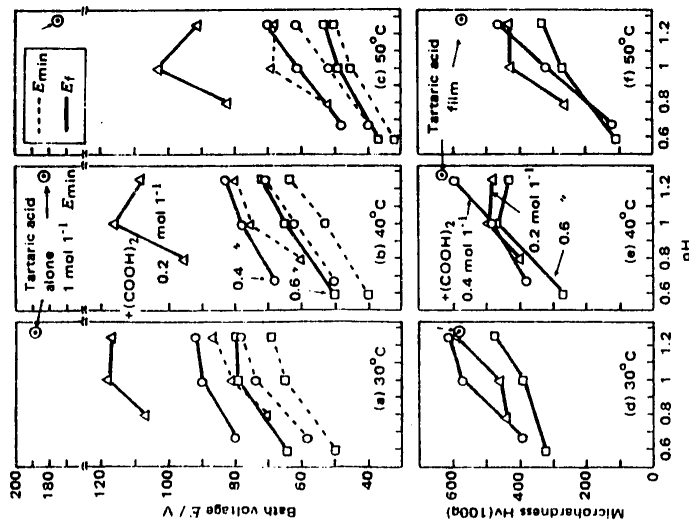


Fig. 2. Dependence of Bath Voltage and Hardness of Films on pH of Electrolytes at Various Temperature and Oxalic Acid Concentrations (2.26 A dm<sup>-2</sup>, 50 min, A6063 alloy)

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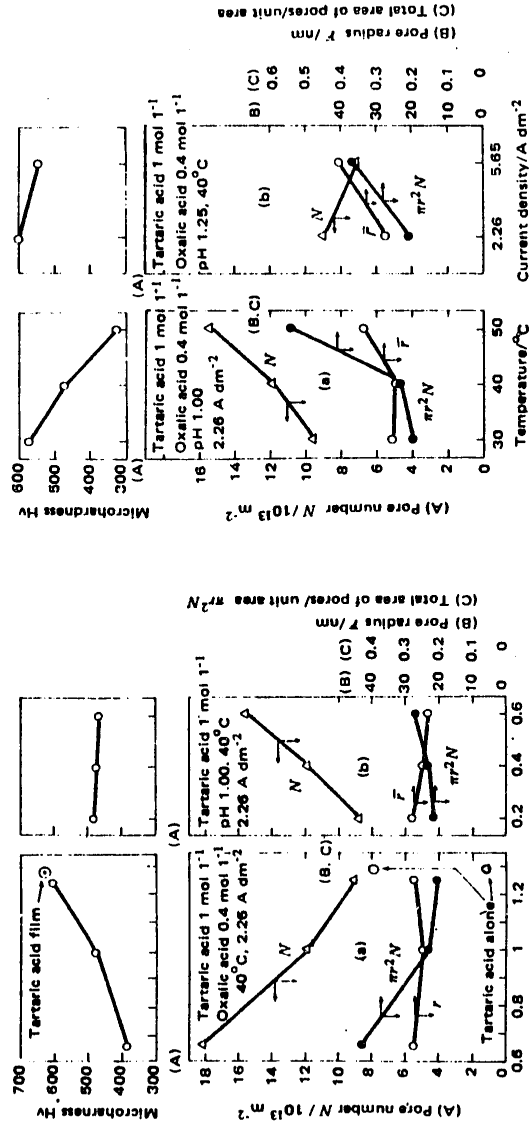
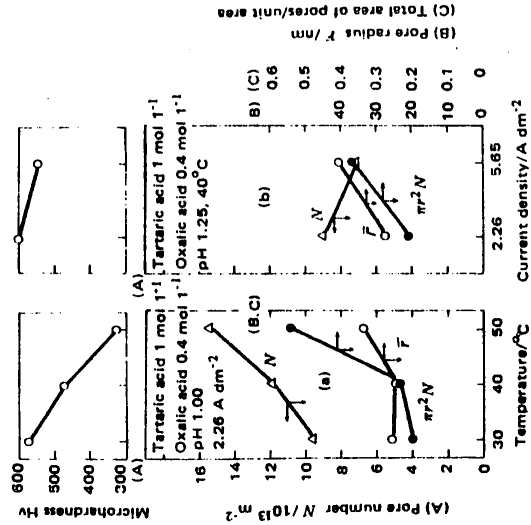


Fig. 4. Dependence of Number, Radius and Total Area of Pores on Electrolyte pH and Oxalic Acid Concentration

Fig. 5. Dependence of Number, Radius and Total Area of Pores on Temperature and Current Density



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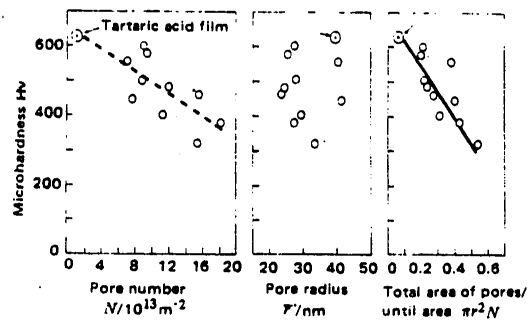


Fig. 6. Dependence of Hardness of Films on Number, Radius and Total Area of Pores

### 5. Discussion

When the pH of a tartaric-oxalic acid electrolyte is raised by addition of triethanolamine, the electrochemical dissolution of the barrier layer is so suppressed that the bath voltage generally increases to maintain a constant current flow. The role of triethanolamine in this case is considered to be only suppression of dissolution of the film by reducing the acidity of the tartaric-oxalic acid electrolyte, as in the oxalic acid-triethanolamine bath.<sup>12)</sup>

The porous layer contains a considerable amount of electrolyte anions,<sup>15)</sup> the anion content of the phosphoric,<sup>16)</sup> oxalic,<sup>11)</sup> or sulfuric<sup>17)</sup> acid film becoming maximum at a point between the wall/solution interface and the cell boundary. Electrolyte anions are considered to migrate through the barrier layer. Assuming that electrolyte anions are immobile, the porous layer arising from the barrier layer formed only by anion ( $O^{2-}$  and  $OH^-$ ) migration<sup>18)</sup> would contain no electrolyte anions.

The radius of oxalate ions seems to be smaller than that of tartrate ions. Thus oxalate ions are more mobile than tartrate ions in the barrier layer. The solvent action of oxalic acid on the oxide film is stronger than that of tartaric acid. The bath voltage rises gradually with anodizing time (Fig. 1). As the porous layer grows, the supply of oxalic acid by diffusion from the bulk of the solution to the surface of the barrier layer is retarded,<sup>19)</sup> the dissolution of the barrier layer is suppressed and the layer gradually becomes thicker, leading to a gradual rise in bath voltage. In  $0.2 \text{ mol dm}^{-3}$  oxalic acid baths, the  $E_f$  at pH 1.25 is lower than that at pH 1.00. At pH 1.25, a local rise in temperature of the anode might occur<sup>20)</sup> owing to uneven current distribution. However, apparently uniform films were formed.

According to the theory of ionic equilibria,<sup>21)</sup> in pH range

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0 to 1.25, little tartaric acid dissociates, while 5 to 48% of the oxalic acid dissociates into  $\text{HC}_2\text{O}_4^-$  ions. For instance, at pH 1.00, 99% of the tartaric acid remains undissociated, while 65% of the oxalic acid remains undissociated and 35% of the oxalic acid is present as  $\text{HC}_2\text{O}_4^-$  ions. When this mixed acid has the same pH value,  $\text{HC}_2\text{O}_4^-$  ion concentration increases with the addition of oxalic acid, causing a decrease in bath voltage.

No cracks were observed in films obtained in high temperature processing. From the fact<sup>22)</sup> that cracks increase as the anode warms up to room temperature after withdrawal, it can be concluded that the film formed by the low temperature process may easily be cracked under the influence of tensile stress caused by expansion of the anode. On the other hand, in the case of the high temperature process, when the anode is cooled to room temperature after withdrawal, the film undergoes compressive stress by contraction of the anode, but it can withstand the stress.

The hardness of the film is controlled by the geometrical structure of the film, but not the carbon or anion content of the film. The hardness of the film is closely related to its porosity,<sup>23)</sup> but the porosity varies with the number of pores and radius of pores. Hardness seems to be related to the wall thickness. The relation between these parameters and the hardness was examined in detail.

Higher pH gave a harder film with a smaller number of pores and smaller area of pores, or lower porosity (Fig.4a). The distance between the pores, or wall thickness, increases with increase in pH (Photo 1). Lower oxalic acid concentration gave a harder film with a smaller number of pores and lower porosity (Fig.4b), the cell wall becoming thicker. Lower temperature also gave a harder film with a smaller number of pores and lower porosity (Fig.5a). The cell wall became thicker with the lowering of temperature, the parameters changing with current density (Fig.5b). When the current density was high, the number of pores was small but the porosity was high and the hardness value small. In this case, the relation between the number of pores and the hardness was opposite to that obtained in other cases. The bath voltage at  $5.65 \text{ A dm}^{-2}$  was higher than at  $2.26 \text{ A dm}^{-2}$ , thus the cell wall near the pore base should have been thicker. However, the thicknesses of the walls near the surface were nearly the same as those of walls formed at  $2.26 \text{ A dm}^{-2}$  (Photo 2b). When the current density was high, considerable heat was generated from the anode, making heat transmission insufficient and causing easy dissolution of the film. No definite relation was found to exist between hardness and the radius of the pores (Fig. 6).

When the bath voltage was raised, the cell wall as well as the barrier layer became thicker and the number of pores decreased (Fig.7), leading to a decrease in porosity and increase in hardness. Thus, in many cases, hardness was related to number of pores, wall thickness and porosity. However, the number of pores was not closely related to hardness (Fig.6). As shown in Photo 2, film (a) is harder

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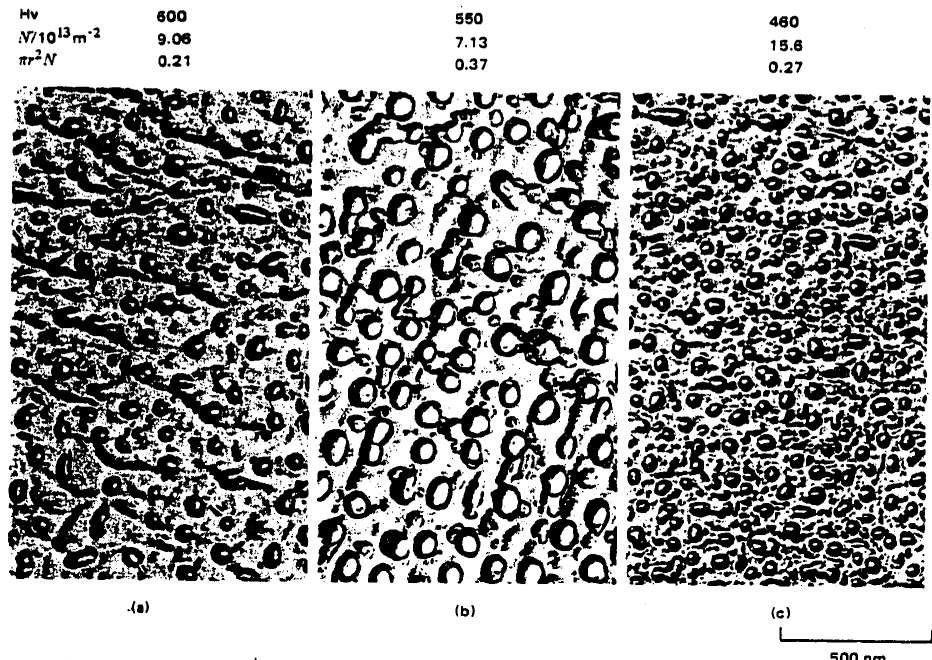


Photo 2. Porous Structures (Replica Image) and Hardnesses of Films. (a)  $1 \text{ mol dm}^{-3}$  Tartaric Acid— $0.4 \text{ mol dm}^{-3}$  Oxalic Acid— $0.34 \text{ mol dm}^{-3}$  Triethanolamine, pH 1.25,  $40^\circ \text{C}$ ,  $2.26 \text{ A dm}^{-2}$ , 50 min. (b) The Same Bath as (a),  $5.65 \text{ A dm}^{-2}$ , 20 min. (c)  $1 \text{ mol dm}^{-3}$  Tartaric Acid— $0.6 \text{ mol dm}^{-3}$  Oxalic Acid— $0.43 \text{ mol dm}^{-3}$  Triethanolamine, pH 1.00,  $40^\circ \text{C}$ ,  $2.26 \text{ A dm}^{-2}$ , 50 min.

than film (b), while (a) has a larger number of pores than (b). This is due to the lower porosity of (a). Film (b) is harder than film (c), while (b) has a higher porosity than (c). This is due to the thicker wall of (b).

The hardness of the film is controlled by the wall thickness and porosity of the film, but not the anion content of the film; the thicker the wall and the lower the porosity, the harder the film.

### 6. Conclusions

High temperature hard anodizing of A6063 alloy was tested in baths of  $1 \text{ mol dm}^{-3}$  tartaric acid with 0.2 to  $0.6 \text{ mol dm}^{-3}$  oxalic acid and 0 to  $0.54 \text{ mol dm}^{-3}$  triethanolamine, at  $30$  to  $50^\circ \text{C}$ , and at current densities of  $2.26$  and  $5.65 \text{ A dm}^{-2}$ . The results were as follows:

- 1) In the tartaric-oxalic acid baths, the films formed by addition of  $0.2 \text{ mol dm}^{-3}$  oxalic acid gave hardnesses above Hv 400, but the bath voltage was too high (above 100V).

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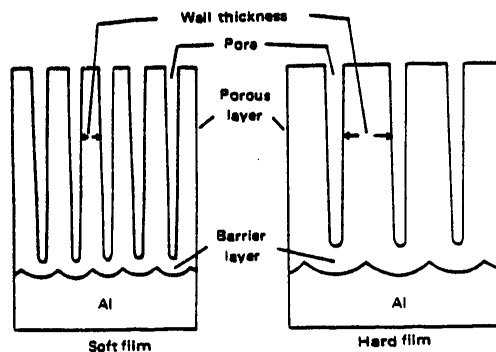


Fig. 7. Porous Structure (Cross Section) and Hardness of Film

When the oxalic acid concentration was increased to 0.4 to 0.6 mol dm<sup>-3</sup>, the hardness of the films as well as the bath voltage decreased.

2) When 1 mol dm<sup>-3</sup> tartaric acid—0.4 to 0.6 mol dm<sup>-3</sup> oxalic acid baths were adjusted to pH 1.00 and 1.25 with triethanolamine (0.26 to 0.54 mol dm<sup>-3</sup>), crack-free films with hardnesses above Hv 430 were formed at 40°C with voltage 65 to 85V.

3) The hardness of the film is independent of the anion content of the film, increasing with increase in the thickness of the cell wall and decrease in porosity.

## References:

- 1) S. Wernick and R. Pinner, "The Surface Treatment and Finishing of Aluminium and Its Alloys," 4th ed. Robert Draper Ltd., Teddington (1972), Vol.2, p.566.
- 2) P. Csokán and M. Holló, *Werkst. Korros.*, 12, 288 (1961)
- 3) S. Tajima, S. Itoh, and T. Fukushima, *Denki Kagaku*, 23, 342, 395 (1955).
- 4) T.L. Sharma and Y.N. Trehan, *NML Technical Journal (India)*, 18, 54 (1976).
- 5) J.M. Kape, *Metallurgia (Brit.)*, 60, 181 (1959)
- 6) J.M. Kape, *Brit. Patent* 1173597 (1965).
- 7) T. Fukushima and Y. Fukuda, *Japan, Patent* 705694 (1973).
- 8) Y. Fukuda, *J. Metal Fin. Soc. Jpn.*, 27, 398 (1976).
- 9) Y. Fukuda, *J. Metal Fin. Soc. Jpn.*, 27, 681 (1976).
- 10) Y. Fukuda, *J. Metal Fin. Soc. Jpn.*, 29, 33 (1978).
- 11) Y. Fukuda, *Nippon Kagaku Kaishi*, 1974, 1868; *Trans. Nat. Res. Inst. Metals*, 17, 239 (1975).
- 12) Y. Fukuda, *Nippon Kagaku Kaishi*, 1975, 1299; *Trans. Nat. Res. Inst. Metals*, 18, 197 (1976).
- 13) JIS-H4100, alloy composition: Mg, 0.57; Fe, 0.19; Si, 0.23; Mn, 0.03; Cu, 0.008%. T 5; quenched from high temperature during extrusion, followed by tempering (ca. 205°C, 1 h).
- 14) When NaOH was added to solutions containing 0.2 mol dm<sup>-3</sup> or more oxalic acid, precipitation was observed.

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- 15) S. Tajima, "Advance in Corrosion Science and Technology," ed by M.G. Fontana and R.W. Staehle, Plenum Press, New York (1971), Vol.1, p. 281.
- 16) H. Takahashi and M. Nagayama, Nippon Kagaku Kaishi, 1974, 453.
- 17) Y. Fukuda and T. Fukushima, Preprint for 52th Lecture Meeting of Metal Fin. Soc. Jpn., p.80 (1975).
- 18) J. Siejka and C. Ortega, J. Electrochem. Soc., 124, 883 (1977).
- 19) S. Hoshino, T. Imamura, S. Matsumoto, and K. Kojima, J. Metal Fin. Soc. Jpn., 28, 167 (1977).
- 20) I. Mizuki, N. Baba, and S. Tajima, J. Metal Fin. Soc. Jpn., 28, 30 (1977).
- 21) H. Freiser and Q. Fernando, "Ionic Equilibria in Analytical Chemistry," translated into Japanese by T. Fujinaga and E. Sekido, Kagaku Dojin, Kyoto (1972), p.65.
- 22) Ref. 1, p.592.
- 23) F. Keller, M.S. Hunter, and D.L. Robinson, J. Electrochem. Soc., 100, 411 (1953).

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LONG-TERM PROSPECTS OF JAPAN'S STEEL INDUSTRY IN 1980'S

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 45-48

[Text]

Since November 1979, The Japan Iron and Steel Federation (JISF) had conducted surveys on the long-term prospects mainly from the steel demand and resource/energy problem aspects. The steel demand forecast for fiscal 1985 made in May, 1979 was outmoded by the second oil crisis which caused drastic changes in economic trends both at home and abroad. Therefore, the long-term steel demand forecast up to fiscal 1985 was revised and, at the same time, that for fiscal 1990 was prepared.

The following is a summary of the survey conducted by JISF.

1. Total Output Is Estimated at 130--140 Mil. Tons for FY1990

Japan's economy in the 1980's is interdependent on the world's economy, particularly in energy and politico-economic trends.

Assuming that increases in oil prices continue and that the growth rate of public investment drops off, the real economic growth rate is projected at 4.5% for the fiscal 1978-90 period. This figure is arrived at by averaging the projected growth rates of 4.8% for the fiscal 1978-85 and 4.2% for the 1985-90 periods.

The mean annual growth rate of private capital investment between fiscal 1978 and 1990 will remain at 4.9%. That of private housing investment will be 3.1%, reflecting a slight decrease in the number of new housing projects. Based on these figures, the growth rate of gross domestic fixed capital formation (GDFCF) is expected to be 4.1% and the ratio of GDFCF to gross national expenditure will be down to 31.5% in fiscal 1990 from 33.3% in fiscal 1978.

As in the previous forecast, the long-term forecast for domestic steel demand was made using two different methods; the macro-forecasting method whereby domestic demand for

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steel products was estimated on the basis of macro-economic factors, and the cumulative-forecasting method whereby total steel demand was estimated on the basis of the demand expected in selected steel consuming sectors.

To incorporate changes in demand structure emerging after the oil crisis, macro-forecasting was carried out in two ways; one taking private capital investment as the most important factor and the other focusing on gross domestic fixed capital formation.

As for cumulative-forecasting, changes in demand structure by different steel consuming sectors and changes in the basic unit of steel product consumption were taken into consideration. Summarized below are demand trends in major industries consuming ordinary steel products and specialty steel products.

Civil Engineering: Although civil engineering in the private sector is expected to show a relatively constant increase, growth in public investment will decrease substantially. As a result, deterioration in the growth rate of steel consumption in the civil engineering field as a whole will be inevitable.

Construction: Though the floor area of construction work related to private capital investment will increase constantly, a substantial decrease in the growth of private house construction is expected. Accordingly, the growth rate of steel consumption in this field will remain low.

Shipbuilding: Improved demand for ship construction is expected reflecting worldwide tendencies to decelerate ship speeds to save fuel and to adopt shorter depreciation periods for ships. These factors contribute to an increase in the number of ships required by the marine transport industry. Accordingly, steel demand in this field is expected to turn upward.

Automobiles: Deterioration in the growth rate of steel consumption will be inevitable due to a saturation of the domestic auto market, a slowdown in exports, and the reduced amount of steel used in the production of lighter autos.

Industrial Machinery: Because of a stable domestic demand for machines related to private capital investment and an expected upturn in the growth of exports, steel consumption is expected to increase in this field.

Electrical Machinery: Though the growth rate of demand for household electrical appliances will slowdown due to a saturation of the market, electrical equipment, electronics equipment and other types of equipment are showing favorable trends in both domestic demand and exports. Accordingly, a stable growth of steel consumption is expected in this field.

Others: The growth rate of steel consumption in the field of household/office appliances will deteriorate due to a saturation of the steel furniture market. In containers, a stable steel demand is expected because of an increasing demand for canned products. In processed products, the growth rate will remain low partly because of a decrease in ordinary wire exports.

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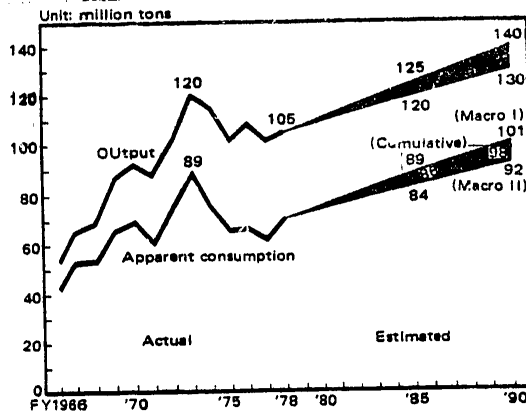


Fig. 1. Projected Output and Apparent Consumption of Crude Steel

Specialty Steel Products: Demand in the auto industry, which accounts for 40% of domestic demand for specialty steel products, is expected to slowdown. However, it is also expected that demand in the industrial machinery and electrical machinery industries will mark a relatively higher growth, reflecting higher production levels.

Based on the factors mentioned above, it is estimated by macro-forecasting that total domestic consumption of steel products will be 77.5-82.6 million tons in fiscal 1985 and 84.9-93.5 million tons in fiscal 1990. According to cumulative-forecasting, it will be 79 million tons in fiscal 1985 and 90.7 million tons in fiscal 1990. The mean annual growth rate between fiscal 1978 and 1990 is estimated at 2.6-3.4% by macro-forecasting and at 3.2% by cumulative-forecasting.

Continuous casting has been highly evaluated as an effective means to improve productivity and product quality. It is also capable of realizing a substantial improvement in yield and in the saving of energy. As a matter of course, the CC ratio is expected to rise even further in the 1980's, which will lead to a higher yield. Improved yield allowed the industry to "save" 7 million tons of crude steel per year between fiscal 1973 and 1979. Even if the yield remains at the fiscal 1979 level, the amount of crude steel saved would reach about 5 million tons in fiscal 1985 and 6 million tons in fiscal 1990.

Reflecting this improved yield, the apparent consumption of crude steel is estimated to total 84.2-89.5 million tons in fiscal 1985 and 91.9-109.0 million tons in fiscal 1990 by macro-forecasting, and 85.7 million tons in fiscal 1985 and 98.1 million tons in fiscal 1990 by cumulative-forecasting. The mean annual growth rate between fiscal 1978 and 1990 is estimated to be 2.3-3.1% by macro-forecasting and 2.8% by cumulative-forecasting.

It should be noted that growth rate of crude steel apparent

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Table 1. Long-Term Steel Demand Prospects

(Unit: million tons)

		FY1973 (actual)	FY1978 (actual)	FY 1985		FY 1990			Mean annual rate of Increase/Decrease (%)										
				Cumulative	Macro		Cumulative	Macro		1973-78	1978-85			1985-90			1978-90		
					I	II		I	II		Cumulative	Macro		Cumulative	Macro		Cumulative	Macro	
												I	II		I	II		I	II
Domestic consumption	Ordinary steel products	66.3	55.2	70.2	72.9	68.2	80.7	82.3	74.5	-3.6	3.5	4.0	3.1	2.8	2.4	1.8	3.2	3.4	2.5
	Specialty steel products	6.6	7.2	8.8	9.7	9.3	10.0	11.2	10.5	1.7	2.9	4.3	3.8	2.6	3.0	2.4	2.8	3.7	3.2
	Total	72.9	62.4	79.0	82.6	77.5	90.7	93.5	84.9	-3.1	3.4	4.1	3.1	2.8	2.5	1.8	3.2	3.4	2.6
	Crude steel apparent consumption	89.4	70.4	85.7	89.5	84.2	98.1	100.9	91.9	-4.6	2.8	3.5	2.6	2.7	2.4	1.8	2.8	3.1	2.3

consumption is lower than that of steel product consumption because of improved yield.

Because there are so many uncertainties in the trade environment, it is difficult to make an exact forecast on Japan's steel trade. On the premise that net steel export in the 1980's will be 35-40 million tons on a crude steel basis, it is expected that Japan's crude steel output will be 120.0-125.0 million tons in fiscal 1985 and 130.0-140.0 million tons in fiscal 1990.

2. Countermeasures for Resource/Energy Problems

Resource/energy problems are one of the most important subjects in the 1980's for the Japanese steel industry. Supply and demand of raw materials and fuels are estimated below based on the expected crude steel output mentioned earlier.

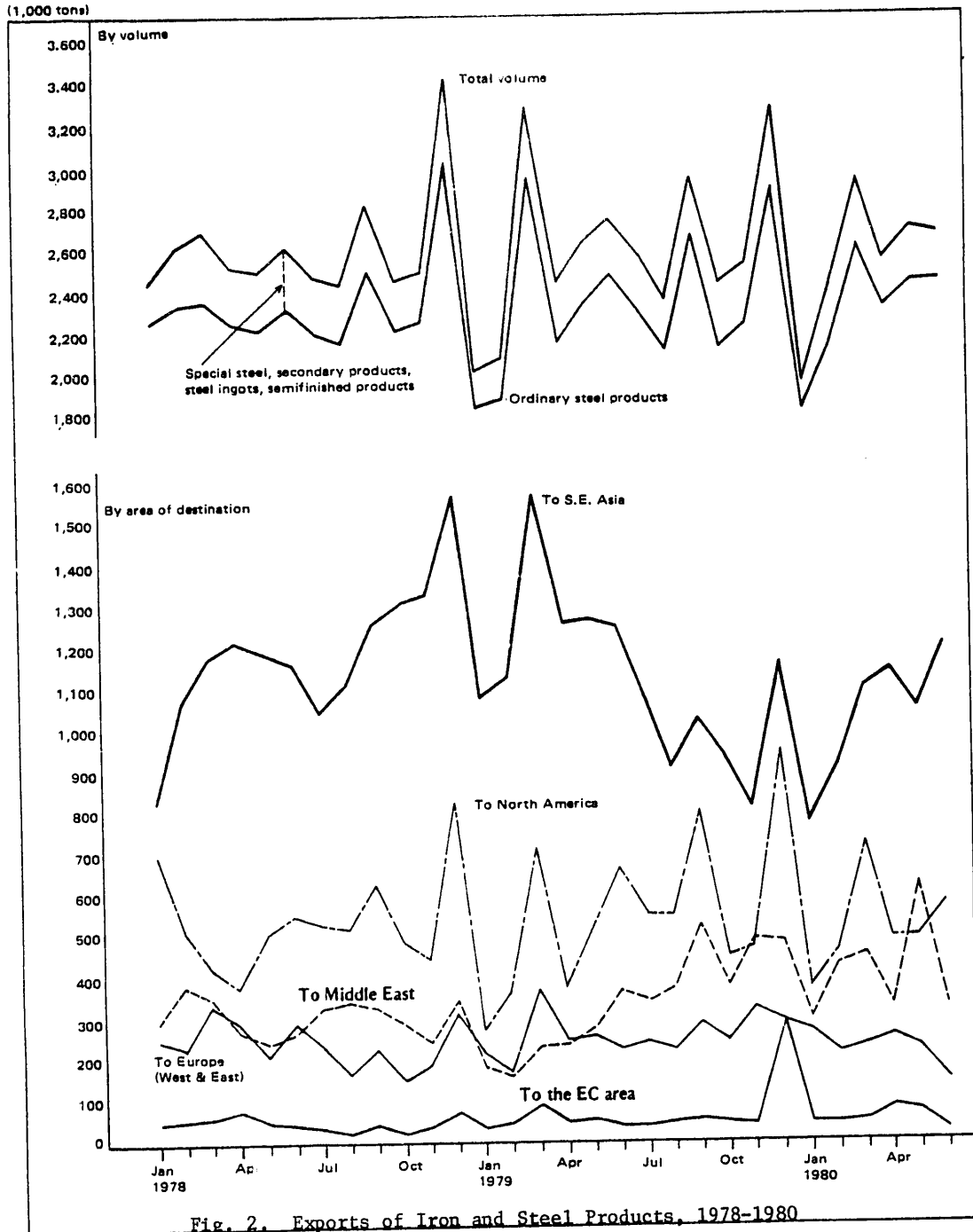
a) Iron Ore

If the existing contract amount is to be applied for iron ore supply in the fiscal 1985-90 period, a serious shortage of supply is expected. This will be true not only for Japan but for the whole world. Accordingly, it will be necessary for Japan to develop new iron ore mines.

The exploitation of new iron ore mines will require a huge amount of capital and Japan will be expected to contribute to helping supplying countries construct their infrastructures by extending loans or participating in capital investment. Japan must carry out these plans in order to guarantee future supplies of resources.

Because of its very high dependence on foreign resources, the Japanese steel industry has been introducing larger vessels and improved transport systems. As high prices of bunker oil are expected to continue, it is necessary to further promote rationalization of transport including fuel cost saving and introduction of very large vessels. It will also become necessary to arrange sea routes and port facilities to accept such very large vessels. As in the 1970's, it is essential for Japan to maintain friendly relations with resource-producing countries throughout the 1980's. Other subjects to which Japan has to

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give special consideration include diversification of supply sources and the establishment of effective measures to assure a balance of supply and demand.

b) Coal

Demand for coking coal is expected to increase as progress will be made in substituting coal for heavy oil blown to blast furnaces. On the other hand, a substantial short supply of coking coal is forecast for the fiscal 1985-90 period if the existing contract amount is maintained. It is necessary, therefore, to solicit leading coal producing countries such as Australia, Canada, and China to carry out development programs for new coal mines. Measures to secure coal are exactly the same as those required for iron ore.

In price, it is anticipated that sky-rocketing oil prices will have far-reaching effects on all other energy prices. To avoid such a situation as much as possible, the steel industry must have an orderly purchasing system and, at the same time, maintain close cooperation with industries consuming non-coking coal to establish systematic countermeasures among industries as a whole.

Technical subjects to be examined include the blowing of powdered coal into blast furnaces, improvement of techniques to utilize non-coking coal for general purposes, such as a method to produce formed coke, and the establishment of measures to utilize by-product gas. Output of by-product gas is expected to increase as a result of substituting coking coal for heavy oil utilized in blast furnaces.

c) Ferrous Scrap

In Japan, ferrous scrap has a particular importance as a primary resource which supports the existence of steelmakers using electric furnaces, and as a recycled resource which meets requirements for energy-saving and resource conservation. Under such circumstances, its supply and demand, which may be affected by availability trends of ferrous scrap abroad, is a growing concern. According to our forecast, there will be a slight shortage in fiscal 1985 but a balanced supply and demand will be possible by fiscal 1990. Though circulating scrap generated from steelworks will decrease due to improved yields, capital and process scrap will increase as steel used during the highgrowth period will turn into scrap. The domestic supply as a whole is expected to increase.

d) Energy

Petroleum products: Japan's steel industry has been carrying out energy-saving efforts for years. To deal with the unstable oil supply and expected oil price increases, the industry will further promote oil-free operation and energy-saving programs. In this light, the operation of blast furnaces without the use of oil will be further facilitated. Efforts to save fuel oil in steel-rolling and power generation, and substitute them with by-product gas will be stepped up. If these measures are implemented on schedule, annual oil consumption of the industry in the fiscal 1985-90 period will be lower than the fiscal 1978 level despite a higher crude steel output. It is necessary, however, to take a flexible attitude toward replacing

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oil with coal and to implement this program in accordance with further developments of the energy situation.

Electric power: The steel industry must prepare itself for an electric power shortage and rate increases anticipated in the future.

Integrated steel works have been striving to improve the rate of self-sufficiency by using the electric power generated on the premises, by setting up on-site power stations jointly with local power companies, and by applying blast furnace top pressure for power generation.

Parallel with these efforts, self-sufficiency will further be encouraged by utilizing the gas generated by an increasing amount of coal in blast furnace operation aimed at oil-free operation and by setting up small-scale waste gas recovery systems.

Although no significant change is anticipated in the dependence on the purchased power by electric furnace operators, further power saving will be achieved by this group of steel-makers by using recovered waste gases to melt down scrap.

To make these forecasts, we focused on demand, resource and energy problems among various subjects that Japan's steel industry will have to deal with in the 1980's. Other important subjects including the stable supply of steel products, improvement of management, the upgrading of facilities, the development of new products, and the innovation of production techniques were not taken into consideration.

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MOTOR OPERATION CONTROL BY AN INVERTER

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 48-51

[Text]

Since saving and more rational use of energy are among the essential conditions for industry to survive, nearly all enterprises, factories, institutions are making desperate efforts to decrease power consumption. On the other hand, choice of a power source is a problem because reduction or elimination of labor and introduction of automation are in progress simultaneously. And, to be considered as fulfilling both requirements, precise control of motor operation is now being highlighted in Japan.

Up to the present time, too, controlling the rotational speed of motors has been made use of considerably. Methods for this are by d.c. systems, eddy-current coupling, and primary-voltage control. An advance in the techniques of thyristor and transistor control, in addition to these, is making it possible to use widely, an inverter for precise rotational control of a motor. In the near future, the inverter system will be replacing the older systems.

Power consumption by use of electric motors, in the field of general industries, is said to amount to about 60% of all that used. The rationalization of the use of electricity for electric motors is being taken up as a priority cause for saving energy in enterprise management, with the view to cost reduction and securing stable supplies of electrical power. And this tendency, it is considered, will be strengthened even further.

There are three courses to advance the saving of energy in electric motor applications:

- (1) Use of power saving type motors with small losses in the motors
- (2) More highly efficient operation by use of rationalizing control systems
- (3) Optimization of shaft output by reconsidering drive capacity

It is necessary to establish an operational scheme for analyzing and examining these comprehensively. (1) Is represented by a power saving type motor with higher efficiency than standard motors. (2) Is, in the case of driving a fluctuating load, corresponding to variable-speed operation by a pole-changing motor, a variable-speed motor, or an inverter device.

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One of these first attracted attention as the ideal drive system for pumps of every kind, and blowers. This received notice because such have wide applications throughout the whole industry. As the present energy consumption for such is large, and there is a great possibility of attaining energy saving.

Power consumption of pumps and blowers driven by motors in Japan amounts to more than 150 billion kW a year (a little over ¥3 trillion in power cost) equal to about a half of industry's total power consumption. Therefore, it can be said that it is extremely important to reduce the amount of energy consumption in this sector.

On the other hand, devices such as pumps and blowers having variable loads, often controlled by valves, dampers, or vanes, which have been used for many years to control the flow of quantity, remarkable effect on saving energy can be had when controlling by variable speed rather than by an a.c. motor driving at constant speed. Development of this kind of drive system has been expected for a long time.

The technique of converting an a.c. motor into a variable speed motor not only fills the variable speed need for pumps and blowers mentioned earlier, but also has greater merits, even compared with conventional Ward-Leonard system using a d.c. motor. And it is also a technique being developed with intention of replacing d.c. systems by a.c. systems.

As for use, it is being put to practical use for established pumps in various classes to several thousand kW, first, mainly in domestic steel industries.

Cases of application have the following features: Operation methods, like batch processing in plants as is often seen, and the conversion to a variable-speed type drive has remarkable effect in saving energy. As for equipment investment, many cases with the term of repayment in less than one year can be seen, and, as for exporting abroad, too, they have an actual export record for large-sized variable-speed systems, with a capacity of 7,000h.p., used in the steel industry and oil loading of petroleum pipe-line systems.

Recently, pumps with capacities ranging from several hundreds to 1,000kW also have been used, more in most fields except for steel, as their permissible term of repayment is prolonged.

And, while economical and high-performance control devices using new elements, such as G-TR(giant transistor), etc., have been put to practical use for driving pumps and blowers with small-to-medium capacity less than 100kW, this can meet the comparatively small-scale demand in each field and has come to be widely used as a measure to save energy.

Further, as a variable-speed drive system for pumps and blowers, there are mechanical systems such as a hydraulic coupling, gas-turbine drive, or diesel engine, besides electric motors. But, the electric system has greater merit, in general, in terms of maintenance, efficiency, and so on. While the method best meeting the requirement of a plant is used, many other restrictions are often imposed in the case of actual application, reliability, and economical efficiency of electric

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systems have been drastically improved recently, and the application areas of this system is expanding.

An inverter is a device to convert d.c. into a.c., operates variable-speed control by controlling the power-source frequency of the inverter motor. As it has merits of being maintenance-free and saving-power, and existing equipment is usable untouched, it has attracted the most interest and has been utilized more frequently. It can be classified into current-type and voltage-type, or into a thyristor system or transistor system according to the conversion element.

Main features of an inverter control system are as follows:

- (1) The speed can be changed continuously over a wide range.
- (2) It is excellent in maintenance and environment-resistance because it has no consumption parts like brushes.
- (3) Synchronous motors can be operated and controlled simultaneously with high accuracy.
- (4) Various torque characteristics can be easily obtained by changing the frequency and voltage.
- (5) High efficiency.
- (6) High control performance in quick acceleration and deceleration running, four-quadrant running, and so on.

Voltage-type is characterized by small internal impedance viewed from the output terminals. It needs a regenerative converter for electric power. Judging from its characteristics, it is fit for the following cases:

- (1) When one-directional running and sequential load start are possible at uniform running speed of large-sized motors or multiple motors.
- (2) When quick-response of control is not necessary in a motor under load and with small-to-medium capacity.
- (3) In the case of continuous running with a high accuracy, at an arbitrary frequency, in an open loop.

On the other hand, in the current-type, the direction of input d.c. is constant and the output impedance is large. It can be driven by a pair of converters, it does not need a smoothing capacitor, and it can be small-sized and of light weight. As four-quadrants running is possible (power regeneration is possible), which is also a distinctive feature of this type. It is suited for use with an induction motor.

Pulse-amplitude modulation(PAM) system has so far been used as an output voltage control for constant-voltage type inverters. This is a system to control pulse width of the output voltage waveform with output of a square-wave inverter circuit connected in series. It has a good power factor for input power source, is suited for large capacity installations, and is leading to adaptive control of the output voltage. But, to obtain polyphase output, an inverter transformer and separate inverter circuits for each device are necessary, and then control becomes complicated. It has also a defect that higher harmonic components at low output become comparatively large when the range of output voltage control is wide.

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Table 1. a-c Variable-Speed Drive Systems

Uses	Control system	Motor	Small capacity		Small-to-medium capacity		Medium capacity		Medium-to-large capacity		Large capacity			
			3.7	5.0	10	22	45	50	100	132	500	1,000	5,000	10,000(kW)
Power saving	[1:N] [1:1]	IM	Transistor inverter				Voltage-type thyristor inverter				Current-type thyristor inverter			
											Thyristor scherbius			
	[1:1]	SM									Medium-to-high voltage thyristor motor			
											Forced commutation thyristor motor			

To remove these defects, pulse-width modulation control (PWM) system has recently often been adopted. This is a system to control the output voltage by on-off controlling, plural in a multiple fashion, the main thyristor in one inverter circuit. PWM needs no output transformer, and the power factor is as good as with PAM. Further, the output capacity is not limited, and it is suitable for small capacities, too. However, since an increase in higher harmonics depends on a choice of the on-off control system of modulation frequency, makers are developing PWM system inverters, each based on their original technique.

The vector control system, which can control a cage-induction motor on equal terms with a d.c. motor, has become the subject of much discussion in recent years. Separating primary current into the field current component and torque current component, it controls two components separately and transmits their resultant vector to the motor. It can be applied in the field where usual d.c. motors have been used, it makes possible severe running of reversible regeneration, field control, torque control, and very quick-response control. Furthermore, other advantages of this system are: good protection, high efficiency, capacity easily to be made larger, and the moment of inertia of the motor to be made smaller. While it is now applied in paper machine lines and steel rolling mills, it is likely to be more widely spread from large capacity motors to small ones.

Development of a thyristor and a transistor, which are used as the power element for an inverter, also makes large contributions to spread of the inverter system. A thyristor is a semiconductor that can control and operate quickly a high-voltage and large-power circuit by a small gate signal. Then it plays an important role in variable-speed motor systems, too. A thyristor inverter has been used, with its characteristics put to a good use, for some time now in the industrial field. Developing GTO (gate turn-off thyristor) and making it highly efficient are supposed to extend further control capacity of a thyristor inverter and the range of

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applications. Once usual thyristors are turned off, they cannot be turned on by a controlling gate. As for GTO, it can be turned off by a current flow of inverse direction, which makes possible high-speed switching. Thyristors are adopted mainly from the viewpoint of structure and price, in inverters controlling for a capacity from medium to large systems. Hence, circuits will be made simpler and more highly efficient.

Demand for inverters using transistors, as small-capacity variable-speed systems for general purpose, has suddenly increased. Owing to development of G-TR (giant transistor), etc., the inverter system is becoming much smaller and lighter, with high-speed switching characteristics put to use and PWM system adopted. It costs less than a thyristor system, and is also quite reliable. Parts of circuits are becoming a unit, and maintenance and examination are facilitated. This transistor system is considered to be spread widely throughout the entire industrial field, where variable-speed control has not been possible until now.

Ex. 1. Examples of Saving Power by an Inverter  
(the method of calculation)

There are mechanisms of various kinds aiming at saving power by using an inverter. Let us take a blower, whose calculation method is simple, as a general example. The following relations are usually found with a blower:

- (1) Airflow is proportional to the number of revolutions.
- (2) Pressure is proportional to the square of the number of revolutions.
- (3) Shaft power is proportional to the cube of number of revolutions.

That is to say, when only 80% airflow is necessary, 80% velocity and about 50% (the cube of 0.8) shaft power are sufficient. In the same way, as a 50% airflow, 50% velocity and 12.5% power are enough.

As for damper control, shaft power can be decreased only by 35% at the most, even when it is totally enclosed. Therefore, no less than 82.5% of the shaft power, the sum of a half of 35% and 65%, is required to reduce the airflow to half.

(A) Case of 100% Continuous Running  
Annual power consumption = 19.4 million kWh  
Annual power rate = ¥29.1 million  
Economy of electric power = 0

(B) Case of Damper Control  
Annual power consumption = 17.52 million kWh  
Annual power rate = ¥26.28 million  
Economy of electric power = ¥2.82 million

(C) Case of Inverter Control  
Annual power consumption = 13.70 million kWh  
Annual power rate = ¥20.55 million yen  
Economy of electric power = ¥8.55 million

[Note] 300-days running per year, and the electric rate is 15 yen per kWh.

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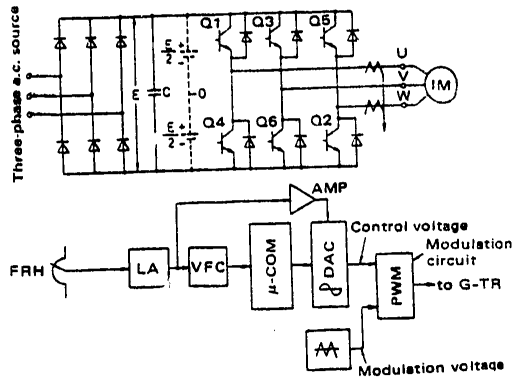


Fig. 1. Functional Block Diagram of PWM Inverter

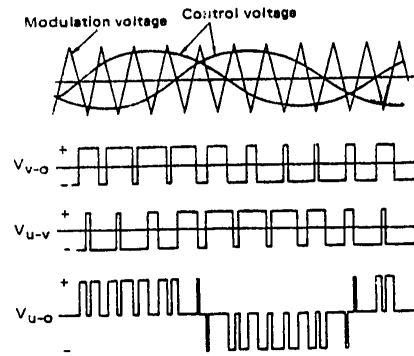


Fig. 2. Typical Waveforms of PWM Inverter

Appendix: The Principle of the PWM Inverter

In the case of variable-speed control of induction motors by an inverter device, running characteristics of high efficiency cannot be obtained without changing frequency and applying a voltage proportional to the frequency. One of the methods to vary the frequency and voltage is the PWM system. Since this system needs no voltage control element in the power rectifier, unlike other systems of converter-inverter, chopper-inverter, etc., arrangement of the main circuit can be made simpler and the device smaller. Further, higher-harmonic components of motor current can be decreased by sine-wave PWM control. A decrease in torque ripple and an improvement in the motor efficiency can be then expected.

Functional block diagram of the PWM inverter is shown in Figure 1. Cross conversion and voltage control are provided for d.c. power source E, which is obtained by rectifying and smoothing the three-phase a.c. source, in the part of the inverter composed of the main transistors (Q1-Q6).

At this time, the output voltage V and frequency F are controlled by the pulse width of transistors Q1-Q6 and changed. An a.c. control voltage with an amplitude, which is proportional to the input given by the setting frequency, is generated. The control voltage is then modulated in the modulation circuit by the modulation voltage of a triangular signal. The desired output voltage and frequency can be provided after on-off controlling the main transistors (Q1-Q6) using the signal. This system is called square-wave PWM control or sine-wave PWM control when the control voltage is a square wave of a sine wave, respectively.

Figure 2 shows two phases taken as an example of the waveform-modulation method in sine-wave PWM control.

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Potentials with respect to the neutral point are  $V_{U.O}$  and  $V_{V.O}$ , and the line voltage across U-V is  $V_{U.V}$ . Accordingly, in the case of sine-wave PWM control, a pulse width of the output voltage varies during one cycle. Then, the a.c. voltage becomes an artificial sine wave with less components of higher harmonics, and motor current becomes almost a sine wave.

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SPACE MATERIALS IN TT-500A ROCKET NO 8: INTERIM REPORT ON TEST

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 pp 51-54

[Text]

As already reported, a test for producing materials in space by using TT-500A rocket No. 8 was carried out and a report has been published of which the following is an outline:

#### 1. Test for Manufacturing a Ni-TiC alloy

##### 1.1 Purpose and Significance

Ni-TiC alloys are required for operations at high temperatures and particularly, to increase the efficiency of thermal engines. And for this purpose, it is hoped that new materials that can withstand a severe thermal environment, and have high strength and high hardness will be developed.

As a trial for this purpose, tests at ground level have been promoted to manufacture, in a low-gravity environment, as in space, basic materials required for developing ceramic-metal compound alloys which, different from conventional thermally resistant alloys, and which are composed of thermally resistant ceramics: titanium carbide (TiC) and the thermally resistant metal nickel (Ni). Because on earth it is impossible to manufacture complex alloys such as by distributing TiC uniformly in Ni, the latest test aimed to produce a Ni-TiC complex alloy with TiC uniformly distributed, by mixing powdered Ni with TiC (whiskers and powder), making 2 sample cakes by baking and then heating, melting, pressurizing and cooling them in electric furnaces No. 1 and No. 2.

##### 1-2 Test Materials

For the test, TiC whiskers 1 mm long and several  $\mu\text{m}$  in thickness on the average, TiC grains 1  $\mu\text{m}$  in dia. and Ni and Molybdenum (Mo) grains 2  $\mu\text{m}$  in dia. were used. By using these materials, samples for an inflight test with components: TiC whiskers and grains as shown in Table 1.1 were prepared after mixing, molding, sintering and likewise treating.

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Table 1.1. Samples for Inflight Test.

Electric furnace	Composition (weight %)			Dimensions (mm)	Weight (g)
	TiC	Mo	Ni		
No.1				9.7 $\phi$ x 6.6 (1 piece)	3.13
	30 (Whiskers)	10	60	2.9 $\phi$ x 18.3 (3 piece)	0.72
No.2	25 (Grains)	10	65	(9.7 $\phi$ x 14.7)	(5.9)

## 1-3 Test Data

## (Pressurization of Samples)

Pressure was applied to the molten samples 4 min. after the start of heating. The pressure applied was about 20 kg/cm<sup>2</sup>. In electric furnace No. 1 pressurization was carried out with an approximately 10 mm stroke because of reductions in dimensions of the limited samples (see Photo 1.1).

For electric furnace No. 2, no effects of pressurization were established because the containers for the samples leaked.

## 1-4 Analyses of Samples

## (Microscopic Structure)

Photo 1.2 shows the microscopic structure of a cross section of a sample from electric furnace No. 1. End faces of whiskers are seen because the whiskers are directed vertically to the plane of the Photo. That a reinforced alloy with an excellent structure like this could be manufactured by the melting method is because the low-gravity environment utilized. No alloys like this can be made on earth at present.

Photo 1.3 shows the microscopic structure of a sample from electric furnace No. 2. It has a good structure with fine TiC particles evenly distributed. This structure was obtained from a small sample remaining in the container. In addition, the microscopic structure obtained from a test on earth of the same sample from electric furnace No. 2 is shown in Photo 1.4. The figure from this test shows that macroscopic segregation appears together with local fine segregation, proving that it is not possible to obtain a good structure with even distribution.

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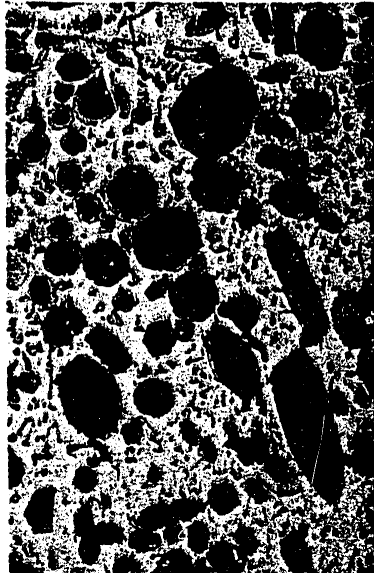


Photo 1.2. Microscopic Structure of Sample from Electric Furnace No.1 (x700)

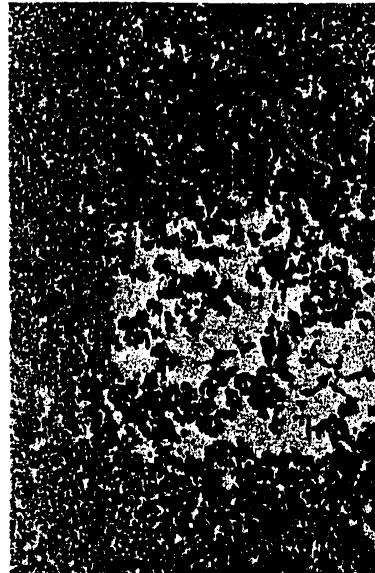


Photo 1.4. Microscopic Structure of Sample from Ground Test (x300)



Photo 1.1. Carbon Piston



Photo 1.3. Microscopic Structure of Sample from Electric Furnace No.2 (x700)

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**1-5 Conclusion**

Although in its latter half, the test involved an unexpected temperature rise of the Ni-TiC sample in electric furnace No. 2 samples from both electric furnaces showed good structure compared with those made in tests at ground level.

Also, the sample from electric furnace No. 1 achieved a hardness equivalent to ultra-heat-resistant alloys for casting and had a density increased by about 2.5 times by pressurization.

Although the latest tests alone were not sufficient to analyze the full effects of a low-gravity environment, the effect is clearly observed in the structures of the alloys produced and thus will be further investigated in the future.

**2. Tests for Manufacturing Amorphous Semiconductors**

**2-1 Purposes and Significance**

The silicon (Si)-arsenic (As)-Tellurium (Te) system amorphous semiconductor, broadly, is very similar in physical properties as single crystal semiconductors, such as germanium (Ge), Si and gallium-arsenic (GaAs). The material has excellent basic properties with wide applications electronic alloy, such as in electronic devices, light-emitting elements and optical memories.

While it is very difficult to obtain perfect amorphous structures on the earth because of differences in specific gravity and melting point of the three elements: Si, As and Te, it is possible to manufacture excellent amorphous semiconductors in a gravitation-free environment in remote space because then no such differences exist. However, if a sample is made simply by pulverizing and mixing up the three elements, it would destroy the container because of the gas pressure developed by As. So, the latest test aimed at producing an amorphous semiconductor from the three elements evenly mixed to form an alloy by heating, melting and cooling, in an electric furnace No. 3 in remote space, the stock contained in a vacuum container, consisted of a powder made by melting the elements to form an imperfect alloy and again pulverizing it beforehand on earth.

**2-2 Sample**

The sample used in the latest test consists of Si, As and Te at an atomic mol ratio of 9:14:21 in the order shown. If the sample thus prepared were contained in an ampul and melted by heating, the gas pressure of As would rise over 10,000 Hg. So, the material was melted to form an alloy in a large ampul 5 cm in dia. and 8 cm long. Then it was pulverized and placed in an

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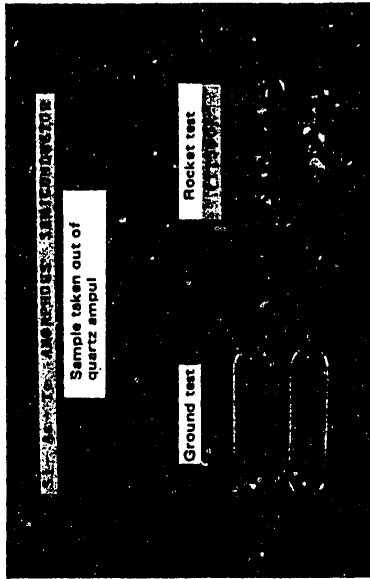


Photo 2.2. Appearance of Samples After Ampul Cutting



(b) Sample from ground test

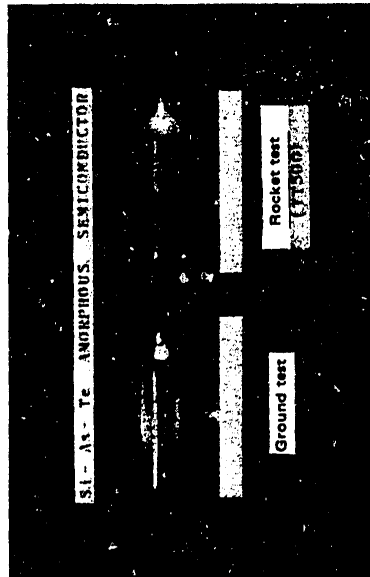
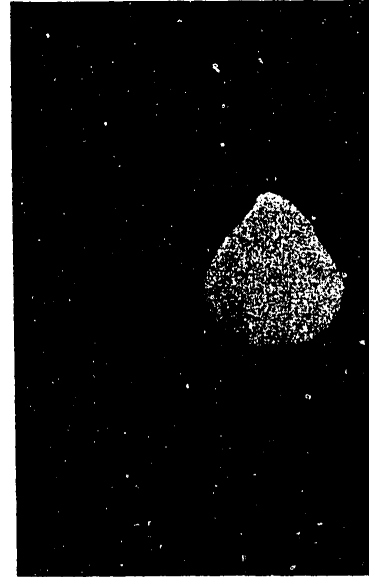


Photo 2.1. Samples in Ampuls Obtained by Preliminary Ground Test and the Rocket Test



(e) Sample from rocket test

Photo 2.3. Microscopic Photographs of Metallic Surfaces of Samples (x5)

(The surface of the sample from the space test appears smooth.)

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ampul under vacuum for rocket testing. The ampul looks as shown in Photo 2.1 and is 9.5 mm outside dia. (7.5 mm inside), and 38 mm long (33 mm inside length). The sealed ampul weighed 2 g.

**2-3 Test Data**

**(Sample Uncasing and Crystal Structure)**

The sample was removed by carefully cutting the ampul with a diamond cutter. When the ampul was cut, the sample was found evenly depositing on the ampul walls and solid like a drop in the head (navel) of the ampul; in contrast to the sample made in a ground level test, which was found solid in the bottom of the ampul, as shown in Photo 2.2.

Photo 2.3 shows microscopic photographs (multiplication: 5). For comparison of ground surfaces of the sample made at ground level and that made in the rocket test. The sample from the rocket test has an even and smooth, beautiful mirror-like surface, while the sample made at ground level has a rough surface.

The extent of amorphous perfection of atomic structures is usually evaluated by examining the extent of X-ray halo images. However, this is not considered to be a definite method of evaluation because both samples from ground level and the rocket tests showed nearly perfect halo images. So, for this evaluation, the latest test used X-ray diffraction waves (111) of the element Si which is the slowest among Si, As and Te to form an amorphous structure. For the level for evaluating the extent of crystal imperfection, quantity  $\Delta A$  was defined and compared among patterns.  $\Delta A = 17$  was achieved by the sample from the rocket test in contrast to  $\Delta A = 32$  by the sample made by 2-minute melting in a ground level test. Furthermore, the sample made by melting for more than 18 hours in a ground level test achieved  $\Delta A = 21$ . This suggests how nearly perfectly the rocket test sample was made amorphous.

**2-4 Conclusion**

Analysis of metalized structures and X-ray diffraction patterns has proved that an amorphous semiconductor alloyed by melting in a low-gravity environment as in the rocket test, shows a more perfect amorphous structure than not only the sample made by 2-min. melting but also the sample made by 18 hour melting in a ground level test.

The results of analyses of electrical and optical properties have proved that the sample from the rocket test is better than the sample from at ground level with the same melting time. It is hoped that more detailed analyses will be carried out after test results have been obtained regarding optical conductivity, absorption spectra and Roman scattering.

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**ROBOTS FOR MAINTENANCE OF MACHINE, EQUIPMENT; THEIR FUTURE PROFILE**

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 55

[Text]

Even highly automated labor-saving systems are being operated ineffectively in terms of maintenance. Once they develop faults, a large number of people are required to fix them. Periodic inspections of these systems are also made by people. Recently an idea has arisen that, from the point of view of raising efficiency and of labor-saving, automation and robotization ought to be introduced into the field of maintenance work. The reality is that the movement for robotization of maintenance work is beginning to take firm shape. In nuclear powerplants, in particular, that face a dilemma between the need of raising the plant operating rate and the need for protecting workers from exposure to radiation, automation and robotization of checks and maintenance work is urgently sought. At the Tokyo Electric Power Company plants, devices for cleaning the surfaces of a valve measuring 60cm in diameter during periodic inspection, and for automatically changing nuclear fuels, are being put to practical use.

An automatic scar detector that can detect defects in the welded parts of a pressure vessel in a nuclear reactor has also been developed, by the cooperation of the Tokyo Electric Power Company, Toshiba Corp., and Hitachi, Ltd., and it is to be introduced in nuclear power plants to be built in the future. Such devices are more close to automation devices than to robots. As for the automatic flaw detector, the direction is for the development of a flaw detecting robot that moves around on magnetized feet fastened to the pressure vessel, since it is very difficult to install an automatic flaw detector in existing nuclear power plant installations.

Development of an "automatic inspection system inside the nuclear reactor compartment" that can patrol inside the compartment of an operating nuclear reactor to detect equipment malfunctions, is about to be started on a full-fledged basis. The robot which the Ministry of International Trade and Industry is attempting to develop (in a 5-year program) by giving makers subsidies, is intended for use for examining in detail the conditions of equipment and instruments inside

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the nuclear reactor compartment when the nuclear power plant develops faults. Equipped with a thermometer, radiation meter and microphone. in addition to a TV camera, the robot is to be structured with an endless track so that it can go up or down the stairs. For the future, there is an idea to provide the robot with a manipulator, so that it will be able to perform simple work such as opening or closing valves. Selection of the firms that will be charged with the development of the robot has not yet been made but the six nuclear power plant makers, including the Toshiba Corp., Hitachi, Ltd., and Mitsubishi Heavy Industries Ltd., have established a voluntary association so that they will be able to undertake the development as a group, once MITI decides to award them with the R & D contract.

Development of robots for use for maintenance of nuclear power plants is underway abroad as well. At the time of the Three Mile Island nuclear power plant accident, a work robot was introduced. It is reported that the robot installed inside the power plant, with its many ups and downs, and thus could not execute the jobs required.

The Karlsruhe Research Institute of West Germany is going ahead with the development of an inspection robot of the same type as the one planned for development in this country. In Britain, development of an electrically-operated remote control manipulator is underway.

As robots and automated machines have been introduced, automation in the maintenance of unmanned plants has become an important task. If there is no one around, and the robots or machine tools break down or go "berserk", the unmanned plant will turn into "a manufacturing plant of defective products".

It is therefore necessary to provide robots with the capacity to detect their own faults and automatically cease functioning, or in some cases, the capacity to repair faults on their own.

Fujitsu FANUC Ltd. has developed a monitoring technology that can detect the wear, tear, and damage to instruments in NC machine tools, and is planning to introduce the technology into the firm's Fuji Plant, a plant slated to become a model unmanned plant.

Orii Co., a maker of robots for material handling for presses, has developed a robot that detects any failure of the robot to grasp the raw material. By designing a mechanism where the motion of securing the work in place is repeated before the press goes into operation; if the robot fails to grasp the work three or more times, a warning is issued.

Robots that monitor faults in microcomputers in the control section are beginning to be placed on the market. Furthermore, development of a method of acoustically diagnosing abnormalities is being vigorously promoted as a powerful tool for detecting mechanical faults, and the technology is expected to be introduced increasingly into robots.

Attempts at the robotization of repair work have already been started.

Tokyo University Professor Yoshikawa and his group has already started the development of a self-repairing robot that

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can detect its faults for itself and replace the faulty parts on its own. A repair robot will patrol day and night inside an unmanned plant, and the workers will carry out the maintenance of the robot in daytime, during normal work hours. This is the shape of the plant that Professor Yoshikawa envisions ten years ahead. Rather than pursuit of the realization of such a dream, systematization of the maintenance technology through analysis of maintenance work is his principal goal in the development of a self-repairing robot, says the professor.

One element that weighs heavily in the production of industrial robots, is cost. Whether going ahead with the robotization of maintenance is a clever decision economically will depend on what category of industry the plant is in. But raising the efficiency of maintenance is a theme as important as raising the efficiency of production, and the industry's concern for the technology is expected to surge rapidly.

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DEVELOPMENT OF ADVANCED COAL TRANSPORTATION SYSTEM

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 56

[Text]

Electric Power Development Company is planning construction of a pilot plant with 2t/h capacity at Nagasaki Shipyard of Mitsubishi Heavy Industries, as part of the development of an advanced coal transportation system. The system uses slurry transportation of coal from a colliery to a port. Following de-watering, the coal is loaded onto a ship for exclusive use and used as fuel for coal fired power plants after granulation. The system is called "Advanced Coal Chain (ACC)".

The company plans a series of experiments with the pilot plant, such as (1) feasibility tests of slurry transportation, (2) granulating and de-watering under water, and (3) combustion of granulated coal. A practical ACC system is expected to be completed by 1985. Expansion of coal utilization depends on the development of coal transportation systems. ACC will be used for import of general coal from U.S and Canada.

ACC makes powdered coal at collieries, and the resulting slurry is transported by pipelines to ports where the coal is de-watered and granulated by the use of additives such as heavy oil. The granulated coal is loaded in specially-designed ships and transported to thermal power plants through sea-bottom pipe lines, de-watered, and used as boiler fuel at the plants.

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SATELLITE STATIONS FOR NATURAL GAS CONVERSION USING SYNTHETIC METHOD

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 56

[Text]

Tokyo Gas Co. has completed a satellite station for conversion of natural gas. This station uses a synthetic method which mixes "City Gas 6C" and propane, and is the first of its kind in Japan. The company began the conversion program in June, and has since completed the conversion of 100,000 customers, about 10% of the total.

Toho Gas Co. uses an area partition method, which completes the conversion of a 1000-customer sector in three days. The method requires quick conversion from city gas 6C (4,500 calories) to 13A (11,000 calories). In the case where a single pipe line supplies city gas 6C to more than two sectors, another pipe line for 13A is required.

The satellite method is mostly used in the region, where laying of the pipe line is very difficult and/or newly-buried line is not useful afterward. Toho Gas Co. adopted the mixing method for 6C and propane, which mixes 6C and propane in the proportion of 55% to 45% respectively, by means of a compressor and a carburator. Features of the method are low installation cost (about ¥40 million) and ease of transfer. The company plans four satellite stations in its service area.

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POLLUTIONLESS C-HEAVY OIL COMBUSTION TECHNOLOGY--FLUIDIZED BED BOILER DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 57

[Text]

Severe energy situations, in which petroleum oil composition tends to become heavier necessarily forces small- and medium-size combustion facilities to convert their fuel from current kerosine and A-heavy oil to C-heavy oil. This requires pollutionless C-heavy oil combustion technology for small- and medium-size combustion facilities. To this end, the Osaka Prefectural Industrial Research Institute has been developing a fluidized-bed combustion boiler. Fluidized-bed combustion involves blowing air up from under a layer of solid particles, such as sand, to float the solid particles and thereby form the fluidized bed having liquid properties. Combustion is conducted in the fluidized bed. The technology, which has been rapidly developed mainly in the U.S. and England, has found increasing application in waste combustion facilities in Japan. The development program aims to apply this technology to small- and medium-size boilers.

Features of the fluidized-bed combustion boilers are: (1) higher combustion efficiency and nearly homogeneous temperature distribution in the combustion chamber; (2) higher heat-transfer coefficient permits down-sized facilities; (3) lower combustion temperature (800-900°C) restricts generation of NOx; and (4) injection of calcium oxide and dolomite permits simultaneous desulfurization in boilers which can eliminate the necessity for expensive desulfurization facilities.

The boiler burns C-heavy oil, injecting sand and desulfurization chemicals in the fluidized bed and blowing high-pressure air from underneath. Before production of a test boiler, basic experiments using transparent plastics will soon be conducted to obtain basic data.

At present, expensive desulfurization facilities are required for the use of C-heavy oil. Thus, minor enterprises use rather expensive A-heavy oil or kerosene. Practical fluidized-bed combustion facilities permit minor enterprises to use C-heavy oil.

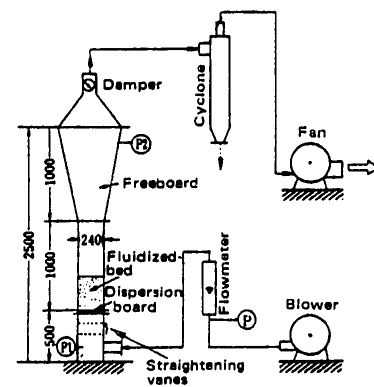


Fig. 1. Plastic Model of Experimental Equipment

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ENERGY-SAVING SYSTEM FOR BUILDINGS--OVER 50% ENERGY-COST REDUCTION POSSIBLE

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 57

[Text]

*Oshita Housing Laboratory has developed an energy-saving system for use in office and apartment buildings by means of an air circulation method. The air circulation method already developed for "Air Circulation Housing" has been applied to office and apartment buildings, which circulates air in walls and uses atmospheric heat for air-conditioning. The laboratory claims that energy savings of more than 50% are possible, and expects large demand because the method can be applied to existing buildings by simply adding air ventilation panels to external walls. The panels also prevent dew condensation.*

*The newly-developed system places air dampers (check valves) every 1.5m, which permit airflow only to the ventilation panels of 20mm width between inner wall and insulator and insulator and outer wall on each floor. Special vent ports are placed every 5m at the upper part of the outer walls. The vent ports have valves which automatically close when the wind speed is over 2m/s. In winter the valves are closed and south-side air, warmed by solar heat, circulates to the north side to warm the whole building. On the other hand, in summer the valves of the vent ports are open to exhaust heated air, and cold air in the nighttime is used to cool the concrete walls to enhance daytime cooling effects.*

*Experiments indicate that the difference between maximum and minimum temperatures of the walls is about half that of walls built using conventional construction methods, which results, in a 50% reduction in heating cost and more than a 50% reduction in cooling cost.*

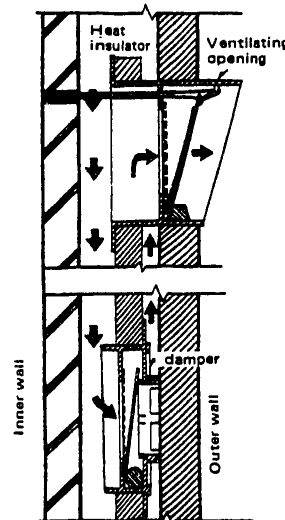


Fig. 1. Air Circulation System (in the Case of Summer)

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SECONDARY REACTION ASSOCIATED WITH EUTECTOID TRANSFORMATION IN CU-BE ALLOY

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 62

[Text]

The behaviour and kinetics of cell growth during secondary coarse lamellar pearlite reaction in Cu-22.6at%Be alloy have been studied principally by metallographic observation. The variations in cell radius, interlamellar spacing and volume fraction of the  $\gamma$  phase in pearlite cells with aging have been determined by quantitative metallographic measurements of specimens aged at temperatures from 673 to 823K. The results obtained are as follows: (1) After the initial, fine lamellar pearlite reaction is almost completed, the coarse lamellar pearlite reaction occurs wherein the fine pearlite is replaced by coarse pearlite. (2) Cell growth rate of coarse pearlite decreases, and the interlamellar spacing increases with aging. (3) Interlamellar spacing of coarse pearlite 4-5 times larger than that of fine pearlite occurs with each period of aging. (4) Be concentration of the  $\alpha$  phase in fine pearlite is supersaturated at the initial aging stage, then decreases with aging time and attains an equilibrium value prior to the occurrence of a coarse pearlite reaction. It is thus, considered that there are no chemical free energy changes during the cell growth of coarse pearlite. (5) Grain boundary diffusivities, evaluated from the discontinuous coarsening model proposed by Livingston and Cahn, are reasonable. Therefore, it can be concluded that the cell growth of coarse pearlite occurs by a discontinuous coarsening mechanism.

[H. Tsubakino, et al.: *Nihon Kinzoku Gakkai-shi*, 44 (1980), 1127]

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SUPERCONDUCTING PROPERTIES OF IN SITU CU-22.5MASS%NB-SN COMPOSITES

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 62

[Text]

Superconducting properties,  $J_c$  and  $T_c$  of in situ Cu-22.5mass%Nb-7~8mass%Sn composite wires ( $\phi 0.24$ mm) were measured to make clear the influence of heat treatment and Sn content. Structures were also observed by optical microscopy, SEM and EPMA from a metallurgical point of view. The results obtained can be summarized as follows. (1) The overall  $J_c$  increased with increasing heat-treatment time at 823 and 873K, while it was scarcely influenced by time when heat-treated at 927K. The highest time overall  $J_c$  at 9T was  $5 \times 10^8$  A/mm<sup>2</sup>, and was obtained after heat treatment at 873K for 346ks. (2)  $T_c$  of about 17K was attained after heat treatment, but the value was mostly unaltered even if the heat treatment condition varied in the range of 823~923K for 86.4~691ks. (3) The EPMA observation showed that electroplated Sn diffused homogeneously into the center of wires after heat treatment at 873K for 346ks. This was in accord with the results of  $J_s$  measurement. With the prolonged diffusion process most Sn reacted with Nb fibers to form the Nb<sub>3</sub>Sn compound and, consequently, there remained little Sn in the Cu matrix. Structural changes of fibers due to the formation of Nb<sub>3</sub>Sn after heat treatment were also detected by SEM observation.

[M. Liu, et al.: *Nihon Kinzoku Gakkaishi*, 44 (1980), 1259]

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SEPARATE DETERMINATION OF WORK-HARDENING, SOFTENING RATES IN PURE METALS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 62

[Text]

In order to clarify the high-temperature deformation mechanism in pure metals, the work-hardening rate without dynamic restoring effect,  $h$ , and the softening rate without work-hardening effect,  $\gamma$ , are measured by applying the strain-rate change method to the high-temperature deformation of pure aluminum, and their stress and temperature dependences are determined for steady state deformation. By examining the experimental results theoretically, it is shown that the deformation cannot be explained by the widely believed mechanism of lattice self diffusion controlling, and the restoring process may not be a single thermally activated process. The results lead us to consider that the dislocation structure in the steady state depends not only on stress but also on temperature.

[Z. Horita, et al.: *Nihon Kinzoku Gakkaishi*, 44 (1980), 1273]

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## PHASE TRANSFORMATION, SHAPE MEMORY EFFECT IN IN-PB ALLOYS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 62

[Text]

The  $\alpha_1$  (fct, c/a > 1)  $\alpha_2$  (fct, c/a < 1) and  $\alpha_2$  (fct, c/a < 1)  $\beta$  (fcc) phase transformation and the shape memory effect in In-rich Pb alloys have been studied by means of X-ray diffractometry supplemented by metallographic observations. Alloys containing 12~15at% lead transform from the  $\alpha_2$ (fct) phase to the  $\alpha_1$ (fct) phase by way of an intermediate phase (m phase) on cooling. The results of X-ray diffraction show that the metastable intermediate phase is observed both on cooling and heating, and has a face-centered orthorhombic (fco) structure. It is concluded that the  $\alpha_1 \rightleftharpoons \alpha_2$  transformation is expressed by the  $\alpha_1 \rightleftharpoons m \rightleftharpoons \alpha_2$  transformation both on usual cooling and heating with rate more than  $8 \times 10^{-3}$  K/S. The alloys containing 30~36at% lead transform from the  $\beta$ (fcc) phase to the  $\alpha_2$ (fct) phase on cooling. Surfaces of these m- and  $\alpha_2$ - phase alloys show a banded struc-

ture (surface relief) due to [110] transformation twinning, and the banded structure disappears above the transformation temperature. The  $\alpha_2 \rightleftharpoons m$  and  $\alpha_2 \rightleftharpoons \beta$  transformation take place with a mechanism involving macroscopic shear and are of diffusionless (martensitic) type. The temperature hysteresis in the two transformations is 10~13K between the heating and cooling transformations. The mechanism of these phase transformations is discussed in terms of the soft phonon mode, considering the double shear mechanism. A remarkable shape memory effect is observed in the reverse transformation on heating. The features of the shape memory behaviour are presented and the mechanism of the shape memory effect is also discussed on the basis of the crystallographic reversibility of these transformations. [Y. Koyama, et al.: *Nihon Kinzoku Gakkaishi*, 44 (1980), 1431]

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A SERIES OF CEMENTED CARBIDE END MILLS BY CATEGORIES

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 63

[Text]

*Towa Yakin Co. has developed a throw-away-type small-diameter end mill "combination mill", and a "cemented carbide end mill" for cutting high-hardness materials.*

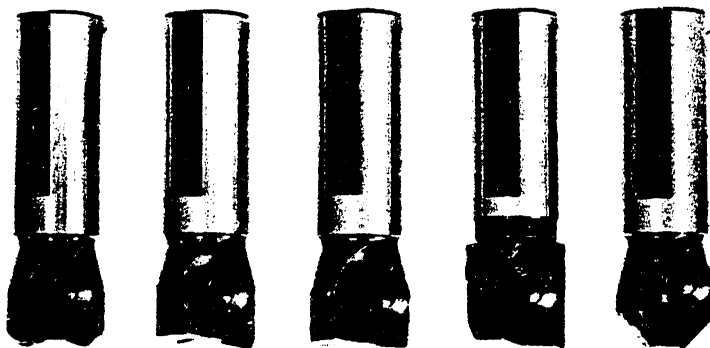
*End mills along with drills lag in high hardening, and manufacturers of cemented carbide tools are tackling this challenge with the development of cemented carbide end mills, which will provide a predominant market in the future.*

*The combination mill recently developed by the company is a multi-purpose end mill. It is composed of tools used exclusively for the following five operations: (1) beveling and trapezoidal grooving; (2) deep grooving and corner cutting; (3) draft cutting and small surface cutting; (4) spot facing and grooving; and (5) corner rounding and small surface cutting.*

*The cutting edge and shank are uniformly set to 30mm in diameter and 25mm, respectively. The use of a positive-type cutting edge with a large chip pocket, along with the use of a mushroom clamp bridge with less swarf, have assured good cutting characteristics. The high-hardness end mill is among the first cemented carbides to be used for cutting high-hardness materials. Thoroughly rigid short-edge design and a large core thickness, along with the use of a 45° angle of torsion, have obtained good cutting and have made it suitable for the cutting of high-hardness materials and hard-to-cut materials.*

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Combination Mills



Endmill for Highly Hard Materials

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DEVELOPMENT OF EROSION DIAGNOSIS TECHNIQUE FOR REFRACTORY BODIES OF BLAST FURNACES

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 63

[Text]

*Conventionally, measurement and analysis of the degree of erosion of blast furnace refractory bodies have been carried out, depending on heat transmission engineering, by making thermal measurement with thermoelectric couples, calorimeters, infrared cameras, etc. and by assuming the physical values of the refractory bodies (thermal conductivity, specific heat, density, etc.) and boundary conditions (refractory wall inner surface temperature, etc.).*

*However, certain problems have come to light, among them: a problem in the reliability and durability of measurement sensors; the physical values of refractories change with time; boundary conditions are difficult to determine; measured values at the overhaul are not sufficient. To solve these problems, Kobe Steel Co. has developed a sensor (FMT sensor) which detects the thickness of the remaining refractory wall from the delay in propagation of temperature signals in the thickness direction of the refractory wall, and its analysis method (trigger response method). Its application to the blast furnace shaft has shown good results.*

*Fig.1 shows an outline of the FMT sensor. The FMT sensor consists of the feelers (temperature measuring sections) of a plurality of*

*sheathed thermoelectric couples or sheathed resistance thermometers. These feelers are arranged in parallel so as to be disposed at predetermined positions along its length. The tip of each feeler is connected with a dummy made of the same material as that of the temperature-measuring devices. The feelers are kept out of contact with each other by refractories, and are encased in sheathing tubes. All cross sections of the FMT sensor are kept geometrically uniform.*

*The FMT sensor not only measures absolute values of temperature, but also grasps as signals changes in temperature at each position in the thickness direction of a refractory body. An analysis method by which the thickness or degree of erosion of a refractory body is obtained from the propagation of temperature changes on the basis of the above-mentioned characteristics is called a "Trigger Response Method". As compared with conventional sheathed temperature-measuring devices, the FMT sensor has the following features:*

- (1) Improved operational characteristics attained by the reduction of buried holes.*
- (2) Elimination of varied temperature measuring points, and increase in reliability due to absence of thermal contact maintenance by the uniform distribution of sheathed temperature-measuring devices.*
- (3) Increase in durability attained by high filling rate of insulating refractory and little volume of residual gas in the sensor.*

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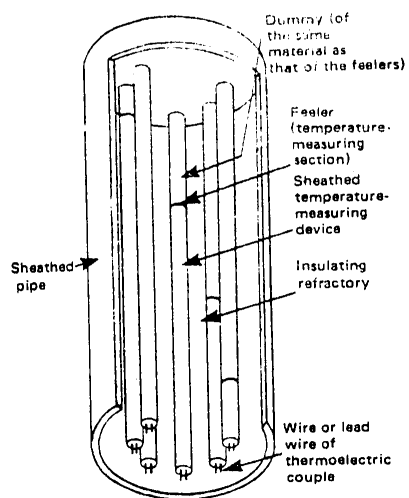


Fig. 1. Structure of FMT Sensor

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LARGE-CAPACITY TORUS-TYPE ELECTROMAGNETIC PUMP FOR LIQUID SODIUM

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 64

[Text]

Sukekawa Denki Kogyo Co. has completed the development of an electromagnetic pump which will drive liquid metallic sodium at 1500 liters per minute, and has delivered it to the Power Reactor and Nuclear Fuel Development Corporation. The pump has the largest capacity of any doughnut-type electromagnetic pump ever manufactured in Japan.

The pumps for driving liquid sodium come in two types, mechanical and electromagnetic. With regard to reliability and ease of maintenance, the electromagnetic type is said to be superior to the mechanical type, but there exist only a few pumps with a large capacity. With the demand for pumps for driving sodium expected to increase, in keeping with the construction of fast breeder reactors, development of large-capacity electromagnetic pumps has been urgently called for.

Incorporating a driving mechanism that utilizes the electromagnetic conduction function by taking advantage of the conductivity of sodium, the recently developed electromagnetic pump is a by-product of the torus flow-way type linear induction type pump, that uses stainless piping in the duct with a core of high permeability magnetic material installed inside. Consequently, the pump excels in pressure-and shock-resisting characteristics and also has a high safety reliability; its greatest feature is that it can be easily connected to piping in atomic reactors and sodium loops.

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SCROLL-TYPE GAS COMPRESSOR

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 65

[Text]

*Hitachi, Ltd. has recently succeeded in the development of a new spiral shape scroll-type compressor, completely different from conventional piston-type or rotary-type compressors, for use as a refrigerant gas compressor.*

*A simple construction, provided with only a scroll-type fixed vane (lap) and a scroll-type rotary vane, this machine continuously performs the compression and suction and discharge functions by trapping gas inside the two vanes (a plural number of gas chambers is created inside the two vanes) by giving the rotary vane both revolution and rotation. In experiments conducted using a trial manufacture model, the unit has proved to be 10% more efficient, compared with a conventional gas compressor.*

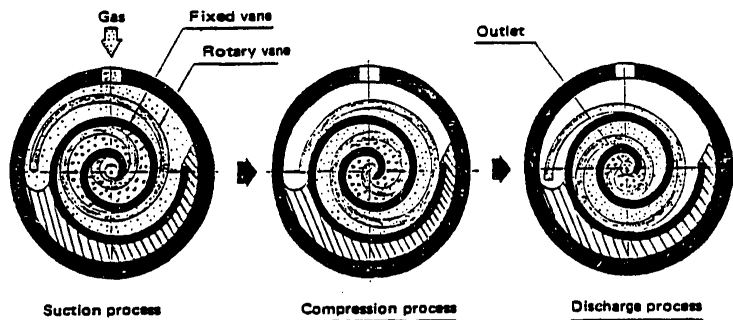
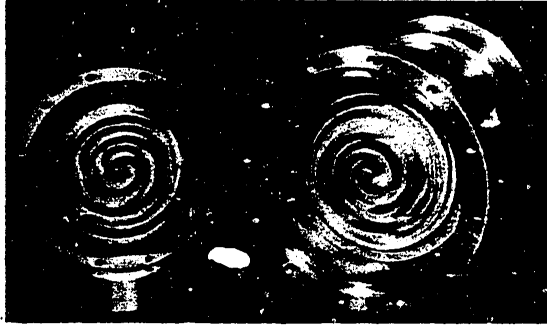


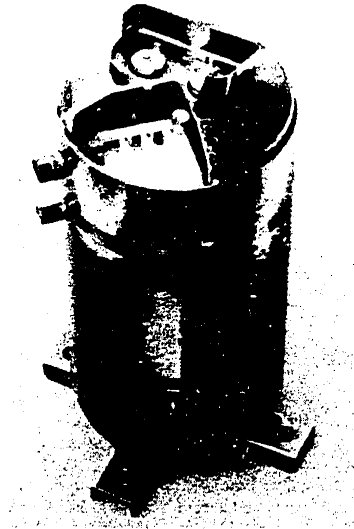
Fig. 1. Principle of Scroll Type Gas Compressor

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Scroll-Type Gas Compressor



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DEVELOPMENT OF HEAT PUMP SYSTEM USING GAS ENGINE TO DRIVE COMPRESSOR

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 65

[Text]

With the combined efforts of the related industries, development of "the dream gas air-conditioning system" — a heat pump that uses a gas engine as its driving mechanism — is to be started shortly. The three large city gas firms and makers of refrigerators and engines are scheduled to begin the development of small and medium-size air conditioning machines with a refrigerating capacity of 1 to 50 RT (refrigeration tons), by establishing a "technology research institute" as early as 1981.

Development of small and medium-sized air conditioning equipment is urgently called for from the standpoint of energy-saving, and the greatest expectation is placed on the development of a heat pump system driven by a gas engine. With this system, a gas engine is used in place of an electric motor, and exhaust gas from the engine can be used for

home heating and for warming water for the hot-water supply.

The mechanisms of air conditioning are as follows: (1) A refrigerant steam is compressed by a gas engine-driven compressor; (2) the compressed air is condensed in a condenser placed outside the house; (3) the liquid thus obtained is expanded by the operation of the expansion valve, and robs the heat inside the house again to be evaporated in an evaporator; (4) the steam returns to the compressor to repeat the cycle; (5) exhaust heat from the gas engine is recovered in the form of hot water and the hot water is utilized for the hot-water supply.

The system can save about 40% in primary energy consumption per year, according to Tokyo Gas Co., Ltd. This has been made possible by the high COP of the energy input, standing at 85 for air-cooling calories and 137 for heating.

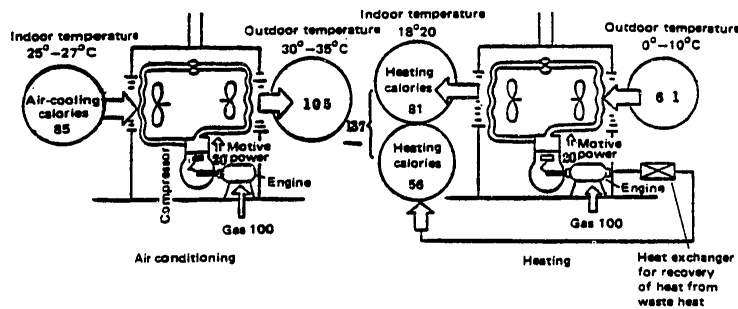


Fig. 1. A Schematic Drawing of Gas Heat Pump

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DEMANDS FOR LARGE MACHINE TOOLS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 66

[Text]

Demands for large machine tools, which have been running low, have shown a trend towards recovery. The major users of large machine tools, the shipbuilding and iron manufacturing companies, have started upon a renewal plan for the existing machine. The Toshiba Machine Co., a leading large machine tools maker, has been operating at full capacity at its large machine tools section, and it is expected that the orders received in the latter half of the year will have reached 5,300 million yen, 23% over those of the previous year, and it is expected that this tendency will continue.

The previous maximum demand for large machine tools was in 1970 and since then, for the last 10 years, the demand has remained low. After the first oil crisis, investments by the major users - the shipbuilding and iron manufacturing companies - in the renewal of equipment had stopped, due to their poor business results. Under these circumstances, the large machine tools section was silent except for occasional laments, and it thus formed a striking contrast to NC machines

section which showed significant signs of activity.

The Numazu Firm, Toshiba Machine Co.'s large machine tools plant, had been in full production at its peak in 1970, and after that time, its operation ran low (except in the export of machines to the U.S.S.R. and Rumania in 1977 and 1978); but the plant is back now in full operation after the lapse of ten years.

The main reasons for this recovery in demand are as follows: the shipbuilding industry is developing a new engine which has a lower oil consumption, and in much the same way the automobile and iron and steel industries have started to introduce large NC machine tools for roll machining in order to rationalize production and save labor.

Due to there being few competitive companies in the world in the large machine tools field, the shipbuilding and iron and steel industries' investment in equipment renewal will be on a full scale, and the received orders or the company will, over a long period, be witness to the improved conditions.

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SINTERED MATERIALS UNDER SUPER-HIGH PRESSURE

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 66

[Text]

The Science and Technology Agency has published the results of "an integrated study of synthesis for sintered materials under super-high pressure" which, thanks to the Science and Technology Agency, has been progressing for 3 years, since 1976.

According to the report, superior sintering diamond grains with cobalt catalyzer, sintered materials for cutting tools, have been developed, and a super-high pressure generator of 60,000 atm. has been put into operation for the practical application of this development.

But the development of a heat radiator material for LSI, the other study target, has not succeeded, and it has been concluded that study should be continued on the improvement of super-high pressure techniques and on the application of them.

By applying a super-high pressure, diamonds and boron nitride acquire superior hardness and heat-resistance, and these features are suitable for precision cutting tools.

Furthermore these materials give superior performance in electric insulation and heat conduction, and, consequently, these ma-

terials are expected to be used in heat radiator materials for LSI. Because of backwardness in the development of super-high pressure techniques in Japanese industry, recently, sintered boron nitride production has been started by some companies and artificial diamonds are being produced by industrial processes.

Taking these circumstances into account, the Science and Technology Agency has studied to establish basic sintering techniques for diamonds and (boron nitrides).

The results obtained by the study show that sintered materials now have performance sufficient for cutting tools but not for LSI's heat radiator, due to poor electrical insulation caused by some black carbons.

In order to solve these problems, the report recommends the use of 100,000-120,000 atm. pressure: twice that which is conventional, and without a catalyzer.

According to the study report, since 1980, the Science and Technology Agency has started upon the development of a super-high pressure (100,000 atm.) generator.

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METAL DIES FOR SMALL BATCH PRODUCTION

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 66

[Text]

Tohoku Giken Kogyo has developed a metal die manufacturing technique which can copy precisely from actual parts with a lower cost and a shortened time. The die material is an alloy of four elements: zinc, nickel, beryllium and copper. With a super precision molding technique, the dies are manufactured directly from a wood pattern, a plastic pattern or an actual part.

Applying the techniques, a conventional steel master pattern has become superfluous, and the total die manufacturing costs and required time are radically reduced.

The features of this method are as follows:

- (1) hardness of the metal dies are freely controlled by the composition ratio of the four elements (zinc, nickel, beryllium and copper);
- (2) Accurate copying is realized even from an actual part or complicated shape;
- (3) the surface finish is the same as a mirror finish;
- (4) the molded dies can be used without need of finishing.

Furthermore, a long die which is conventionally manufactured by electro-molding, for example a ball-point pen spindle, is easily manufactured by the method.

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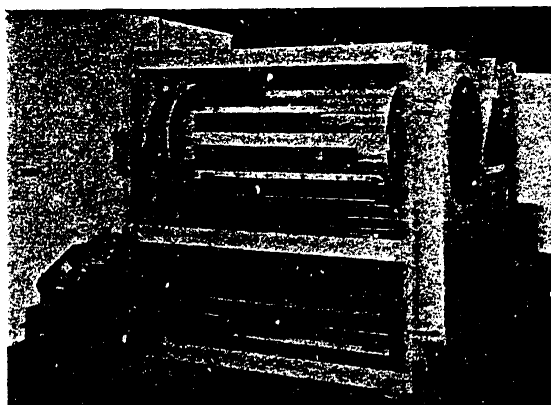
SFT-1 TYPE CNC CUTTING MACHINE

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 67

[Text]

*The photograph shows the SFT-1 type CNC cutting machine from the Chuo Denki Seisakusho.*

*The machine controls the cutting lengths, the synchronizations on the line feed and the set-up changes by the CNC equipment. The machine is designed for the cutting of adiabatic materials for buildings, and the company is developing a machine for the cutting of metallic material for the machine industries.*



SF T-1 Type CNC Cutting Machine

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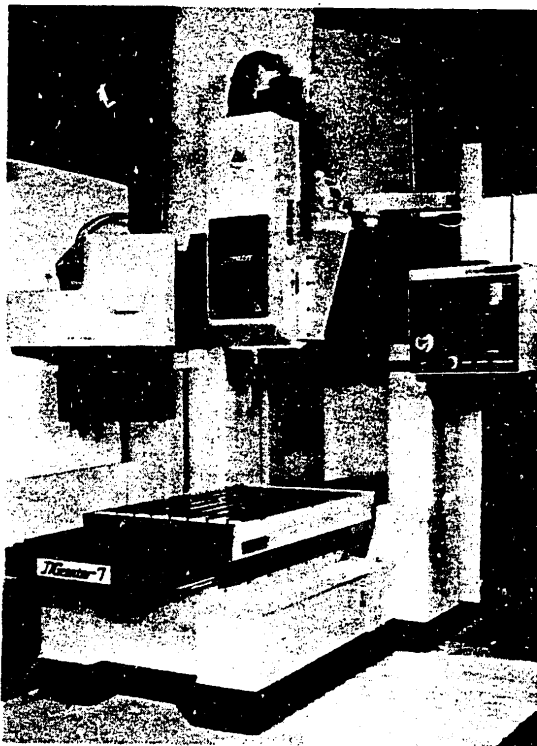


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**DOUBLE COLUMN-TYPE MACHINING CENTER**

Tokyo TECHNOCRAT in English Vol 14, No 2; Feb 81 p 67

[Text] The photograph shows the Jig Center-7 type machining center from Kitamura Machinery Co. The machine is designed for large parts demanding high accuracy, such as aircraft and metal dies.



Double Column-Type Machining Center

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Table 1.  
SPECIFICATIONS

Working table dimensions (width x length)	800 x 1500mm
Maximum load on table	2000kg
Travels (X x Y x Z)	1100 x 700 x 480mm
Spindle socket	NST. No.40
Spindle speed	60-6000rpm.
Rapid traverses (X and Y axes)	12000mm/min
Rapid traverse (Z axis)	9000mm/min
Cutting feedrate	0-5000mm/min
Number of tools to be stored	20
Minimum chip-to-chip time	15sec.
Spindle motor	DC 7.5kW (rated at 30 min.)
Machine weight (incl. N/C)	7800kg

Design and specifications are subject to change without notice.

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CUTTING TOOLS WITH EASY CHIP TREATMENT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 67

[Text]

Professor Kazuo Nakayama (Yokohama National Univ. Faculty of Engineering) has succeeded in developing a new spherically grooved cutting tool which has better chip treatmentability and yet the same cutting resistance and toolwear as a conventional one.

The tools have a unique configuration of two spherical grooves on the rake surface, and the cutting chips have a U-shaped section by the spherical grooves and are easily broken by being deformed a little.

In the manufacturing industries, with the advance of automation and labor saving, the automatic chip treatments have become a serious problem due to the wide variety of chip patterns and lengths caused by wider cutting conditions.

A chip length of a few mm. is the most suitable for easy automatic treatment. Taking account of this Prof. Nakayama has succeeded in making fine chips rendered suitable for automatic treatment by the self-curving of the chips.

Grooved spherically on the rake surface, the chips have a large side rake angle and they have consequently a down component of the velocity. The chips are fed out with a twisted curl besides the conventional up-curl and side-curl, and as a result, the chips are easily crashed into the rake surface and are broken.

Using the tools, the cutting chips are easily broken at feed of 0.1mm/rev or less, and are applicable for finish cutting.

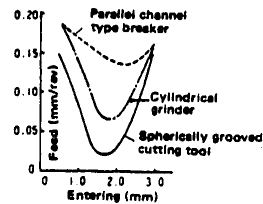


Fig. 1. Comparison of Chip Treatmentability of Cutting Tools

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NEW ICEBREAKER ABOUT TO BE BUILT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 68

[Text]

Mitsui Shipbuilding has developed a method for building "Archimedean (AST-002)", the optimal icebreaker as a boat for assisting oil development in icy sea areas.

Rising prices of crude oil have gradually driven submarine oil developments from shallow seas to deep seas and further to icy sea areas. Development in icy sea areas involves many problems in respect of meteorology, marine meteorology and the properties of ice itself. In Japan, studies, both governmental and otherwise, are being promoted to develop icebreaking tankers and LNG ships and ice-resistant marine structures which will be needed in the future. The development of icebreaker "Archimedean" is one of such efforts.

The new icebreaker breaks ice up to about 50cm thick by its own weight (1.8t) and runs over thicker ice. It can move forward and backward and leftward and rightward freely. It is equipped on both sides with Archimedean screws looking like large drills. By rotating these screws, the boat advances on the sea and runs onto the ice as the screws claw the ice inwards. In principle, these screws are an extended bar-type version of a usual propeller and have high propulsion efficiency. Also, the icebreaker can move sideways by rotating the screws in the same direction.

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'CARGO PUMP' FOR LIQUEFIED-GAS CARRIERS NOW IN COMMERCIAL PRODUCTION

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 68

[Text]

Nikkiso has recently started commercial production of a non-seal "cargo pump" for submersible carriers for liquefied gas.

The cargo pump is a non-seal submersible enclosed motor pump developed as a cargo pump for liquefied-gas carriers. It is made highly safe. The pump and its motor are integrated and the motor is enclosed in stainless steel sheet and the pump is submerged in the liquid. Since rotary parts are thus all submerged (none of them exposed), no shaft sealing is required, permitting a safe enclosed structure, the optimal structure for risky cargos.

The pump is available in two types: top mounting and bottom mounting. The top mounting type makes use of the ease of installation of deep-well pumps, and the safety and reliability of submerged pumps, and is best suited for room temperature pressurized cargo tanks. The bottom mounting type can be applied to any cargo tank, permits free selection of cables, including cabtyre and MI cables, and can be used for a variety of cargos from lowest-temperature materials such as LNG to high-temperature molten materials.

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## AUTOMOBILE INDUSTRY PROMOTES INTERNATIONAL REORGANIZATION

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 69

[Text]

Due to circumstances of the 1980's, it is felt that a war in the compact-car market is about to spark worldwide and already, there is a strong movement emerging toward reorganization by automobile makers internationally. Trends in the Japan's automobile industry last year included significant events: plans to organize a joint-venture company by Toyota, the top maker in Japan and Ford, the third maker in the U.S., and an attempt to establish affiliation between Nissan Motors, Japan's second maker and Volkswagen, the No.1 maker in West Germany.

Negotiations for affiliation between these leading companies in the world have just started but leave a long way to reaching final agreement. Although the above two groups who started negotiations for affiliation have something common in their circumstances and purposes, they differ much in the progress and actual details of negotiations.

They differ as follows: The planned affiliation between Toyota and Ford is restricted to the production of Toyota's small-size cars in the U.S. by a joint-venture company to be newly established. On the other hand, the Nissan-Volkswagen group has a developing affiliation starting with joint production of Volkswagen's small-size cars in Nissan plants in Japan and after this production becomes stable, extending to production of Nissan cars in West Germany and also cooperative promotion in the American and Brazilian markets. Again, the group plans to exchange technologies in the form of cross licenses.

At the same time, both the Toyota-Ford and Nissan-Volkswagen groups show something common in the cause and purpose of their negotiations for affiliation.

First, as causes, the following can be pointed out. With the worldwide energy crisis working as a direct trigger, Japanese cars which are excellent in fuel consumption, have in these few years found, a greater demand when

supplied to overseas countries. On the other hand, large-sized American cars, and European cars which include small cars as good as Japanese cars, are a step behind Japanese cars in technical development from an energy saving point of view.

Although Nissan and Volkswagen expect to stand on equal terms in technical affiliation, it is clear that Nissan is ahead of Volkswagen in respect of economy in fuel consumption, measures against exhaust gas pollution and car electronics. And after all, at this time the world has started a small-car war, movements toward establishing affiliations between Toyota and Ford and Nissan and Volkswagen are daring attempts and challenges toward tactics for survival.

In addition to the movements of these two groups toward establishing affiliations, Honda of Japan has decided to offer technical assistance to British Leyland of the U.K and also is taking necessary steps for the same purpose with the South African company of Benz of West Germany.

On the other hand, recent movements of overseas makers in the last year or so have also been very active. Peugeot and Citroen of France merged and bought up the 3 European companies which Chrysler of the U.S. had owned. This gave them an opportunity to affiliate with Chrysler itself in the way of capital. To this, Renault Corporation a domestic rival of Peugeot and Citroen, responded by building up their capital affiliation with AMC of the U.S. Also, Volkswagen which will become a partner to Nissan affiliated with Renault Corporation in the way of speed changers. Though with no results as yet, 6 European companies: Volkswagen, Renault, Peugeot, BL, Volvo and Fiat affiliated together for joint development and research for the production of compact cars. Thus, beyond nationalities, the world's leading automobile companies have been developing "bilateral or triangular" affiliations.

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*Competition in developing energy-saving high-performance compact cars will no doubt become increasingly intense. The rule of the survival of the fittest will also apply here and it is inevitable for not a few makers to go out of worldwide automobile markets. Thus, there will still be more active movements toward worldwide reorganization for survival.*

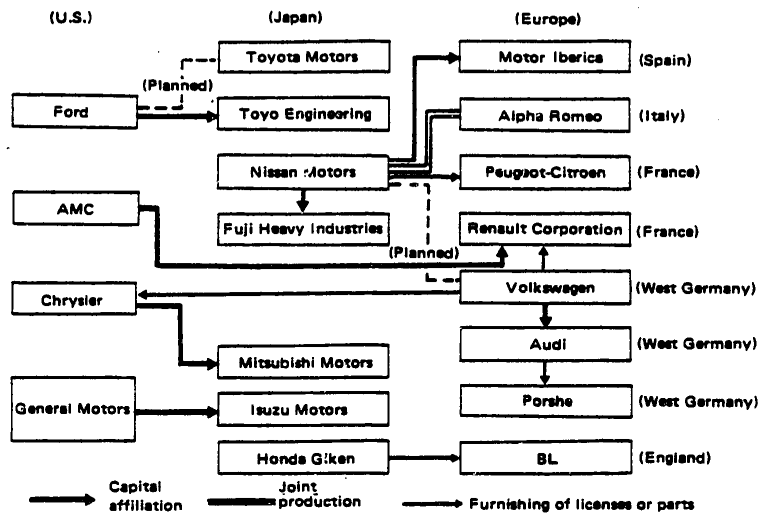


Fig. 1. Mutual Affiliations among Japanese, American and European Automobile Makers

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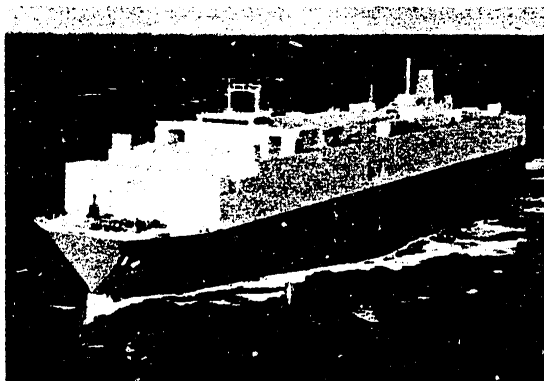
ROLL-ON/ROLL-OFF AUTOMOBILE CARRIER

Tokyo TECHNOCRAT in English Voi 14, No 2, Feb 81 p 69

[Text]

*Mitsui Shipbuilding Co. has recently completed "Olympus Ace", a roll-on roll-off type automobile carrier.*

*The carrier in total is about 190m long, about 32m wide and weighs 11,750t. The main features of the carrier are: 1) the center ramps provided on both sides in the center are designed to meet the rise and fall of tides in any scheduled harbors, 2) It is equipped with a heavy oil A-heavy oil C mixer for main diesel generators, which have also been modified for mixed oil, for the purpose of energy saving.*



"Olympus Ace"

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**FOUR-BIT MICROCOMPUTER DEVELOPED BY HITACHI**

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 70

[Text]

Hitachi Ltd. has developed a 4-bit one-chip microcomputer with a built-in LCD driver circuitry and a display function extending LSI.

For wider applications, three lines of products are available; the built-in LCD driver circuitry C-MOS type microcomputer "LCD-III", the alphanumeric dot matrix LCD-driving controller/driver LSI "LCD-II", and the "HD44100", which can be used to extend the display functions of those LSI's.

The C-MOS LSI "LCD-III", supplied in an 80-lead flat package, has two models; the HD44790 operating on a 5-volt supply voltage and the HD44795 operating on a 3-volt supply voltage. Both have 4 scanning lines (common outputs) for LCD driving and 32 signal lines (segment outputs), which can be extended up to 96 lines by externally connecting the HD44100 (supplied in a 60-lead flat package). Programs are used for all displays, such as 7-segment 14-segment, and graphic displays. The C-MOS type LSI "LCD-II", supplied in an 80-lead flat package, receives character data from a 4-bit or 8-bit microcomputer and drives the 5 times 7 or 5 times 10 dot alphanumeric dot matrix display circuitry. It has a large capacity built-in character generator, 16 scanning lines display output (can be extended up to 360 lines by connecting the HD44100 externally), and a digit number of 8 to 80 (5 times 7 dots) for a 1/8 duty cycle.

The C-MOS LSI "HD44100" can receive serial data from a CPU or a controlling circuitry, latch it, and convert it into the LCD driving wave form.

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HIGH-PERFORMANCE ELECTRIC INSULATING MATERIAL

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 70

[Text]

Hitachi Kasei Co. has now developed an epoch-making FRP laminated plate (trade name: Ultra high heat-resisting voidless FRP laminated plate VL-H series) which combines ultra high heat-resisting resin, glass cross, glass roving loss, and glass matt; and matches the performance of silicon resin or polyimide resin. Also developed is the new compiled mica prepreg tape using epoxide resin and glass cross, in which the reliability of the compiled mica insulation is further improved by increasing the aspect ratio.

The ultra high heat-resisting voidless FRP laminated plate VL-H series has the following characteristics: (1) Very high heat resistance with little heat loss, due to the use of an ultra high heat-resisting resin, (2) Stable characteristics, compared with other FRP products, due to its ability to endure high heat rates with little decrease in mechanical intensity. (3) Excellent electrical characteristics, particularly in voltage withstanding, because there is no void inside the FRP.

Also the new compiled mica prepreg tape uses tape employing the new compiled mica with an increased aspect ratio (diameter/thickness of mica grains), and has the following characteristics: (1) Insulation layer with excellent mechanical intensity and dielectric breakdown withstanding, compared with the conventional compiled mica insulation, (2) Excellent insulation layer electrical characteristics when stress is applied, (3) Good mechanical winding ability due to high tape strength.

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SEMICONDUCTOR WAFER CLEANER, DRIER

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 70

[Text]

Fuji Advanced Co. has developed a shower cleaner (FA-8) and the spin drier (FA-7) for semiconductor wafers in line with micro-machining. The products are priced at ¥800,000 for the cleaner, and ¥1,800,000 for the drier with a static electricity remover provided.

This new cleaner adopts a structure which employs a shower and a stirring effect. In this system, when wafers in a cassette are placed in the bath, pure water will pour from both the upper and lower showers, the level gradually rising in the bath until automatic drainage is repeated. The processing is executed automatically and in such a way that permits the upper showers to clean the wafers, supported by the stirring/convection effect of the lower showers. The upper showers are installed in several stages so that the wafers can be cleaned and dirt removed even when the cassette is taken out.

The spin drier adopts a system in which, after the wafers are set in the bath, clean air is vented to decrease the pressure at the center of the rotor exhausting both moisture and air simultaneously from the lower part of the rotor. The clean air to be exhausted is controlled by the rectifier plate, to prevent the dirt or moisture removed from the wafers re-attaching. The wafers are prevented from charging due to plasma production, by the electrodes set on the rectifier plate for high voltage, to remove static electricity caused by the high-speed rotation or drying process.

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COMPETITION IN DEVELOPMENT OF EB RESIST PRODUCTS AT ITS HEIGHT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 70

[Text]

Electron-beam resists are indispensable in the use of the electron-beam drawing unit needed in V-LSI micromachining. In the development competition, following the fore-runner Tokyo Oka Industry Co., Toray Industries and Chisso Corp. have joined forces to develop and sell this product.

Tokyo Oka has developed the "OBER100", a highly sensible negative EB resist using PGMA (polyglycidyl methacrylate) material. The high-resolution positive resist "OBER1000" uses PMMA (polymethyl methacrylate). Also among the positive resist products available, the more highly sensible one "OBER-1010" using PMIPK (polymethyl isopropyl ketone), and the "OBER1030" using the MMA (methyl methacrylate) interpolymers and AN (acrylonitrile), respectively, as improved materials.

Toray Industries, newly joined the competition for development of EB resist products, says it has developed a previously unknown material as a positive resist. The company states that "EBR1" employs a trichloroethyl methacrylate polymer and "FBR9" trifluoroethyl chloroacrylate as new materials, which give almost the same high resolution, and a 100-fold sensitivity over the PMMA.

Chisso Corp. is beginning the import and sale of a positive EB resist "P5" (which uses PMMA) developed by the British Micro Image Technology Co. Ltd.

Nippon Synthetic Rubber Co. Ltd., which at present does not deal with EB resists, is also considering the development of these products.

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### HIGH-SPEED MEMORY TESTING SYSTEM

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 71

[Text]

*Takeda Riken Industry Co., Ltd. has added the 40-MHz high-speed memory testing system "T3331" to its T3300 series of V-LSI testing system.*

*The T3331 is for high-speed, large-capacity storage devices and uses the same architecture program as the 100-MHz V-LSI testing system T3380 (general-purpose system) and T3370 (memory-exclusive system).*

*The characteristics of the T3331 system are as follows:*

- (1) 40-MHz high-speed real-time testing is possible.*
- (2) Timing accuracy of  $\pm 700$  picoseconds can be given as the combined worst-case accuracy.*
- (3) The testing patterns are created by the highly versatile algorithmic pattern generator that tests (to say nothing of 64-K bit devices) 256-K bit devices, 1-M bit devices, or multichip-architecture storage devices made of these devices.*
- (4) Data capacity can be expanded to 16 bits to correspond to multi-I/O storage devices found in static RAM's or multi-chip ROM's.*
- (5) 256-bit malfunction analyzing storage device is built-in.*
- (6) Overall reliability is increased by R.A.S. giving board compatibility, self-diagnosis, and self calibration.*

*Storage devices of up to 48 pins can be tested in the inputs or outputs isolation system of the testing station; high-speed station for bipolar types, such as ECL, and high-level station for MOS type.*

*Specifications:*

*Testing Functions: Dynamic function test and DC parametric test for V-LSI storage devices*

*Number of pins: Up to 32 input pins and 16 output pins*

*Testing speed: 40-MHz*

*Combined timing accuracy:  $\pm 700$  picoseconds*  
*Memory testing vector: 10 bits for each X and Y address and 8 bits for Z address, 16 bits of data, 72 bits times 256 words WCS*

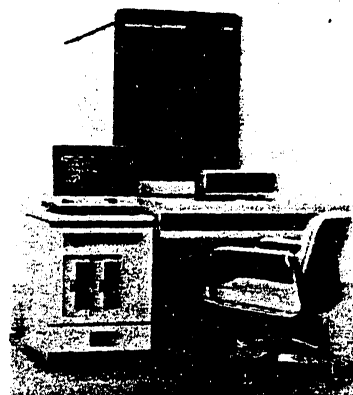
*Timing generator: 24 timing edges, real-time 16 setting, 500 picoseconds setting resolution, 100 picoseconds delay resolution*

*DC testing units: Up to two units (32V, 0.3A)*

*Programmable power supplies: Up to four units (20V, 2A)*

*Testing processor: 32-bit data, 24-bit addresses, 256K bytes of main storage*

*I/O: CRT displays (up to two units), floppy disk (256K bytes, up to two units), printer*



High-Speed Memory Testing System

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NEW INTERDEVICE ISOLATION TECHNOLOGY FOR LSI

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 71

[Text]

*NTT Electrical Communication Laboratory, which has been researching C-MOS LSI density and performance, has now developed a new isolation technology called "Full Isolation by Porous Oxidized Silicon (FIPOS)" that uses a porous oxidized silicon membrane.*

*This technology concerns interdevice insulation, one of the important areas to in which these improvements are used. This method is better than Silicon on Sapphire (SOS) and is more economical because of its simple process, and can be used to enhance MOS LSI micro-processors, transistor characteristics, and accurate control of injected impurity concentration.*

*P-type single crystal silicon being used as the substrate, the process is as follows: (1) Hydrogen ions are implanted into the device-formation area on the substrate surface and the entire chip is heated, thus changing the device-formation area to n type. (2) The substrate is anode-formed. The anode side of the p-type silicon will become porous and completely surround the n-type area. (3) The entire chip is heated at high temperature. The n-type area will return to p-type because the hydrogen atoms are removed from it. Then the porous silicon is oxidized to form the insulation membrane. Since the process, as given above, is simple, the device formation area can economically be completely isolated.*

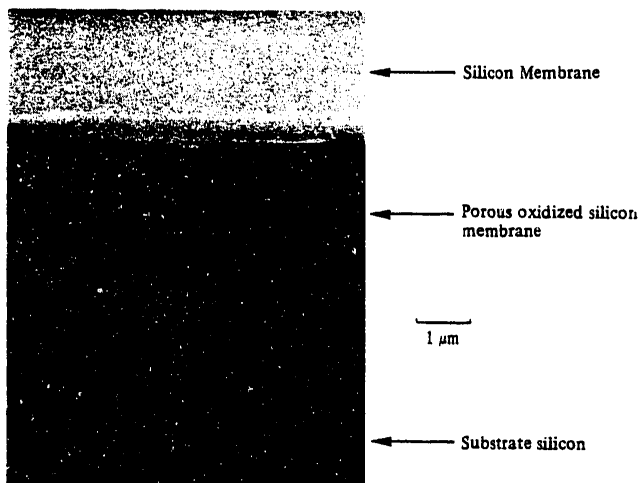
*The hydrogen atoms to be implanted during the process travel in a straight line so that the device-formation area can be clearly defined, enabling inter-device spacing to be short. Also, porous silicon can be oxidized with very little change in volume, thus providing a relatively smooth device surface (refer to the photo) on which etching can be easily performed. This makes pattern micromachining possible. For the above-mentioned reasons, FIPOS can be applied up to submicrometer high-density processes.*

*In contrast to SOS processes, this method uses single-crystal silicon as the device to give good device crystallization, contributing to excellent MOS transistor characteristics. Also, the hydrogen atoms, once implanted in the device-formation area, will be removed completely so that in subsequent device formation, impurities can be injected into almost pure silicon. This enables highly accurate control of the impurity concentration on which the device transistor characteristics are dependent.*

*The 29-stage C-MOS ring oscillator produced experimentally by this method has shown the following characteristics with a transistor channel length of 1.5 $\mu$ m and a supply voltage of 5 volts: propagation delay time of 0.5 seconds, power dissipation of 50 $\mu$ W, and a power dissipation times propagation delay time of 25fJ. These values indicate an approximately three-fold increase in performance over C-MOS devices fabricated by conventional processes, such as SOS.*

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Structural Cross-section of Interdevice Isolation by FIPOS

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PROSPECT OF INFORMATION INDUSTRY IN 1980'S

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 74

[Text]

Information Industry' Sectional Meeting of the Industry Structure Council has compiled its interim report about "Ideal and Proposition of Information-Oriented Society and Industry in 1980's".

This report consists of three items (1) the meaning and role of information orientation and the information industry, (2) future prospect for information orientation and the information industry, and (3) the system of proposition for information orientation and the information-oriented industry. In Item (3), the report states that promotion of information orientation is the future power source of Japan and will form the foundation of society. Also the Government emphasized the necessity of manifesting idealistic information orientation and indicated the importance of adjusting the information-oriented foundation to protect the privacy of individuals, to establish software

rights, to look at communication lines using this system, and to help train people in the field and employed by smaller enterprises. It placed emphasis on the promotion of various financial services, database services, and social system developments for establishing self-supporting developments by overcoming the vulnerability of the information industry foundation. Moreover, it states that the Government itself should lead the development of such emergent technologies that require a long amount of time to place in actual practice and which often exceed the risk-bearing ability of private enterprise; and it also states that the Government, private enterprise, and universities should cooperate in the development of fifth-generation and highspeed computers. The Government also asks for the cooperation of the information industry in advanced countries and developing countries.

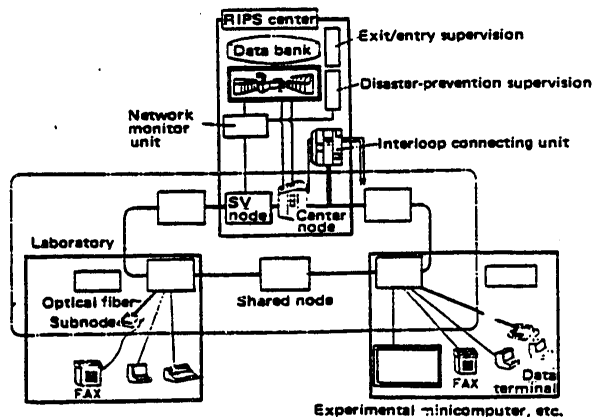


Fig. 1. System Diagram for Shared Network

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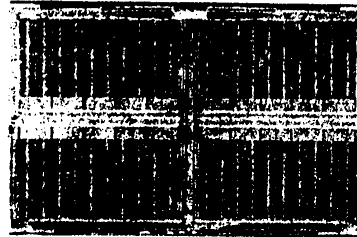
1M BIT ROM FOR GENERATING CHINESE CHARACTERS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 75

[Text]

*NTT has developed a 1M bit read-only memory (ROM) for producing Chinese characters. It is used exclusively for the production of 3,760 Chinese characters and is expected to play a large role in reducing the cost and size of terminals that display Chinese characters. General terminals for Chinese characters require 3,000 to 4,000 characters, and a memory capacity of about 1M bit is needed to display them in an 18x16 dot matrix. Existing ROMs have a capacity of less than 128K bit, and a large-capacity ROM has been sought for some time. The newly developed ROM can accommodate on a 3x2cm chip, patterns for 3,760 characters including kana, alphanumerics, and special symbols, and JIS codes for Chinese characters.*

*Technical features are as follows. (1) The chip can output the 288 bit patterns for Chinese characters (16x18) and 14 bit JIS codes for the characters. JIS codes reduces the transmission load on communication circuit by about 1/20 and permit high-quality transmission of Chinese characters over general telephone circuits. (2) Use of multi-gate transistors has reduced the size of memory cells which are the minimum unit of memory, to about 1/3 that of conventional cells. (3) A duplex system that stores the same character at two places and collates them and then outputs correct characters, has raised the yield of chips to 20% or more.*



1M Bit ROM for Generating Chinese Characters (31.0mm x 19.2mm)

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## METHOD FOR INPUTTING DATA FOR THREE-DIMENSIONAL FIGURES WITH A TABLET

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 75

[Text]

Computer aided design (CAD) systems will soon be able to generate three-dimensional models from which manufacturing drawings, perspective drawings, working processes, and inspection data can be generated. Present methods of inputting figure data into a very complicated and are now seen as very important in achieving three-dimensional models. A method has been developed that generates three-dimensional models from two dimensional figures described on tablets. The basic parts of this method have been completed. This system makes it possible to construct a system by which planning figures, sketches, and so forth described by a designer, can instantly be recognized as a three-dimensional object and can be viewed from any angle. This makes it possible to more clearly understand what the designer intended and to quickly make corrections or additions.

In general, it is impossible to determine three-dimensional data from two-dimensional line drawings. Human beings can interpret two-dimensional line drawings as three-dimensional objects, but a computer cannot. Overcoming this and finding a method by which computers can interpret three-dimensional objects from two-dimensional drawings is now under development.

With this method, drawing line figures is used as identifying information, and a coordinate axis or a coordinate plane including two coordinate axes is designated as a secondary means of three-dimensional recognition. A designer draws a perspective figure of a three-dimensional object based on these axes. Perspective figures are used because they can more easily express designer's images and have more information than projection drawings. Further, the line drawings that are depicted can instantly be made three-dimensional and rotatable. This enables the rear side of an object that can not be seen in the first drawing to be added and changed in real time into three-dimensional data.

A unique algorithm has been developed that permits figures with complicated shapes to be easily input one item at a time in a conversational manner. This is done as follows.

- 1) An object to be depicted is assumed to be in a stable position on a coordinate plane, and based on this, coordinate values of the base are calculated.
- on a coordinate plane, and based on this, coordinate values of the base are calculated.
- 2) An edge extending parallel to a coordinate axis from the vertex having a known coordinate value is searched to determine the coordinate at the tip of the vertex.

By repeating this, the coordinates of each vertex are determined, and if a vertex can not be easily determined, default values are used or the designer is prompted to input a value. Future expected improvements are:

- 1) Figure editors will be prepared so that a designer can freely modify shapes on drawings.
- 2) A conversational learning system will be established for more complicated figures.
- 3) It will be combined with an appraisal module, such as a structural analysis module, an automatic drawing module, or a module that automatically generates three-dimensional geometric models.
- 4) A function will be developed that permits free curved surfaces to be directly input with spline functions.

For the mutual exchange of three-dimensional object coordinate data and two-dimensional drawing coordinate data, the position coordinate of each point of the respective coordinates is expressed by a four-dimensional vector and is integrally calculated with  $(4 \times 4)$  dimensional transformation matrices.

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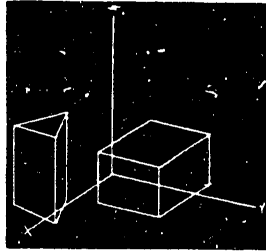


Photo 1. Example in which a tablet is used to depict a parallelepiped and a trigonal prism with reference to the depicted coordinate axis.

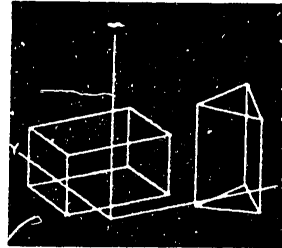


Photo 3. Example in which the line drawings in photo 1 are rotated, and edges that at first can not be seen, are added

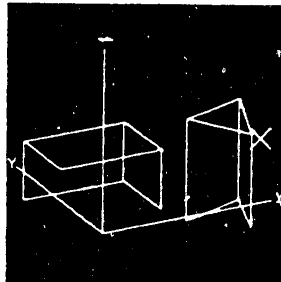


Photo 2. Example in which the line drawings in photo 1 are three-dimensionally recognized and rotated about the Z axis.

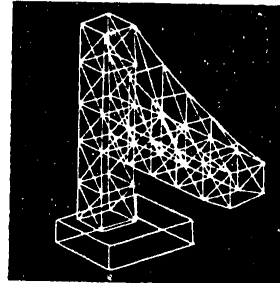


Photo 4. Example in which a complex structure is depicted on a tablet and is three-dimensionally recognized

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MASS-PRODUCTION TECHNOLOGY FOR DISTRIBUTED REFRACTIVE INDEX-TYPE LENS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 76

[Text]

Nippon Sheet Glass Co., Ltd. has succeeded, in cooperation with assistant Professor Kenichi Iga of the Precision Engineering Laboratory of Tokyo Institute of Technology, in developing a plastic microlens thereby making possible that refractive index-type microlenses can be made on mass production lines. These lenses have applications in various areas such as in copying presses, source light for optical fiber communications, or in optical branching filters. Moreover, they have started study of mass production because they consider that they can put on mass production lines microlenses at low cost by diverting the manufacturing technology of that type of lens to the production of glass. If it is successful, miniaturization can be expected to proceed rapidly of optical devices in the optical systems using semiconductor lasers or light emitting diodes.

This technology just developed uses a metaacrylic resin sintered in such a way that the exchange reaction of monomers of the resin is utilized to create a refractive index distribution, and then the plastic plate microlenses are given a lens effect.

The particularly notable aspect of this technology is a great expectation for mass-production because a great volume of microlenses can be effectively manufactured by creating special thin-material film on one plate of a substrate of glass.

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GAS FLOWMETER USING ULTRASONIC SENSOR

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 76

[Text]

Kaijo Electric Co., Ltd. has developed and started selling for industrial use an "Ultrasonic Gas Flowmeter". This gas flowmeter, developed in cooperation with Kamishima Seisakusho Co., Ltd. is the first of its kind in the world.

This equipment measures a flow in such a way that the sensor, which is plugged into the tube wall, propagates ultrasonic waves in both forward and reverse directions to the gas flow, and determines flow speed by the difference of their propagation speeds. It then converts this data into the quantity of the flow. The accuracy of measurement is  $\pm 1$  percent, and has such merits as little load on the flow and high accuracy due to the pressure resistance at the detector area being almost zero, as compared with conventional mechanical flowmeters such as turbine flowmeters using vane wheels, or area flowmeters using special measuring tubes.

Also the price is reduced greatly to ¥1,350,000 per unit, while the conventional mechanical units being ¥10 to 20 million per unit.

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NEW DIGITAL DEW POINT METER ADOPTS USE OF CRYSTAL OSCILLATOR

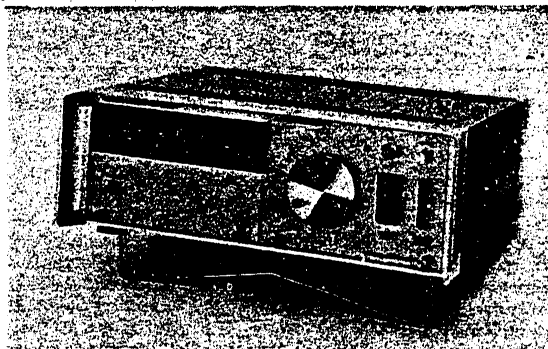
Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 77

[Text]

*Yokogawa Electric Works, Ltd. has taken the world's lead by successfully manufacturing a high-accuracy, high-resolution digital dew point meter "MODEL 2586" which uses a crystal oscillator as the heart of its system.*

*The method by which this instrument operates is to bring the gas to be measured into contact with a crystal oscillator, cool the gas gradually by a built-in electronic cooler device that can either cool or heat by reversing the electric current, and then with high-accuracy, measure the thermoresistance of the temperature, i.e. dew point, at which dew starts to form on the surface of the crystal oscillator (i.e., any water vapor in the gas to be measured is cooled to form dew due to lowering of the temperature of the gas).*

*The stage of dew forming is automatically judged by use of the principle that the dew forming on the crystal oscillator's surface will cause the apparent mass of the oscillator to increase, thereby decreasing its resonance frequency which in turn, is then measured. The range of dew point measurement is -50 through +40 degrees Centigrade and the resolution is 0.1 degree Centigrade.*



Digital Dew Point Meter

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MEASURING MAGNETIC FIELD INTENSITY USING LIGHT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 77

[Text]

*Mitsubishi Electric Co., Ltd. has successfully developed a magnetic field intensity meter that adopts the use of optical fibers to measure field intensity of a distant area, enabling it to measure large currents and high field intensity.*

*This optical magnetic field intensity meter uses the Faraday effect, whereby the surface of polarized light passing through a transparent Faraday device placed in a magnetic field will rotate depending on the field intensity. That is, the Faraday device is placed between two sources of polarized light, the field intensity affects brightness of the light, so that the field intensity can be measured.*

*The company says that this meter gives 30dB SN ratio in 3-gauss magnetic flux density and even a higher SN ratio in a higher field.*

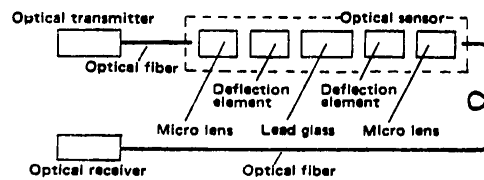


Fig. 1. Blockdiagram for an Intensity Measurement Gauge of Optical Magnetic Field

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LIQUID LEVEL INDICATOR

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 77

[Text]

*Kimura Seisakusho Co., Ltd. using a double-pipe construction a float guide tube for protection, have succeeded in arranging close together a group of magnetic response devices.*

*The conventional liquid level indicator of the float type using a read switch, has problems with accuracy in that detection pitch of the liquid's level is inaccurate due to limitations of read switches. Whereas the new type level indicator of this company enables levels down to 1mm units to be detected, one fifth of the minimum pitch to date, solving technically as well as costwise, the problems that limitation of liquid level indication by magnetic means has been in 5mm units.*

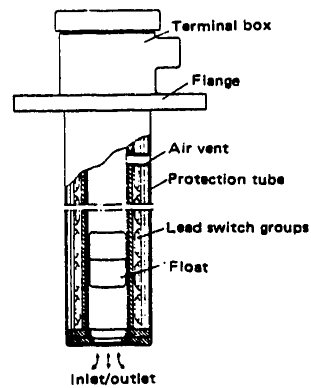


Fig. Double Pipe Type Liquid Level Indicator

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ESTABLISHMENT OF MANUFACTURING TECHNIQUE FOR POLYCRYSTAL SINTERED SUBSTANCE

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 78

[Text]

A technique of synthesizing granulated diamond or boron nitride at a very high pressure has been developed as a result of a comprehensive research by the Science and Technology Agency.

While single crystals of diamond or boron nitride are put to practical use as industrial materials as in very hard implements, a manufacturing technique for a polycrystal sintered substance has first been developed in our country. Now that the Science and Technology Agency has confirmed that a synthesized polycrystal sintered substance can be brought into practice as material for very hard implements, it intends to increase the range of its use as a new material in the industrial field.

A very hard substance such as diamond has so far been utilized in the form of a single crystal for industrial material such as in very hard implements. But, some attempts have been made to increase the range of its use as industrial material by synthesizing this substance into a large-sized polycrystal sintered substance (10mm).

The Science and Technology Agency has been making a study, on a three-year program,

with "Comprehensive Research on Synthesizing Sintered Material at Very High Pressure" as its theme, and has been at grips with the synthesis of a polycrystal sintered substance of diamond or cubic boron nitride, and its application.

Consequently, they succeeded in making, on an experimental basis, a large-sized polycrystal sintered substance of about 7mm diameter and 5mm length, at a high-pressure of 55-56 kbar and a high temperature of 1700°C.

As a result of examining the machinability of diamond and boron nitride sintered substances thus obtained, the diamond system showed excellent machinability for an aluminum-20% silicon alloy. The boron nitride system was shown to have a surface roughness less than 3µm. Furthermore, putting each of the bearing steel materials, SKD11, SKJ3, SNCM8, and tungsten carbide to a machinability test under the same conditions, it was found that a very hard implement made of a polycrystal sintered substances has a longer life than an ordinary one by a factor of more than 1.7 on the average.

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ELECTRIC POWER PRODUCTION BY SURPLUS STEAM

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 78

[Text]

While each chemical company is attempting to develop energy-saving devices, an imbalance still exists between saving steam and electric power.

While Kashimakita Kyodo Hatsuden is supplying electric power and steam to each company of the industrial complex in the Kashima district, with Mitsubishi Petrochemical Co. as the chief member, the supply of electric power has not decreased and there is more than enough steam whereas the amount of the steam supply has become smaller. On the other hand, the Kashima Enbi Monomer Co. is using large amounts of steam and electric power, but its factory is compact unlike those in other companies. For that reason the company has decided to convert medium-pressure steam into that of low pressure and produce electric power at less than two thousand kilowatts using medium-pressure steam.

Thus, Kashimakita Kyodo Hatsuden will make it possible to dispose of the surplus steam and thus reduce the cost of production. The Kashima Enbi Monomer Co. also established a system where about a quarter of the electric power consumed is supplied by an independent power plant. Accordingly, a reduction of the production cost is expected and repayment is possible within three years.

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WET TYPE DIGESTION GAS RESULFURIZATION PLANT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 86

[Text]

Shimomura Kogyojo has developed a wet type desulfurization plant of an iron oxide fluidation system which is able to remove up to 99.9% of hydrogen sulfide in digestion gas generated during disposal of sewage and excrement.

The plant mainly consists of an absorption case, a reproduction tank, a separation tank and a circulation tank. Digestion gas is taken into the absorption case together with a circulating absorption liquid and is delivered to the reproduction tank to be oxidized by aeration with the aid of an iron catalyst included in the tank. Then, it is delivered to the separation tank to be separated from the powdered iron oxide and is returned to the reproduction tank.

The new system performs alkali absorption and hydroxide desulfurization, and in this respect it is the same as conventional methods. Its greatest feature is the use made of the iron catalyst in fluidity which contrasts to the conventional use of the iron catalyst in suspension or fixation. Thus, in the new system there is no question of provoking iron concretion or sulfur trouble in the absorption, which have been the greatest difficulties in conventional methods.

Also, the running costs of the new system are lower because (1) it allows cast iron basins to be used directly as catalysts, (2) it uses iron oxide in circulation, and (3) it is equipped with a special multi-stage absorption unit which consumes less alkalis.

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BASIC RESEARCH FOR MARINE GENERATION PLANT

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 88

[Text]

The necessity of sites for power generation in Japan is not so pressing for the time being as to require the use of space on or below the surface of the sea. However, it may eventually be necessary to utilize sea space. For the Gobo power plant (1,800MW(E)), in practice, it has been decided to construct an artificial island 20m deep in the sea as the base for the plant, and this island is now under construction. The utilization of space off the coast will aim at a depth of 50m. Main technical development includes environmental measures such as control of marine pollution and submarine construction. A pilot plan is being studied which will make use of the space, 50m deep in design, in a circular or semi-circular (with a radius of 1km) breakwater which will be constructed by an on-the-off-sea site system. It consists of a plant barge system which provides an artificial still-water surface inside and in which is anchored a floating structure supporting a plant. Other studies are also being promoted for a suspension system for a water depth of 100m which has the greater part of the plant submerged and a sea-bottom system for relatively shallow seas which installs the plant on the sea bottom.

At present, companies are steadily promoting basic studies for the structure of breakwaters and the rolling of platforms inside breakwaters.

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## MEASURING WATER TEMPERATURE SENSOR TIME CONSTANTS

Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 89

[Text]

*In order to measure a varying water temperature with high accuracy, measurements have to be corrected. This, in principle, is because water temperature sensors respond more slowly than sensors for electrical conductivity or water depth. Thus, water temperatures, as measured in the sea, deviate somewhat from actual values. Such deviations found here can have disastrous results, in the case when accuracy of calculations of salt content is to be obtained accurately using calculations based on electrical conductivity and water temperature. This is why data on water temperature, which is considered to be responsible for salinity spikes, has to be corrected. This correction is possible only if time constants of water temperature sensors are positively established. At present, there is no established method of measuring such time constants. In order to eliminate this inconvenience, JAMSTEC has developed an instrument for establishing time constants and has been investigating by comparing time constants obtained by various tests.*

*The instrument consists of a measuring unit and a control panel. The measuring unit consists of a pair of water tanks, like a doughnut in shape, 600mm outside diameter, 200mm inside diameter and 300mm height and which separated by a partition board and shutter. The two water tanks are so designed that water can be heated in either of them independently. Bar heaters (6mm in diameter) in the tank create water temperature distributions.*

*Shutter: made of synthetic resin sheet 2mm thick with the front formed like a wing, is designed to move with the aid of springs and solenoids.*

*Swivel: provided with springs, is designed to provide various swiveling angles, by swiveling the arm at low speed (0.25-50mm/s) or at high speed (40-2000mm/s).*

*Arms: two types: one for swiveling (-2000mm/s) only and the other for lowering and swiveling (-1000mm/s).*

*Sensors: the arms at their bottoms are provided with a water surface detection sensor, a reference temperature sensor and so on. Each water tank is provided inside with 2 sensors for monitoring the temperature of the tank water.*

*Several signals, including water temperature output, are sent to the control panel. Some temperatures are displayed digitally on the control and also are output for other purposes. The instrument is able to measure time constants using 4 systems: a descent system, a swiveling descent system, a shutter system and a water temperature distribution system.*

*Fig.1 shows an example of time constant measurement using the descent system. The time lag between the time when the water surface detection sensor starts outputting and the time when sensor output rises represents a delay in rising and the time lag between the time when the sensor output reaches an ultimate 63% and the time of rising represent a*

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time constant. For these time lags, the test equipment recorded 0.04sec. and 0.72sec. respectively.

Fig.2 shows an example of time constant measurement using the water temperature distribution system. As swiveling speed increases, there appears an decrease in the amplitude of sensor output and a phase delay. The time constant calculated from these is 0.47sec. Reportedly, errors in time constant measurement are  $\pm 0.62\%$  for descent, swivelling descent and shutter systems and  $\pm 19\%$  for the water temperature distribution system. These errors can be further reduced by optimization of measuring conditions.

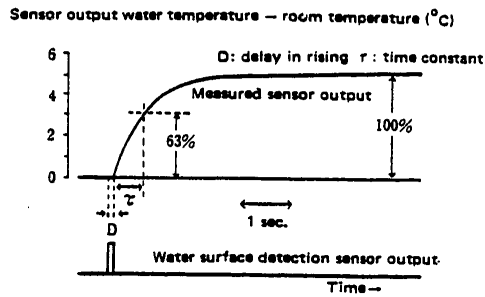


Fig. 1. Measurement of Time Constant Using Descent System

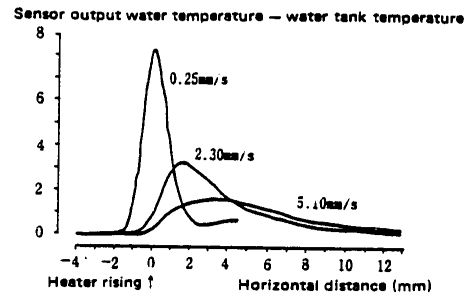
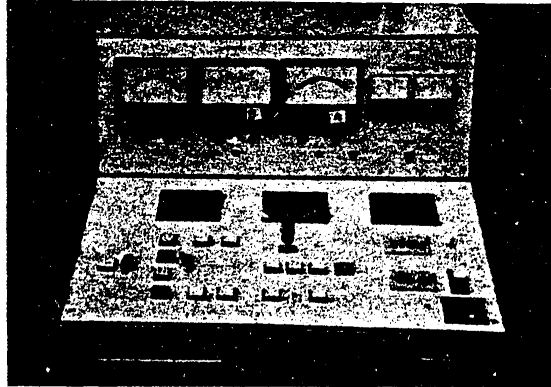


Fig. 2. Measurement of Time Constant Using Water Temperature Distribution System



Control Panel



Measuring Unit

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## BRIEFS

OILSHALE DEVELOPMENT WITH BRAZIL--The Japan Petroleum Development Corporation, having established a preparatory section for oilshale development to promote oilshale development following after oil sands development, proposed an oilshale joint development with the National Petroleum Corporation of Brazil, a nation which has the second-largest oilshale reserves in the world. Brazil, where the expectation for oilshale is greater than that for oil, has about 25% of the world's mineral reserves. Primitive reserves are 800 billion barrels, second only to the U.S., with 2,200 billion barrels. Brazil's willingness to develop oilshale is also very high. Petroglass is to construct a demonstration plant with a capacity of 1,000 barrels a day in Parana state, followed by a full-scale plant with a capacity of 50,000 barrels a day. According to the Ministry of International Trade and Industry, alternative fuel and new energy sources are expected to amount to 38.5 million kl in 1990, with about 7 million kl being supplied by oilshale. Thus, expectations on the joint project with Brazil are very high. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 56]

INTERNATIONAL COOPERATION OF HEAT PUMP--The Agency of Industrial Science and Technology, responding to an IEA request, has joined an international activity that aims to diffuse newly-developed heat pumps. This is a joint research agreement for the new types of heat pump systems, on the basis of an appeal of Belgium. Its object is to exchange data and utilization technology of the most advanced heat pumps, in order to jointly develop heat-pump "know how". The agency has taken notice of an absorption-type heat pump developed by Tokyo Sanyo Electric Co., the first commercialized product of the "Moonlight Program", and has submitted the IEA a number of data collected by Gunge Co., a user of the pumps. In return, data accumulated in other countries can be obtained for use in the promotion of heat-pump utilization in Japan. Current cooperation agreements made at the executive committee held at the IEA include presentation of heat-pump methods of each country, efficiency comparison, development of utilization methods, and examples of practical applications. One of the applications is a new-generation process line in milk and food plants, which integrates heat pumps into process lines with heating/cooling cycles. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 56]

METALLIC MIRROR PROCESSING EQUIPMENT--Toshiba Machine Co. has completed the development of a metallic mirror processing equipment incorporating an ultra-precision spherical pneumatic bearing. The metallic mirror processing equipment is used for making metallic mirrors which are incorporated in high-output laser

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oscillators, by the application of a simple cutting process using diamond tools. The machine has an in-built quality control to ensure that the metallic mirror manufactured by machine will be fully satisfactory with respect to hardness, vibration and deformation from heat, enabling it to display its optical capabilities to the fullest. It also adopts a super-precision spherical pneumatic bearing in its cutter axis. The pneumatic bearing has the following features: (1) A favorable rotation precision can be gained over a wide range, from low-speed to high-speed rotation; (2) thermal deformation is negligible because the coefficient of air friction is small. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 64]

HYDRAULIC POWER SYSTEM--In 1981 the Japan Oil Hydraulic Association will start a research and development project (3-year program) for the development of a hydraulic power system using a high water base fluid (HWBF), which is about 95% water. Equipment systems designed for the use of HWBF have many merits, e.g. resource- and energy-saving, since the content of the functioning liquid is almost all water, free from pollution and low in price. In contrast to oil, there is no difficulty in obtaining a steady supply. These equipment systems, however, have shortcomings in that, in addition to their low lubrication, that they tend to rust, corrode and leak, and thus their practical use has been delayed. The current program is aimed at promoting the development of systems and equipment using HWBF by promoting research on additives to the water, and the material, structure and operating principle of hydraulic equipment. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 64]

GEAR MEASURING CENTER, LABORATORY--Osaka Precision Machine Co. has completed the construction of a general gear measuring center (officially christened the Gear Measuring Center and Laboratory) where the accuracy of gears and gear testers can be measured. Until now there was nowhere in Japan where gear testers could be measured, and the newly built center is the second such facility in the world, after the National Laboratory on Physics and Engineering (PTB) in West Germany. Housed in a 3-story building (a total floor space of 495 m<sup>2</sup>), the center is equipped with a digital-type automatic gear precision measuring and analyzing machine, a machine that measures the results of two engaged tooth surfaces, and a tooth form measuring machine. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 64]

PRODUCTION TYPE NC AUTOMATIC LATHE--Miyano Tekkojo Co. has developed the ENC-3BC type NC automatic lathe. The machine has both functions of an automatic lathe: high productivity and an NC machine's flexibility. Main specifications: Max. workpiece diameter 105 mm; travel (2 directions) X 145 mm, Z 250 mm; spindle speeds 115-3,500 r.p.m.; spindle motor D.C. 5.5 kW; weight 3,000 kg. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 66]

NEW MACHINING CENTER--Kurashiki Machinery Co. has developed the KV-700 type vertical machining center. The KV-1000 type machine with longer travel is available also. Main specifications: Table area 1,000 x 460 mm; travel (3 directions) 720 (X) x 400 (Y) x 500 (Z) mm; spindle speeds 100-5,000 r.p.m.; spindle motor D.C. 5.5 kW; number of tools in ATC 24. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 66]

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WORLD'S BIGGEST BULLDOZER--Komatsu Ltd. has recently developed the world's largest bulldozer "D555A". The bulldozer weighs 120t and has an engine output of 1,000 hp. It is 2 or 3 steps bigger than D10", 85 t and 710 hp, from Caterpillar Tractor of the U.S., which has been the biggest bulldozer throughout the world. Thus, the new bulldozer is likely to remain in the premier position for some time ahead. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 68]

LONG-LIFE GAMMA RAY DETECTOR--Fuji Electric General Laboratory has successfully developed a long-life, real-time gamma-ray detector using ultra high-purity silicon. The P-type silicon used in this detector has an ultra-high purity of 10,000 ohm/cm relative resistance, which greatly surpasses the conventional type used in I/C's, giving a depletion layer 100 times as thick as in the case of a 10 ohm/cm relative resistance. This means that the sensitivity can be up-graded because the detect/sense area can be widened for the gamma detector, which senses secondary electrons produced inside the depletion layer. Also a relatively low operating voltage of 100 volts or less, besides simplifying the bootstrap circuit, makes the detector smaller in size and with a longer life, due to the decrease in the load to be applied to the device. A wide measuring range of one milli-Roentgen to 10 Roentgen per hour can be attained, with a high reliability of 10% or less of its dose-rate linearity (accuracy). [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2 Feb 81 p 70]

SINGAPORE SOFTWARE DEVELOPMENT--The Singapore Government is seeking to change its industrial base from labor-intensive industry to knowledge-intensive industry; Promotion of the computer industry is a particularly important subject, however, there are not enough trained engineers available, at present to strengthen the computer industry. Therefore, the Singapore Government has Japanese Government assistance in educating engineers for software development. In response to this request, the MITI (the Ministry of International Trade and Industry) and the MPT (the Ministry of Posts and Telecommunications) has sent a team of specialists to Singapore through the JICA and started talks to determine the type of assistance needed. The Singapore Government will establish the Software Technology Training Center to train software engineers in order to promote the computer industry in Singapore. To do this, the Singapore Government has asked for assistance from the Japanese Government in the form of capital, facilities, lecturers, training curriculum, and so forth, to start the Software Technology Training Center. The above two ministries (MITI and MPT) plan at present to establish an indirect education system whereby several lecturers from Japan will be sent to Singapore starting from the end of 1981 to train the Singaporean lecturers who will do the actual lecturing at the new training center. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 74]

COMPLETION OF RIPS--The Agency of Industrial Science and Technology of MITI has completed and started the trial running of the information center "Research Information Processing System (RIPS)" that has been under construction in Tsukuba Science City. The RIPS is a super computer system to be shared by 9 research agencies in the Tsukuba Research Center of the Agency of MITI and its Tsukuba management office. The main feature is the ability to connect, through fiber optic cables, the central computer to terminals in each agency. The system stores data to execute not only information retrieval but to support creation of research plans, experiments, trial designs, and so forth. [The total

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length of the fiber optic cable used 320 kilometers. The Agency of Industrial Science and Technology of MITI is planning to expand its services after operational achievements are met after starting RIPS (scheduled for Feb. 1981). For example, it is planning, as well as adjustment of the data collection system that uses artificial satellites or large-scale general-purpose simulation systems, to store as the data base, all the achievements and know-how gained in each research center and use this information in making calculations. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 74]

NEW DIGITAL SIGNAL TRANSMITTING SYSTEM--The NTT has successfully developed a new transmitting system which has twice the frequency use efficiency of conventional systems. This system is referred to as 16QAM (16-Value Quadrature Amplitude Modulation) system, and its transmitted signal per HZ consists of 5 bits. The 16QAM system sends out a 4-bit signal. Two carrier waves perpendicularly intersecting each other undergo amplitude modulation on each 4-value (2-bit) pulse and are then combined vectorwise to provide the 16-value (4-bit) modulation signal. The experimental unit operates on a frequency of 4, 5, or 6 GHz with signal transmission rate of 200m bits per second, to give 5 bits of frequency use efficiency (signal transmitting ability for one Hz of frequency) in the transmission experiment. The frequency use efficiency of 5 bits is 2 times that of phase modulating systems that are presently available and whose signal transmission capacity per Hz is 2.5 bits. Therefore th's new system, if put to practical use, is expected to have great impact on future digital network organization. [Text] [Tokyo TECHNOCRAT in English Vcl 14, No 2, Feb 81 p 74]

NEW GLASS FIBER--A new alkali-proof glass fiber has been developed in the National Institute for Research in Inorganic Materials of the Science and Technology Agency. While fibrous glass reinforced concrete (GRC) is now used as a facing material for buildings or a civil engineering and construction material, the new glass fiber is better suited for GRC because of its alkali resistance and high strength. The new glass fiber is called aluminosilicate glass and is different from ordinary soda glass in composition. Its alkali resistance has been raised by mixing 10-20% of metal oxides such as yttrium, lanthanum and titanium in soda glass. It can also be easily processed into the fibrous material. While soda glass with zirconium oxide is now used as glass fiber for GRC, the new glass fiber has better qualities. For example, the alkali resistance of the new one is 10 times that of the former and the modulus of elasticity is also about 70% higher. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 78]

FINE CERAMICS DISCUSSION MEETING--Fine ceramics are widely used in very hard materials, catalyzers, and heat resistance industries, and the development of new techniques is of major significance. In view of this, a Fine Ceramics Discussion Meeting has been started in order for private companies to promote joint research. Members of the meeting are the Toshiba Co., Asahi Glass Co., Denkkigaku Co., Sumitomo Denko Co., Kyoto Ceramics Co., Nihon Tokushu Yogyo Co., Nihon Glass Co., Sentan Kakogijutsu Shinko Kyokai, Ishikawajima Harima Heavy Industries, and the Kobe Seiko Co. Many kinds of fine ceramics such as lanthanum boride, silicon boride, boron nitride, a kind of titanate, alumina derivative, and synthetic quartz and synthetic diamond were developed, and the

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practical application of these is being carried forward. Since each member of the meeting possesses excellent ceramic techniques, the development of new ceramics is expected when these techniques are exchanged among the companies. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 78]

SLUDGE INTO COMPOST--Mitsubishi Heavy Industries, Ltd. has recently installed a pilot plant for turning sewage sludge into compost without adding any secondary materials and has started a proof test. Compound sewage sludge, about 60% of whose solids is made up of organic materials, can be used as a material for compost. However, it contains so much water, fluid and viscous material that it has had the drawback of effecting poor fermentation owing to insufficient oxygen (the result of decreased aeration during fermentation processes with aerobic microbes). Conventionally, bulky organic materials such as chaff were added as secondary materials to sludge in order to eliminate the above drawback. The new plant, which adds no secondary materials, first reduces the water content of the sludge to 60% by using a drier, agitates in a mixer the produced compost returned from the compost hopper, and further adjusts the water content to about 55%. The stock thus prepared is stored in a fermentation tank and receives appropriate aeration and agitation every 3 days. After maturing for 2 weeks, with fermentation heat it will turn into an odor-free compost for grain. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 86]

DEEP-SEA RESEARCH SUBMURGIBLE--On January 21st, "Shinkai (Deep Sea) 2000", a practical deep-sea research submergible, the first in Japan, was launched. It will be test-submerged off the coast of Japan in July and will be put in service in the fall while being supported by "Natsushima", a mother ship which was launched on August 1st of last year. It has been under construction since 1978 with a total construction cost of 3.7 billion yen. Its details will now be described in TECHNOCRAT. The submergible has a double structure. The outer shell is made of 5mm FRP and the inner shell consists of a steel sphere about 2.1m in diameter, with a sphericity of 0.06 and made of 3cm NS90 steel. Its crew consists of 3 members. Its living zone is conditioned to 1 atm and air is circulated while removing carbon dioxide by using a lithium adsorptive agent, and replacing with oxygen. The standard submergence time is totally 8 hours including 1 1/2 hr for descent, 3 hr for submarine work, 1 1/2 hr for ascent and 1 hr each for preparatory and finishing jobs. The air circulation system is designed to operate for 80 hours, 10 times as long as the above time. Communications with the mother ship are by telephone using radio above the sea surface and supersonic waves underwater. The submergible is 9.2m long, 3.0m wide and 2.9m high. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 88]

EARTHQUAKE-PROOF COMPUTER--NTT has added to its library, in addition to the DEMOSE service for data communications and scientific and technical calculations, a program for designing overpass abutments, ABUT, and a program for designing overpass piers, PIER, and has recently placed these services on the market. With DEMOSE, users can readily tie in to software services for construction with normal telephone lines. ABUT performs various calculations for maintaining stability of designs of various abutments, such as reverse T-type, counterfort type, power type, and for cross sections of frame-work members. PIER performs stability calculations of piers with respect to sliding, falling, and bearing

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strength, and calculations of stress intensity at design cross sections and of necessary reinforcing rods. Shimizu Construction Co. plans to calculate the earthquake-resisting strength of existing reinforced concrete buildings by developing a program called "DOC-S". The Ministry of International Trade and Industry (MITI) is planning to develop within 1981 a program to actively analyze earthquake-proof designs of pillow-type storage tanks inside high-pressure gas plants, and to use it for inspection of buildings. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 90]

EARTHQUAKE-PROOF BUILDING TESTS--The Building Research Institute will start from FY1981, jointly with the U.S., tests on earthquake-proof characteristics of steel-frame buildings. Earthquake-proof building designs have made a rapid progress but almost no information is available on the complex reactions of buildings to outside forces. In particular, there have never been any experiments performed using real size buildings. As reported previously, BRI has been promoting experiments on reinforced concrete buildings in cooperation with the U.S., and it is going to expand from FY1981 its cooperative setup with the U.S. to include earthquake-proof tests on steel-frame buildings using a real sized 7-story building. Plans call for a preliminary experiment in FY1981 and a full-fledged structural experiment using a 7-story model building. These experiments are expected to contribute data on the synergetic effects of the floor structure and beams. The results may contribute to increased safety in the composition of materials used and in the width-thickness ratio (the ratio of width and thickness of a board element of a cross section) for joints. In the preliminary experiment planned for 1981, tests are to be conducted in such fields as pillar-beam joints, pillars and foundations, composite beams, three-dimensional directions, and vibration of a scaled-down model. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 90]

PERMANENT HOME EQUIPPED WITH MICROCOMPUTER--Experimental homes equipped with microcomputers have been built but no permanent house provided with a computer has ever been built in Japan. Misawa Homes Co. reportedly is going to start selling homes equipped with an elementary microcomputer from April of this year. Sony Corporation reportedly is going to provide the software for the computer. Projected items to be controlled by the microcomputer are: 1) automatic shut-off of gas in case of leaks, 2) automatic cut-off of power when there is a short circuit, 3) automatic fire alarm, 4) automatic theft alarm, 5) air-conditioner control, 6) central cleaner control, and 7) TV and stereo control. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 90]

U.S.-JAPAN MACHINERY COMPETITION--Competition has heated up recently between Japanese and American makers of construction machinery over development of ultra-heavy duty construction machines. Development of the technology to make construction machinery in Japan has made great strides since the 1970s. Centerpieces of the development were higher quality hydraulic equipment and application of electronics. In this field, in the manufacture of large machines, the U.S. was far ahead of Japan technologically, but now the technological gap between the U.S. and Japan is almost nonexistent. In 1980, Hitachi Construction Machinery Co. placed on the market an 80-hp shovel car UH50, weighing 157t, and Komatsu Ltd. followed suit with the sale of a 120t bulldozer, D555A. The largest

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bulldozer in the world until then was the Caterpillar D-10 (86t). Komatsu will shortly start selling a heavy-duty loading shovel PC-1500 (150t). Construction machinery makers of the U.S. are expected to start a roll-back offensive in 1981. In the field of heavy-duty dump trucks, where U.S. makers have an edge, Japanese makers are promoting development. Thus, competition is expected to intensify the world over in the heavy-duty machinery market. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 2, Feb 81 p 90]

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