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Japan Report

(FOUO 47/81)

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JAPAN REPORT

(FOUO 47/81)

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SCIENCE AND TECHNOLOGY

PINBOARD TYPE SEQUENCER DESCRIBED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 pp 11-14

[Article by Yosuke Mikase, Third Designing Section, Izumi Co., Ltd.]

[Text]

Recently there has been significant development of sequence control in industry. These devices come in various types and kinds, namely drum, cam, pinboard, and stored or memory type sequencers, and the most applicable kind of sequencer for a particular use is determined by the application and the object of control for which it is to be used.

This report describes an easy-to-operate pinboard type sequencer that has been most popular in recent years and is the easiest to adopt.

1. Position of Pinboard Type Sequencer in Sequence Control

Fig.1 shows the relationship between the pinboard type sequencer's control capacities and its ease of control. As can be seen from the figure, the pinboard sequencer can be used in a wide range of applications, from those in which the cam- and drum-type sequencers can be used to where the stored or memory type sequencers are applicable.

Depending on the object of control, an appropriate model

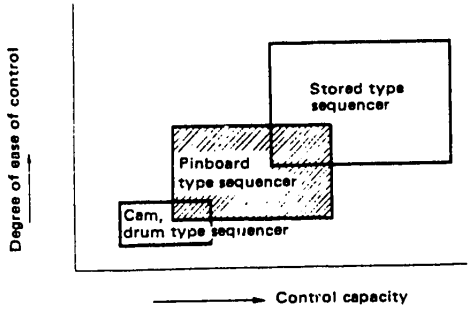

Fig. 1. Occupation Range of a Pinboard Type Sequencer

can be selected from among the various kinds of pinboard type sequencers mentioned below.

2. Definition of the Pinboard Type Sequencer

A pinboard type sequencer is a sequencer that permits designing of a sequence, in quite a different way from previous methods using combinations of relay circuits, from an operation time chart, yet requiring no special language for instructions and that easily affords incorporation of sequence time elements and confirmation input elements.

In this article, the setting of a sequence from an operation time chart for a pin-board type sequencer is described, using control of a small machine as an example. The movements of the small machine (sketch) are shown in Fig. 2.

2-1. Operation Time Chart

An explanation is given under the assumption that the operations of the small machine shown in Fig.2, follow the

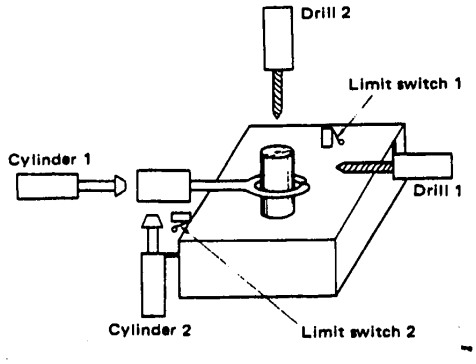

Fig. 2. Sketch

movements shown in the operation time chart in Fig.3. In the operation time chart in Fig.3, cylinder 1 goes into operation in the 1st process, and as the time T_1 advances, the procedure progresses into the 2nd process. Upon shifting to the 2nd process, drill 1 and cylinder 2 start operation and cylinder 2 travels as far as the limit switch (LS_1) attached at the machine end. At this time, LS_1 switches "on", starting the 3rd process. In the 3rd process, cylinder 2 maintains its operating state continuous from the 2nd process and drill 2 starts operation. The drill, equipped with a limit switch (LS_2) at its end, advances to the limit, whereupon LS_2 switches "on", starting yet another process. In this way, a sequence has been completed.

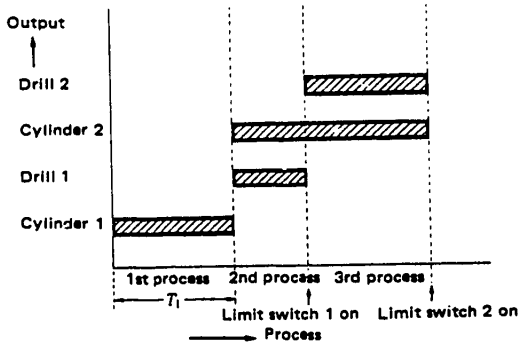

Fig. 3. Operating Time Chart

2-2. Setting a Pinboard

From the operation time chart in Fig.3, a pinboard sequence as shown in Fig.4 can be established. In Fig.4, the + mark shows insertion of a diode pin, and it is equivalent to + in terms of a circuit. In this way, the axis of ordinate (output line, time line, etc.) has been connected with the axis of abscissa (process line) by a diode.

The setting of a pinboard as shown in Fig.4 can be explained as follows: Since output 1 is "on" at process 1 from the operating time chart in Fig.3, a setting pin is inserted at where the line for the 1st process crosses the line for output 1. And furthermore, a setting pin is inserted at where process 1 line crosses timer T line since process 1 is time controlled.

In process 2, a pin is set at each of the crosses where process 2 line intersects the lines for output 2 and output 3, since output 2 and output 3 are in a state of "on". Since the progression from process 2 to process 3 is governed by the confirmed input of limit switch 1, LS_1 signals are connected to the confirmed input mechanism of process 2.

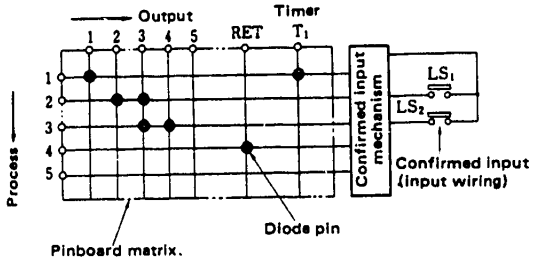

Fig. 4. Setting of a Pinboard

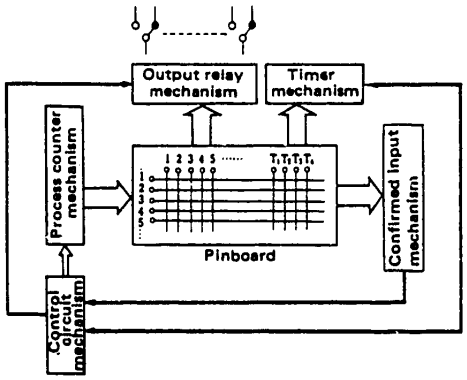

Fig. 5. Block Diagram

In process 3, outputs 3 and 4 are in a state of "on", so a pin is set at each of the spots where process 3 line crosses the lines for outputs 3 and 4. Since the progression from process 3 to process 4 is governed by the confirmed input of limit switch 2, LS_2 signals are connected to the confirmed input mechanism of process 3.

All these settings complete the operation time chart. Consequently, the 4th process is a return process. When a pin is set at where process 4 line crosses the RET line (return line), as soon as progression advances from the 3rd to 4th process the sequence returns to the 1st process, thus completing a sequence.

The writer believes that the reader can easily understand the method of setting a pinboard from an operation time chart.

2-3. Composition and Interior Structure of a Pinboard Type Sequencer

As shown in the block diagram in Fig.5, a pinboard sequencer is composed broadly of a pinboard matrix, process counter, control circuit, output relay, timer, and confirmed input mechanisms. The function of each of these mechanisms is as follows:

(1) Pinboard matrix mechanism

This is a setting mechanism where the relationship between the process, output, and timer are set by a diode pin from an operation time chart.

(2) Process counter mechanism

This is a counter that changes processes in sequence.

(3) Control circuit mechanism

This is the brain of a pinboard sequencer, and which sends out progression signals, or resets signals to the process counter, or controls output, timer, etc. by start signals.

(4) Output relay mechanism

This is an output relay contact that drives the actual load (electromagnetic valve, etc.) by output set by the pinboard matrix.

(5) Timer mechanism

The timer comes in two types, a CR type and a digital type. In the digital type, the timer time can be set by the pinboard matrix, and the process progresses by time signals.

(6) Confirmed input mechanism

This is a mechanism in which by connecting the confirmed input with the process signal of a pinboard sequencer, proceed signals are generated by confirmed input signals.

3. Features of a Pinboard Type Sequencer

(1) It can be easily set from an operation time chart.
(2) By changing the positions where a diode pin is inserted, output settings and timer settings can be altered with ease.
(3) Interlocking of a confirmed input signal with a process signal is easily provided.
(4) When using a digital timer, precise time settings can be made, and time settings can be made for each process.
(5) Relays are eliminated in the sequence.
(6) With changed settings, a pinboard can be used for other machines, which raises its utility value still further.
(7) No specific language for instructions is required.

4. Kinds of Pinboard Type Sequencers

4-1. Setting Method

There are three setting methods.

(1) Push-in diode pin setting method

This type of sequencer features insertion of a diode pin in a pinboard matrix (see Photo 1). With this type, the setting pin is inserted or removed with ease, but the pinboard matrix is expensive. This type is especially suited for use in machines that demand frequent changes in sequence.

(2) Screw-in diode capsule method

In this type of sequencer, a diode capsule with a diode sealed into it, is fastened by a screw to a printed-circuit substrate of matrix wiring (see Photo 2). This type of sequencer is cheaper because it uses a printed-circuit substrate in its matrix, but more time is required to attach to or detach a sequencer from a machine. It is especially suited for use in small machines.

(3) Direct attachment of diode type

In this type of sequencer, a diode is soldered directly onto a printed-circuit substrate of matrix wiring. This type of sequencer is the least expensive because it uses a printed-circuit substrate and, moreover, uses diodes directly, but it has a drawback in that to change a setting requires a great amount of trouble since the attachment or detachment of

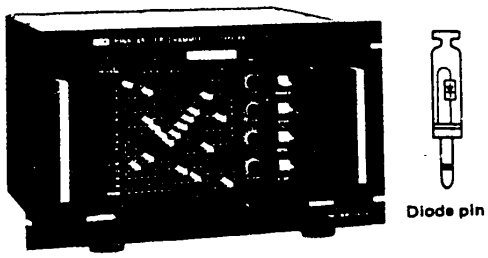

Photo 1. Setting Method of Diode Pin
(Izumi PRS 1515, 15 processes, 15 outputs)

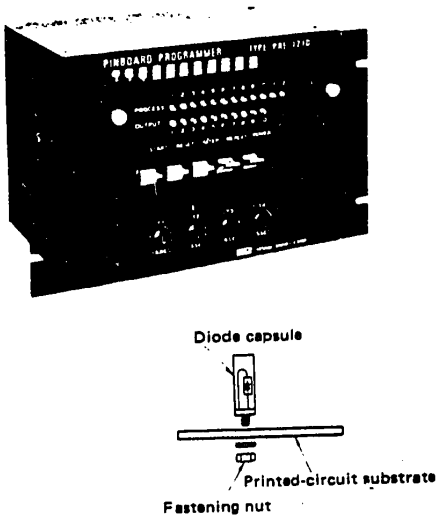

Photo 2. Screw-in Diode Capsule System
(Izumi PRE 1210, 12 processes, 10 outputs)

a diode involves soldering. It is especially suited for use in exclusive small machines that do not require sequence changes.

4-2. Control Systems

Pinboard type sequencers can be broadly classified into three types from their control systems.
(1) The so-called stepper system that controls process/progress only.

(2) The logic system that is not provided with the process/progress function but is equipped with the function to set logics for relay by AND and OR.
(3) A hybrid type that can set inputs, AND and OR logics, that are progress conditions for process/progress function.

5. Standards for Adoption of Pinboard Type Sequencers

When introducing a pinboard type sequencer, depending on what kind of operation a machine is expected to perform, the following items need to be taken into account for selecting the right type of sequencer.

(1) Stepper system and hybrid stepper system
   a. The number of processes
   b. The number of outputs
   c. The number of timers and time
   d. The number of confirmed outputs
   e. Existence or non-existence of jumps in a process
(2) Logic system
   a. The number of inputs
   b. The number of outputs
   c. The number of timers and time
   d. Address

6. Future Trends

As the number of applications for sequence controllers has increased, the progress of stored type sequencers incorporating microcomputers has been outstanding. In small robots and small plants, the demand for pinboard type sequencers is great because of their low price and ease of operation. Automation is expected to advance in medium-and large-size plants in the future through the adoption of stored type sequencers. Automation is expected to be further promoted in simple small robots and small plants, and consequently the number of applications for sequencers is expected to expand still further.

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SCIENCE AND TECHNOLOGY

STAGE TYPE SEQUENCERS AID EQUIPMENT DESIGN

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 pp 15-19

[Article by Hiroki Daigo, chief, First Technical Development Division, Koyo Electronics Industries Co.]

[Text]

With the advent of a stage of slower industrial growth and the trend toward automation of machinery, with the main objectives being labor-saving and energy-saving, in industrial processes there is greater sophistication,and processes have become more complex.

Aimed at labor saving in design, manufacture, setting and maintenance, and designed with a new look at the original role of sequencers for control of machinery and equipment, the stage type sequencer has been developed on a quite different premise from conventional control devices that required sequence circuit diagrams to enable them to perform sequence control of machine operations. The stage type sequencer has completely eliminated the need for the knowledge of a sequence circuit diagram, and with it, mechanical engineers, with no knowledge of sequence circuit designs as well as engineers engaged in the designing of sequence circuits, can design control equipment with ease.

1. Sequence Control Equipment

In designing sequence control equipment, the most common methods until now have been: 1) to design a sequence circuit diagram and, based on the diagram, to wire a number of relays, or 2) to program into a stored program sequencer (PLC) of a ladder type.

Control devices with relays as their component and PLC's require sequence circuit diagrams, but they are only a means of obtaining sequence operations. The primary purpose of a control device is to control a machine. Consequently if instructions for a control device are obtained directly from the operation of a machine, it means the device responds directly to the machine's operations, thus resulting in great savings in design, setting and maintenance. The stage type sequencer is thus aimed at realizing control of a machine from its operations, and this dream has been realized by the development of the "KOYO-KOSTAC-SA" (see Photo 1).

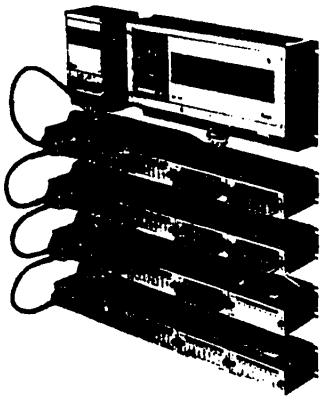


Photo 1. KOSTAC-SA

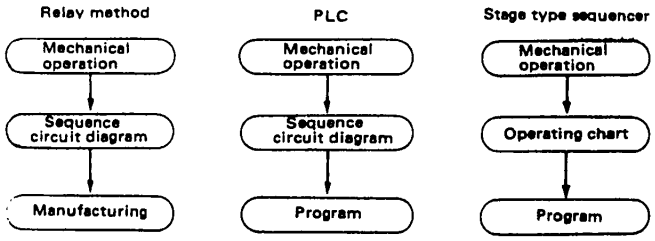


Fig. 1. Procedures of Control Devices

Fig.1 shows the procedures for manufacturing various control devices.

2. Structure of KOSTAC-SA

An outline of the stage type sequencer KOSTAC-SA is as follows:

Being a sequencer of a stored program system, KOSTAC-SA is composed, as shown in Fig.2, of a program counter, program memory, operation processing, internal memory and input/output sections.

The program counter reads from top to bottom program memories 0000–1023 repeatedly. With the capacity for 1024 words, each word consisting of 12 bits, the program memory stores programs written by the programmer (see Fig.12). On receiving instructions to read from the program counter, it sends the content in turn to the operation processing unit. The operation processing unit reads the contents forwarded by the program memory, and executes operations by checking signals from the internal memory. The internal memory temporarily stores the results of the operation process, and the state of input and stage. The input/output unit is a mechanism that sorts inputs from the limit switch or operation switch, or sorts input that moves the motor or valves.

3. Expression of Stage

The basic idea of the stage system is explained in the following:

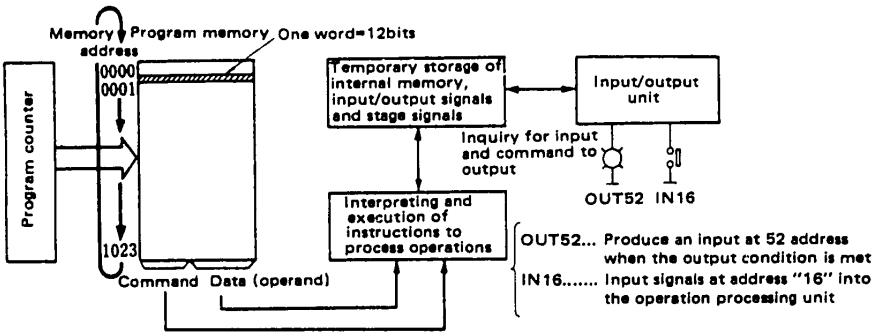


Fig. 2. Composition of KOSTAC-SA

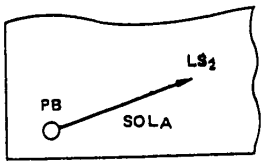


Fig. 3. Control Core

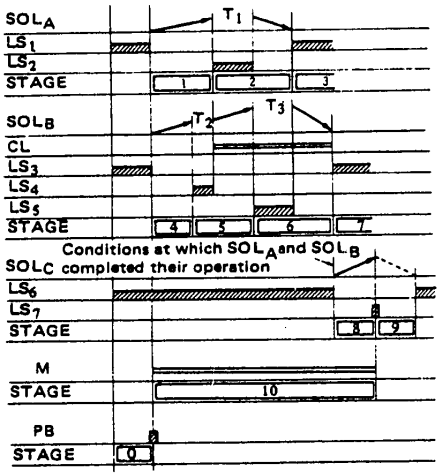


Fig. 4. Time Chart

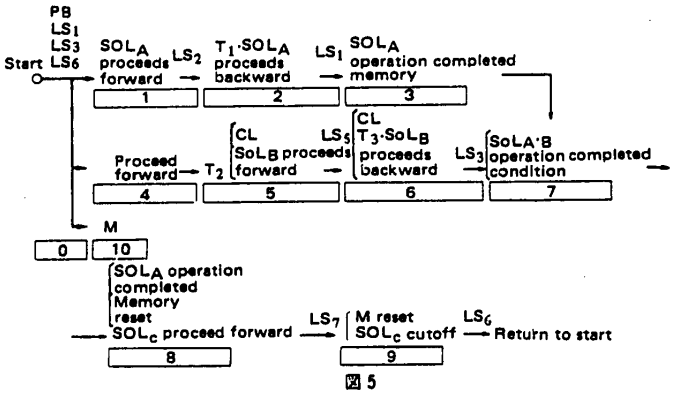


Fig. 5. Operations Expressed in Words

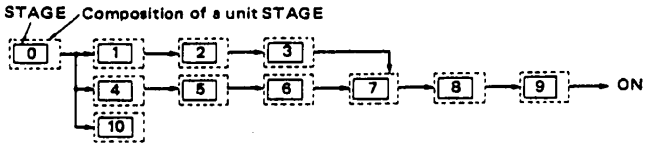


Fig. 6. Flow of STAGE's

3-1. Control Core

The minimum unit of control begins with producing output by control start signals and ends with stopping output by control stop signals. For example, in Fig.3 SOLA starts operating by PB and stops operating upon detecting LS_2.

Instruction signals are signals from sensors and counters, such as the operation switch, a limit switch or proximity switch, and outputs are electromagnetic valves, motors, lamps, etc. Sequence control is a collection of such control cores, and it executes these control cores according to a certain rule of orders. The control core is called STAGE.

3-2. Role of Stage

From the operations of the time chart in Fig.4, let us consider the role of a stage. As shown in the diagram, a time chart has load signals listed in it, and it is a graphic display of the control relationships between signals and loads. As is apparent from the diagram, stages are always controlled by start signals and stop signals, and a sequence is composed of a combination of stages.

From another view, a sequence can be broken down into stages. Also, each stage is positioned in relation to a series of controls and contains conditions determining a sequence. Fig.5 is a version of the time chart shown in Fig.4 expressed in words. It is a method of displaying the flow of operations in letters. As is apparent from Fig.5, stages start operating by start and stop signals, with one stage leading to the next, to compose a sequence.

Fig.6 has the above operations expressed in the flow of stages.

4. Flow of Stages

Upon completion of a transfer from one functioning stage to the next stage, the stage that has just completed an execution is reset and stops execution. That is, executions of stages proceed according to a program. It has already been mentioned that the stages themselves are provided with the conditions determining the flow of operations in a sequence, and thus if the flow of stages could be contrived in any conceivable combinations, sequences of any combinations would become feasible. The goal has been achieved by the stage type sequencer that employs three kinds of flow processing, as shown in Fig. 7.

5. Chart of Stages

A chart of a stage has a certain set of rules, and it is drawn up according to these rules.

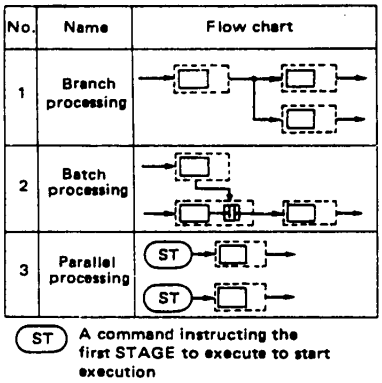


Fig. 7. Processing of 3 Kinds of STAGE Flow

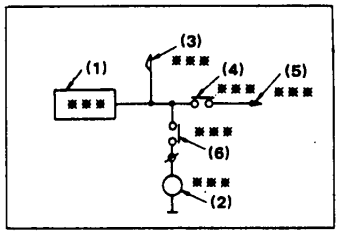


Fig. 8. Basic Chart of STAGE

5-1. Basic Chart of a Stage

Fig. 8 shows a basic chart of a stage.

(1) Indicates STAGE, the stage No. is written in ***. The command is expressed, STAGE***.

(2) Indicates output, and I/O No. is entered in ***. There are no limits to the number of outputs. Command: OUT***.

(3) Is for resetting another STAGE, and the STAGE No to be reset is entered in***. There are no limits to the number of stages for resetting. Command: R. STAGE***.

(4) Is conditions for advancing from one STAGE to the next STAGE, and in *** is entered I/O No. Conditions are combinations of AND or OR, or AND.OR. Command: IN*** AND*** OR***

A STAGE can be treated as a transfer condition. STAGE No is entered in ***.

Command: IN·STAGE*** AND·STAGE*** OR·STAGE***

Furthermore, the condition can be changed to NOT.

Command: IN·NOT*** AND·NOT*** OR·NOT*** IN·NOT·STAGE*** AND·NOT·STAGE*** OR·NOT·STAGE***

(5) Indicates the next STAGE to be transferred to when the condition has been attained. The STAGE NO. for the next STAGE is entered in***. There are no limits to the number of STATE's to be transferred to.

Command: JUMP***

For advancing onto the next STAGE when a condition has not yet been met, N.JUMP*** command is used.

(6) Is the condition for outputting at a time when a STAGE is in a state of execution, and the same commands as mentioned in Item 4 apply.

The conditions for (5) and (6) can be further loaded with conditions for counter functions.

Command: T***

*** timer 0.1–25.5 seconds
counter 1–255 counts

It can be provided with a total of 256 points of input/output points, with the input/output total being 128 points and the expanded input/output total being 128 points. For command, OUX is added to the input/output command.

The STAGE No. that is to be executed first (at the time the sequencer starts executing) needs to be designated. There are no limits to the number of the STAGE's to be executed at the start.

For command, START***

*** The No. of the STAGE to be executed first is entered.

5-2. Three Processing Functions of a STAGE

In a condensed form of the basic chart of a STAGE with some sections cut away, a STAGE has three processing functions as shown in Fig. 9.

6. Operation Chart and Preparation of Programs

Fig.10 is a diagram of the operations in Figs.4 and 5 as displayed in the operation chart of the stage type. Fig.11 is a program prepared from Fig.10 in accordance with the previous chapter.

7. Write-in of Program

The program prepared in Fig.11 is written into the program memory of the sequencer using a programming device. As

No.	Name	Chart
1	Operation processing	
2	Condition judgment processing	
3	Memory processing	

Fig. 9. Three Processing Functions of a STAGE

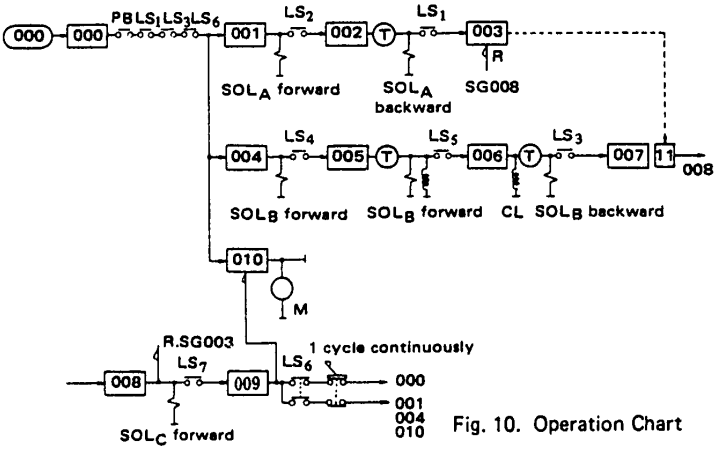


Fig. 10. Operation Chart

Fig. 11. Program

START	000	STAGE	004	IN	LS_7
STAGE	000	OUT	SOL_B forward	STAGE	009
IN	PB	IN	LS_1	R.STARE	010
AND	LS_1	STAGE	005	IN	LS_6
AND	LS_3	T	010	AND	1 cycle
AND	LS_6	OUT	SOL_B forward	J	000
JUMP	001	OUT	CL	IN	LS_6
JUMP	004	IN	LS_5	AND	continued
JUMP	010	STAGE	006	J	001
STAGE	001	OUT	CL	J	004
OUT	SOL_A forward	T	010	J	010
IN	LS_2	OUT	SOL_Bbackward	STARE	010
STAGE	002	AND	LS_8	OUT	M
T	010	STAGE	007		
OUT	SOL_A backward	IN,STAGE	003		
AND	LS_1	STAGE	008		
STAGE	003	R.STAGE	003		
		OUT	SOL_C forward		

Although input and output are written in letters, in the actual program they are represented by I/O No.

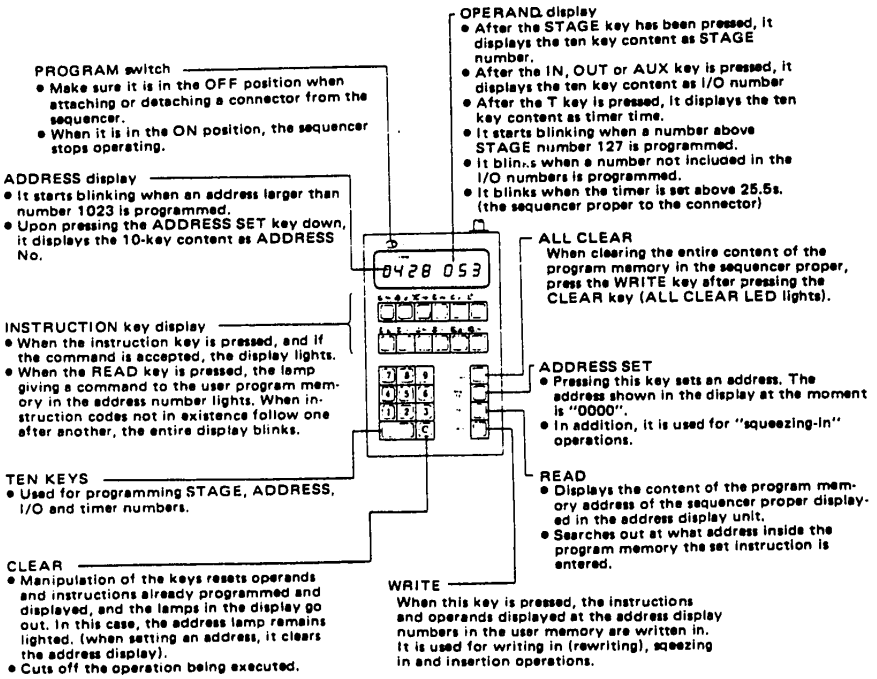


Fig. 12. Programming Device

shown in Fig.12, the programming device has a command key, number key, operation key and a command display, and it can write in a program as it is.

In addition to the write-in function, the programming device is provided with read-out, squeezing in of additional instructions, erasion of memory, and check of programming error functions.

8. Specifications of KOSTAC-SA

The general features of a stored program type sequencer are:

(1) Simplification of manufacture.
(2) Ease of design changes and remodeling.
(3) Small size and energy-saving.
(4) Greater reliability.
(5) Reduction in total cost.

Other main features of KOSTAC-SA include:

(1) No need to design sequence circuits.

(2) Monitoring of all STAGE's and all inputs and outputs is available on an LED display.

(3) Programs can be directly written into the program memory using a programming device.

An explanation has already been given about Items (1) and (3). An explanation of (2) follows: KOSTAC-SA is an assembly of units with distinctive functions. The sequencer proper is provided with 128 points of STAGE, 128 points of I/O, 128 points of expanded input/output and 6 points and 8 displays (LED) for self-diagnosis. The operating state of the sequencer can be judged from the display function, greatly contributing to the ease of setting and maintenance. With the stored program sequencer, there existed a problem that the state of execution could not be fully monitored from the outside since, as shown in Fig.2, the execution is carried out at a high speed by IC's, but when using KOSTAC-SA, the state of execution of STAGE's and input/output signals can be monitored by eye, so it can be handled in the same way as one would handle a conventional control device.

Table 1. Specifications of KOSTAC-SA

Power source voltage	AC 100V ±10%
Surrounding environment	Moisture below 90% (no dew formation) Temperature 0–50°C
Number of stages	128 stages
Number of instructions	26 kinds
Program memory capacity	1,024 words
Input/output points	128 points (expandable to 256 points)
Program timer•counter	Timer 0.1–25.5g Counter 1–255 counts
Scanning time	12.8ms
Monitoring functions	Stage display – 128 points Input/output display – 128 points Expanded input/output display–128 points Self-diagnosis display – 6 points

CSO: 4120/288

SCIENCE AND TECHNOLOGY

EXAMPLES OF AUTOMATION BY SEQUENCERS GIVEN

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 pp 20-23

[Article by Tatsuo Takahisa, Cannon Co., Ltd.

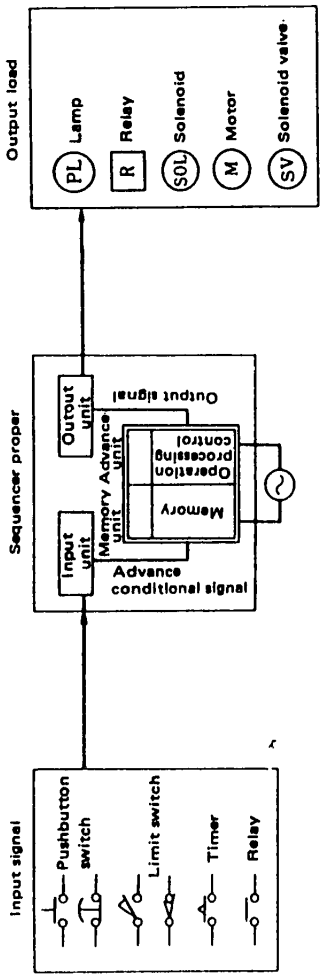
[Text]

1. Name and Definition of Sequencer

Referred to as "programmable controller" or "programmable logic sequence controller", sequencers are on the market under various product names, such as "Procon" (meaning program control), "pin-board program" since it incorporates pin-boards, and "stepping programmer" since its process advances step by step. Sequencers that advance by means of timers are called "program timers", and those whose operations are controlled by limit switches by motor driven cams are called "program cam timers".

These products all originate from the idea of how to simplify the conventional sequencers that rely for control of sequence circuits on relays. Consequently, minicomputers incorporating sequence circuits might have to be included in the category of sequencer, but in this article the definition extends to include sequencers incorporating minicomputers that are sold under the product name "programmable controller".

Since there are no regulations in the Japanese Industrial Standards that pertain to naming of products, each maker may be permitted to tag his product with a characteristic brand or product name. What matters is what contents sequencers are provided with, so the writer will henceforth confine himself to describing the definition of "sequencer". In the meaning that a sequencer is a module of sequence controls that are governed in the JIS, it may be defined as follows: "A sequencer is a unit of circuits that can freely devise a control that promotes step-by-step a predetermined sequence of procedures or a fixed sequence of logical steps". (see Fig. 1).



• This section sends out signals for starting or for advancing the circuit. In other words, it can be said to be an outside conditional-signal that satisfies the condition built in the sequencer. More than two conditions may be set at the same time.

• With the sequencer that does away with the troublesome work of designing a circuit, all that is needed is to insert pins in the order of movements shown in the sequence chart. At this time, external conditions can be met by simply inserting pins. This is based on a philosophy of interlock in which once external conditions are entered in the memory, the operation never moves on to the next stage of processing unless the condition satisfies the condition input previously.

• When the condition for an input signal agrees with the advance memory for the sequencer, it sends out an output signal kept in the memory for that stage and operates the external load. Some types of output loads are provided with a contact point that enables direct operation from the sequencer of some AC200V15A.

Fig. 1. Functions of Sequencer (pin-board type)

2. An Example of Sequencer Design

As anyone comes to know when setting himself to the task of designing a sequence circuit, all people, including those who are engaged in the designing of machinery, are naturally endowed with capabilities of the analog type. But, as is represented by the Boolean algebra, the designing of a circuit requires instead a digital way of thinking. The first step in circumventing this difficulty is to draft a design in an analog way, that is, in the form of a sequence flow chart and a block diagram. They can then provide a guide to drafting a sequence circuit.

In addition to preparing these two, it is also important to come up with a list of parts that perform the various operations, such as solenoid, motor, relays, switches, lamps, etc. In drafting a design, it is naturally expected that some special conditions would need to be filled, so such conditions should be jotted down as special reminders. These could be included in a list of specifications.

2-i. Procedures for Drafting a Circuit Design

a) A list of design specifications (desired features of machine and related items)
b) A block diagram
c) A sequence flow chart
d) A sequence circuit diagram and a list of symbols for reference
e) A machine profile with circuit parts diagram (with instructions for installation)
f) A diagram of electrical equipment box (with instructions for handling)
g) An operating manual (instructions for maintenance, makers of parts used, and a list of symbols and marks)

When the items listed above have been prepared, the designing work has been completed. It is quite a challenge to draft a design, but an even greater challenge is to clearly explain the machine design to the people who actually make a sequencer based on the design, or to those who will use or maintain the manufactured product.

From such a comprehensive definition, a sequencer is for itself being treated as a standard unit, and consequently no explanation is required of this point. The use of a sequencer reduces the problem of maintenance by that much, and since the sequencer has the guarantee of its maker, it is almost the same as if the electric equipment box itself has been guaranteed. In other words, everything goes fine, beginning with the work of designing.

Next is an example in which one company's relay sequence circuit, that appeared in a magazine, is designed using a sequencer.

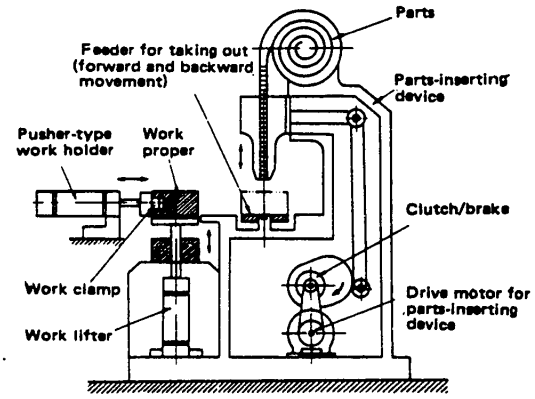


Fig. 2. Profile of Machine

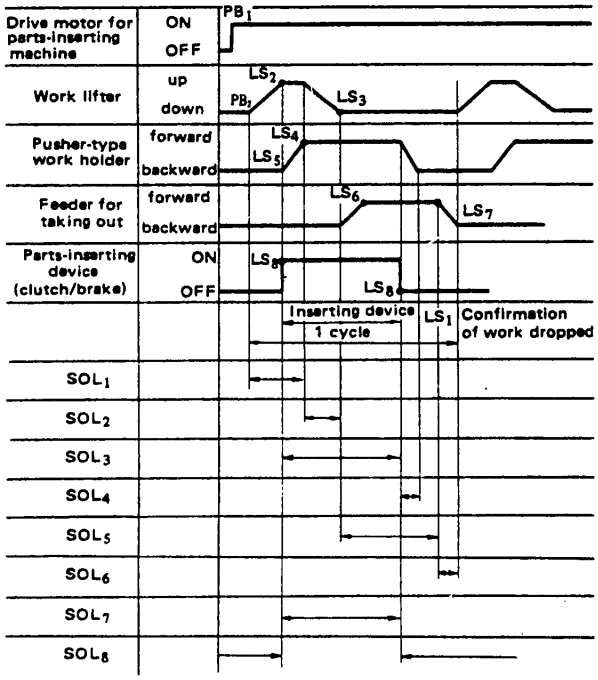


Fig. 3. Flow Chart for Sequencer

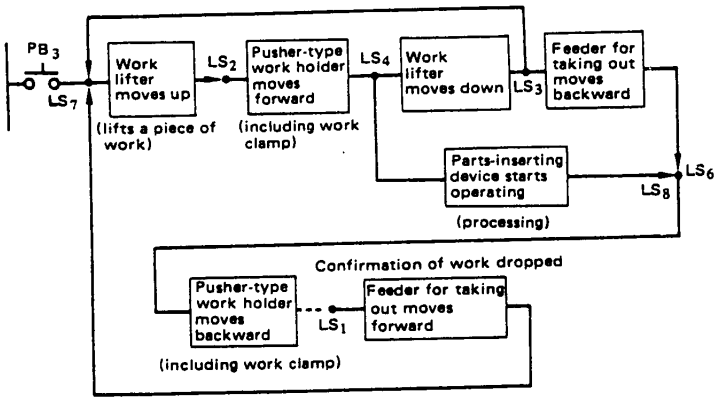
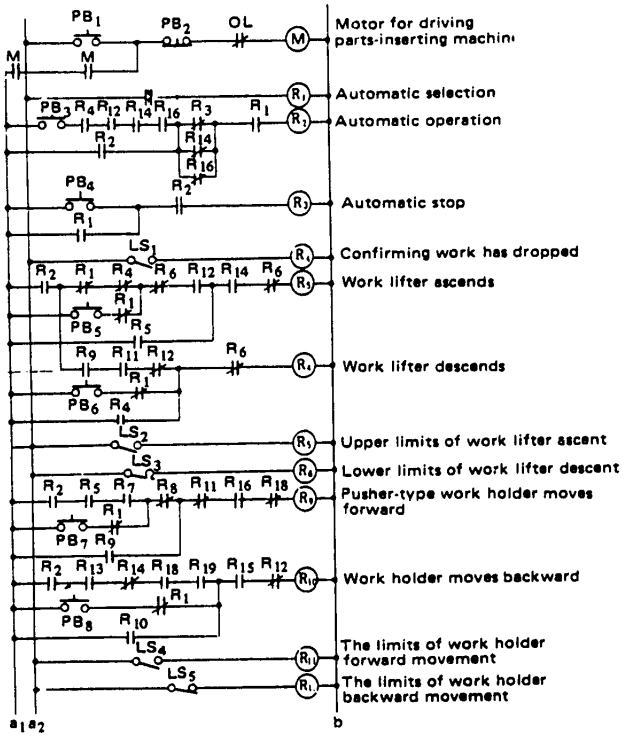


Fig. 4. Block Diagram



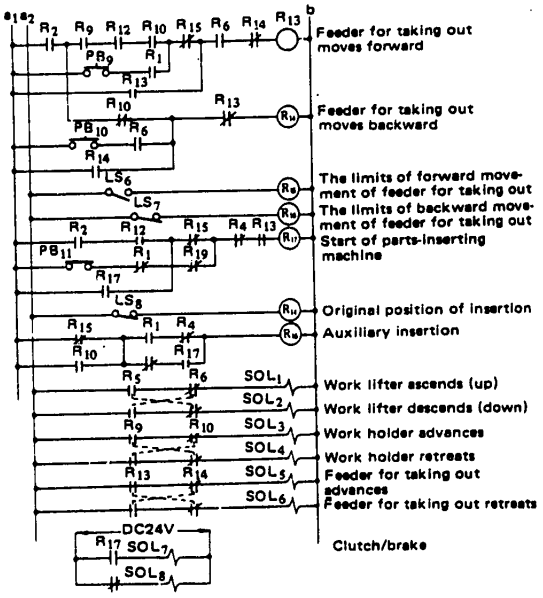


Fig. 5. Relay Sequence Circuit

2-2. An Example of Designing

Fig.2 is a profile of the machine. Explanation of its operations is given in the sequence flow chart in Fig.3, and a rough idea of the machine can be grasped when the flow chart is compared to a rough sketch of the block diagram in Fig.4.

The sequence circuit for the rather complex machine movements can be drawn as shown in Fig.5 when using con-

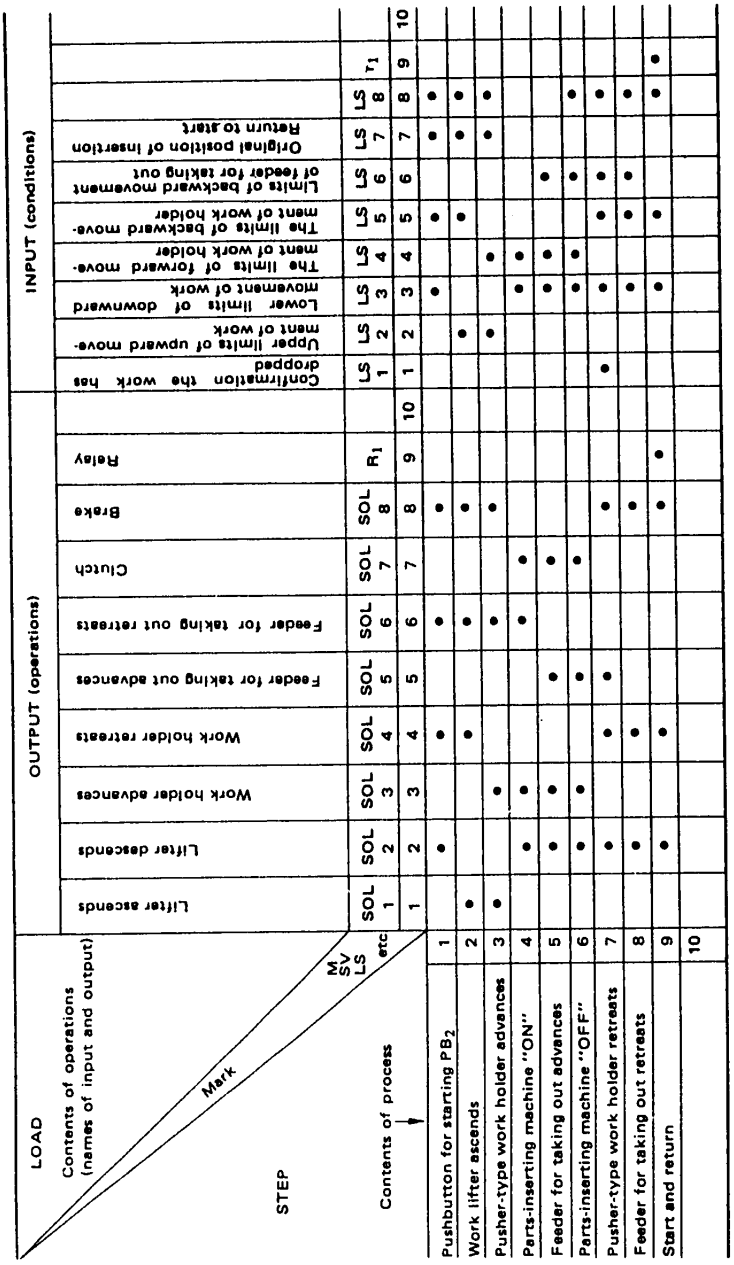


Fig. 6. Program Chart for Pin-board Type Sequencer

ventional relays. The sequence is still short of providing perfect interlocks but is sufficient to provide a certain degree of sequence of operations.

The sequence circuit is so confused that a man who has been engaged in the designing of machinery would hardly be able to draw up such a plan. Table 1 is a table of reference for symbols.

Let's now draw up a sequence using a sequencer. We here, however, assume that the part of the sequence corresponding to starts and emergency stops is the same as that of conventional sequence circuits, and thus omit that part. Therefore, written in the program chart is a sequencer of the pin-board type (being of a diode matrix type, input points can be used repeatedly) from the start of operation to its termination.

Fig.6 shows the result of the work, and the time needed to make entries in the chart was less than 30 minutes. The round spots in black show the positions where diode pins are inserted. The great merit of a sequencer is that even a person with no knowledge of electricity can take full advantage of it. Even for a person well experienced in the designing of electrical equipment, it would take half a day to design a sequence circuit using relays. Suppose a foolhardy designer of a machine has taken on the task: despite 2 or 3 nerve-racking days and after using many more relays or pushbutton switches than are actually needed, what he comes up with will be a circuit wired by a labyrinth of wires.

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SCIENCE AND TECHNOLOGY

TREND OF OPTICAL-FIBER COMMUNICATION STUDIED

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[Article by Sadakuni Shimada, member of NTT Yokosuka Electrocommunication]

[Text]

1. Introduction

Low-loss optical fiber was made public 10 years ago. Since then optical fiber technology and photodevice technology have made remarkable progress. As for optical fibers, 0.2dB/dm, which is said to be the ultimate loss value for silica materials, has been proven[1]. And as for semiconductor lasers, average life times of 100,000 hours or more have been established[2] for 0.85μm-band GaAlAs devices in actual operating conditions (up to approx. 50°C), and development of InGaAs devices of the 1.3μm band or the 1.5μm band, which are the loss valleies of optical fiber, is proceeding[3]. Therefore it can be said that the main technoiogies needed for optical communication systems have almost been developed.

System experiments in on-the-spot environments started around 1975. From 1976 through 1979 approximately 100 systems all over the world were tested in various fields, such as public communication, CATV, computers, and leased communication for electric-power companies, railroads, plants, expressways, and military facilities[4]. These tests have confirmed the predictions about light transmission systems of being fitted to wide-band transmission of graphics, in which strong induction resistance is given and a long relay interval can be achieved. Also, the strength of optical fiber has improved and the life-time of optical devices has become longer, confirming that light systems "can be used".

In recent years large-scale systems have been put into actual use or are planned to be used as shown in Table 1[5][6]. This table includes, however, those systems for which the plans have not been finalized. The technology trends on the system side since our 1978 April special issue can be summarized as follows:

(1) Optical fiber has improved in terms of loss, and developments of InGaAsP/InP semiconductor lasers have brought

Table 1. Examples of Large-scale Optical Communication System including Marine Transmission System, Which are Now Operated or Planned

Application area	Agency	Place	Time	Route length (km)	Transmission rate (Mb/s)	Remarks
Repeatered system in city or outskirt suburbs	NTT (Japan)	Kawasaki	1980.7	17.6	6.3, 32, 100, CTV	0.85μm band 1.3μm band
	NTT (Japan)	About ten places	1981~1982	Approx. 10each	Same as above	
	ATT (U.S.)	11 places	1979~1981		44.7 as main	Total fiber length of 11,000km
	ENTEL (Argentina)	In Buenos Aires	Commercial application started in Feb. 1981	Total of 320	34, 140	Total fiber length of 7,000km
Long distance	NTT (Japan)		1980~1981	80	400, 800	Single-mode fiber for 1.3μm band
	ATT (U.S.)	Washington D.C. —N.Y.—Cambridge	1983, 1984	Total of 983	44.7, 90	48 to 144 cores, total fiber length of 80,000km
	BPO (Britain)	London-Colchester	1979~1982	Total of 450	8, 34, 140	Total fiber length of 3,600km
Subscriber system (including CATV)	NTT (Japan)	Yokosuka	1980	8.5	1.5, 6.3, 32, CTV	Wave-length multiplexing at 0.8 to 1.3μm
	DOC, CTCA (Canada)	Elie	1978~		TV, telephone, data	280 subscribers
	ST (Canada)	Saskatchewan		Total of 3,000	Same as above	
	(France)	Biarritz	1981~		TV, etc.	2,000 subscribers at first stage
Computer link	Engineering Technology Institute	Tsukuba campus city	1980~1981	3 loops (approx. 10km each)	16, 32 (data, fax, voice), TV	Approx. 200 terminals
Submarine system	NTT (Japan)	Izuinatori—Kawazu	Laid in Nov. 1980	10	6.3, 32, 100	1.3μm, 12 cores (half of them are single mode)
	BPO, STC	Loch Fyne (Scotland)	Laid in Feb. 1980	9	140	6 cores (two out of them are single mode)
		Across the Atlantic Ocean	1988~1990	6,500	140 (280)	Up to 12 cores, 1.3, 1.55μm

practical use of the 1.3μm band or the 1.5μm band within reach.

(2) The reliability of 0.85μm-band GaAlAs/GaAs semiconductor lasers has increased to an average of 400,000 hours at 50°C (one million hours or more at 25°C). The study of the optical fiber reliability improvements has advanced, prompting the popularization of the 0.85μm-band system.

(3) Practical use of the single-mode fiber system has become possible by progress in the technologies of manufacturing single mode fiber, of coupling it with semiconductor lasers, and of connecting two single-mode fibers together (connector and splicing).

(4) Progress in the fabrication technique for multi-demultiplexers permits wave-length multiplexing technology to be used in the system[7].

(5) Progress in mode control technology for the semiconductor lasers has improved high-speed transmission technology[8] and direct-modulating analog transmission technology[9], which has promoted study of mode partition noise and modal noise[10][11].

(6) Progress in refractive-index distribution control technology for graded-index fiber has made it possible easily to obtain the fiber bandwidth of 800MHz/km or higher. Also analyses of graded-index fiber transmission characteristics have progressed.

(7) Progress in research and practical use of optical splitters, isolators, circulators, attenuators, and switches have contributed much to the characteristics improvement and the functional integration of light transmission systems. Many kinds of measurement equipment have been developed for practical use[12].

(8) Much attention has been given to integrating the electronic circuitry and photo-devices, and is primarily aimed at miniaturization and the improvements of characteristics and reliability, such as unification of PIN photodiodes and FETs[13][14].

(9) As for applications, discussions have already begun on applications for subscriber systems including the possibility of new service introduction[15]. Also, development of a marine transmission system and an on-the-spot testing system for it have already been announced[16].

These trends will be explained below. However because of limited space, the long wave-length band technology (Chapter 2), which exerts a vital influence on system configuration, and the single-mode fiber technology (Chapter 3) are explained in detail, then the recent achievements are introduced in Chapter 4 about the photosemiconductor device reliability, which greatly affects the practical use of optical communication systems. Also, progress in wave-length multiplex transmission technology, of which applications are expected in future subscriber systems or large-capacity transmission systems are covered in Bibliography entries[7], [17], and [18].

2. Long Wave-Length Band Technology

Line loss in silica optical fiber varies with the wave-length of the light used, as can be seen from the curve in Fig.1 (upper part). Generally speaking, the curve is shaped and Railey scattering is dominant to the wall on the short wave-length side and the molecular oscillation absorption of silica accounts for the wall on the long wave-length band. The loss peak for 0.95μm, 1.25μm, and 1.39μm is an absorption loss based on the OH radical as impurity. Some fibers recently fabricated by the VAD method suffer little OH-radical absorption loss[19]. This is the result of a dehydration process that uses chlorine. In the MCVD method, the content ratio of OH radical is limited to several ppb's.

The loss valley lies near 1.2μm, 1.3μm, and 1.5 to 1.6μm, the minimum ultimate loss being 0.2dB/km in 1.5 to 1.6μm.

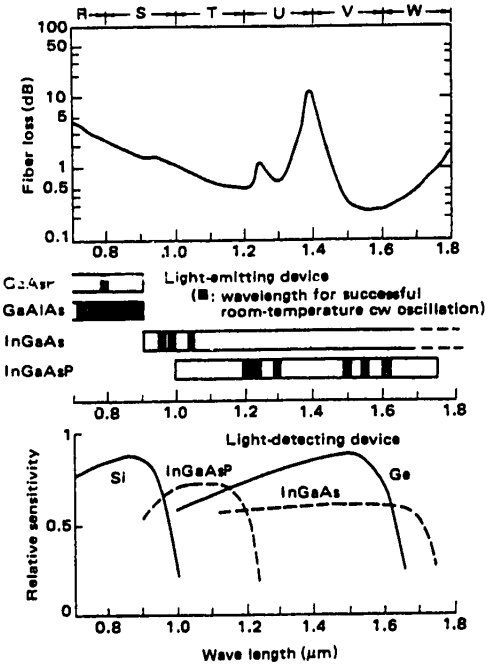


Fig. 1. Fiber Loss Spectra and Various Types of Light-Emitting/Light-Detecting Devices Applied to Each of Optical-fiber Wave Length Regions

Table 2. Selection of Optical Fiber and Wave-length Corresponding to System Requirements

Repeater spacing	Bit rate (Mb/s)	Graded-index fiber			Single mode fiber		
		0.85μm	1.3μm	1.5μm	0.85μm	1.3μm	1.5μm
10km	100	◎	○ (with sufficient loss margin)	○	○ (graded-index type is better)	○	○
	400	(B, △C)	△ (B)	△ (B)	△ (C)	◎	◎
30km	100	× (A)	◎	◎	× (A)	○ (graded-index type is better)	○
	400	× (A)	× (B)	× (B)	× (A)	◎	△ (C)

◎ Easy to use now
○ Usable but can be substituted by other
△ Hard to use because of marginal spacing
× Difficult to achieve
(A) Loss limit
(B) Modal dispersion limit
(C) Mode partition noise limit

If such a loss curve appears at the beginning, use of the 1.3μm band or the 1.5μm band must be considered. Actually however, the large OH-radical loss covered the loss valley of those wave-lengths and the loss valleies of only the 0.85μm band and the 1.05μm band could be seen. Therefore it seems natural that the 0.85μm band is used first. Such bands as the 1.05μm, 1.3μm, and 1.5μm bands, longer than the 0.85μm band, are generally referred to as long wave-length bands. They may be classified in more detail such as shown below, however, because their uses or dopant material and photo-semiconductor material of the optical fiber differ depending on their wave-lengths.

R band	0.7μm band (0.61~0.80μm)
S band	0.9μm band (0.81~1.00μm)
T band	1.1μm band (1.01~1.20μm)
U band	1.3μm band (1.21~1.40μm)
V band	1.5μm band (1.41~1.60μm)
W band	1.7μm band (1.61~1.80μm)

How to name the bands should be fully discussed because of their large influence on the system. R in the above stands for Red, and the letters following R are sequentially given as the band names for each 0.2μm. It is popular for the wave-length to represent the band, but the merits and demerits of using the frequency instead should be discussed.

A long repeater spacing is essential to transmission system configuration. Therefore the less line loss there is in the transmission medium, the better. Of course use of the long

wave-length band will become more important as research on long wave-length band semiconductor device progresses.

The transmission system design requires that the type of optical fiber and its wave-length be selected to meet the requirements for repeater spacing and bit rate. Table 2 shows four examples of setting two repeater spacing, 10km and 30km, and selecting two bit rates, 100Mb/s and 400Mb/s, for each setting.

The above results are arranged as follows:

(a) For 10km or less and 100Mb/s or less: Graded-index fiber can be used. The most useful wave-length should be selected based on economic efficiency, reliability, and ease of use*. (*In bands of 0.9μm or lower, the costs of semiconductor lasers and optical devices can be reduced by shared use in the video disc. Visible light can be used for very short distance and provides easy handling and maintenance.)

(b) For 10km or less and 400Mb/s or more: The graded type is difficult to use because of the band limits. A combination of single-mode fiber and longer wave-length region is better. At the higher bit rate, the 1.3μm band is better.

(c) For 30km and 100Mb/s or less: Only the longer wave-length region can be used. It is not necessary to use the single mode fiber because the grade-index fiber serves the same purpose.

(d) For 30km and 400Mb/s or more: Only the longer wave-length band and the single mode fiber can be used. For 1.5μm, limits are imposed by mode partition noise.

As a result, the system requirements can be met by using graded-index fiber for the lower bit rate and selecting** the best wave-length for the repeater spacing. (**It is not necessary to use only 1.3μm or 1.5μm. As the wave-length increases from 0.85 → 1.1 → 1.2μm in this order, the line loss is reduced to around 1dB/km. At this wave-length, fiber with a large OH-radical loss can be used. Also it is not necessary to change the profile for each wave-length because the narrower is the wave-length selection area, the smaller will be the change of bandwidth.) The single mode fiber must be used for the higher bit-rate. If a longer repeater spacing is required in addition, only the single mode fiber is available and the low-loss band such as 1.2 to 1.7μm is preferable.

The factors limiting the repeater spacing are explained below. The loss limit gives the maximum repeater spacing at which the prescribed error ratio can be maintained by keeping the receiver's S/N ratio decreased by line loss in the optical cable. Even if there is some margin for loss, the band limit by the optical cable will cause distortion in the waveform, increasing the error ratio by intersymbol interference. Although waveform equalization can improve the S/N ratio to some extent, the narrower the band width, the greater the loss penalty increases and the finer is the equalizer's adjustment,

thus creating problems for practical use. Usually the penalty can be suppressed to 2 to 3dB by inhibiting the spacing to that length, which is called the band limit for repeater spacing.

Table 3 shows band limit factors. Model dispersion is predominant in graded-index fiber, while in the single mode fiber, the mode partition noise[10] of the semiconductor laser is predominant even though the band limit is determined by the structure dispersion and the material dispersion. This is because noise is generated when waves go through a transmission line that provides a different delay time for different wave-lengths, because the actual semiconductor laser gives multiple oscillation wave-lengths and each wave is either generated or not generated at the leading edge of the pulse. The higher the bit rate, the faster the pulse rises, increasing the number of oscillation wave-lengths and the spectrum width w (half-value width). The longitudinal mode is produced even if the transversal mode control is executed, providing only one transversal mode. Usually 3 to 4nm (30 to 40Å) is given as the value of w if the bit rate is 400 to 800Mb/s.

The repeater spacing L (km) due to the mode partition noise limit is given by the following equation[20].

$$f_0 L = 3.5 \times 10^5 \frac{1}{mw}$$

f_0 is bit rate (Mb/s), w the above-mentioned spectrum width, and m the fiber's dispersion (ps/km·nm).

Next, which wave-length to use in order to get the longest repeater spacing is discussed[20].

The fiber I, shown in Table 4, is a single mode fiber designed to provide zero dispersion at wave-length of 1.29μm. While fiber II has a larger refractive index to provide zero dispersion at 1.55μm, its core diameter is half that of fiber I.

The actual minimum loss value after cabling is expected to be as shown in Table 4. The minimum loss value is 0.3dB/km, which is obtained when the fiber I is used at a wave-length of 1.55μm.

The reasons for the loss are explained in more detail below. The inherent line loss of the optical fiber consists of the losses caused by Railey scattering, ultraviolet absorption, and infrared absorption. However, for wavelengths of 1.29 or 1.55μm, Railey scattering loss is the majority. Therefore the inherent loss at a wave-length of 1.29μm is greater than otherwise because the Railey scattering loss is proportional to λ^{-4}. For example, for fiber I, the value is 0.31dB/km for 1.29μm or 0.18dB/km for 1.55μm. Also the inherent loss of fiber II is greater than that of fiber I because, as the amount of dopant increases, the amount of Railey scattering increases. The inherent loss in fiber II is 0.50 and 0.28dB/km for wave-length of 1.29 and 1.55μm respectively.

Actual manufacturing of the optical fiber results in imperfect structure, such as residual bubbles, microfluctuation at core-clad boundary, and fluctuation in the outside diameter, all of which increase the loss. This loss is roughly proportional to the difference in refractive index. The OH radical loss at

a wave-length 1.29μm is somewhat larger than at 1.55μm. And the larger the refractive index difference, the less is the microbending loss during cabling. Recent progress in the technology for optical fiber manufacturing and cabling can reduce the loss caused by all these factors to 0.1 to 0.2dB/km.

Fig.2 shows how a long repeater spacing can be achieved for each bit rate when using these fibers (SI, SII) and graded-index multimode fiber (GM). The top curve in Fig.2 shows the maximum spacing when a semiconductor laser is used as the light source and an APD is used as the detector. The other 5 curves give the calculated values under actual conditions as follows:

Input power into fiber −5dBm (Average power for mark ratio of 1/2 and occupancy ratio of 1/2)
Received level $-70.4 + 10\log f_0$ (dBm) (Error ratio:10^{-11})
(f_o:Bit rate (Mb/s))
Splicing 1 position/2km
Loss of connector, etc., SNR deterioration 4dB
Semiconductor laser spectrum width 3nm

The above results are arranged as follows:

(1) The combination of SI and wave length of 1.3μm is best for bit rates of 100Mb/s or more.

(2) For any lenthening of the repeater spacing, the combination of SI and a wave length of 1.55μm is recommended. However the existing semiconductor laser can provide only up to approximately 100Mb/s. Further improvement in the bit rate requires improvements in the oscillation spectrum of the semiconductor laser. (The combination of an external modulator and a DBR laser[22] or semiconductor laser is an example.)

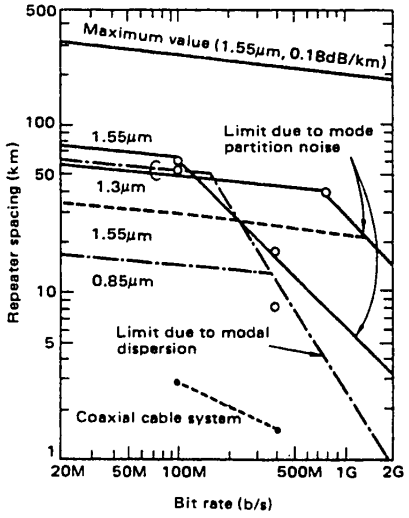
(3) The combination of SII and a wave length of 1.55μm is not as effective because calbe and connection loss are larger.

(4) In the case of GM, the bit rate can not be as high even with a wave length of 1.3μm because of the band limit due to modal dispersion.

Finally, Table 5 shows the examples of experiments in the 1.3=m and 1.5μm bands. An example of analog transmission using a semiconductor laser is also shown in the lower part of the table. Fig.4 shows the relationship between the received light power and the error rate. You can see that the curve produced by the mode partition noise for the combination of a wave length of 1.5μm and 400Mb/s flattens out. At 100Mb/s, the low-loss characteristics in the 1.5μm band can be used.

3. Single Mode Fiber Technology

A single mode fiber is best suited for the best transmission system for sending more information over a longer repeater



Line	Fiber	Loss (dB/km)		Splicing loss (dB/km)
		1.29μm	1.55μm	
———	Single mode I	0.67	0.50	0.15
– – –	Single mode II	(0.91)	0.63	0.75
—·—	Graded-index type (1 GHz/km)	0.69	2.74 (0.85μm)	0.1

Fig. 2. Relationship Between Bit Rate and Repeater Spacing (o mark: Experimental Results)

spacing. Higher expectations of it may have caused single mode fiber to be used in all areas. Generally however, it is more difficult to use single mode fiber than to use multimode fiber, but the difference has been appreciably reduced over the past few years. The technological trend in this area is described below.

Table 6 shows the differences between single mode fiber and multimode fiber (mainly the graded-index type).

As for line loss, little difference exists between the two, though the single mode fiber has less loss by as much as the lesser portion of the Railey scattering loss caused by the smaller refractive index difference (0.2% or so) between the core and the clad. As for the bandwidth, the single mode fiber can be wider. It can be even wider if the light-source spectrum is made narrower.

The connection (splicing, connector), or coupling technology of LD-to fiber is more difficult for single mode fiber. Fig.5 shows the connection loss when the displacement (abscissa) and folding (ordinate) are given.

Splicing loss by the fusion method averages 0.1dB for multimode fiber and 0.3dB for single mode fiber. The loss varies with the fiber's refractive index distribution or dimension ac-

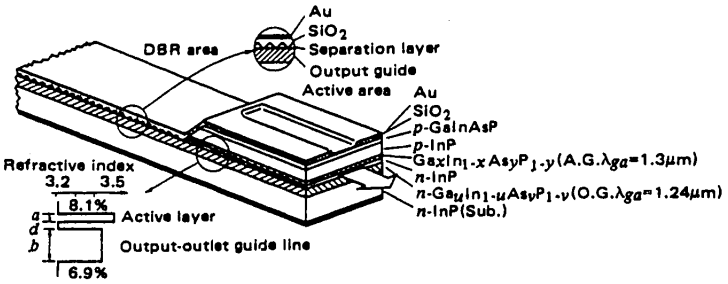
Table 3. Band Limitation

		Multi-mode	Single mode	Remarks
Unrelated to light-source spectrum	Mode dispersion	O	–	
Related to light-source spectrum	Structure dispersion	–	O	The bandwidth of an L-long fiber is determined by spectrum width (w) and value (m) of both dispersions as follows: $4.4\times10^5 \times \frac{1}{mwL}$ (MHz)
	Material dispersion	O	O	

Table 4. Single Mode Fiber

		Fiber I		Fiber II	
Ratio of difference in refractive index (%)		0.2		1.0	
Cut-off wave-length	(μm)	1.1~1.2			
Core diameter	(μm)	10		4.5	
Wave length λ_0	(μm)	1.29	1.55	1.29	1.55
Fiber loss*	(dB/km)	0.47	0.30	0.71	0.43
Fiber dispersion**	(PS/km·nm)	4	19	14	4
Splicing loss	(dB)	0.1		0.5	

* Loss due to intrinsic absorption in silica material, imperfect structure, OH absorption, and cabling process.
** Within width of $\lambda_0 \pm 20$nm.



(The Bragg reflection determines the oscillation wavelength, providing only one oscillation spectrum and 1/4 wave-length change caused by changes in temperature as compared with usual LD.)

Fig. 3. 1.3μm DBR Laser

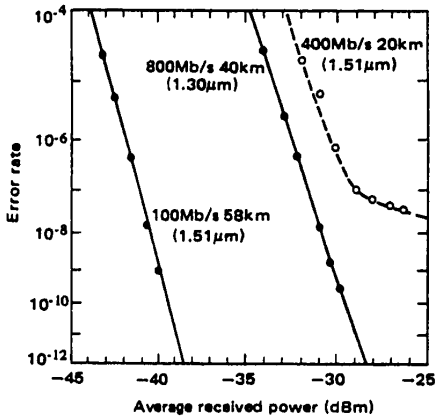


Fig. 4. Experimental Results of Error Rate Characteristics When Using Single Mode Fiber I

Table 5. Transmission Experiments at 1.3μm and 1.5μ Band

Wavelength (μm)	Bit rate (Mb/s)	Transmission distance (km)	Optical fiber type	Optical fiber loss (dB/km)	Date of announcement	
1.27	32	53.3	GM	0.66	1978.8	(22)
1.295	100	52.6	GM	0.6	1979.3	(23)
1.295	400	20	GM	0.6	do.	
1.31	400	34	S	0.73	1979.8	(24)
1.31	800	30	S	0.73	do.	
1.31	800	40	S	0.6	1980.4	(25)
1.51	100	58	S	0.5	do.	
1.51	400	20	S	0.5	do.	
1.29	4MHz CTV	32	S	0.67	1979.9	(26)
1.29	30MHz CTV	17	S	0.84	1979.10	(27)

curacy (refractive index differences, profile, fiber's outer diameter, core diameter, core eccentricity, or core ellipticallization). Single mode fiber requires more accuracy and research[28] is continuing with such countermeasures as (1) to adjust one core to another by rotating the fibers when connecting them, (2) to adjust the cores by a fine control mechanism, (3) to narrow the discharge beam, thereby prohibiting the fiber outer circumference coincidence effect due to surface tension from producing the core-position displacement and (4) to decrease to 1 degree or less the error in the rectangular angle between the fiber face and the fiber axis from 90 degree when cutting the fiber as part of preconnection preparations. It should be determined whether it can stand use on the spot.

For the connector, the fiber can be set at the center of the

Table 6. Differences Between Multimode Fiber and Single Mode Fiber

T6

Item		Multimode fiber	Single mode fiber
Transmission characteristics	Line loss	Same	Same (favorable if Δ is less)
	Bandwidth (per km)	≈1GHz	≈100GHz* (spectrum width: 10Å)
Connection (splicing, connector)		Easy	Difficult
LD-fiber coupling		Easy	Difficult
Microbending loss (cabling, jacketing)		<0.1dB/km	Less problematical than multimode (fitted to marine cable?)
** Raman scattering, Brillan scattering		Large tolerance power (≈100W)	Small tolerance power (≈3W)
Cost			Strict dimension tolerances raise the cost?
Analog transmission (modal noise)		Problematical	Less problematical
Fault location		Easy	Difficult

* Limited due to mode partition noise

** Will be problematical when using high-output laser

plug by simply inserting the optical fiber into an accurate hole at the center of a ceramic mount and fixing it with adhesive[29]. This is called FA (Field Assembly), meaning that it can be assembled in the field. This is the only connector[30] that is practical for use with single mode fiber at present. It can be used for a single mode fiber due to its high accuracy, though it has been originally designed for use in on-the-spot experiments of short distance transmission systems with graded-index fiber. Tolerance for the fibre and the hole is an average displacement of 0.7μm and a folding angle of 0.3 degrees. The relative displacement of the plugs on both sides must be considered when thinking of the connector. However a random combination will multiply the above values by $\sqrt{2}$, assuming averages of 1μm and 0.4 degrees respectively as the displacement and the folding angle.

The loss of the actually manufactured connector was, in the 1.3μm band, an average of 0.5dB and 1.2dB maximum. If matching material is used and the gap at the connector part is filled, the loss is only 0.3dB. The Fresnel loss is calculated to be 0.3dB. However the actual connector may have in some cases very little gap, tending to make the difference due to the presence or nonpresence of matching material somewhat less than 0.3dB. The characteristics of the connector for use with graded-index fiber, as a reference, has reached a stable technological level, with little dispersion: 0.4dB as average loss and 0.6 to 0.7dB for the worst case.

Direct coupling of an LD with a single mode fiber, as shown in Table 7, will give 10 to 11dB of coupling loss. However, by

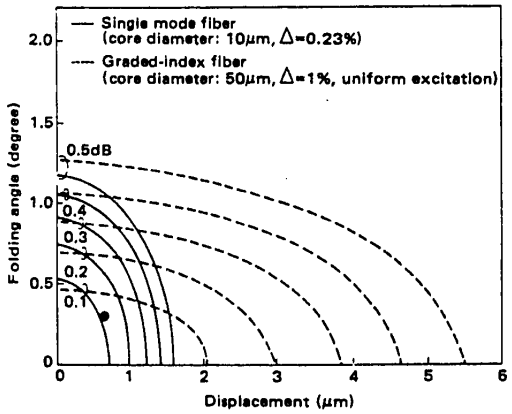


Fig. 5. Relationship Between Loss and Imperfections at Optical Fiber Connections
(● mark: Achieved value on average of FA-type connector accuracy)

Table 7. Coupling Methods for Semiconductor Laser with Optical Fiber

Coupling method	Structure	Coupling loss (dB)		Allowable displacement in the case of single mode fiber (μm)	
		Single mode fiber	Multimode fiber	Lens	Fiber
Direct connection		10~11	5~7		1
Fine lens		3~4	1	0.2	1
Top-ball taper (with ball lens and semiball lens)		5~6	1		0.4
Fine lens + Cellhock		4~5	1	0.2	1

using a fine cylindrical lens (Fig.6) or by machining the fiber face, the connection loss can be reduced to 3 to 5dB[31]. Research on making the module version is proceeding, and has almost reached the practical level. At present, countermeasures are being sought against changes in the relative position of the LD and the fiber, caused by changes in ambient temperature or LD radiation pattern due to oscillation mode skipping (which is not a problem for the transverse mode-controlled LD)[34].

A method that blocks the reflection light by inserting an isolator between the LD and the fiber is also discussed[35].

Technological progress has succeeded in reducing cabling loss to 0.1 to 0.2dB/km or less for overland cable. The single mode

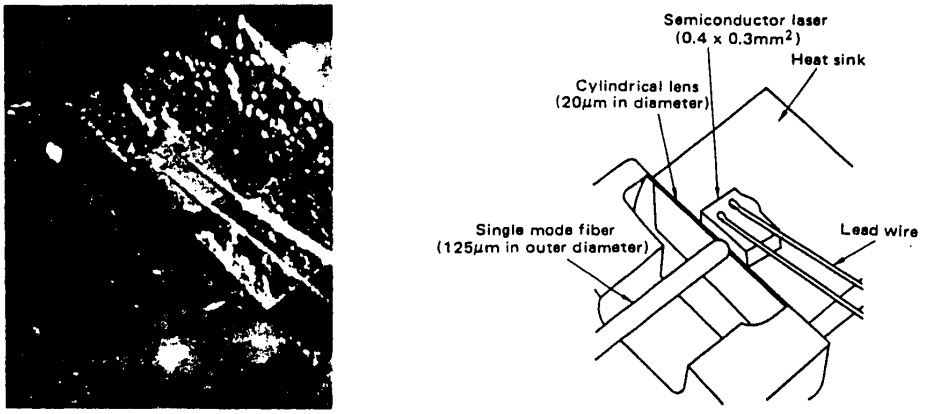


Fig. 6. Coupling for Semiconductor Laser with Optical Fiber

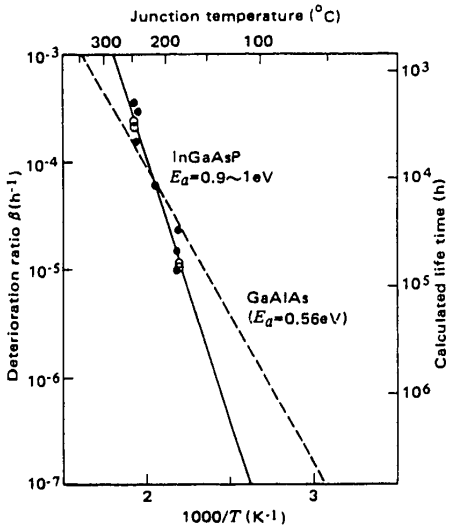


Fig. 7. Life Time of Light-emitting Diode

fiber generally reduces cabling loss more than multi mode fiber because the single mode fiber becomes more highly microbending resistant as its refractive index increases. For submarine cables, the optical fiber can be inserted[36)37)] into copper pipe in order to avoid the influence of sea-pressure and by applying the pressure to the fiber (loading the lagging with part of the water pressure). The former suffers the problem of flooding of the copper pipe when it is damaged, so a recommendation has been made to fill the pipe with jelly material. In the latter method, since side pressure is applied, the single mode fiber will be easier to troubleshoot that the other.

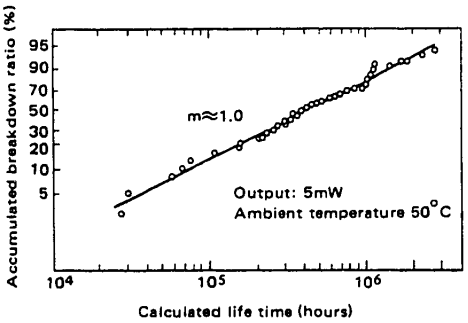


Fig. 8. Weible Distribution for Calculated Life Time of GaAlAs Semiconductor Laser in 0.85μm Band

In nonlinear scattering, the threshold value determines the fiber's tolerant transmission power. The LD output can be neglected because it is only a few mW. The threshold value cannot be neglected, however, when lasers with more output are used for submarine non-repeatered, transmission, optical fiber break-point detection, or laser machining. If the light source is near to an ideal single wave, the threshold is less for Brillian scattering, but, as the spectrum width is narrow, 50MHz (1.6×10^{-4} nm), the Raman scattering[38] occurs first in a normal laser.

The normal method of detecting breaks or faults in optical fiber is to send an optical pulse to detect the reflection wave created by the break point and measure the delay time, thereby determining the distance to the point. However this method can not locate all faults because light does not always return. It depends on the fiber face conditions at a damaged point.

Another method is available that uses the Railey scattering, an inherent property of the optical fiber. The Railey scattering is caused by the nonuniformity in the glass and scatters the light in all directions. If backward scattering (i.e. reflected light) can be collected by a light directivity coupler, the output that attenuates as it passes through the optical fiber can be obtained. The curve will show a gap if the light stops at a break because the reflected light scattered from any points behind a break are drastically weakened. These phenomena will tell you the fault location, the fiber's loss by the curve gradient, and by the losses at the break or splicing point how large the gap is[39)40)].

Now, assuming that the light output is 10mW (inside the fiber), the loss in the optical fiber (in the multi mode) is 2.5dB/km (wave length: 0.85μm), and the Railey scattering loss is 2.0dB/km; the detectable distance will be 11km by the backward scattering method and 17km[49)] by the Feesnel reflection detecting method. The pulse width is 100ns (therefore distance resolution is 20m) and the receiving side uses a high-sensitivity system that uses averaging.

Also if the section is perpendicular to the fiber axis, the Fresnel reflection level is −14dB and if the section is tilted or its surface is not smooth, the reflection decreases even more. The backward scattering level is 0.85μm, 32dB lower.

As the wave-length increases, the Railey scattering decreases in proportion to λ^{-4}, decreasing the backward scattering by an equal amount. Also, however, the loss becomes less so the detection distance is elongated, e.g to 20km at a wave length of 1.3μm by the backward scattering method, with a fiber loss of 1dB/km, a Railey scattering loss of 0.37dB/km, and a Ge-APD as detector.

For single mode fiber, most of the light reflected at fiber face is assumed not to return, therefore, it is necessary to rely on the backward scattering method. However the low dopant content of the core decreases the Railey scattering to a low level and the ratio of the backward fiber carrier level to total scattering level is also lower. In addition, the loss of the directivity coupler tends to increase, decreasing the detection distance as compared with the multimode fiber; the countermeasure to this is one of the main problems with using single mode fiber in long repeater spacing systems.

4. Light Sources and Detectors

GaAlAs/GaAs and InGaP/InP are typical light source materials for the 0.75 to 0.9μm bands and 1 to 1.7μm bands respectively. CW oscillation is generated for various wave-lengths in an attempt to improve reliability.

If the life of the light-emitting diode is defined as the time over which the light output is reduced to half the initial value, the life time for the GaAlAs device is, as shown in Fig.7, calculated to be 10^7 hours at room temperature (equivalent to 40°C at the light-emitting part). While for the InGaAsP device, it is calculated to be 5×10^9 hours[41].

Some GaAlAs devices rapidly deteriorate in terms of the output caused by dislocation development if they undergo electrification testing of 100mA at 20°C. InGaAsP devices do not suffer from this and are known to have comparatively stable characteristics even though they were only recently developed.

Factors affecting the deterioration of semiconductor lasers in the 0.85μm band have been analysed to a considerable extent, and average life times of 400,000 hours have been achieved[2] for a fixed output of 5mW at 50°C (the highest temperature in practical use) as ambient temperature, as shown in Fig.8, where the life time is defined as the time required for the drive current that maintains the above-mentioned output level to reach 180mA (the drive current increases roughly proportional to the square root of time). The digital transmission system uses the pulse driving method, and longer life-times are expected; approximately three times that of present experimental ones.

The 1.3μm-band InGaAsP laser had a problem in which the oscillation stopped at temperatures higher than 50°C because

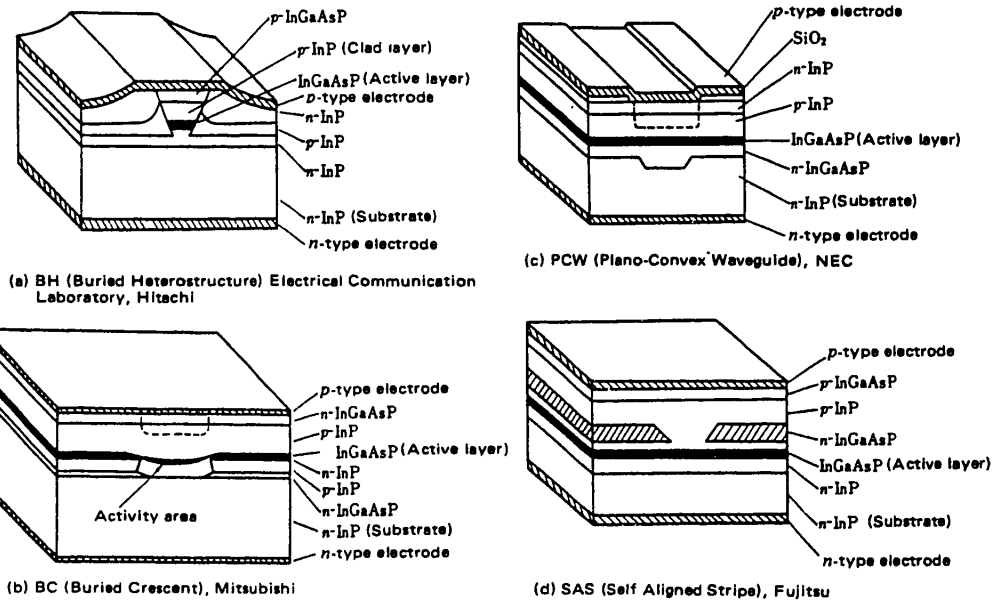


Fig. 9. Various Transverse Mode Control Technologies

the threshold value rapidly increased with a rise in temperature. However, progress in the transverse mode control technology (Fig.9) has enabled reduction of the threshold current to 100mA or less (20mA for the lower-current one), so that correct oscillation, even at 70°C, can be maintained. Presently the life time test of over several thousand hours is continuing. The present tendency shown by the drive-current increase rate suggests a life-time of over 100,000 hours at 50°C[46]. Even a 1.5μm-band device is being developed[47)-49)], and its life-time test is also being conducted.

As compared with the GaAlAs device, the InGaGaAsP device (1) free of initial deterioration caused by the dark line or dark spot defects and (2) stable even without surface protection because of the low rate of oxide growth on the edge surface of the resonance device. Therefore the main factor of deterioration is diffusion of the electrode metal.

Si and Ge devices have now reached a practical level as detectors. Efforts are being made to develop InGaAs or InGaAsP devices, which generate less noise than Ge devices in the longer wave-length region. Under the present conditions, however, a stable device cannot be obtained due to the impurity of the crystal used as the APD. Combination of a PIN-PD and FET, has achieved a sensitivity equivalent to that of the Ge-APD[13)14)].

5. Conclusion

A set of tools for the design of optical fiber transmission are now available. The technologies have undergone on-the-spot tests, and systems have been placed in commercial use. The reliability, after enduring the early-stage use, is now proceeding to the next step, and its application in the field of the submarine transmission, which requires high reliability, is being pushed.

Japan is taking the leading role in such new research fields as repeater spacings of several tens of kilometers or more in the longer wave-length region, large capacity transmission at bit rates of 800Mb/s or more by use of single mode fiber, and variations in system configuration by using wave-length multiplexing technology.

From now on, systems must be configured by using such basic technologies, and optical systems applied to various fields. The economics of optical systems are still a matter of discussion but are expected to improve year by year.

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SCIENCE AND TECHNOLOGY

PRODUCTION OF PEPTIDES BY NUCLEIC ACID SYNTHESIS, GENE ENGINEERING

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[Article by Yoshifumi Jigami, Hideaki Tanaka and Tstomu Nishimura, Bioorganic Chemistry Division, National Chemical Laboratory for Industry]

[Text]

1. Introduction

Research on vital nucleic acids was initiated when nucleic acids were discovered by Miescher (1869), and later their chemical structure was clarified by Baddiley and Todd[1]. Further, based on Chargaff's research, Watson and Crick[2] proposed the double helix structure of DNA, which triggered the development of molecular biology. The advance in molecular biology has lead to rapid progress in researches on genes and also stimulated progress in chemical synthesis of nucleic acid. Finally, it can now be shown that synthetic nucleic acids manifest their function in an organism. Apart from this, while Berg et al.[3] have succeeded in connecting hetero-plasmids and Cohen et al.[4] have first succeeded in gene engineering, various kinds of enzymes pertaining to vital nucleic acids have been isolated one after another, and instances of cloning by the use of an microorganism are numerous. Since it has thus become possible to control artificially the genetic information that is the most distinctive function in an organism, active researches have been made to control the production of useful end-products or to apply it in medicine. These researches are called gene engineering or gene manipulation. While they are of scientific and technical interest, they are expected to play a major role, as the frontier technique of molecular biology, in science and technology for the 21st century, including not only industrial field such as the chemical industry but also medical science and biology.

It is now possible to introduce genes of a higher organism into a microorganism by using these techniques, and to produce, at a low price and in large quantities, various kinds of physiologically active materials, formerly extracted only from higher organism and then expensive. These techniques are also considered to have a great influence in the near future on the matter producing systems in the chemical industry. That is to say, biocatalytic reactions will be utilized

to produce selectively useful materials, under normal temperature and pressure. The techniques of gene engineering, by introducing genes into a different species, are making it possible to utilize the function fitting a purpose. It has recently become possible not only to get a gene from an organism but also to synthesize chemically a DNA with an arbitrary base sequence. Therefore, the possibility to make a micro-organism produce matters pertaining to an organism, like a polypeptide, which so far has never been produced in vivo by an organism, has now been considered. In this report, we shall first give a concise account of the gene structure and the manifestation mechanism of gene information, describe an outline of gene manipulation and synthesis of nucleic acid, and finally introduce an example of producing an active peptide in an organism by the use of a synthetic gene.

2. Manifestation of Genetic Information

In eukaryotes, over 90% of the genes are present in the nucleus and the rest in the cytoplasm. In a bacterium, a circular gene with a small molecular weight, called plasmid, exists in a region other than the nucleus. These genes are the very deoxyribonucleic acid (DNA). Though molecular sizes of all DNA are different, they are composed of four kinds of mononucleotides. These four kinds have different bases as shown in Figure 1. That is to say, DNA is formed as a thread-like connection of 2'-deoxyribonucleotide-5' monophosphates, each of which is a connection of four main bases; adenine(A), guanine(G), thymine(T), and cytosinc(C). In an organism, DNA is usually composed of two chains with the complementary double helix structure. The bases of the respective chains are connected by a hydrogen bond so that the base pair is necessarily either A-T or G-C. The double helix structure shown in Figure 1 is called the Watson-Crick model.

Protein synthesis is the result of the manifestation of DNA function in vivo (see Figure 2). First, a protein molecule unpacking DNA is connected with one strand of the gene and the double chain is unpacked. Ribonucleic acid (RNA) complementary to DNA is synthesized, with one strand of DNA taken as a template, by the aid of an enzyme called DNA dependant RNA polymerase. In this case, RNA synthesis is subsequently completed from 5'-end to 3'-end in the direction opposite to the DNA chain. RNA has four kinds of bases; adenine(A), guanine(G), cytosine(T), and uracil(U), and a single chain structure, as shown in Figure 2(b). The synthesis of RNA is called "transcription". The RNA having an informational function is called messenger ribonucleic acid(m-RNA). Amino acids are transferred by transfer-ribonucleic acid(t-RNA), and synthetic peptides arise from the connection of the amino acids, by the aid of m-RNA, in

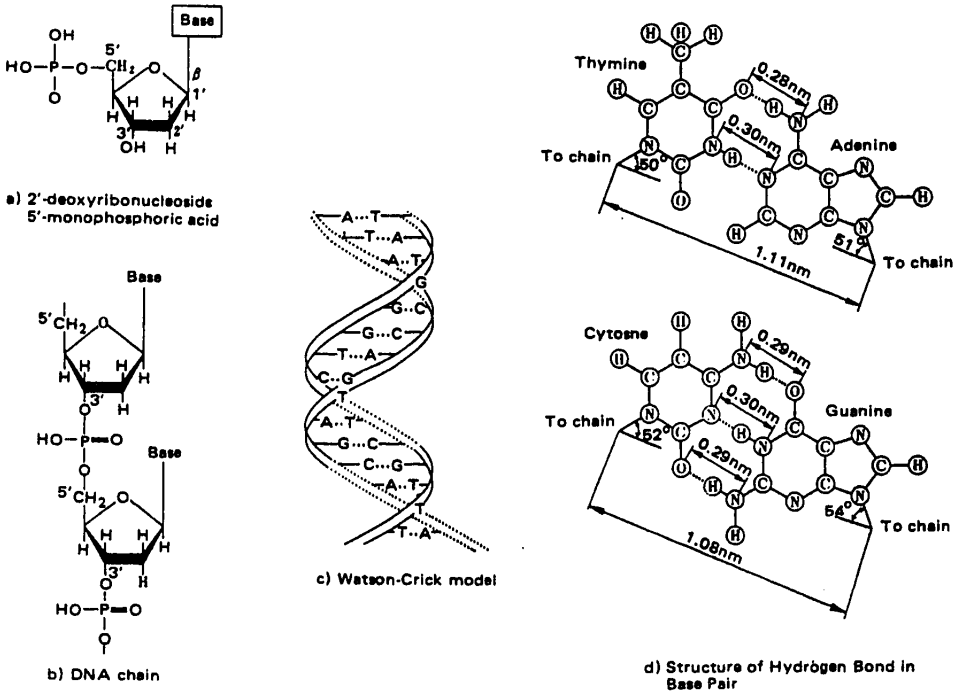

Fig. 1. Structure of DNA

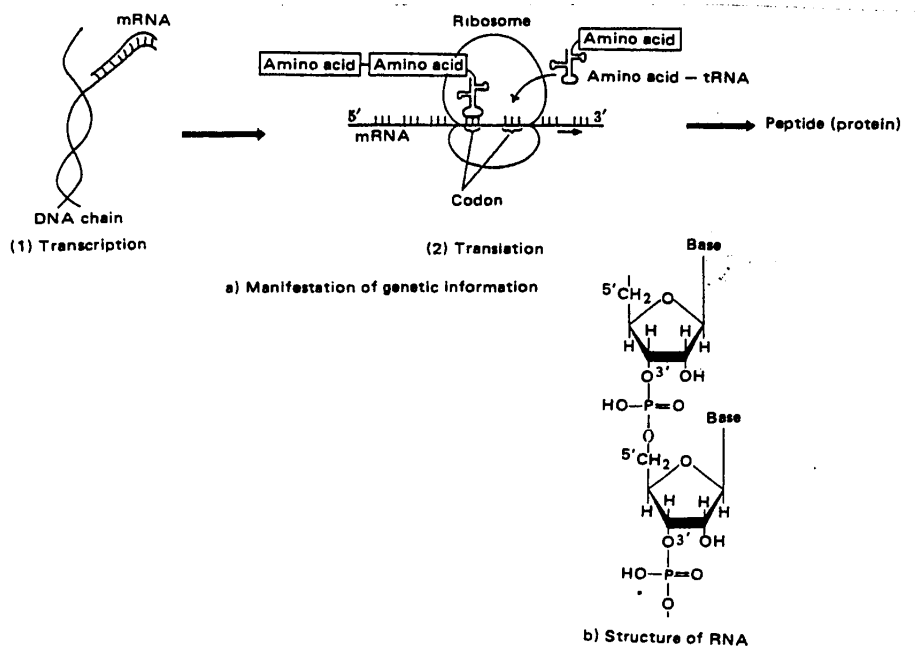

Fig. 2. Manifestation of Genetic Information and Structure of RNA

a cellular organism called ribosome. This is called "translation". Each sequence of three bases in m-RNA, corresponds to one amino acid, and the sequence of the three is called "codon". Since one codon is determined by the three amino acids sequence, the number of codons made from four bases is 64, and their respective contents of information has already been revealed.

Though, as described above, it is m-RNA that directs the peptides synthesis in vivo, they are bio-synthesized based on information provided by DNA, because DNA is transcribed into m-RNA as illustrated.

3. Outline of Gene Engineering

Gene engineering is generally operated through the following steps:

(1) Take out a particular gene fitting a purpose from a suitable biological material or synthesize one chemically.
(2) Insert the gene into an extranuclear gene*1 capable of autoreduplication in vitro, and connect them.
(3) Have a suitable host cell(mainly, E. coli) infected with the recombinant gene obtained and, then, multiply the cell.
(4) Select the cells(called recombinant cell) having the recombinant DNA out of the whole.
(5) Check for the presence of the end product and determine structure of the end gene, in the recombinant cells.

In this case, how to isolate and purify the end gene or synthesize it chemically, which has been already stated in (1), is an important problem. However, this will be described later. Here, we refer to the general method to produce recombinant DNA and the method to detect recombinant cell.

3-1. Production of Recombinant DNA

3-1-1. Restriction Enzyme–Ligase Method

Nucleic acids are composed of a branchless chain of nucleosides connected, by a phosphodiester bond in the 3'–5' ends direction. Each nucleoside is the connection of four bases (adenine(A), guanine(G), cytosine(C), and thymine(T) or uracil(U))*2, with a ribose or 2-deoxyribose. Particularly, DNA, a gene in itself, has the helix structure of two complementary chains antiparallel to each other. The enzyme that identifies a particular oligonucleotide sequence (3-6 base pair) in this DNA and cleaves within this sequence, is called a restriction enzyme. More than 100 kinds of restriction enzymes have been identified and an example of reaction by a typical enzyme is shown in Figure 3.

First, once the two kinds of DNA are cleaved, as shown in Figure 4, by using the same restriction enzyme, *Eco* RI, they are mixed and made to react with DNA ligase at 5–10°C.

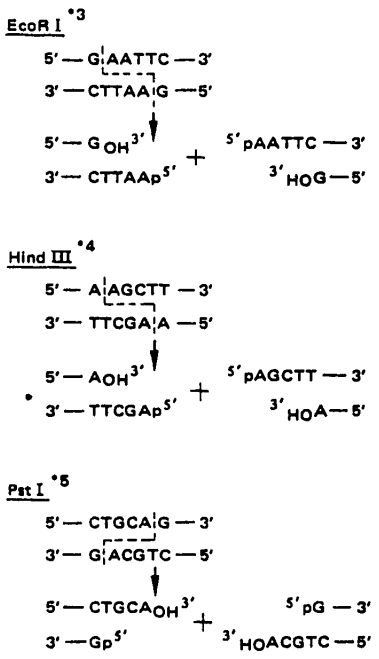

Fig. 3. Reaction Examples by Typical Restriction Enzymes

Both DNA form A-T base pair at AATT-adhesive ends, and at the same time the ligase connects the glycohydroxyl group (-GOH3') of the nucleotide in one DNA with the phosphoric-acid group (5'pA-) in the other. When this is added to E. coli treated with calcium chloride, this bacterium can incorporate the foreign DNA *6

If these cells that have incorporated DNA are multiplied, recombination DNA is stably kept in the coming daughter cells, along with DNA from other materials replicated. The cells with the desired property are then selected out of a large number of the daughter cells.

3-1-2. Terminal Transferase Method

The restriction enzyme-ligase method is often used owing to its simplicity. However, it has some defects. For example, in the case of a cleavage by a restriction enzyme inside the selected gene, the gene is divided and the recombination DNA cannot be produced. And also, in the case of an active protein produced by inserting an animal or plant gene into E. coli, it is in general necessary to isolate and purify

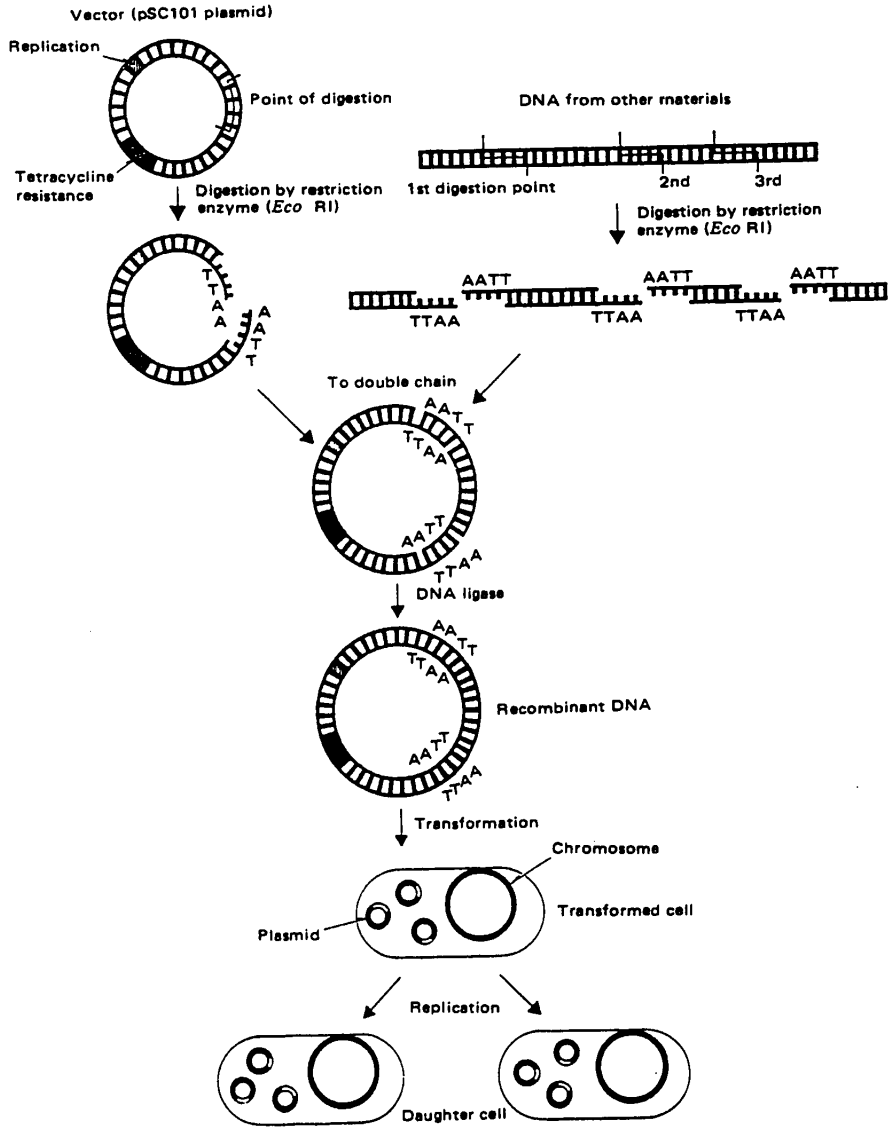

Fig. 4. Production of Recombinant DNA by Restriction Enzyme and Ligase[5)]

m-RNA and use a complementary DNA (c-DNA) prepared from this m-RNA with a reverse transcriptase. Also, this c-DNA does not have adhesive ends as the one obtained by using a restriction enzyme. In this case, another method called Terminal deoxyribonucleotide transferase method (TdT method) is then used. Terminal transferase is an enzyme obtained from calf thymus, and capable of adding homo-

polymers of deoxyribonucleotides to the 3'-OH end of an arbitrary DNA with deoxyribonucleotide triphosphate taken as substrate. Accordingly, as shown in Figure 5, poly (dC)*7 is added to 3'-OH end of c-DNA prepared from m-RNA, and poly (dG) *7 to 3'-OH end where vector pBR322 is cleaved by restriction enzyme PstI. When both DNA are mixed, heated at about 60°C, and subsequently cooled gradually to room temperature, they adhere to each other at the sites of poly(dC) and poly(dG) by a hydrogen bond *8. In DNA produced at this time, as illustrated in Figure 5, either of the chains has gaps, and both DNA are not connected by a covalent bond. But, if this untouched DNA is given to E. coli treated with calcium chloride, DNA is incorporated into the bacteria and repaired in vivo, by enzymes (DNA polymerase, DNA ligase, and so on) to become complete recombinant DNA. The method to prepare c-DNA from m-RNA is as follows: First, m-RNA is made to react with reverse transcriptase and c-DNA, in connection with m-RNA, is produced. After degradation of RNA by alkali treatment, single chain DNA unchanged is made to react with an enzyme synthesizing double chain DNA, (DNA polymerase or reverse transcriptase) and double chain DNA is thus produced. Further, when the hair pin part is excised by S-1 nuclease, it becomes the end product, double chain c-DNA.

This method is often used when animal's genes are inserted into a microorganism. In this case, as the *Pst* I site of the vector (pBR322) is inside the structural gene of penicillinase protein, hetero-genes inserted into this site are transcribed, in E. coli, in those in connection with a part of penicillinase m-RNA, and further this m-RNA is translated by ribosome. Therefore, the hetero-protein produced is synthesized in connection with the penicillinase protein.

3-2. Detection of Recombinant Body

3-2-1. Detection of Strain Having Recombinant DNA

In the DNA produced in vitro by recombination, there are various kinds of complexes arising from insertion in the opposite direction or from incomplete connection, in addition to the recombinant DNA inserted in the correct direction. Therefore, as this DNA mixture is infected with E. coli, the transformed bacteria incorporate various kinds of DNA. For this reason, it is necessary to detect and select the recombinant DNA containing the end genes. In this case, if the end-product manifests its character and the physiological property of the bacteria is changed, detection is easy. For example, leucine gene*9 of B. cubtilis changes the mutant *10 of E. coli from leucine dependant into non-dependant. That is, the character is transformed so that the bacteria are viable even in culture medium without any leucine added to it. But, if the physiological property of the bacteria is unchanged by the character manifestation,

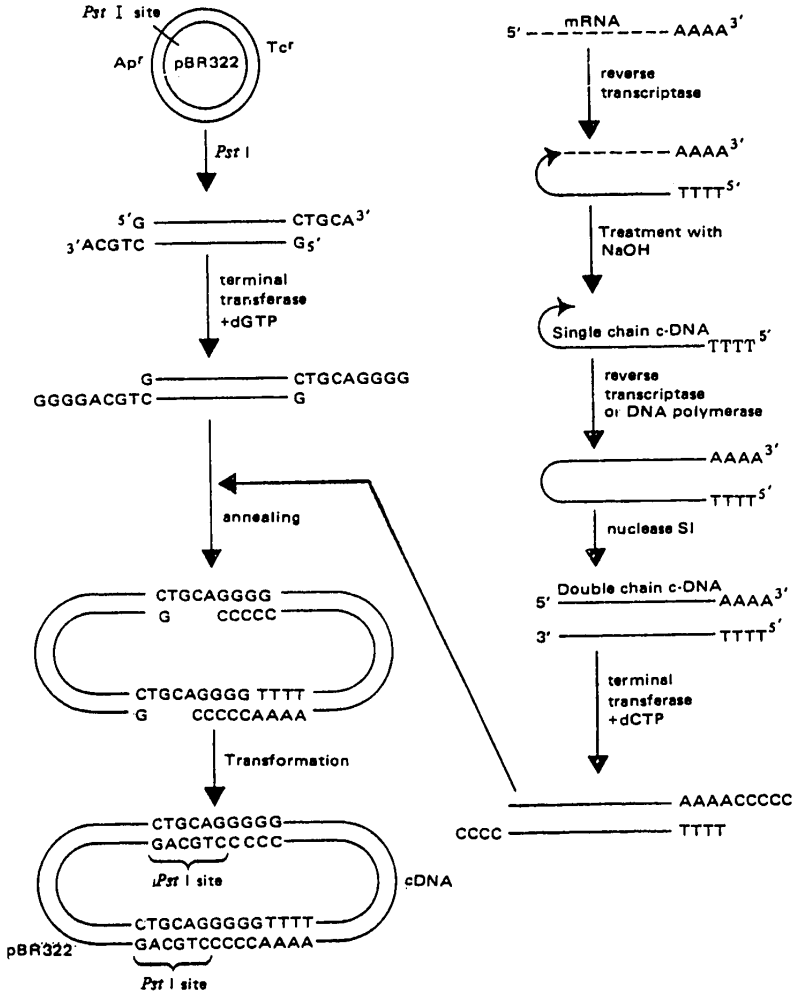

Fig. 5. Production of Recombinant DNA by Terminal Transferase Method [poly (dG-dC) method] [6]

or animal's DNA is introduced into E. coli in connection with the vector, protein is not produced whereas DNA is replicated; or the activity of the protein is not detected whereas the protein is produced. For example, proinsulin gene, inserted into *Pst* I site by the aforementioned method shown in Figure 5, is translated into protein. However, the activity of the protein does not manifest itself as proinsulin is synthesized in connection with penicillinase[7]. For these cases, the method (colony-hybridization method) allows to examine for the presence of specific DNA by bacteriolyzing

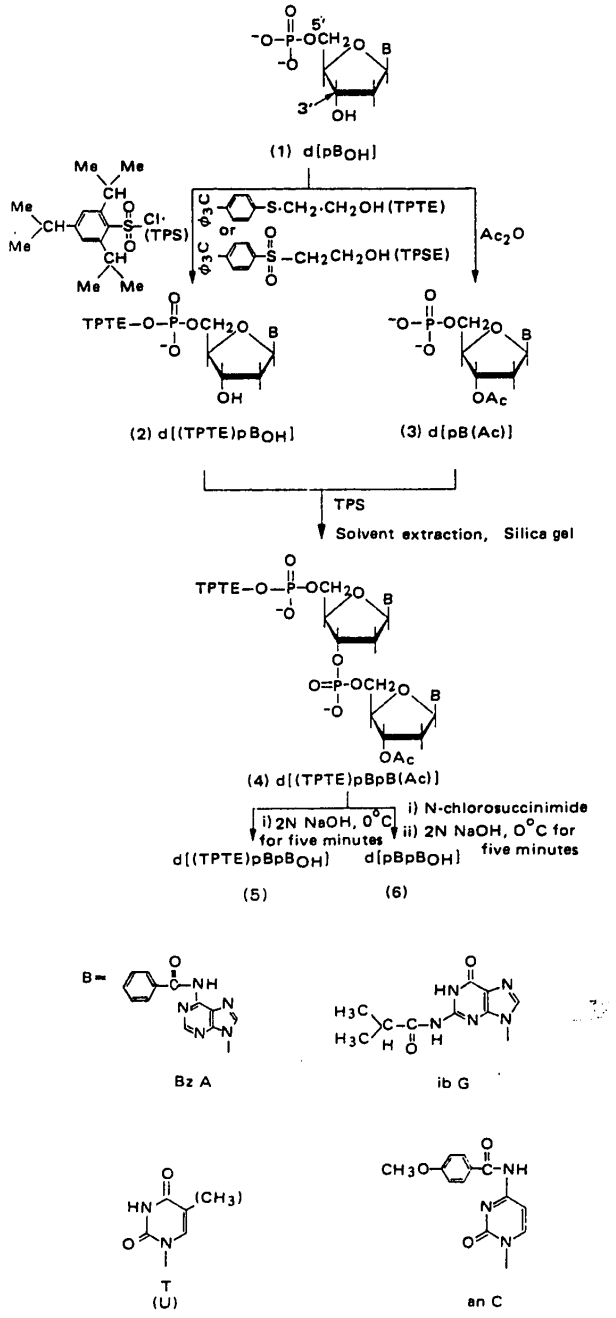

Fig. 6. Examples of Condensation by Diester Method

a colony of bacteria, left as it is, and containing recombinant DNA, on the flat culture medium[8]. The method is as follows: a colony of transformed strain is formed on a nitrocellulose filter spread over the flat culture medium, bacterioloyzed with alkali, and neutralized. After DNA-splitting enzyme are digested by protein-splitting enzyme, DNA leaked from the colony is fixed on the filter. Apart from this, DNA to be detected (c-DNA made from m-RNA in vivo, chemically synthetic DNA, and etc.) is prepared and radio-labelled with ^{32}P and etc. *11. Next, when the filter, which has adsorbed DNA, is mixed with the probe, only the colony, with DNA whose base sequence is homologous to the probe, is trapped into it by hydrogen-bonding between bases. Therefore, only the colony with DNA homologous to the probe is detected by auto-radiography of the filter.

3-2-2. Detection of Stock Producing Foreign Proteins

Detection of foreign proteins produced by inserting animal's genes into E. coli is generally conducted by the radioimmunoassay method. For example, when a prepolyinsulin gene is inserted into the *Pst* I site of pBR322 by the method in Figure 5, proinsulin in connection with β-lactamase protein of pBR322 is synthesised[7]. In this case, the detection is conducted by the following method (solid phase radioimmunoassay method)[9] the colony producing proinsulin is is bacteriolyzed on the agar-agar with bacteriolytic enzyme (lysozyme), and made to react with anti-insulin antibody labelled with ^{125}I, etc. Of course, if biologically active and free proteins are produced, detection and determination by the bioassay method is possible.

4. Chemical Synthesis of the Gene

Chemical synthesis of the gene is to synthesize 10–15 DNA fragments (DNA oligomers) of nucleotide, and get long DNA by connecting oligomers through enzyme reaction. It is fundamental for the chemical synthesis to make phosphodiester bonds between two nucleosides in the presence of a condensing agent. All amino groups and unnecessary hydroxyl groups must be covered with protecting group so as to make this linkage only between 5'-hydroxyl group of one nucleoside and 3'-hydroxyl group of the other. Matters listed in Figure 6 are generally used in protecting amino groups *12, however, there are two ways to make phosphodiester bonds between nucleotides[10]. The first is called the diester method, which was developed by Khorana et al., and its outline is illustrated in Figure 6[11],[12]. The second is called the triester method, which was adopted by A.M. Michelson and A.R. Todd[13]. It is by using of the improved triester method that S.A. Narang and K. Itakura, have recently synthesized DNA of somatostatin[14], insulin[15-17], human growth hormone, etc., successively[18,19].

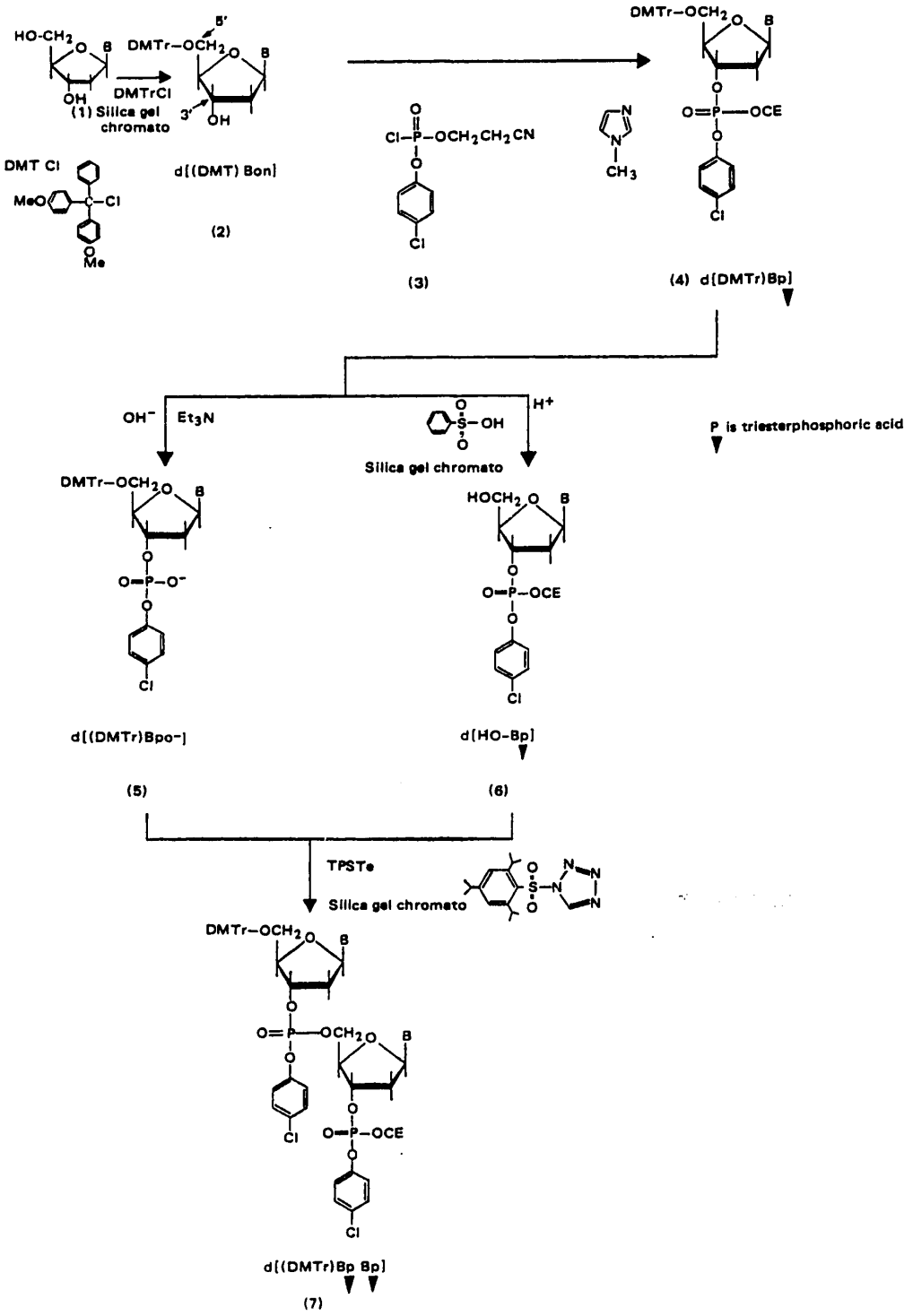

Fig. 7. Condensation by Triester Method

4-1. Diester Method

It was by the diester method that Khorana et al. synthesized E. coli tyrosine t-RNA. The original material in this method is a 5'-mononucleotide(1). 5'-phosphate group protected by TPTE, (2) is made to react with (3), 3'-hydroxyl group protected by Ac group, at room temperature in the presence of the condensing agent TPS, and a dimer (4) is then obtained through solvent extraction or purification by using a silica gel column. Taking 3'-Ac group off (4) by alkali treatment results in (5). And, after TPTE in (4) is oxydized into TPSE by N-chlorosuccinimide treatment, the removal of TPSE together with Ac group by alkali treatment produces a nucleotide (6) in the same form as (1). In the presence of (3) and 3'-Ac-compound of (6) made to react with (5) a trimer and a tetramer are produced respectively. The diester method starts from the 5'-end and extends step by step as described above. A yield at one condensation reaction is estimated at 30–50%. In this method, all linkages between the nucleosides to be produced are by active phosphodiester bonds.

4-2. Triester Method

In the case of the triester method, all linkages between nucleosides are by inactive phosphotriester bonds. They are fat-soluble and can be eluted, on silica gel, with organic solvent, as their phosphate groups are covered with chlorophenyl groups. While the triester method has been improved by Itakura and Hirose et al., a synthetic method almost unifying their results has recently been published[19]. The method is illustrated in Figure 7. The starting material in this case is a nucleoside. The way to protect the amino group of the base is the same as in the diester method. DMTrCl is a reagent that protects only 5'-hydroxyl group and its deprotection is possible by the use of benzenesulfonic acid. And, since DMTr group shows an orange color on the reaction with 10% perchloric acid solution, the reaction of changing into DMTr is useful for detection following TLC (silica gel and reversed phase). After the nucleoside (2) changed into DMTr is purified by the use of silica gel chromatography, a monomer (4) with all functional groups protected is obtained by phosphorylation of 3'-hydroxyl group by phosphorylation reagent (3), p-chlorophenyl-β-cyanoethylphosphochloridate. The monomer (4) is purified and isolated by silica gel chromatography (85% yield). The reaction of (4) with $CHCl_3$-MeoH (7:3) containing 2% benzenesulfonic acid, for a few minutes, results in the elimination of DMTr and the production of (6). This is purified and isolated by silica gel chromatography (90% yield). And, reaction of (4) with triethylamine and pyridine results in the release of cyanoethyl group from (4) and the production of (5). Acrylonitrile produced by the elimination reaction of cyanoethyl group and triethylamine in excess are completely removed under low pressure. About 70% of (6) equivalent to (5) is dissolved

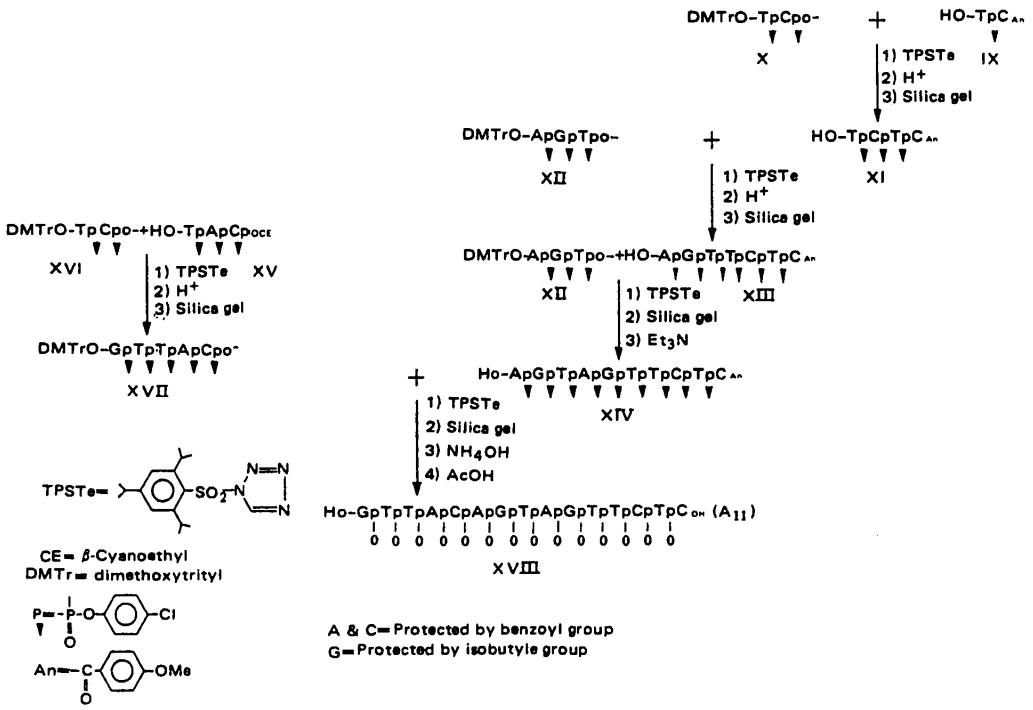

Fig. 8. Synthetic Route of Pentadecamer GTTACAGTAGTTCTC (A_{11}) by Triester Method[19]

in dried pyridine, and added, together with excess of TPSTe, to (5). After TLC (about two hours), the condensation reaction is finally stopped by adding a small quantity of water and a dimer (7) is then obtained with 80% yield. Elimination of DMTr group and cyanoethyl group in (7), just as in the case of (4), by benzenesulfonic acid and triethylamine treatments produces (6) and (5) types of compounds, respectively. Successive extension of the chain thus becomes possible. The yield of trimer from monomer is 30–60%. In the case of condensation in the triester method, 3'-active phosphate group in excess by 1.5 equivalents to 5'-hydroxyl group is used. And, when the number of nucleotides exceeds 6, cyanoethyl group, which is a protecting group of 3'-phosphate, is difficult to be eliminated quantitatively. So, the extension from 5'-end in the 3'-direction cannot be so long. But, in the triester method, since 3'-hydroxyl group, only in nucleotide at one end, can be protected by anisole group, and 5'-DMTr protecting group can be eliminated by triethylamine, extension from the 3'-end in the 5'-direction is possible. Figure 8 shows a synthetic route of pentadecamer GTTACAGTAGTTCTC used in the case of human insulin. In the final condensation of pentamer and decamer, 20μmol

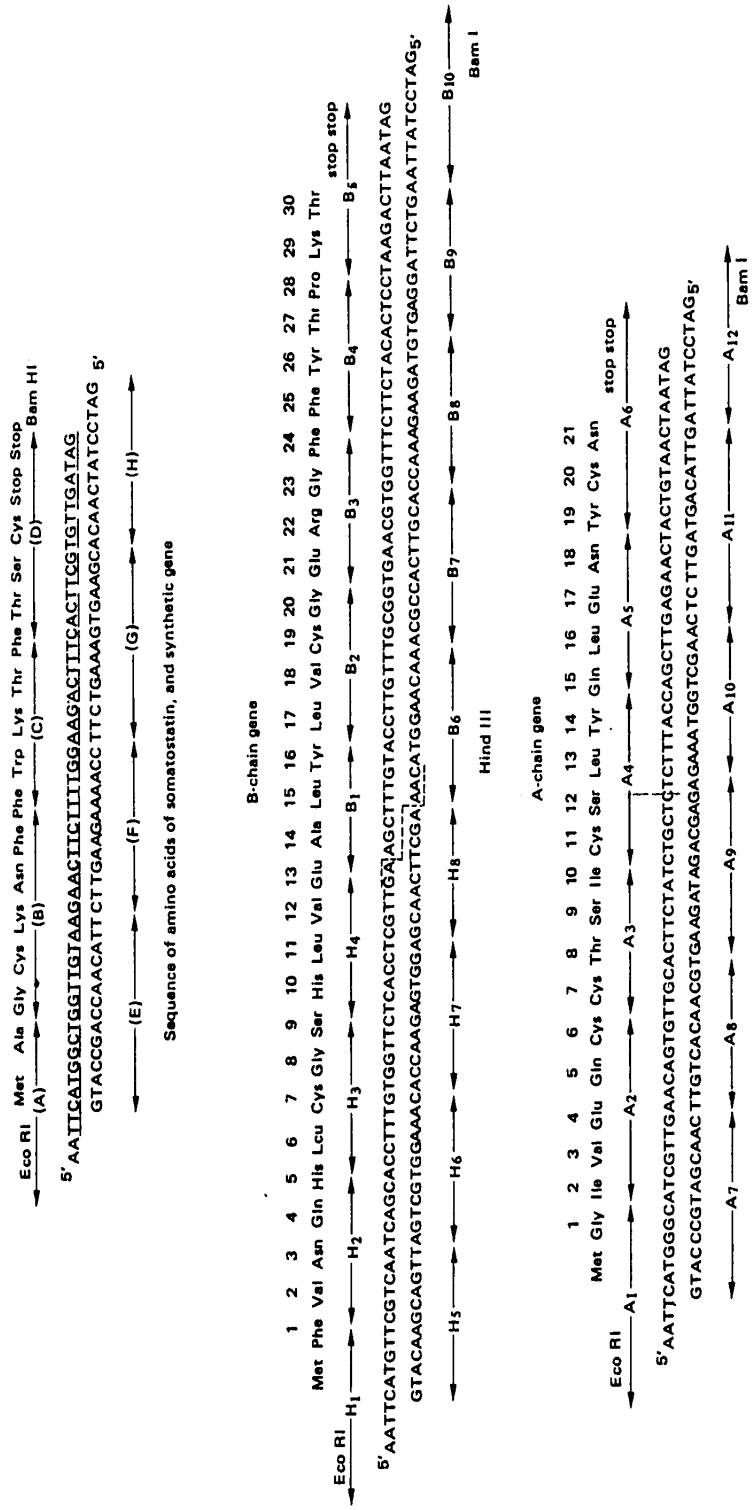

Fig. 9. Sequence of Amino Acids of Somatostatin and Human Insulin, and Their Synthetic Genes

of 5'-hydroxyl group (decamer) and 180μmol of TPSe are used for 35μmol of 3'active phosphate (pentamer), and the yield is about 40%. After the pentadecamer synthesized in this way is purified, with protecting groups kept intact, by the use of a silica gel column, treatment with concentrated aqueous ammonia and 80% acetic acid results in the elimination of all protecting groups (those of DMTr, chlorophenyl group, 3'-anisole group, base amino group). After separation from the aqueous solution by liquid chromatography (column: Permaphase AAX, moving phase: KH_2PO_4 aqueous gradient), and dialysis, freeze-drying is conducted. DNA oligomers with hydroxyl groups at both ends can be synthesized in this manner. In the case of somatostatin genes, eight kinds of oligomers (A)–(H) have been synthesized, which are shown in Figure 9 including adhesive ends of restriction enzymes *Eco* RI and *Bam* HI. In the case of human insulin the genes corresponding to A and B chains are synthesized as shown in Figure 9. But, as the Gln-Ala corresponding codon of the B chain contains the recognition codon of the restriction enzyme *Hind* III, it is not necessary to synthesize a long B chain of genes at once. In fact, a long B chain has been produced as follows: the parts on the left and right sides of *Hind* III site are respectively synthesized and then separately amplified by cloning. Finally, after cleavage by *Eco* RI and *Hind* III, the long B chain is produced.

4-3. Joining Oligomers by Ligase[21)]

As the synthetic DNA oligomer has hydroxyl groups at both ends, its connection by ligase requires the phosphorylation of the 5'-terminal. It is labelled with ^{32}P to determine the purity of DNA sequence.

Oligomer (200pmol) with 60mM Tris-HCl (pH 7.8), 6.7mM $MgCl_2$, 15mM dithioslator, and 66μM[$\gamma^{32}P$]ATP with four units of T_4 polynucleotidekinase are incubated at 37°C for 40 minutes. The reaction is stopped by addition of EDTA, and the product is purified by Sephadex column. Next, the oligomer with 5'-(^{32}P)-terminal is partially hydrolyzed by using snake venom. An aliquot for each hydrolysis period of 5, 10, 20, 60, 90, 120, and 180 minutes is taken, and the reaction is stopped by EDTA. Mixture of all reactants is put in the electrophoresis, on cellulose acetate, at pH 3.5 and 2,500V. The oligomer is transferred from cellulose-acetate into DEAE-cellulose and chromatography by two-dimensional electrophoresis is performed. Removal of the 5'-mononucleotide, from the 3'-hydroxyl group with snake venom, makes the pattern of electrophoresis-chromatography as shown in Figure 10[22)].

Since each DNA oligomer, synthesized as described above, has 5'-phosphate and 3'-hydroxyl groups, the oligomers can then be elongated by using DNA ligase[21)]. at this time, as shown in Figure 10, synthetic oligomers are arranged complementarily by hydrogen-bonding. This is because they can be connected in the desired sequence by the use of ligase and coenzyme AMP (adenosine monophosphate).

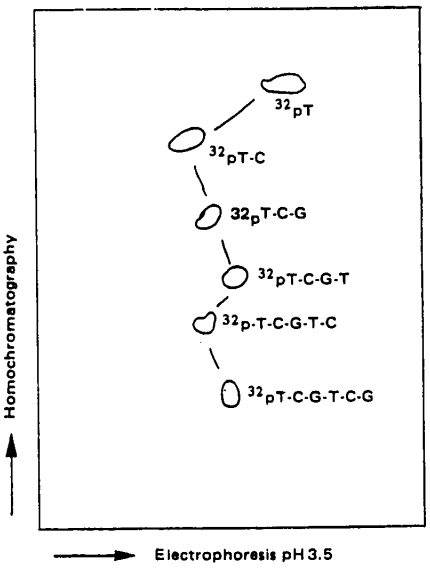

Fig. 10. Determination of Sequence of DNA Oligomers by Homochromatography

CSO: 4120/288

SCIENCE AND TECHNOLOGY

SINTERED ZINC OXIDE SYNTHESIS EXAMINED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 pp 44-46

[Text]

Zinc oxide, known as an N-type semi-conductor oxide, finds use over a wide field of applications. The National Institute for Research in Inorganic Materials has, as a world's first, succeeded in synthesizing a transparent sintered system of zinc oxide, synthesis of which until now has been considered to be very difficult. The synthesis consists of producing large transparent crystals, 2cm in diameter and 1mm thick by sintering under pressures at low-temperature. The products are expected to find new applications in luminous display windows and sensors. Also, valuable data obtained from observation of the fine structure of the sintered material, using an electron microscope, suggests that it will find many uses including improved quality and performance of electronic materials such as zinc oxide varistor. The following is a report on the study of the synthesis.

The basic key points in conventional manufacture of transparent sintered materials, such as MgO, Y_2O_3, Al_2O_3 and BeO, were control of external factors – producing high-density sintered materials (with nearly ideal density) by reducing residual pores and minimizing precipitation of impurities, and segregation at grain boundaries that are likely to scatter light. From this point of view, a desire to synthesize transparent sintered ZnO may point out the following attempts: 1) to prepare samples easy to sinter, 2) to raise sintering temperature as much as possible in order to increase diffusion, 3) to sinter the materials under reduced pressure or in a specific atmosphere in order to obtain pore-free products, and 4) to induce lattice defects, which are likely to increase diffusion of ions or control excessive grain growth, by adding a trace of impurities. These possibilities were reviewed thoroughly to find that the synthesis of transparent sintered ZnO requires several processes different from conventional methods.

As an original material, ZnO (grain diameter around 3μ) made by dissolving highly pure zinc carbonate or basic zinc carbonate, at a temperature below 500°C and under reduced pressure is favorable. Sintering temperature must be below 1000°C, preferably around 800°C. A temperature over 1000°C will have a detrimental effect on transparency because it promotes the reaction $ZnO \rightarrow Zn^{2+}(i)\cdot 2e+1/ZO_2$ and this inter-lattice zinc ($Zn^{2+}(i)2e$) interferes with the absorption of light in the visible

range. As impurities, alkaline metals are very effective. Alkaline earth metals proved almost harmless. P-block elements and transition elements with a higher valency than zinc, even in small quantities, have an ill effect on transparency. It is interesting to note that lower temperatures are preferable in manufacturing transparent sintered ZnO, which agrees with the fact that transparent single crystals of ZnO by hydrothermal synthesis or a flux method are synthesized at very low temperatures. This also suggests that the conventional recognition that high temperatures are favorable in manufacturing high-density transparent sintered substances is not necessarily applicable to zinc.

In order to increase firmness at low temperatures, sintering under pressure is favorable. For pressurized sintering, molds made of multicrystal alumina were used because this material can withstand higher pressure than graphite, and BN powder is used as a mold release agent, but, here, let us omit the practical details of pressurized sintering.

As an example of pressurized sintering, Fig.2 shows data on sintering at 800°C for 2.5 hours under different pressures. The speed of grain growth starts accelerating at 500kg/cm^2, reaches a peak at 1200kg/cm^2, and then declines under higher pressures. Light penetrability is satisfactorily high with grain diameter over 10μ, and this corresponds to a sintering pressure of over 700kg/cm^2 in Fig.2. In particular, light penetrability is highest at around 1200kg/cm^2 under which grain diameter reaches its peak. In general, it is usual to carry out conventional pressurized sintering of transparent ceramics at high tem-

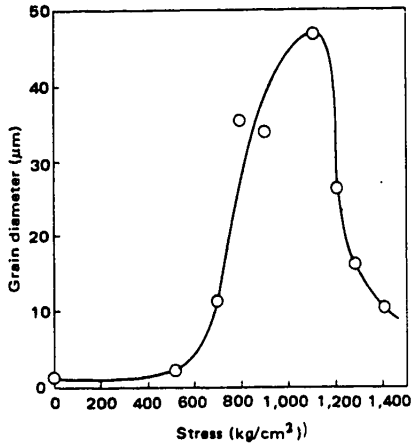

Fig. 1. Relation between Grain Diameter of ZnO Sintered at 800°C for 2.5 Hours and Sintering Pressure

peratures and at low pressures (over 1000°C and below 600kg/cm^2) because pressure available is limited by the mechanical properties of graphite molds. So, ZnO, for which low temperature and high pressure (below 1000°C and over 700kg/cm^2) are favorable, is exceptional in the scope of conventional pressurized sintering. The knowledge of these features may be helpful in turning transparent not only ZnO, but also semiconductor oxides and transition metal oxides for which the control of true properties is important.

Observation of the microstructure of sintered substances under an electron microscope directly shows how internal defects unique to pressurized sintering are formed and how impurities are precipitated.

Fig.3 shows photos taken by an electron microscope of samples sintered at 800°C under different pressures for 2.5 to 16 hours. Under pressures around 500kg/cm^2, defects in lamination are characteristic internal defects. These defects in lamination have a phase vector of (1/2) C+P (where C = <0001> and P = (1/3) <10T0>), and are considered to appear when grains grow in excess of precipitated and segregated impurities, or when grain boundaries move (Z.Phys, Chemie in printing). Therefore, defects in lamination appear irrespective of the level of pressure.

In a pressure range from 790kg/cm^2 to 1200kg/cm^2, not only lamination defects, but also dislocation are observed. For samples sintered for 16 hours, in particular, part of the dislocation turns polygonal, forming what is called small-inclination grain boundaries. Because almost no dislocation is detected under pressures below 700kg/cm^2, it is presumed that dislocation is caused by stresses. Analysis of photos taken under various conditions of diffraction shows that such dislocation has Burgers vector vertical to axis C.

In the ranges of pressure over 1200kg/cm^2, impurities precipitate along dislocation and grain boundaries. Fig.2 shows that grain growth slows down under pressures over 1200kg/cm^2. This may be because the movement of grain growth is retarded by impurities precipitated along grain boundaries.

The quantitative relations between these microstructures and light penetrability have not yet been clarified. A comparison of the microstructure of transparent single cyrstals made by the flux method with that of the samples in the present study shows that such factors as a trace of impurities precipitated in bulk, lamination defects, and dislocation have little effect on light penetrability. It still seems to be an important aspect remaining to be studied to explain the relationship between the properties of grain boundaries and light penetrability.

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SCIENCE AND TECHNOLOGY

PRESENT CONDITION OF LARGE-SCALE MINICOMPUTER EXAMINED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 pp 52-54

[Text]

1. Large-Scale Minicomputer

To clearly define a "large-scale minicomputer" may be difficult because the definition of a minicomputer itself is unclear. However the following respects might serve as the standards of the "large-scale minicomputer": (1) One mega-byte or more of the main storage capacity which is capable of direct address specification; and hence (2) (in relation to Item (1) above) the 32-bit machine (or the machine with the large internal word length). The thus-defined large-scale minicomputer may be regarded a general-purpose computer to differ from in the following respects:

(1) The large-scale minicomputer can adopt the newest technologies of hardware architecture because it is provided with little or no accumulation of previous software. For example, the latest large-scale minicomputer is provided with such remarkable functions as paging, segmentation, call stack, and WCS, whereas the general-purpose computer requires massive expenses in the development of its operating system (OS), which raises the overall cost of the system. On top of that, adherence to it and the later addition of the various functions make the system configuration inflexible and complicated;

(2) the large-scale minicomputer, as compared with the general-purpose one, is provided with a user-convenient hardware I/O control bus or memory access (DMA) bus;

(3) the large-scale minicomputer's software is of convenient size, allowing significantly easier creation of user-specific modules such as the I/O control driver, as compared with the general-purpose one. In the case of the general-purpose computer, the addition of the OS's nuclear parts or of the I/O driver is almost impossible without the assistance of factory engineers because publication of the internal specifications or of the source programs is limited and at the same time the specifications are difficult to understand;

(4) the general-purpose computer is good at input/output or accumulation of a great deal of standard-form data, processing by use of the many general-purpose terminals, usage of the large-scale general-purpose programming language, and its information-center wise usage; but the large-scale minicomputer is superior in terms of the expense-to-performance ratio in the case of exclusively processing the jobs of

Table 1. Typical Minicomputer

Partition	Early-stage mini-computer average type	Early-stage mini-computer	First mega-mini-computer	Recent large-scale minicomputer		
Date of delivery	Early 1970's or before	1969	1974	1978	1979	1979
System name		FACOM-R	INTERDATA 7/32	PDP VAX 11/780	PRIME 750	PERKINELMER 3240
Price	Approx. 5 million yen	5 million yen or more	$ 20K~60K	$ 100K~300K	$200K~350K	$220K~400K
Memory	Magnetic core	Magnetic core	Magnetic core	ECC MOS	ECC MOS	ECC MOS
Cycle time (μs)	1.5	1.5	0.75	0.60	0.60	0.70
Word length (bit) x interleave	16	16	32	64x2	32x2	32x4
Maximum capacity(byte)	16~32kW 4kW module	64kW	1M	2M	0.5~8M	16M
Cash	Parity option No cash	None	None			
Access time (ns)		–	–	290	80	50
Capacity (kB)		–	–	8	2~16	8
CPU	Without multiplication and division					
Word length (bit) (excluding string instruction)	16	16	1~64	1~16	1~64	1~64
Number of instruction	30	28	191	244	415	261
Paging/segmentation	None	None	16 segments	512 bytes/page	4096 segments, 2kB page, 32MB/user, ring protection	256 segment
Address mode	5	5	7	9	6	7
Operation register, index fp register	2 Without fp function	5 (memory) None	32 8x32 8x64	16 Using 16 GR's	128 12x64 bit	128 8x32 bit 8x64 bit
Addition rate (μs)	4~20μs	6.0	1.0~3.75	0.40~1.40	0.24~	0.68~2.37
WCS	None	None	None	1kW/99 bit	4kB	2kB+ROM2kB
I/O						
Transfer width (bit)	16,8	16	16	16,32	16	16,32
Bus and rate (MB/sec)	DMA MPX	DMA 1.6	DMA 2.0 MPX 0.36	SBI 13.0 (32 bit) MASBUS 2.0 (16 bit) UNIBUS 1.5 (16 bit)	DMA 8.0 DMC 0.96 DMT 2.5MB	DMA 40.0 (32 bit) EDMA 10.0 (32 bit) MPX 0.40 (16 bit)
Interrupt level	1~4	1	4	32	16	4
Interrupt cause (including those by means of instruction execution)	1~10	4	10	19	14	33
OS	Without OS Boot loader I/O driver library	Abs loader I/O driver	OS 32 MT	VAX/VMS	PRIMOS PRIMENET	Dynamic OS 32 MT MTM ITAM
Language-processing processor	2-pass assembler FORTRAN 3000 Level	2-pass assembler FORTRAN 3000	Optimization assembler FORTRAN IV~V MACRO	FORTRAN IV PLUS BASIC, COBOL, MACRO etc.	FORTRAN, COBOL, PL/I, BASIC, FASCAL, ALGOL, etc.	Optimization assembler FORTRANIV~IVV MACRO, BASIC, COBOL, etc.

non-standard forms by using the system which is optimized for the specific purpose.

2. Computer Technology

The development from the minicomputer to the large-scale minicomputer has been supported by advances in integrated-circuit technology, magnetic storage technology, and other electronics-related technologies. One of the factors that exercised vital influence on the architecture and packaging of the computer is integrated-circuit technology, in particular the rapid improvement in the integration density.

The capacity of the IC memory has approximately quadrupled every three years, and its cost has been halved every two or three years. And now the capacity of 64K bit/chip is viable and also that of 256K bit/chip is anticipated within several years. The logical circuit has also improved year by year, though at a slower rate than the memory, in terms of integration density. One-chip CPU's of 16-bit word length are presently available, and 32-bit word length will be realized in the near future. The present-day IC technology employs photolithography, with a precision of about 3 micrometers. However, as production methods using electron-beam lithography equipment have been established, the processing precision has also improved from one micron to submicron, allowing realization of the very-large scale integrated circuits (VLSI). And in near future the one-megabit storage device or the 64-bit CPU chip will be available.

As for the operation speed, that of the TTL gate in the first generation was 10 nanoseconds, that of the Schottky TTL in the second generation was three nanoseconds, and that of the advanced Schottky TTL in the third generation is one nanosecond, approaching that of the ECL gate.

As for reliability, the hazard rate of the M6800 processor for example, was 0.006%/1000 hours according to the data of 1979, which means the very small value of 10^{-9} per gate. Reliability can be improved also in the same circuit as well as by configuring the redundant circuit by using a portion of the improved integrations.

The surface density of the magnetic storage has doubled every two years for the past 20 years, due to proper selection of the magnetic material on the basis of detailed study of the various materials, and to the raised record density resulting from the gradually-decreased head gap and the gap between head and medium.

The progress in magnetic storage technology has greatly contributed to the trend toward larger capacity and lower price of the secondary storage unit of the computer system. In fact, the large-scale minicomputer can economically employ the mass storage disk of 50 to 300 megabytes per pack, a significant improvement over the 10 megabytes at most as a total value of the magnetic disk capacities of a conventional

minicomputer. It has enabled the even larger capacity and enlargement of the application subjects.

Also the flexible (floppy) disk is substituted for the conventional paper-tape base equipment as a convenient external storage for the small computer.

Significant among the peripheral technologies is the progress of the dot matrix-type printer and the like. For example, the non-impact type printer has facilitated the configuration of the small-scale computer system by its low noise level, low price, and long service life due to a decreased number of mechanical parts. Various cheap and high-performance CRT displays are also available due to progress in IC circuit technology.

All these things will help meet the requirements necessary to configure more easily the information-processing system, including processing of images and Chinese characters.

3. Architecture of Large-Scale Minicomputer

The most characteristic aspect of large-scale minicomputer architecture is preferred adoption of such functions as to be desired to be employed in the computer as early as possible. Some of them, though desired, could not previously be employed in the general-purpose computer because of software incompatibility, including such functions as paging, segmentation, ring protection mechanism, cash memory, call stack, service-queue management, dispatch function, data communication instructions and the WCS.

The progress in the LSI technologies will all the more promote the trend toward miniaturization, larger capacity, and higher performance of the hardware. In fact, the main storage of one megabyte or more is already common, and the higher-level CPU functions or the firmware version of the OS nuclear parts will be realized earlier than for the general-purpose computer. In addition such functions as the matrix/vector-operating function or the image processing function and the database processing function, which have not been employed in the conventional CPU, can be expected to be incorporated in the easier-to-use form.

Thus, as new functions are being adopted one by one, standardization at the hardware level can hardly be expected except at the I/O unit interface or the memory interface.

4. Software of Large-Scale Minicomputer

The operating system of the large-scale minicomputer, unlike the 16-bit CPU which comprises only the loading monitor and the IOCS at the best, is almost the same as that of the general-purpose computer in that it enjoys in many

cases the TSS function or the multi-task function which comprises swapping, paging, and or segmentation, and is provided with the filing function.

The system generation can be executed by selecting the option according to the application. The comparatively easy system generation enables quick-wheeling grading up or alteration of the system. The operating system is offered in many cases as the source program as well as in the object form, enabling changing most suitable to the application. Particularly the I/O driver module, which has a wide range of possible alterations and additions, provides easy operation which cannot be obtained with the general-purpose computer system. As a language processor, BASIC or FORTRAN is generally provided, and in some cases COBOL, PASCAL, or PL/I can be used.

The assembler is provided with the macro function, enabling the user to effectively create the system module by calling the macro library of the system. The interactive editor or various utilities are virtually problem-free, so inconveniences can hardly be found in such fields.

The status quo of the software scale in the case of the large-scale minicomputer may be said to be already more than that of the middle-sized general-purpose computer. As for the software productivity, there is not much difference between the large-scale minicomputer and the general-purpose computer. However, as for the software resources, there is no guarantee that the large-scale minicomputer will not repeat the same failure as the general-purpose one.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

FUNDS PROVIDED FOR POPULARIZING SOLAR SYSTEMS

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 57

[Text] Almost 3/4 of Japan's primary energy depends on imported oil, and around 70% of all electric power that occupies nearly 1/4 of secondary energy is produced by oil-burning thermal plants. The self-sufficiency of Japan is only a mere 10%.

The use of more solar power is urgently needed as an alternative energy source as the price of oil continues to climb, specially for industrial applications (cf. Fig. 1 and 2).

In response to this need, the Government started in FY 1980 to provide an overall budget for the development and use of solar systems. The following three items were emphasized:

(1) Increasing the nation's knowledge of solar systems by publicity campaigns.

(2) Expanding the use of solar systems through low-interest loans, Government subsidies, or tax breaks, since the systems have a high initial cost despite their low running cost.

(3) Establishing performance evaluation criteria for solar systems.

As for (1) solar system PR, the subsidies provided from fiscal 1981, are to be used for a standing exhibition.

Low-interest financing stated in (2) will be available at an annual interest rate of 5.5% for private individuals and 6.5% for businesses. Government subsidies can also be used by local public corporations, and will cover half the cost of system installation. Additionally, the preferential tax measures allow a 30% tax write off, or 7% tax exemption when installing business solar systems, and exemption of 3/4 of real estate tax for 3 years, all effective from 1981 F.Y.

To formulate performance evaluation standards for solar systems (3), the Ministry of International Trade and Industry is to assign eligible facilities and an organ to commission that task, but, so far, no decision has been made.

Fig. 1. Applications for Industrial Fields

Item		Applications for industrial fields: Heated objects	Controlling temperature levels (°C) 20 40 60 80 100	Notes
Industries	Boiler feedwater heating	Soft water		Preheating
	Heated water for bottle washing	Service water		
	Heated water for painting & degreasing	Service water/ Process water		
	Heated water for food processing	Service water		
	Heated water for pasteurizing	Service water		Air temperature: 60°C or more
	Drying	Air		Absorption type refrigerator
	Cooling	Absorbing liquid		
	Fermenting	Fermenting liquid		
	Dyeing	Dyeing liquid		Room temperature: 10–25°C
Agriculture	Green house heating	Air		Soil temperature: 15–20°C
	Soil heating	Soil		Water temperature: about 15°C
	Water heating	Sprinkler water		
Animal husbandry	Barn heating	Air		
	Supply water heating	Service water		Air temperature: 70°C or more
	Hay drying	Air		Water temperature: 20–30°C
Others	Fishpond heating	Pond water		Air temperature: 70°C or more
	Timber drying	Air		

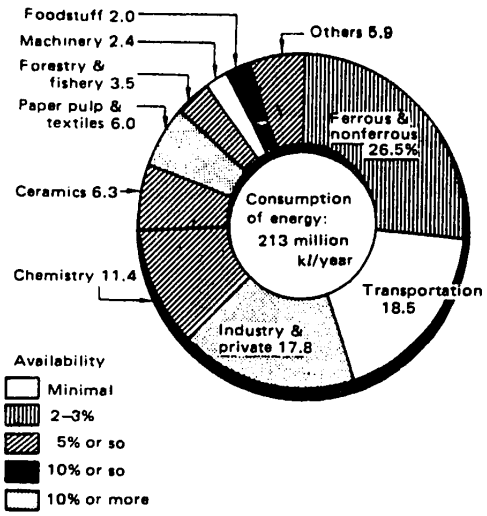

Fig. 2. Availability of Solar Heat for Various Industries

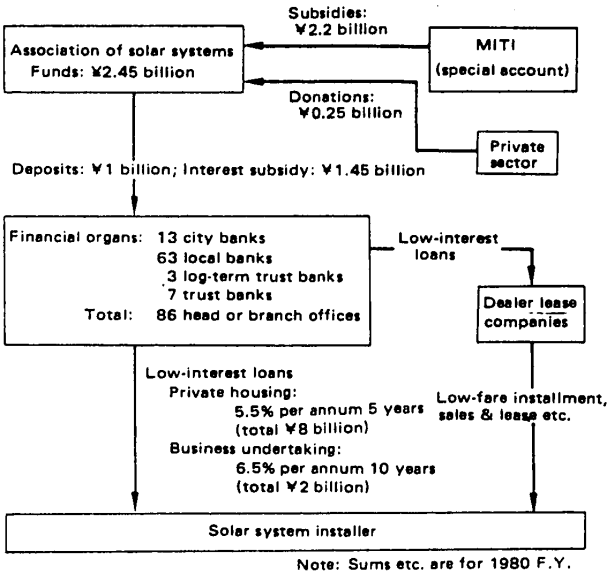

Fig. 3. Publicizing & Promoting Loan Institution for Solar Systems

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DEVELOPMENT OF IRRADIATION CHAMBER FOR FUSION REACTOR

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 59

[Text]

In an effort to develop exotic materials needed for nuclear fusion reactors, the National Research Institute for Metals of the Science and Technology Agency plans to build an irradiation creep simulation test facility, and has decided to develop an irradiation chamber called a target test component starting in FY1981. To produce fusion reactors, irradiation test data that will play a key role in core structure design and new materials development are urgently needed. Consequently, with construction planned for fiscal 1982–1984, the institute will build at its laboratory in Tsukuba Research Garden City (provisional name), a "light ion irradiation creep test facility", a new type of cyclotron that will irradiate protons and carry out creep or fatigue tests or materials.

The Japan Atomic Energy Research Institute is proposing to use SUS316 stainless steel for the experimental fusion reactor in its design. Since there are almost no data available for irradiation by neutrons of 14 mega electron volts (MeV), a lower reactor output must be specified to avoid higher irradiation damage. Stainless steel SUS316 could not survive the operating conditions of the next-stage prototype reactor, necessitating new material development. Above all, neutron energy in fusion reactors is 14MeV in contrast to about 1MeV in fast breeder reactors, in addition to far more helium being generated that can cause problems for fusion core materials.

To meet irradiation test requirements for the more severe conditions of fusion reactors than those in FBRs, the institute plans to introduce a simulation testing technique to collect irradiation test data for core structure designing and new material development.

According to the plan, a compact cyclotron capable of accelerating protons and alpha rays up to 16MeV is expected to be built in FY1982–1984. First in fiscal 1981, costing ¥27 million, a demonstration irradiation chamber will be developed to conduct creep and fatigue tests, in order to acquire reliable information for the irradiation creep simulation test facility system that will be built for approx. ¥500 million. The new type cyclotron features material endurance tests that can be carried out under simulated conditions. Furthermore, the testing facility is capable of helium irradiation followed by proton bombardment to evaluate both irradiation embrittlement and creep simultaneously.

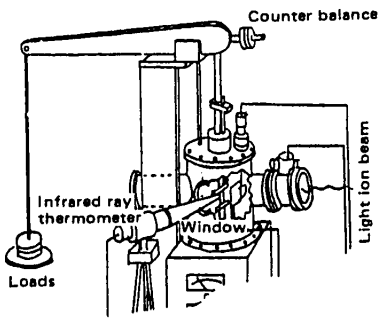

Fig. 1. Target Test Section of Irradiation Creep Test Facility

The device will provide a maximum energy of 16MeV for protons and alpha rays, which corresponds to the ability of the protons to penetrate, or helium ions to halt in, 0.1mm thick stainless steel (SUS316). The proposed test temperatures for the equipment are 300–1000°C, with a maximum test stress of 50kg per square mm.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

SLAB CORE REFLOOD TEST FACILITY PRODUCED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 59

[Text]

Ishikawajima-Harima Heavy Industries Co. has produced a slab core reflood test facility (SCTF). It completed a large-scale cylindrical core reflood test facility in 1979. These systems can simulate reflood phenomena in pressurized water reactors, the process that during a loss-of-coolant accident, an emergency core cooling system is activated to reflood exposed and overheated core fuels to prevent assembly failure.

SCTF will perform a two-dimensional study on core reflooding. It is roughly rectangular in shape, compared with the cylindrical shape of the cylindrical core test facility. This is the same as the operating reactors.

The test chamber in the facility is a flat, standing type pressure vessel with a body formed by plates. The vessel consists of three sections: lower, middle, and upper bodies. Each is connected with oval flanges, and the top and bottom are sealed with oval blank flanges. Inside, a partitioning board forms a downcomer section, and the external surface is ribbed to give added strength to the plates. Nozzles to attach measuring instruments are also located on the exterior surface.

The main specifications are as follows:

Design pressure: 6 kg f/cm²
Design temperature: 350°C
Dimension:
Major axis (interior width): 3541mm
Manor axis (interior width): 460mm
Thickness: 105mm
Height: 8911mm
Materials:
Flat parts: (SGV49) + (SUS304) clad
Round parts: (SF50) + (SUS304) clad

Moreover, mock-up fuel assemblies lined up side by side in the test chamber consist of 8 bundles each providing dummy fuel rods in a 16x16 configuration to form a simulated reactor core. The core, to avoid flow interference by the core wall while reflooding, the interior is covered with a honeycomb slab that is supported and shielded by a barrel structure.

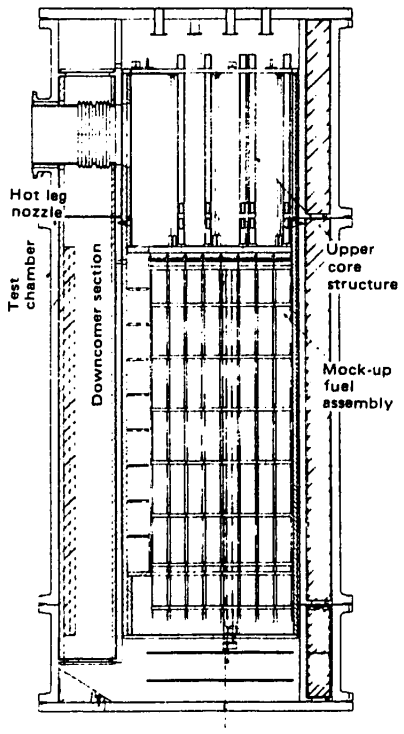

Fig. 1. General Arrangement of Pressure Vessel Fuel Assembly (SCTF)

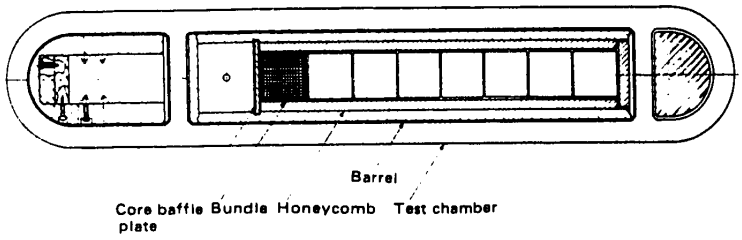

Fig. 2. Arrangement of Fuel Rods (SCTF)

CSO: 4120/288

SCIENCE AND TECHNOLOGY

APPLICATION OF ELECTRONIC TECHNOLOGY IN MACHINE TOOLS

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 66

[Text] * A lot of electronic technology is being utilized in machine tools to the extent that an advance in electronic technology immediately results in an advance in machine tools. Let us here look into in what fields of machine tools electronic technology is being utilized.

1. Driving

DC motors, whose speeds are easy to control, are most widely used for motors, including servo motors for positional control, which rotate work and tools. In these DC motors, electronic parts such as transistors in addition to SCR are playing an important role. On the other hand, high-frequency motors are used for high-speed driving. And now, it is anticipated that the method of facilitating the control of the speed of AC motors will be developed in the future.

2. Control

Supported by the striking advance of computer technology, numerical-control technology is also showing a dramatic evolution, NC made up of hard wires has developed into soft-wired NC or CNC (computer NC) equipped with mini- or micro-computers, which are compact and of high performance. Recent easy availability, in particular, of memories at low costs has enabled machine tool makers to incorporate various devices which facilitate program input by adding functions peculiar to individual machines. Tapeless operation has also been made practical which transfers data from keys on control boards directly to memories without using any tape.

Also there are bubble memories which do not require any power backup. In addition, for external memory media, magnetic disks and tape are used as well as magnetic tape cassettes and floppy disks.

At the command stored in these memories, operation is performed nearly unattended for long hours. Here, of course, it is required to install automatic tool exchangers which change tools, or replace worn tools with new ones, depending on processes, or install automatic work exchangers, which change different kinds of work in the course of processing. Commands for these operations are also recorded in memories, and the control of these mechanical sequences is set by programmed control and incorporated in microprocessors.

3. Management

Systems consisting of a couple of these numerical control machine tools together with accompanying conveyors, electric carts and robots, which are under the control of computer management programs, are called DNC (direct NC: NC commands directly from computers) systems, or FMSs (flexible manufacturing systems), which are almost operatorless plants.

Also, computers are efficiently utilized in making, machining and managing programs necessary for operations. Machining technology is incorporated in computer software and is used to improve the functions of automatic programming. Adaptive control which seeks optimal machining conditions during machining with machining technology software directly incorporated in CNC is used to optimize machining accuracy, machining speed, machining efficiency and machining costs.

4. Detection, Input and Display

With regard to NC systems, electronic technology, in addition to computation control technology, is serving to improve operativity as it is incorporated in various units such as detectors for position and speed, and displays

for characters and figures, including tape readers. These units include magnetic scales, optical scales, laser light interference length meters, plasma displays and cathode ray tubes (CRTs).

For the input of machining commands, paper tape is in most cases used with magnetic tape, floppy disks, while bubble memories are occasionally used. Other systems have character readers and input commands in handwritten characters on paper. Vocal command systems are also under consideration. There are also machine tools which automatically profile 3-dimensional models and 2-dimensional figures, and machines which automatically read models and figures, convert them into NC commands and carry out machining. Successful development of these machines owes much to electronic and computer technology.

5. Machining

In the field of machining, electronic technology is coming to play an important role.

Also, in removal machining, which removes unwanted parts of the material to form desired shapes, or in joining machining, including welding and surface treatment processing, methods that utilize electronic or optical energy are considered increasingly important.

One of them is laser machining. Conventionally this has primarily been used for drilling, welding and cutting of gems and electronic devices. Recent success in increasing output, as can be observed in carbon dioxide gas lasers, has made laser light machining practical for cutting sheets, whether metallic or non-metallic, in the mass production automobile industry.

Laser light machining easily permits automation and conversion into NC systems. It is easy to establish a production system which can be operated for 24 hours, 7 days a week, without rest only by shifting the direction of laser light on many pieces of work arranged spatially.

Again, laser assisted machining, which uses laser machining along with single point machining, enables the machining efficiency, machining accuracy and tool lives in cutting processes for hard-to-cut materials, such as cemented carbide alloys and fire resisting alloys, to be greatly improved. For plate machining, machines combined with punch presses have been produced.

Electron beams are also used in welding as well as fine and deep drilling. Systems include vacuum types and non-vacuum types. This application has the advantage of involving little thermal distortion and eliminating secondary machining.

Discharge machining and wire-cut discharge machining have been proving effective in machining molds of complicated shapes and this success has been supported by controls using electronic technology.

Table 1. Application of Electronic Technology in Machine Tools

Driving power	Electronic technology in controlling and changing motor speeds	Transistors and SCR in DC motors, high-frequency oscillation in high-frequency motors
Control	Computer technology in controlling mechanical movement	NC, CNC (computer NC), AC (adaptive control), PC (programmable control)
Management	Computer technology in management and operation of mechanical systems	DNC (direct NC), FMS (flexible manufacturing system), unmanned system
Detection	In measurement in process of mechanical movement and phenomena	Position (optical scales, magnetic scales, [illegible] interferrance, etc.), temperature, vibration, stress, strain, etc.
Display	In displaying input data, current locations, measurements and diagnoses, etc.	Plasma display, CRT, etc.
Input	Electronic technology for media of or in reading command input	Punched paper tape, magnetic tape, floppy disks, bubble memories, reading of characters and vocal input
Machining	Cutting, drilling, welding and heat treatment	Laser light, electron beams, high-frequency induction, ultrasonic waves, discharge machining, wire-cut discharge machining, etc.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

ARC WELDING ROBOT DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 67

[Text] Mitsubishi Electric Mfg. Co. has developed a five axis simultaneously controlled welding robot with multiarticulation.

The robot can independently set the point and angle of a welding torch.

Main Specifications;

Arm rotation	range	±150°
	speed	1000mm/s
Carrying weight:	max	10kg
Weight		320 kg

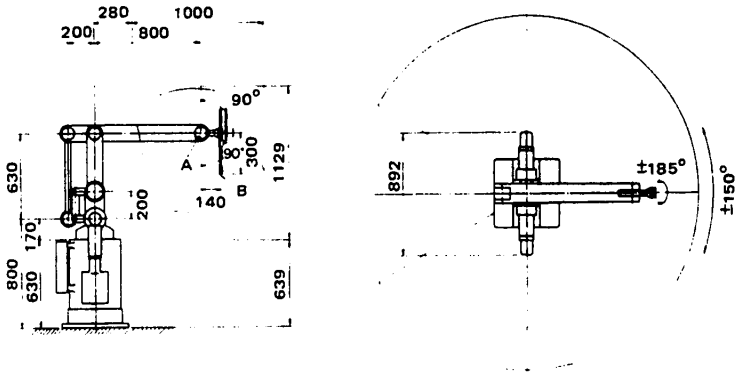

Fig. 1. Working Range of the Arc Welding Robot (Unit: mm)

CSO: 4120/288

SCIENCE AND TECHNOLOGY

LAND, SEA TRANSPORT SYSTEM FOR DEVELOPING COUNTRIES

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 68

[Text]

* Nippon Yusen K.K. has established a policy for definite promotion of a new land and sea continuous transport system, with a view to assisting economic development of the developing countries, mainly in Southeast Asia. And for the time being, the company intends to introduce the system into the Philippines, as the first candidate.

This policy of the company stems mostly from the success of the NYK Transport Service Thailand. NYK T.S.T. is a joint-venture company (71% financed by the Thailand party) established in 1969 to perform all operations including customs clearance, inland transport including arrangements for barges, and delivery and acceptance of imported goods with using leased equipment. Subsequently, Japanese transport equipment makers participated in the project capital-wise to provide an engineering department and this company at present also manufactures and installs machines and other equipment.

Developing countries have strong demands for this type of land and sea continuous transport system, expecting such to help their domestic economic development, and have made requests to Japanese marine and overland transport industries for participation in similar projects.

If the system planned by Nippon Yusen materializes, it will inevitably exclude vessels of other marine transport companies from the country concerned so extensively as to reduce the share of freight handled by these companies. Thus, major marine transport companies are most likely themselves to follow the recent movements by Nippon Yusen.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

ELECTRONIC FUEL INJECTION FOR PASSENGER CARS DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 68

[Text] • Mikuni Kogyo Co. has developed an innovative electronic injection system for passenger cars which increases fuel consumption efficiency of an engine by more than 10% when compared with conventional systems, and has applied for patents in Japan and other major countries.

Conventional fuel injection systems allow a time lag of 0.2–0.3 sec. before engine starting due to variations in running conditions. The new system has made simultaneous starting possible by utilizing a microcomputer which memorizes running conditions in advance.

This simultaneous operation enables the engine to be brought to optimal combustion, preventing excess gasoline from entering the engine. Running tests have proved that the new system increases fuel consumption by 10% on the average when compared with conventional types. This elimination of time lag naturally improves ease of driving.

Optimal combustion achieved also will largely reduce CO, HC and NOx in exhaust gases, enabling exhaust gas controls such as exhaust gas post-treatment systems to be made smaller along with sensors and starters simplified favorably enough to reduce car weight.

However, it will still be about 2 years before the new system is made practical. Mikuni Kogyo intends to sell the technology for the system to automobile makers when the company has completed development.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

AUSTRALIA ORDERS COAL HANDLING SYSTEM

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 69

[Text] Kawasaki Heavy Industries has recently received an order for 5 portal type rake chain reclaimers (2 with a coal discharge: 2000t/h and 3:1250t/y) from Coal and Applied Operation Pty. Ltd. of Australia.

The system consists of a portal installed like a bridge over coal bulk-loaded by stackers, a boom suspended by a wire rope and a rake-fitted chain on the boom, and is designed to continuously rake out coal onto a conveyor located at the rear. It also can run over the coal stacks and is designed to operate by remote control from a central control room.

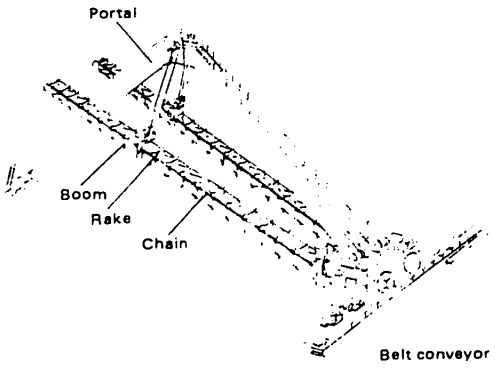

Fig. 1. Portal Type Rake Chain Reclaimer

CSO: 4120/288

SCIENCE AND TECHNOLOGY

EVALUATION OF DC FEEDER SYSTEM WITH THYRISTOR CIRCUIT BREAKER COMPLETED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 69

[Text] Meidensha Electric Mfg. Co. recently completed for evaluation, a stationary DC feeder system intended for DC electric railways, that uses thyristor circuit breakers.

The new approach is an innovative feeder system which uses a thyristor rectifier instead of a silicon diode rectifier generally used as a DC converter at power supply substations for subways, and also uses a thyristor circuit breaker (THCB) made up of an ultra-high-speed microcomputer equipped digital relay (overhead wire faulty current selective detector) and an optical fiber system instead of a mechanical DC high-speed circuit breaker (HSCB) for overhead wire fault protection.

The thyristor circuit breaker used in the new system is stationary having its digital relay pick up fault signals and thyristor elements shut off signals as resultant commands. Thus, no arcing or noise are caused as with conventional mechanical circuit breakers every time a fault occurs, and it has the following advantages: improved environmental characteristics, improved maintenance scarcely requiring any maintenance because of no mechanical parts, nor parts which wear from frequent switching, and a longer working life.

In addition, while a mechanical circuit breaker takes about 20m sec. to break after fault detection, the thyristor circuit breaker has the main thyristor released in only 1.0m sec. Thus, the breaking characteristics are much improved.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PIELSTICK ENGINE PRODUCTION REACHES 5 MILLION BHP MARK

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 69

[Text] With the completion of its latest diesel engine, the total output of IHI-S.E.M.T. Pielstick engines manufactured by Ishikawajima-Harima Heavy Industries Co. (IHI) has passed the 5 million BHP mark.

Since 1965, when the first engine was manufactured, 682 IHI-S.E.M.T. Pielstick engines aggregating 5,007,000 BHP have been produced.

The new engine, a 12PC2-5V type engine with an output of 7,800 BHP, is for a 20,500DWT bulk carrier being built by Imabari Shipbuilding & Engineering Co. for a domestic shipping company.

The IHI-S.E.M.T. Pielstick engine is a 4-cycle medium-speed diesel engine and has been manufactured under a technical agreement with S.E.M.T. of France, since 1964. It features high output with a light weight and a compact size, freely available revolutions with a combined reduction and acceleration gear, and effective use of engine exhaust gas. Therefore, the Pielstick engine is used not only as a marine main and auxiliary engine but also for land generators, pump drive units, etc.

Application-wise breakdown of the engines totalling 5 million BHP:

591 units or 4,332,000 BHP for marine use
91 units or 675,000 BHP for land generator use.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

INTERACTIVE CAD FOR PRINTED CIRCUIT BOARD DESIGN

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 70

[Text] * NEC has succeeded in the production of the interactive CAD system "NWE CAD-PWS" for printed circuit board design. This system can design fully automatically not only simple circuits, but also much more complex circuits that have hitherto been impossible for automatic design. It means that the computer can perform optimum design even for complex circuits if general instructions are given. The system may justly be described as epoch-making.

This CAD system adopts the high performance algorithm and the high level interactive method that were developed by NEC Laboratory. On the other hand, the high performance minicomputer "NEC MS Series" and the graphic display "N6935" are used as hardware to allow the realization of high-speed processing for calculation and easy operation. For example, it takes only two or three hours to process a board design with 100 parts. Its speed is three to five times faster than that of the old products.

The CAD system does not require human checks because an electrical check is automatically made whenever wiring is done. Since the design rules and the connection of signal wires are always monitored by the computer, it is enough for general instructions to be given. If a problem arises in automatic design, its cause will be displayed graphically to allow quick obtainment of some hints as to a solution to the problem.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

ELECTRON BEAM DRAWING UNIT DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 70

[Text] * Toshiba Machinery Co. has developed the reticulum drawing unit "EBM-150RB" by electron beam and has launched it in the market. The following are the major characteristics of the unit.

(1) High productivity is attained because drawing time is not related to the number of flashes. For 500,000 flashes, it takes about three hours for data conversion and drawing, which is about one third of the time required by the former optical pattern generator.

(2) High quality is obtained because there is no variation in line width by multi-exposure as found in the optical system and no bad connection between rectangles. One pattern of resist process is enough because it is easy to invert pattern data from white to black or vice versa and productivity remains unchanged.

(3) The automatic substrate feeder function is provided and it, together with a wide variety of software supplied, enables unattended operation. Key marks can be inserted with ease, corresponding to various steppers.

The major specifications are as follows:

Substrates under object:	3, 4.5 or 5 inch hard chrome mask or chrome/chrome oxide mask.
Maximum pattern drawing range:	105 x 105mm Available key mark up to 114mm
Input data format:	PG 3000/3600 format or IBM format
Number of substrates contained in the automatic feeder:	10 maximum
Drawing time:	30 minutes/100 x 100mm
Maximum irradiation volume:	Above 16 micro. cron/cm^2
Minimum line width/ line width increment:	4μm/1μm

The price is ¥265 million for the standard specifications.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

ESTABLISHMENT OF TWO NEW SEMICONDUCTOR TECHNIQUES REPORTED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 70

[Text] * Fujitsu Laboratory has developed two new technological processes that are important to semiconductor fabrication. One of them has solved the problem of surface instability on the material of the gallium arsenic FET (Field-Effect Transistor) by devising a new gate material. The other has produced a mono-crystal insulator capable of epitaxial growth on silicon substrate.

The former technology is not designed to control directly the surface of GaAs, but to devise material used for the FET gate, which eliminates surface instability. So far gate material that can produce the source and the drain layer regions has been fabricated out of an alloy of titanium and tungsten. It is the first time in the world that this technology has realized the self-alien-source-drain-planar structure with the GaAs FET. Only about 460μA could be carried before, but 900μA is confirmed as passing through this FET, which amounts to double the volume. The highest switching speed is for a gate length of 1.5μm where the figure of 70ps is confirmed. If the gate is converted to a length of 0.6μm, the speed changes to 30ps.

The latter technology creates an insulated monocrystal (spinel) on silicon with epitaxial growth and makes it possible to put further silicon on it. In fact, magnesian spinel ($MgOAl_2O_3$) is made out of the expitaxial growth on silicon. This technology can be used for the fabrication of integrated circuits by the incorporation of high voltage transistors of 400V with low voltage ones. It can also be used for integrated circuits mixed with both bipolar and MOS devices or for the basic technology in the development of new functional devices, such as three dimensional or ultra-lattice devices, the study of which has just been started.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

SEMICONDUCTOR X-RAY DETECTING DEVICE DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 71

[Text]

Toshiba Corp. has succeeded in the development of a semiconductor X-ray device very applicable to the medical X-ray CT.

This device is thin in shape measuring 1 to 2cm vertically and horizontally and 1.5mm thick. It can operate in normal temperatures without having high voltage put into it. The device has gold evaporated on one side and aluminum on the other. When X-rays are passed through, electricity flows in the device to detect it.

The company says that

(1) The limit of the detected dose can be set at one milliroentgen.

(2) When X-rays are not irradiated, the device is stable.

(3) Current leakage is small.

The company has also succeeded in a CT experiment to synthesize a tomogram image by the computer through the arrangement of many detecting devices in a thin shape.

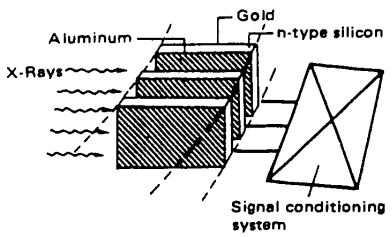

Fig. 1. Application Example of Semiconductor X-Ray Device to X-Ray CT

CSO: 4120/288

SCIENCE AND TECHNOLOGY

NEW PRODUCTION METHOD OF GALLIUM-PHOSPHORUS MONOCRYSTAL

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 71

[Text]

Sanken Electric Co. has succeeded in the development of a new method for producing gallium-phosphorus monocrystal that is destined to become an LED substrate material.

This new production method is based on the SSD (Synthetic Solute Diffusion) method that the company has already used. It is now called the SCS (Solute Control SSD) method. The SSD puts gallium into a crucible with phosphorus vapor and heats it at 1,100c to melt the phosphorus into the gallium to produce gallium-phosphorus monocrystal. The principle of the SCS is the same as that of the SSD, but the following are unique to the SCS.

(1) A crucible changed in shape is used to control the volume and range of phosphorus melting into the gallium.

(2) Seed crystal is used.

(3) A heat sink is placed beneath the crucible to optimize temperature range.

The crystal diameter is about 5cm and the time for crystal growth is 1 to 2mm per day. Since crystal defects are slight and quality is high, the intensity of the LED manufactured with this substrate is high and its luminosity is almost constant.

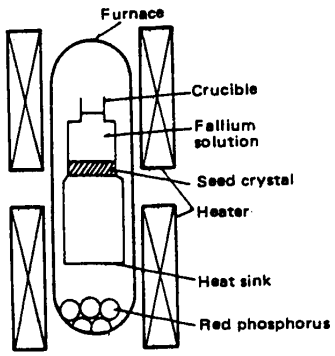

Fig. 1. Summary Diagram of the SCS Method

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DRY DEVELOPMENT OF PHOTO RESIST PROCESS

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 71

[Text]

Tokyo Ohka Kogyo Co., in cooperation with Chiba University has developed an epoch-making process for the dry development of photo resist for circuit patterns of up to 0.5μm in line width. This process does not require any chemicals such as developing solution. The company has decided to manufacture the unit. The plasma dry development process for sub-micron processing, developed by the company, is a plasma etching method as described below.

The special sensitive resin, whose sensitivity is resolved if heated, is painted on silicon substrated with oxide film, and after its pattern is exposed, it is burned in by the warm-air drier. Then, dry development is carried out with oxygen plasma.

In the current etching process the exposed portions are solved in developing solution (wet method) and the pattern line increases to double each time due to its being steeped in developing solution. The pattern returns to its original size in the final hydrofluoric acid process, but its precision goes down to some extent and the effective pattern is limited to 1.5μm. Compared to this, the dry development process which uses no developing solution at all can maintain the utmost precision because there is no swelling phenomenon.

Chiba University and the Laboratory of Tokyo Ohka Kogyo who have cooperated with each other towards the advancement of the new development process were already successful in achieving fixing with precision of 0.25μm in pattern width. It is also said that a practical process with which some companies using semiconductors were progressing, by request of Tokyo Ohka Kogyo, has been established with precision technology of 0.5μm.

There are two points to this process. One is for the development of a negative type of resist for dry development. The other is for allowing the plasma etching unit to become a completely unattended type of fully automatic device (OAPM Model 301B). This resist is composed to respond easily to plasma for development. The current wet development method causes low precision and production yields because the pattern angle (shoulder angle) becomes rounded, while the new dry development method generates very sharp and precise resist images.

Since temperature, liquid volume, pressure, and time are determined by experience and perception under the wet development method, the effective pattern is limited to over 1.5μm. Production thus varies and low production yields result. By-contrast, the new system operates automatically by temperature, gas liquid volume, and time preset in the device, a fact which allows etching yields to be almost 100 percent. The time required for development is 1 to 1.5 minutes per wafer which is almost the same as for the wet method. The cost of chemicals is relatively high for wet development, but the cost for dry development is one tenth of the wet method because only oxygen is required to produce plasma and its required volume is low: that is, about 100cc per wafer.

The price of the unit is not yet decided, but it seems that it will be below ¥50M.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PILOT PLANT FOR ISDN PLANNED FOR INSTALLATION

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 72

[Text] * NTT will start in FY1982 to establish a pilot plant for a digital communication network so that the analogue communication network currently used mainly for telephone calls can be replaced by the integrated system digital network (ISDN), which is used by various kinds of communication systems.

The telecommunication network used at present is made up of an analogue system which permits only transmission/reception of oral signals by telephone. Analogue-based telecommunications, however, which transmit voice wave-form as it is in order to conrey natural voice, are accompanied by defects such as distortion and noise.

Recent development of digital technology has enlivened the transmission/reception of digital information using data terminals and facsimiles. However, transmission of digital information using the analogue network requires specially designed signal conversion equipment. Most urgently needed, therefore, is a digital network which unifies various kinds of signals from all kinds of telecommunication networks into pulses.

There may be many technical problems to be overcome involved in the conversion of the present analogue system into the digital one. Technical interface of both systems, maintenance of the digital network, training of the staff, and introduction of digital electronic exchanges are some of them.

To clarify these technical problems, a pilot plant will be established in a few years in a practical stage following the theoretical study. In the plan, some of the electronic exchange of the present telephone offices will be digitalized and be connected to digital devices such as data terminals, facsimiles, and data telephones. Selected offices and telephone subscribers will have a monitor for the digital devices, and telephone offices and these terminals are also expected to be linked by an optical fiber instead of a copper calbe. The number of monitors expected to be subscribed for will reach about 2000.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

TELEX TELETYPE SWITCHING SYSTEM DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 72

[Text] * Toyo Insatsu Denshinki Co. has announced that it has developed a "Message switching system VIT 1100" which allows considerable reduction of manpower and great improvement of efficiency in telex·teletype communications, both domestic and international.

The system comprises a main body and terminals, such as a multi functional CRT. The main body incorporates a 14.9 Mbyte magnetic disc, 1 Mbyte floppy disc and a system controlling microcomputer, DEC·LSI 11/2. The maximum number of input/output ports is 22. Telegraphic messages input is stored on magnetic disc of variable length.

These features allow the following: (1) automatic allocation of telegraphic messages input from each port. (2) storage of messages in magnetic and floppy disks, the latter being also used, especially for long-term preservation of messages. (3) simple retrieval of messages from the discs and transmission of them to any desired port including a CRT, paper tape printer, printer and circuits. (4) fixed message registration, repeated use of the registered messages and correction at terminals. (5) output of messages to a journal printer (6) relay of messages for international (5 unit) and domestic (6 unit) uses. (7) transfer of faulty messages back to the input terminal after highly accurate checking of the messages.

As mentioned, this system uses magnetic and floppy discs, excluding any kind of tapes used in the storage and retrieval of messages from telex and teletypes, which normally have been performed by paper punch tapes and monitor copies. It is reported to be most suited to companies with channel capacity of about 10 circuits.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

TRIAL SMALL RADIO UNIT FOR LAND MOBILE TELEPHONE SYSTEM

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 73

[Text] *NTT has completed trial production of a new land mobile telephone radio unit which is as compact as 1500cc in volume and 2.4kg in weight. Compared with a conventional mobile unit, the size of the new unit is reduced to less than 1/4, the weight to about 1/3, and the DC power consumption to about 2/3 for transmission and less than 1/2 for stand-by.*

NTT has also developed some unique items of technology to miniaturize and reduce the weight of the machine. The major efforts made by the corporation during the manufacture of the machine are as follows:

In a local oscillator which must generate accurate and stable radio channels for steadier communication, microwave planer-circuit technology has been employed to simplify the circuit structure. A variable frequency local oscillator capable of direct oscillation of 800MHz frequency has been developed to be built into the machine. This is based on thick-film planer-hybrid IC technology. The combination of bipolar semiconductor and CMOS technologies has enabled miniatuarization of a prescaler and a variable divider conducting high-speed control of frequency into LSI's.

In the transmitting section, a 145MHz FM modulator for voice and data has been required. But because an oscillation frequency of 145MHz is too high to be caught by a crystal oscillator, a new device called SAW has replaced it as the oscillation source of the modulator. An up-converter provides an 800MHz band output by mixing the 145MHz modulated carrier with the output of a local oscillator. Although application of thick-film technology to higher frequencies has conventionally been very difficult due to large transmission losses, NTT has successfully completed the circuit using a thick film hybrid IC by applying low-loss technology developed by the corporation.

In the receiving section, a thick film hybrid IC has been used for a receiving mixer which mixes received signals and the output of the local oscillator to produce an intermediate frequency (IF) carrier of 90MHz. Newly developed monolithic crystal filter fabrication technology has also helped in the manufacture of a 90MHz IF filter.

HIC's used for the transmitting section have reduced a great number of adjustment points. A uniquely structured and compact low loss duplexer using high dielectric materials has also been incorporated.

The logic unit performs logic operations required for call processing, channel control etc. The circuits are composed mainly of general purpose LSI's, so that functions of the logic unit can be performed on a digital basis.

Also, transmitter power amplifier efficiency has been improved mainly by 30% to 40%, resulting in a decrease in power consumption.

Table 1 shows the main features of the new mobile radio unit.

Table 1. Specifications of the New Mobile Radio Unit.

Size		214mmx140mm x50mm
Volume		1500cc
Weight		2.4kg
Transmission power		5W
Frequency		800 MHz band
Consumption power	Transmitting	35W
	Receiving	7W

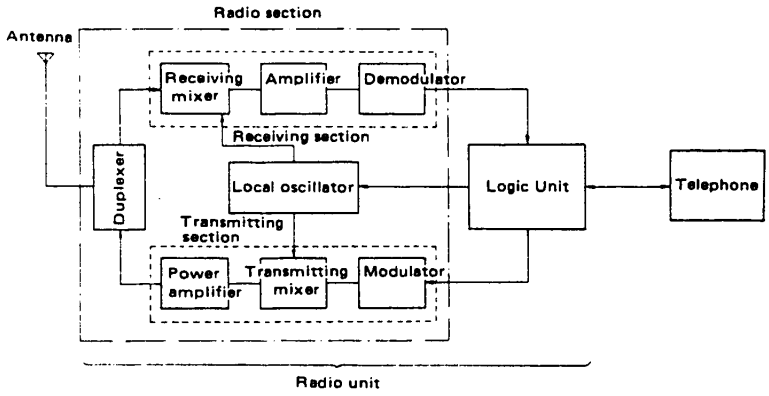

Fig. 1. Block Diagram of a New Radio Unit

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SCIENCE AND TECHNOLOGY

TEST OF TELEPHONE EXCHANGES IN STRICKEN AREAS, GROUND TELEPHONE NETWORK

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 73

[Text]

A satellite communications circuit, which is most unlikely to be affected by ground disasters, may be the most effective means for the rapid reassignment into a telephone network of a region isolated from the network by disasters. NTT has succeeded in a circuit installment connection test in which a ground telephone network and the telephone exchanges of a stricken area are linked via an experimental, medium capacity, stationary communications satellite (CS).

When a trunk line between telephone exchanges or telephone offices is damaged by a disaster, it is necessary to organize quickly an earth station for satellite communication for immediate use by installing a satellite circuit. To cope with these emergency cases, on the assumption of traffic interruption, a test was conducted in which a helicopter carried a quasi-millimeter wave mobile station which communicates with a CS. Next, in the Karasuyama Telephone Office of Tokyo, the mobile station was linked with an emergency telephone exchange substituting for the damaged telephone office. A circuit covering the route of an exchange → mobile station → CS → base station → ground telephone network was established after an hour-long attempt.

A transmission test via the above-mentioned circuit was also conducted to check the influence of dial pulse delay caused by transmission delay time inherent in a communications circuit through the operation of a telephone exchange. However, no trouble was recorded.

On the other hand, when a large part of the trunk line between telephone offices is damaged, the required work is not only to change the route of the circuit, but also to build the structure of a satellite communications circuit mainly for communications with the stricken areas. The former will be conducted by the route alteration function of an exchange, and the latter by the time sharing multiple connection function. In the test, using these methods, circuit structure change required only a very short time.

These tests have proved that public telecommunications with stricken areas can be quickly secured even if exchanges and trunk lines in those areas are damaged.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

COMPUTERIZED PHOTO-COMPOSING CHARACTER PLATE FOR ARABIC

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 75

[Text]

Chukinto (Middle and Near East) Printing Co., specializing in printing Arabic, has lately developed a computerized photo-composing character plate for Arabic.

While it has barely been possible to typeset Arabic sentences in the body of printed materials, it has never been possible to type or typeset lettering letters such as captions, titles and headings which accentuate or make impressive printed materials. The company has designed these lettering letters and has developed a character plate for photo-composition.

The character plate has the following features:

1) Because by combining single characters, other characters can be composed, all necessary characters can be contained in one character plate.

2) Arabic characters, which are as a rule handwritten, can be typeset without separating them so that the dignity and quality of their spellings can be retained.

3) It can reduce typesetting time to 1/10 and costs to 1/5 of requirements in the case of instant lettering.

Fig. 1. Style of Newly Developed Arabic Character

CSO: 4120/288

SCIENCE AND TECHNOLOGY

NEW LARGE CAPACITY MAGNETIC BUBBLE STORAGE UNIT DEVELOPED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 75

[Text]

Hitachi Ltd. has developed a high-speed access (2 milliseconds), large-capacity (64 megabits) magnetic bubble storage unit.

This development constitutes a part of a larger project of the Institute of Industry Technology, the "Development of a Pattern Information Processing System". This unit employs a 256 kilobit magnetic-bubble storage device with six times or more higher density over conventional 64 kilobit capacity devices and three times the speed (300kHz as storage-driving frequency) over them.

The patterns on the chip employ fine patterning of down to one micrometer. For development of this storage device, such technologies as given below were also developed:

(1) Liquid-phase crystal growth for a 2-micrometer-thick membrane crystal and fabrication of a structural defect-free garnet crystal.

(2) Photoetching by means of an argon ion beam.

(3) Design of a series-resonant driver circuit that can apply or stop a magnetic field speedily.

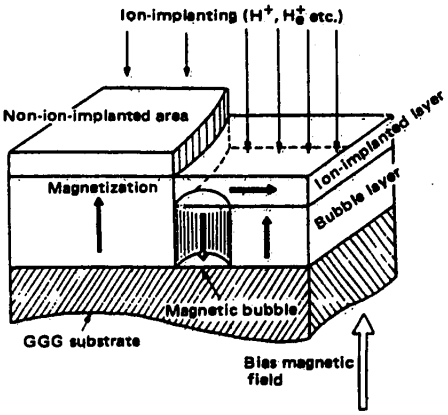

Fig. 2. Concept Design for Ion-Implanted Element

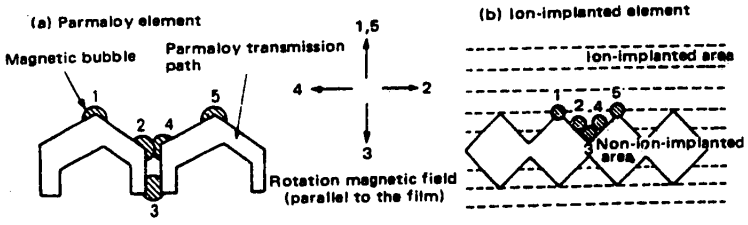

Fig. 1. Transmission Principle of Magnetic Bubble

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DISTANCE MEASUREMENT PROJECT BETWEEN JAPAN, UNITED STATES

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 77

[Text]

Radio Research Laboratory is making progress in the development of the VLBI (very-long-baseline interferometry) system which will be used to measure the distance between Japan and the United States with greater accuracy than ever before. The company will also begin development of an atomic clock that is a heart of the system, and system software.

The VLBI is a system that will receive radio signals from a radio star at two remote receiving stations, where time of day will be set accurately by an atomic clock, and will measure the distance between these two locations from the difference in arrival times of the signal from the radio star.

This measurement was technically difficult between continents, but enhancement of precision of an atomic clock allows each receiving station to accurately record on tape radio signals of a radio star and the time at which they are received, and later to calculate the inter-continental distance by their comparison. Thus, the distance between continents can be measured to a precison of a few centimeters.

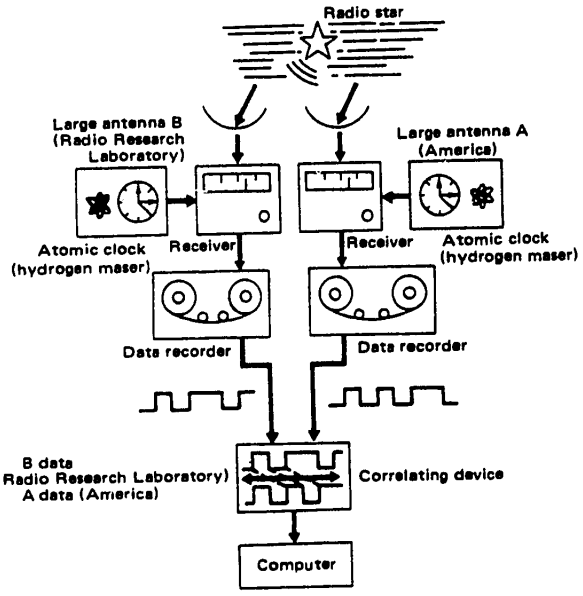

Fig. 1. Overview of the VLBI System

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DEVELOPMENT OF α-TYPE SILICON NITRIDE

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 78

[Text] • Denki Kagaku Kogyo K.K. has developed an α-type silicon nitride that is the most suitable raw material for sintered moldings, and has constructed a commercial plant in Omuta factory.

Silicon nitride has excellent mechanical strength compared with conventional ceramics and it can be used at high temperature above 1,000°C. In addition, the density is 3.18, less than half that of iron. By the development of the nitride, a drastic increase in the efficiency of gas turbines will become possible, as the heat efficiency has previously been restricted by the usable limit of materials. Also its use in automobile engines will significantly increase their heat efficiency and reduce their weight. Other applications including diesel engines and mechanical seal of machines are under research.

These moldings consisting of the nitride and additives can be produced by hot press, hot-isotactic press, atmospheric firing method etc. The high quality of α-type silicon nitride powder as a raw material is warranted by the following properties: (1) the α content is high, (2) the size is fine, (3) the impurity content is low and (4) reproducibility of these properties is good. Compared with β-type silicon nitride, α-type has fine crystal structure and can be sintered at lower temperatures during the sintering process. Also, sintered moldings with high accuracy can be produced. Eight kinds of grade, according to the α content and the size, are available. The company has plans to offer samples to producers of automobiles, generating stations and refineries, and to develop new markets.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PRACTICAL USE OF NEW MANUFACTURING METHOD OF CAUSTIC SODA

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 78

[Text] * Kyoto University has studied a practical use of a β-alumina diaphragm process that is a new method of manufacturing caustic soda.

Fusing caustic soda with high purity can be accomplished through a single process by using the method, and the cost is cheaper than that of conventional ion-exchange film processes.

The β-alumina diaphragm process uses β-alumina as a partition wall through which only sodium ions can pass, and aqueous sodium chloride is dissociated to ions by electrolysis between carbon (anode) and nickel (cathode). Sodium ions penetrate the diaphragm and accumulate at the cathode, and 95~99.9% caustic soda is produced without any concentration process. Bubbling of oxygen gas to the cathode decreases electric power consumption. An electric base unit, an economical index, is 3,300kW·HR at a reaction condition of 350°C, and the value closely corresponds to that of mercury process. Chloride gas is evolved at the anode and this reduces the life of the anode, and electric capacity is relatively large. Although irigium oxide has been found to be a good material, further study to develop for supporter is keenly anticipated.

Ion-exchange film process is adopted instead of mercury process, and thus β-alumina diaphragm process will be used at the next stage. 70% purity can be obtained when mercury process or ion-exchange film process is used, but 99.9% purity without impurities such as chloride ion etc. by one process. It is said that the characteristic of the diaphragm process exists in a high-purity product because the production cost by ion-exchange film process is decreased largely by an advance in the technology.

Fusing caustic soda produced by the diaphragm process is expected recently as a heat carrier in view of saving energy. The increase in demand is promising because it will be used as a generative material that can hold the latent heat of fusion. Therefore, a basic study to develop for practical use metal material with corrosion resistance will be continued.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

CARBON TETRAFLUORIDE OF HIGH PURITY MANUFACTURED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 78

[Text] * Kantoh Denka Industry (whose president is Tadao Yabuki) has succeeded in manufacturing carbon tetrafluoride(CF_4) of high purity, which contains chlorofluorocarbon of less than 1 ppm and which can be said to contain no chlorine. The company is shortly going to sell it as dryetching-gas to be used for the semiconductor manufacturing process. Since ordinary carbon tetrafluoride contains several tens to several hundreds ppm of chlorine, it has been pointed out as one of the problems that the surface of the substrate is often harmed. But the company has succeeded in manufacturing carbon tetrafluoride of very high purity by a special refining method. It is said that no case had been recorded of CF_4 less than 1 ppm.

Carbon tetrafluoride is manufactured (40 tons annual capacity of production) by the equipment constructed at Shibukawa Factory (Gunma pref.). The investment is about 100 million yen. The company is opening up new avenues of use for CF_4 by promoting it as a refrigerant for a very-low-temperature refrigerator for blood preservation, as a vapor insulator, as an attitude control gas for a space rocket, as a leak testing agent, etc., besides as a dry-etching gas.

The etching process in the semiconductor industry is switching over to the dry one with large scale integration of circuit pattern. The ordinary wet method is mainly adopted in producing circuits of up to 16k bits; however, the problems of after-treatment such as rinsing, drying, etc. and of waste water treatment have been pointed out. In contrast to this method, the dry process has been adopted on a full scale since 1979 in the manufacturing process of bits of over 32k, especially 64k bits, in order to speed up such processes as the etching of precision circuits. The demand for dry-etching gas (carbon tetrafluoride is the principal one) has suddenly increased with the adoption of the dry process, and the scale of demand for this fiscal year is expected to be about 30 tons, twice that of last year. While Showa Denko and Daikin Industry, out of domestic makers, have started a full-scale sale since last year, U.S.A. Dupont Co. has a dominant market share.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PRODUCTION, MARKETING OF NEW WATER-SOLUBLE POLYMER IN GOOD SHAPE

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 79

[Text]

Nippon Geon Co. has developed the world's first water-soluble polycarboxylic acid polymer using amylene as a raw material, and started production in October, 1980 at a rate of 5000t/y, marketing it under the tradename "QUINFLOW".

Using its own technology, the company developed . GPI (Geon process for isoprene), a separation process for C_5 fraction. They have already been producing, while marketing, polyisoprene rubber (NIPOL IR) from isoprene, a petroleum resin (QUIN TONE) from piperylene and DCPD, and an epoxy resin hardener and a dibasic acid for polyester resin (QUIN HARD) mainly from isoprene and piperylene.

QUINFLOW is a new product commercialized in Japan Geon's C_5 fraction overall utilization project. Here, the properties and applications of QUINFLOW 540 as one of its typical grades, are shown:

QUINFLOW 540 is a new dispersing agent for aqueous dispersion. QUINFLOW 540 has excellent dispersability for a large variety of organic and inorganic pigments, clays, dyestuffs, agricultural chemicals, portland cement, and gypsum.

1) Uses

Paper coating:	*Pigment dispersant for colored coatings*
Textile treatment:	*Soaping agent, Deteragent base (phosphate replacement)*
Water treatment:	*Scale inhibitor*
Coating:	*Pigment dispersant for water paints*
Building materials:	*Water reducing admixture for gypsum board*
Agriculture:	*Spreader of agricultural chemicals.*
etc.	

2) Properties (Fig.1, 2)

Conponent:	*Sodium salt of synthetic polycarboxlic acid.*
Apperance:	*Clear light yellow aqueous solution.*
Concentration:	*40±1 wt.%*
pH (250°C):	*10±1*
Specific gravity (25°C):	*1.28±0.02*
Viscocity (250 (25°C):	*50 ~250cps*

3) Paper coating pigments dispersability (Fig.3, 4,5 6)

Compared viscosity of various pigments dispersants with sodium slat of polyacylic acid (conventional dispersant for paper coating pigments).

- *– ● – Quinflow 540*
- *– o – Convnetional Na slat of acrylic acid*

4) Scale inhibitation effect for cooling water (Fig.7,8)

5) Typical composition of detergent using Quinflow 540 as a base

LAS	*20%*
Quinflow 540	*20 ~ 0%*
STPP	*0 ~ 30%*
Sodium carbonate	*1 ~ 7%*
Sodium silicate	*3 ~ 12%*
CMC	*~ 1%*
Sodium sulphate	*balance*

6) Toxicity

Acute oral toxicity:	*LD50 (Rats) LDLO, over 10gr/kg*
Toxicity to fish:	*96 hrs TLm (fries of carp) 2,000 wt ppm*

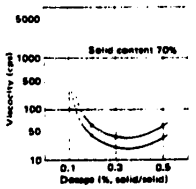

Fig.1. Specific Gravity VS Temperature

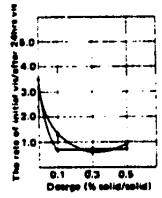

Fig. 3. Ground Calcium Carbonate (2μ>, 75%<)

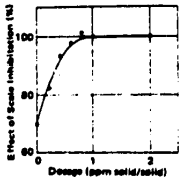

Fig. 5. Satin-White

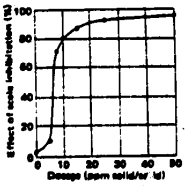

Fig. 6. Stability of in Dispersion Fig.5

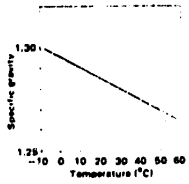

Fig. 2. Viscocity VS Temperature

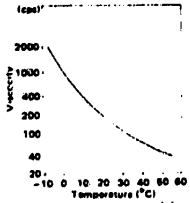

Fig. 4. Stability of Fig.3 in Dispersion

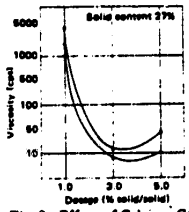

Fig. 7. Effect of Calcium Carbonate Scale Inhibitation

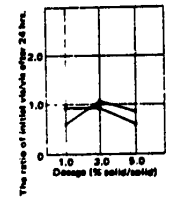

Fig. 8. Effect of Calcium Phosphate Scale Inhibitation

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DEVELOPMENT OF NEW MATERIALS IN 'THE NEXT-GENERATION PROJECT'

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 79

[Text]

The Agency of Industrial Science and Technology has decided to start in the fiscal year 1981 a project of "fundamental techniques in the next-generation industry". The object of this "next-generation project" is to establish new industrial techniques, to support the next age, with priority given to the development of new materials, new biotechnology and new functional devices, with a research budget of 120 billion yen for the next ten years.

The greatest importance is attached to development of new materials among the next-generation projects. A half of the budget, 2.7 billion yen, for the first fiscal year, is to be spent on this research.

Material techniques are indispensable not only for ultra-heat-resisting materials used in nuclear fusion but for every other kind of industry such as machine, chemical, etc.. For this reason, our country intends to develop new materials independently of other countries and put them to practical use.

The following six items are determined as individual themes:

(1) Fine ceramics, (2) High-efficiency separating membrane material, (3) Conductive polymer material, (4) High-crystalline polymer material, (5) High-performance crystal control alloy, and (6) Composite material.

It is the development of fine ceramics that attracts the most attention among them. The names of several companies, such as Asahi Glass, etc., can be mentioned as enterprises participating in this project.

High-efficiency separating membrane, conductive polymer, and high-crystalline polymer materials are polymer membranes for use in salt-to-fresh water distillation or in gas separation. It is intended that superconductive materials with infinite electric conductivity at normal temperatures, and plastic as strong as metal etc. should be developed. Several enterprises, such as Asahi Kasei, etc., plan to participate in this project.

Speaking of the themes "High-performance crystal control alloy" and "Composite material", they declare their objectives are to develop new, mainly metallic materials. Several companies, including Mitsubishi Heavy Industry, hope to participate in this project.

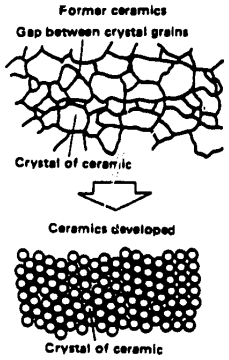

Fig. 1. Comparison of Ceramics to Be Developed with Former Ceramics

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PRODUCTION OF MALIC ACID DESCRIBED

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 83

[Text]

Kyowa Hakko K.K. has succeeded in developing a unique process for production of malic acid by immobilized enzyme.

The organisms used for this purpose have following advantages:

(1) Good growth rate of the organisms

(2) Less production of by products, such as succinic acid and other organic acids

(3) Stable activity of fumarase

The final exchange ratio (yield of malic acid) is approximately 60~80% against fumaric acid.

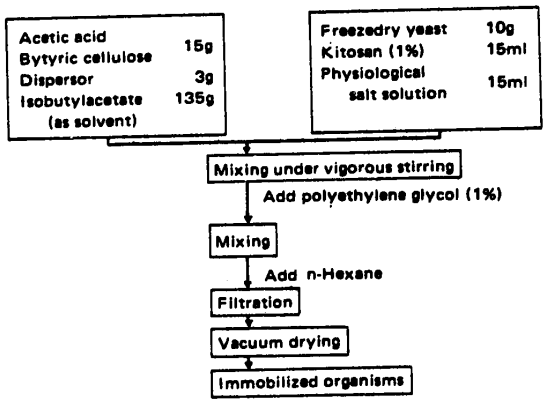

Fig. 1. Fixing Method of Organisms

Table 1. Properties of Organisms and Immobilized Products

Yeast	Activity unit/g.cell	Optimum pH	Optimum temp.(°C)	Method of immobilizing	Activity unit/g.cell	Activity (%)	Half-life
Pichia membranefaciens	329	6.5	35	Duolite A-7	11.0	10.6	–
				CAB microcap	30.2	35.0	>30 days
Candida lypolytica	399	8.5	40	Duolite A-7	9.0	9.3	–
				CAB microcap	40.5	40.0	>50 days

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PROSPECT OF PRACTICAL WAVE FORCE ELECTRICITY GENERATION

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 88

[Text] * Hitachi Shipbuilding & Engineering Co. has decided to launch into the field of wave force electricity generation, which is attracting attention as a potential source of petroleum-substituting energy. The company has designed a wave force electricity generating plant on a practical scale.

Wave force electricity generation consists of converting the energy of waves washing the seashore, etc. into electricity generating energy or heat energy. The company, which wants to become less dependent on shipbuilding than ever as its principal business and progressively move into energy-related areas, has long been aware of these areas, and for two years has carried out the necessary research in cooperation with professors from the Muroran Institute of Technology.

In the present design, the wave force electricity generating system has a pendulum board, 3m wide and 4m long, installed in front of a breakwater. To this is attached an oil hydraulic cylinder → an oil hydraulic motor → an electricity generating turbine so that, when the pendulum board is shaken by wave force, the electricity generating turbine turns as the shake works on the oil hydraulic system. The electric generator and others are positioned in the hollowed-out interior of the caisson used for the breakwater.

The company has made a detailed analysis of wave force data gained at a certain town on the Sea of Japan side of Hokkaido, said to be one of the big rough-wave areas in the world, as well as from repeated water-tank tests. Based on the results of this analysis and tests, they have incorporated into the design an idea that enables energy to be steadily recovered, even in summer when the local wave force is small. Further, the pendulum board and the shaft supporting it are designed so as to be structually strong enough to withstand wave force as well as the impact of flying rocks that come with breaking waves.

Reportedly, about 15% of the energy from the force of breaking waves can be used as electricity. Also, the generating capacity of the new system averages 20kW with a maximum of 28kW.

At present, electricity, generating cost by wave force is about ¥1 million per kW, compared with about ¥200,000 per kW for thermal generation using heavy oil as the fuel. But the cost can be cut if the practical use of wave force for electricity generation progresses.

Because of its output and the geographical nature of its coastal location, electricity generated by this system is suitable for use as the light of a lighthouse, snow melting on embankments and the warming of water for the culture of young fish and young shellfish.

Wave force electricity generation is now being tested by the Agency of Science and Technology as well as by private groups, which have launched into related research, but the prospect of its practical application is not yet in sight.

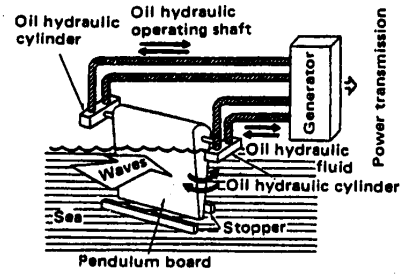

Fig. 1. Setup of a Wave Force Power Generating Plant

CSO: 4120/288

SCIENCE AND TECHNOLOGY

RECOVERY OF SEA WATER URANIUM BY MICROORGANISMS

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 88

[Text] * Prof. T. Sakaguchi et al of Miyazaki Medical College have developed a system to efficiently recover uranium from sea water and mining waste water by means of an absorbent consisting of microorganisms wrapped in a plastic. It involves the technique of causing microorganisms to absorb uranium dissolved in water, and existing in very small quantities, by taking advantage of the process of biological magnification, which used to be a problem in connection with Minamata disease, etc. This process is attracting the attention of many circles as the first instance of the application of biotechnology to the area of atomic energy.

They had first noted the fact that there are microorganisms that especially absorb and accumulate in their bodies uranium alone of all water-dissolved metals, and started tests on two types: Chlorella regulus of the Chlorella group and streptomyces belonging to the group of Actinomycetes.

It is still unknown how these two types of microorganisms absorb uranium but two methods are considered possible. One is physical absorption onto the surface of their cells and the other is the chemical method of accumulating in their interior via the cell membrane. Enriched uranium leaves the cells and melts in 0.1% sodium carbonate solution when the microorganisms are soaked in the solution.

The problem is that the absorbing capacity of the microorganisms decreases, or the device is blocked, if the absorption and desorption of uranium is repeated many times. So, the research team fixed microorganisms by wrapping them in polyacrylic amide so that their cells cannot break and melt in the solution. This enables the absorption and desorption of uranium to be repeated by letting sea water flow continuously.

In their tests using solutions with a uranium concentration of 10ppm (ppm equals 1/1,000,000), Chlorella and Actinomycetes absorbed 0.159g per gram and 0.312g per gram, respectively, of uranium. The activity of the fixed microorganisms scarcely changes after absorption and desorption is repeated five times continuously. Thus, the prospect is that these microorganisms can be used for a long period.

According to Prof. Sakaguchi, this method is not yet at the stage of being able to discuss its economic feasibility, and what must be done in the future is to discover organisms – including soil organisms living near uranium lodes – that absorb uranium more efficiently.

CSO: 4120/288

SCIENCE AND TECHNOLOGY

DEVELOPMENT OF AUTOMATIC ANALYZING SYSTEM FOR SUBMARINE STRATA

Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 89

[Text]

Obayashi Gumi has developed for practical use a "Marine Profile System" that can automatically analyze submarine strata.

In the past, submarine geological profiles have been made by acoustic detection whereby a small number of skilled technicians draw stratal boundaries and infer facies. The newly developed system draws stratal boundaries in accordance with the forms of 3.8-Hz ultrasonic waves transmitted to the sea bottom and received after having been bounced back from there and investigates the components of submarine strata. Since it handles integrated computer processed data that have been gained, it enables inexperienced technicians to rapidly obtain highly reliable geological profiles. The outline of the system is as follows:

It combines a magnetic recorder with a conventional magneto-strictive sound locator. This recorder records on electric discharge recording paper and, at the same time, sonic waves reflected are stored on magnetic tape. Magnetic memory thus obtained is input into the computer, which is central to this system, and the results of computer processing are drawn by the XY plotter as a final geological profile. The computer processing has the following two major functions:

(1) Decision of Stratal Boundary

In the previous magneto-strictive sound locator, hardly any errors caused by the extent of sonic waves were corrected as it was assumed that few sonic waves go sideways. The new system incorporates a newly developed program to rapidly correct these errors. Thus, it can accurately assess the shape of a highly irregular basement.

(2) Determination of Strata

The system determines the facies of strata through comparison of the observed wave form and the wave form pattern simulating it, taking advantage of the fact that each stratum has its own acoustic characteristics (acoustic impedance, attenuation factor, scattering coefficient, etc.) and that these have constants within generally known ranges according to the facies (sludge, clay, silt, sand, gravel and rock) of the stratum.

Main Capacities:

Water depth	:	*2~150m*
Depth	:	*Approx. 40m (case of soft stratum)*
Precision	:	*−0.2~0.3*
Processing speed	:	*10~15km/day*

Applications:

(1) Selection of sites for constructing ports, sea berths, marine airports, pier foundations for sea-crossing bridges, and other marine structures; assessment of submarine ground geology and basement topography; and surveys to confirm distribution and thickness of soft stratum.

(2) Selection of sites suitable for providing littoral areas, such as bulkheads and reclaimed lands; selection of borrow pits and spoil banks; calculation of soil volumes; study of drift sand; and study of bulkhead circular rupture.

(3) Confirmation of distribution and thickness of sludge; this is necessary for environment improving works, such as sludge dredging; division between floating mud and sunken mud; and confirmation of dredged areas.

(4) Surveys necessary for fishery planning and design, such as planning and designing of fish farms and layout of man-made fish habitats.

(5) Surveys necessary to develop marine mineral resources (including drift-sand mineral deposits) or to develop submarine petroleum (excavation, selection of position of producing platform, etc.)

CSO: 4120/288

SCIENCE AND TECHNOLOGY

PRODUCTION, SALES OF INDUSTRIAL ROBOTS DISCUSSED

Shinmeiwa Industry

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 4 Jun 81 p 6

/Text/ Shinmeiwa Industry Co Ltd has now established a system to produce 30 industrial robots per month. The production capacity of 15 units this spring has been doubled in one sweep in order to accommodate the dramatic increase in demand for industrial robots in line with the tide toward labor-saving and automation of production indicated in the industrial world. For the time being, the main model is the robot for arc welding, but the company intends to expand production widely to encompass various models, such as shearing robots that cut steel plates and conveyer robots for press work.

Shinmeiwa Industry has recently begun to sell "Robel /phonetic/ J" welding robots with multiple joints. This is the latest machine which has adopted a 16-bit parallel processing microcomputer in the brain to control the body of the robot, and it is characterized by the high speed and precision of various types of welding work that can be done. Shipment will start in the summer of this year, but the company has already received orders for nearly 30 units.

The company is a "shop of long standing" in welding robots and has sold large machines focusing on rectangular coordinate type products. Up to the end of last year, it maintained production on a scale of about 10 units a month, then raised it to 15 units a month due to the increase in orders from automobile makers and electrical machinery makers this spring. Now, monthly production capacity has been upgraded to 30 units, reflecting the popular acceptance of the latest small "Robel /phonetic/ J." In the Takarazuka plant, Hyogo Prefecture, where the robots are made, full operation has continued while the production equipment has been reinforced. At present, orders for robots are coming in at a very fast pace, and it is very likely that the necessity to expand the production equipment will be felt by the end of this year.

Arc welding robots will be singled out as the main machine model for the time being, and the company plans to stick to the policy of not advancing into the fields of spot welding and painting robots for the automobile industry. However, it is thinking of getting into a wide variety of models, such as a shearing robot and a press conveyer robot by utilizing the technology for arc welding, a fusing robot by using gas and plasma, and a sand-blast robot which will specialize in sanding.

The demand for Japanese industrial robots has been climbing steadily since the "Initial Year for Robots" last year, and it is expected to grow continuously for a while at an annual rate of 40 to 50 percent. Although Shinmeiwa Industry is affiliated with Hitachi Ltd, the future "father and son conflict" is likely to become the favorite gossip of the business world since the parent Hitachi has started to be serious about selling arc welding robots.

Hitachi Ltd

Tokyo NIHON KOGYO SHIMBUN in Japanese 5 Jun 81 p 7

/Text/ Hitachi Ltd (president, Hirokichi Yoshikawa) has consolidated a policy of setting up engineering centers in the United States and Europe and using them as strategic bases in order to prepare for the expansion and sales of industrial robots, said to be the strategic model for the eighties. The centers will not only be in charge of the engineering and maintenance indispensable for the sale of robots, but will also be given a comprehensive function for robot sales in the United States and Europe. Hitachi is ready for sales and production tie-ups in advanced countries, and the centers will serve as a main body to promote these activities overseas.

The company has been producing industrial robots on a commercial basis using technology of its own since 1970; it offered a high-class robot for arc welding, "Mr Allos /phonetic/" to begin with, and a multipurpose work robot, "Hitachi Process Robot." Process robots are maintained steadily in full production and are used primarily for welding in smaller businesses. Also, the assembly robot, regarded as the "winner" among industrial robots, is being developed by the organization of a companywide project team, a special case in this company, indicating its desire to earn the status of an all-out robot maker.

Generally speaking, the fever for robot introduction in the industrial world is higher than expected, and Hitachi is also kept busy coping with the domestic demand. However, the interest in Japanese-made robots expressed overseas is just as explicit as it is here. According to the company, not only is it facing a rush of orders but also it receives many visitors from industries wishing to sign up for sales or production tie-ups.

With this in mind, Hitachi has finally been driven to begin full-scale promotion of industrial robot business overseas, and it tentatively plans to use combinations of three systems to meet the actual conditions of the market in each country, stressing primarily the markets in America and advanced European nations: 1) sales by Hitachi itself, 2) a sales tie-up with local capital, and 3) a similar production tie-up. Already, Hitachi has a tie-up with Automatics of America, but the company is now in the stage of selecting second and third tie-up partners on the pattern of that established with Automatics on the basis of engineering ability, sales network, future possibilities and service network.

On the other hand, the company views the systematization of peripheral technology regarding robots as the selling point for robots, and attaches great importance to engineering for the introduction of robots, which led to the conviction to set up engineering centers in America and Europe. It is planning to promote robot sales

after the engineering and service systems are established. That speaks for itself in describing Hitachi's remarkable spirit in robot sales. According to its conception, centers will be set up at Hitachi America in New York and Hitachi Europe in Dusseldorf, West Germany. These centers reportedly will handle not only robots but also Hitachi's other strategic products such as microcomputers, although the majority of the business will be related to robots.

Kubota Ltd

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 6 Jun 81 p 1

/Text/ Kubota Ltd (president, Keitaro Hiro) has confirmed its policy to advance into the industrial robot sector. It is entertaining the idea first of developing by itself robots for welding and painting as a device to rationalize the production of its major products--agricultural, construction and industrial machines and equipment--and then of promoting them as manufactured products in a few years.

Many machine makers have entered the robot market in one way or another, but it is rare that an agricultural machine maker has made such an entry. Development of the robots will be tackled mainly by the head office, research institutes belonging to each business department, and the Electronization Promotion Office established earlier. "We hope to utilize electronics in every way we can," is the message (executive director Takatsugu Shimamoto).

Kubota Ltd introduced about 20 industrial robots (purchased) in the past, which led to the rationalization of production and labor-saving in the Makikata Manufacturing Plant of the construction machine and equipment sector and in the Sakai Manufacturing Plant of the agricultural machine and equipment sector. Among these, several robots are "improved robots" based upon the technical know-how and specifications of the company, evidence of one step made toward the development or robots by itself.

These robots are used for arc welding the perimeter of the boom of its mini-backhoe in the construction machine and equipment sector, and for painting bodies of cultivators in the agricultural machine and equipment sector. They are concentrated in workshops with monotonous work or an unfavorable work environment.

Already in the research stage, the company has achieved the aim of developing some robots for painting, but it has decided to rechallenge the research and development of the robots based upon the company's judgment that "a new level robot is required suitable for the electronization era" (executive director Shimamoto).

Kubota Ltd, a reputable major agricultural machine and equipment maker, has a sophisticated automation technology in the fields of tractors and combines. In particular, it is said that the company is on the threshold of a stage where "complete unmanned driving" is possible in the field of combines which are used in farming. Last year it developed its "Sunshine Automatic" (with an automatic cultivation depth control attached) as the first of the electronized machines. Subsequently, in the field of tractors, it completed a Monroematic that automatically controls the horizontal level

as a result of systematized electronic technology and oil pressure technology. Additionally, the company is getting into the manufacture of related equipment and devices such as sensors and actuators.

Upon advancing into the field of industrial robots, it is mobilizing its total capacity, not to mention electronic technologies, as a maker of machines, pipes and construction materials.

Osaka Transformer

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jun 81 p 6

/Text/ Osaka Transformer Co has launched an attack in the field of arc welding robots which is showing rapid growth. In August, a plant specializing in robots will be completed, which will raise the monthly production capacity threefold, to a level of 50 units. Also, not only has the company set up an internal task force exclusively in charge of the sale of robots, but also a sales network of approximately 30 agents has been organized nationwide to engage in operations to expand the company's share of the market. Then, in the near future, it plans to begin exporting to Europe and America. With this aggressive domestic and foreign business posture, the company intends to go after Vasukawa Electric Manufacturing, which is now at the top in this field of the business world.

Osaka Transformer recently commenced the construction of a factory to specialize in robots at the Settsu plant, Settsu-shi, Osaka Prefecture. The floorspace of the factory is 3,500 square meters, and it will go into full-scale operation upon completion, which is scheduled for the end of August. In the past, robot production equipment was scattered throughout the Settsu plant. After the completion of the new factory, everything will be consolidated here. This will increase the monthly production capacity from the current 15 to 50 robots. The Settsu plant has further marginal space for additions, and there are plans to build additional factories if the demand for arc welding robots rises further.

Likewise, from the aspect of sales, approximately 35 project teams have been organized. and put in the forefront of the arc welding robots business. Also, at around the same time, an exclusive national robot sales network was set up. Thirty agents were selected, mainly from among the sales agents (approximately 450) for welders manufactured by this company, and a technical education for the sale of these robots is being given to these agents. Meanwhile, facilities for demonstration and display, which are indispensable to the sale of robots, have been installed in metropolitan Tokyo, Osaka and Nagoya, and another one is to be opened soon in the city of Hiroshima, in order to offer attentive service.

Osaka Transformer is a major welder maker. The company started selling a rectangular coordinates type robot for arc welding, the "Soar T", 2 years ago, and subsequently offered for sale a multi-joint type, "Soar K", this spring. In the last fiscal year, more than 100 arc welding robots were sold. There is a plan to raise the sales of the robot sector at a pace of close to 200 percent a year to "foster this sector as one of the three pillars of the business along with electrical equipment and devices, and welding machines" (company president Keijiro Kobayashi).

The demand for Japanese industrial robots rose dramatically starting last year, dubbed the "Initial Year for Robots." It is expected that the market scale will expand at an annual rate of 40-50 percent for a while. Shipments of arc welding robots in Japan total 4.5 billion yen. This is expected to grow eventually to a 40-billion-yen market in 1990. At present, it appears that Yasukawa Electric Manufacturing is running far ahead of the others. Recently, however, Hitachi Ltd and Kawasaki Heavy Industries have been following at a fast pace. It appears that the competition for a share of the market will be further heated up with Osaka Transformer edging into the scene.

Kawasaki Heavy Industries

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Jun 81 p 6

/Text/ Kawasaki Heavy Industries (president, Zenji Umeda) has developed "Kawasaki Unimate Model 9753-EP," a robot for painting with joints and microcomputers, and has begun selling it on a commercial basis. This robot, suitable for painting second and final coats on a car body, has a seven-axial structure with a travelling shaft and can paint continuously conveyed car bodies regardless of the hollow areas such as engine room, trunk interiors and the door openings. The invention of this robot completes the series of painting robots covering virtually all of the auto body painting process, combined with the previously developed robot (Model 3653) for painting the underside of the car, generically called robot for undercoating, and a robot (Model 8653) for the roof. Kawasaki plans to strive to expand sales primarily to automobile makers.

"Model 9735-EP" is characterized by a configuration of shafts for movements, consisting of six shafts for right and left revolutions, to and fro turns, up and down turns, wrist bends, wrist revolutions and wrist twists, and in addition one more shaft for travelling right and left within a range of 3 meters. Because of the design, it is most suitable for painting second and final coats on a car body. Also, with a general six-axial structure, it is said to be useful for painting things other than automobiles, such as refrigerators and washing machines, categorized as "white home appliances."

The carryable weight and the precision of the mechanical parts are 5 kg and $\pm$ 1mm (PTP) or $\pm$ 2mm (CP) respectively. An electric-oil pressure digital servo system is adopted for the controls.

Not only can the orthogonal operation of the robot itself be taught through a remote operation, but also the orthogonal operation and turning operation of the gun can be taught, which makes it easier to take any position and posture. Also, if an optional joy stick (control stick) is used, direct teaching is possible by applying physical force under 500 grams.

Servo DPF compensation and differential compensation are adopted. This simplifies the matching of each shaft. Furthermore, the editing function is characterized by the variety of abilities, such as step input, cancellation and transfer, correction of outside command values, and actual line data conversion from off-line teaching data etc.

The price of this machine, including accessory equipment such as a travelling function, is 18 million yen. It is expected that 20-30 units will be sold per year, mainly to automobile makers.

Fujitsu Fanuc

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 16 Jun 81 p 6

/Text/ On the 15th Fujitsu Fanuc disclosed that its policy is to become aggressive in the field of robots. Specifically, it announced the intention: 1) to offer for sale a specialized internal type handling robot "Model 00" for an NC (numerical control) lathe, and to mass-produce it on a commercial basis after it is introduced for the first time at the Fujitsu Fanuc "Processing Robot Exhibition" to be held at the head office in Hino-shi, Tokyo, in August; 2) to start selling an assembly robot "Model 00," which has been under development for some time, in the European market through its sales tie-up partner, Siemens of West Germany, taking advantage of the European machine tool fair, the "FMO show," to be held in Hanover, West Germany, this coming fall.

Fujitsu Fanuc in the past has merchandised three models of robots: first, an independent handling robot "Model 3" (sale price, 12 million yen) for NC machine tools such as the MC (machining center) that puts on or takes off a maximum 50 kg workpiece (object to be worked), a "Model 1" (sale price, 6 million yen) that can carry a maximum 20 kg workpiece, and a "Model 0" (sale price, 3.5 million yen) that can carry a maximum 10 kg workpiece. This time, it has developed a "Model 00" which can handle a maximum of 10 kg and is integrated in the NC lathe, the lowest level of the model.

Since the demand for labor saving and manless operation of the cutting and shaping process is rising among smaller users, the company has merchandised an internal robot that can easily be fitted in the NC lathe and can load the work precisely on the NC lathe. The price has not been decided yet, but the company confides that "an unbelievably low price will be set" (president Seiuemon Inaba). The OEM (production in the plants of the counterparts) system will be adopted, according to the plan, as a sales method that sells products through the machine tool makers. The company estimates a minimum monthly production of 40-50 units.

Ikegai Iron Works already sells an integrated type NC lathe robot that can carry a maximum 5 kg workpiece, and Okuma Machinery Works has merchandised an independent robot, developed together with Kamiko Kenki, that can handle work up to 10 kg. Others in the act are Yamatake-Honeywell which is striving to increase the production of an independent robot "Robo Ace." Yamazaki Tekkojo (head office, Okuchi, Aichi-ken; president, Teruyuki Yamazaki; capital, 1 billion yen) has also decided on a plan to enter the field this coming fall with its internal robot. In addition, Fujitsu Fanuc, which entered this business ahead of others, will join them in the field of machine tool robots. All in all, it appears that the struggle for a share of the NC lathe robot market will be further intensified in the days to come.

In addition, Fujitsu Fanuc intends to prepare a sales system gradually for an assembly robot. This assembly robot "Model 00" does not come with a sensor (detector), but it is an intelligent robot that can accurately assemble servo motors. It will first be sold in Europe. Specifically, Siemens of West Germany, the partner in the sales tie-up, will start to sell it on full scale after the robot is presented for the first time at the "FMO show."

Also, in Japan, it plans to "introduce 10 robots to the servo motor assembly process in the head office plant in Hino-shi, Tokyo, to be used for production activities of its own, and later to sell them to outside customers" (president Inaba), and to make the outside sales system ready by the end of the year if everything goes well.

For the time being, the company has a set-up to produce a total of 40 units a month combining three models, "Model 3," "Model 1" and "Model 0." It is certain that the monthly production scale will surpass 100 units if the NC lathe robot "Model 00" and assembly robot "Model 00" are added to the total.

Daihatsu Kogyo

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 16 Jun 81 p 6

/Text/ The PNC (programmable numerical control) lathe sector of the Daihatsu Kogyo is being strengthened at a rapid pace--a tie-up with Ikegai Iron Works and the starting of a manufacturing company through joint capital investment with Mitsui & Co. The NC lathe market has continued to expand rapidly with the increasing tide of rationalization and labor-saving in industry. The activities of Daihatsu Kogyo, which is striving to get a piece of the pie using the technical capacity accumulated as an automobile maker, is drawing wide attention in the machine tool industry. Makers specializing in robots cannot underestimate Daihatsu Kogyo, which devised the original PNC system that stresses manipulability. It appears that Daihatsu may become a new "eye of the typhoon" in the NC lathe market. Therefore, we have interviewed Masajiro Sugitani, executive director for the special machine sector of Daihatsu, to ask him about the future strategy for the PNC lathe of Daihatsu.

Question: What is the purpose of the tie-up with Ikegai Iron Works?

Answer: Daihatsu is a slow starter in the field of machine tools. To gain enough strength, it is sometimes necessary to join hands with a major machine tool maker. Also, it seems that Ikegai Iron Works has been interested in the PNC lathe of Daihatsu. Our intention was mutual.

Question: What are the details of the tie-up?

Answer: Our objective is to develop a new PNC lathe product by joining the technology of the two companies, and to form a cooperative production system. For the development of new products, the specific content will be decided between the two companies. However, it is likely that Daihatsu will be in charge of the control device and Ikegai will be in charge of the lathe body.

Question: Does that mean you found an answer to the current issue of strengthening the production system through the tie-up with Ikegai Iron Works?

Answer: That's right. For the time being, we can account for a monthly production of 10 units from the Tada plant (Kawanishi, Hyogo Prefecture), a monthly production of 20-30 units from a company which cooperates with us in Aichi Prefecture and a monthly production of 30 units from Yamagata Koki (head office, Takabatake, Higashiokitama-gun, Yamagata Prefecture) established in April this year by joint capital investment with Mitsui & Co. In addition, Ikegami Iron Works will join us to achieve our current goal of having a structure ready to produce 100 units a month.

Question: What about your plans for export?

Answer: The PNC lathe does not even exist overseas. We believe it is a promising item for export. To prepare for this, we have already been granted patents in major European countries and in America. To give you an example of an actual export result, we have just completed an agreement to export five samples to South Africa. Inquiries from overseas have risen to 250 companies at present. We are getting good bites.

Question: What about the tentative export goal?

Answer: Thinking of the export ratio in the NC lathe market, which rose to 50 percent, Daihatsu also wishes to make it a goal to achieve an export ratio of 50 percent for the PNC lathe. We will be on the right track to produce 100 units a month starting next year, and we would like to allocate 50 of them for export.

Question: How about future production expansion?

Answer: We view the Tada plant as the key point for development of new products, and its production scale will not be expanded beyond the present level. In the future, we will mainly rely on the production increase at the Yamagata Koki and the expansion of production contracted out to Ikegai Iron Works. In particular, we are interested in putting our efforts in to expanding the production bases in the eastern areas of Japan, since 60-65 percent of the total demand for the PNC is from Kantor region.

Question: Sales competition in the machine tool industry is intensifying. Doesn't Daihatsu feel a need to fortify its company structure?

Answer: Exactly. So far we have received some 100 orders for the PNC lathe. The market is rather broad. Strengthening the business operation is the key to success. On 1 July, Daihatsu Kogyo and Kaihatsu Motors will merge. In the rearrangement of personnel in conjunction with the merger, more manpower will be distributed to the machine tool sector.

Question: Please be more specific.

Answer: Although we use the sales route of trading companies specializing in machinery for sales of the PNC lathe, we will not leave everything to them. We would like to have an ample supply of service engineers to stress the importance of dealing with technical needs. Now that we have achieved our goal of setting up a structure that produces 100 units a month, it appears that we can expect annual sales of more than 10 billion yen in the PNC lathe field.

Yasukawa Electric Manufacturing

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 18 Jun 81 p 6

/Text/ Yasukawa Electric Manufacturing is endeavoring to produce industrial robots. With sales of the new product starting in April, it is trying to consolidate its position as the top maker of arc welding robots. Because of this background, some questions were asked of Masayasu Nishizawa, an executive director, concerning the robot strategy. (Interviewer: reporter Matsumoto of the Kitakyushu branch office)

Question: How is the sale of the arc welding robot "Mortman" doing?

Answer: We started to sell the "Mortman" in FY 77. The sales have grown yearly since then, from an initial 10 units in 1977 from both domestic sales and exports, to 40 units in FY 78, 150 in 1979 and 360 in 1980. We started selling a new product, "Mortman L3" in April of this year, and we are expecting to sell 600 units, a 66.6 percent increase compared to the previous year, which is partially attributable to the increase in the variety of the product. Since the beginning of this fiscal year, already a total of 100 "Mortman's" were sold in 2 months, April and May, which gives a clear sign that we can reach our sales goal without fail.

Question: How about the export of the "Mortman?"

Answer: We sold 560 units of the "Mortman" in 4 years, from FY 77 through FY 80. Of these, 480 were for domestic use while 80 were exported. In the past our country arranged tie-ups with Tors Teknik of Sweden, Messer Griesheim of West Germany, GKN Lincoln of England and Hobart Brothers of America. Because of well laid out overseas sales networks such as these, exports are steadily increasing. In FY 81, we are hoping to export 60 units a year, and our export effort will be concentrated in the United States. Because of this plan, in selling the "Mortman L3" in the United States, for the first time more pressure will be exerted through Yasukawa Manufacturing America, a subsidiary of our company, separate from the sales through Hobart. We are thinking of raising the export ratio to 50 percent from the present 10 percent in FY 85.

Question: Where do industrial robots rank in the importance of your business at Yasukawa Electric Manufacturing?

Answer: We consider industrial robots to be a growing sector parallel with NC (numerical control) devices, sequence controllers and servo motors, and we are putting our effort into the growth of industrial robots in the future as we did in the past. We anticipate that industrial robots will show remarkable growth, and we hope to

expand the sales in this sector eightfold in 5 years, from 3.6 billion yen in FY 80 to about 30 billion yen. We estimate that our company's total sales will be somewhere between 150 billion yen and 200 billion yen in 5 years, which means that the sales of the robot sector will reach 15-20 percent of the total. In FY 80, the sales of the robot sector were approximately 5 percent of the total sales. Therefore, this is one of the large growing sectors in the operations of Yasukawa Electric Manufacturing.

Question: Yasukawa Electric Manufacturing is known to be the largest maker of arc welding robots. Do you have any plans in the future to handle other robots besides arc welding robots?

Answer: No. We will go all the way with arc welding robots. However, the present "Mortman" is usable only for welding mass-produced items. Our future task is to develop a welding robot which can be used at workshops where a small number of various items are produced. Currently, we are trying to develop a model with judging functions such as vision, hearing and touch by integrating a sensor (detector) in the robot. We may even start to sell this new model at the beginning of the fall.

Question: Recently, Matsushita Electric Industrial Company, Mitsubishi Electric Corporation, Osaka Transformer and other new faces have entered one after another into the arc welding robot field. How do you intend to challenge these newcomers?

Answer: We are the forerunner in the field of the arc welding robot, and we are confident about our technology. The "Mortman" was built by joining a servo motor and an NC device. We manufacture both components in our company, which is also our strength. We are especially hopeful that the "Mortman L3" can help us do well in competing against other contending companies. This new robot weighs only one-fourth of the conventional products of our company, and also costs 25 percent less. For the present we will work hard to sell this new product, and then we will be ready with a robot equipped with a sensor to be initially introduced to the market in the fall.

Ishikawajima-Harima Heavy Industries

Tokyo NIHON KEIZAI SHIMBUN in Japanese 23 Jun 81 p 8

/Text/ Ishikawajima-Harima Heavy Industries is making a reentry into the industrial robots field. In the past the company had to be at a retreat because the industrial robot market was not ripe, but it has decided to challenge this field once again in consideration of the fact that the industrial robot has entered a new era of expansion and the demand has grown rapidly starting last year, dubbed the "Initial Year for Robots" in Japan. Soon the company will complete the development of a welding robot, which it will first introduce in its own plants and then will merchandise as early as next spring. Recently, the company has become eager to exploit the mechatronics (electronization of machines) market as a pillar of the non-shipbuilding plant sector. In order to foster the welding robot as a major commodity of this sector, it plans to launch an aggressive sales campaign aimed at the shipbuilding construction machinery and industrial machinery makers.

The industrial robot "GMMC" (grouped manipulator module system), to be completely developed soon by Ishikawajima-Harima, has multiple joints in its arms and has the latest 16-bit parallel processing microcomputer in the control section, which is equivalent to the human brain. Tentatively, it will be used only as a welding robot. Next October, the first model will be introduced to the Yokohama plant of the related company, Ishikawajima Kenki (head office, Tokyo; president, Yoichi Doko; capital, 2.4 billion yen). After it is fully broken in here, it will be commercialized and sold extensively as early as next spring if all goes well.

The welding robot weighs only 80 kg, and is characterized by small size and light weight. It is designed so that it can be used even in a small and crowded plant by suspending it from overhead or mounting it on a wall. Also, the company has adopted a group control system whereby one microcomputer collectively controls multiple robots. The price has not been determined, but the target price is somewhere around 10 million yen per set of two robots. This model is highly likely to surpass greatly the current welding robots in cost performance (ratio of performance to cost).

Ishikawajima-Harima developed a cylindrical coordinates type industrial robot in 1968 to advance into this field. However, the scarcity of demand from industry led the company to retreat from this field 10 years ago.

This time, the company has decided to reenter the market because of the rapid increase in demand for robots from the industrial world encouraged by: 1) areas of use for industrial robots have been clarified; 2) the tide of automation and labor-saving in enterprises is rapidly taking over due to soaring wages and shortage of manpower; and 3) an inexpensive high-class robot can finally be realized due to the daily progress of microcomputers.

The FY 80 production of industrial robots compiled by the Japan Industrial Robot Association (chairman, Yoshio Ando) was 74.4 billion yen, an 84-percent increase compared to the previous year. For the time being, the demand will grow at a pace of over 50 percent a year, and this industry is expected to become a 100-billion-yen industry by the beginning of the 1990's. The main use will be in the fields of welding, press, machine tool and plastic processing. However, Ishikawajima-Harima at present plans to single out the welding robot, which is the field in which there is most demand, and exploit this market.

Last fall, the company organized a project team specializing in robots to expend all its efforts on development. The reentry of this comprehensive heavy industries maker will be likely to become a considerable threat to the existing robot makers.

8940
CSO: 4105/189

SCIENCE AND TECHNOLOGY

SALES TACTICS OF 64 K RAM MANUFACTURERS DESCRIBED

Oki Electric

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 5 Jun 81 p 5

[Text] In August, Oki Electric Industry Company will begin mass production of what is reported to be its next strategic product, the 64-kilo-bit RAM (random access memory), at a monthly rate of 300,000 units. In preparation for this, it has actively begun attempts to open up sales routes in the United States, which company president Masao Miyake has designated as its "main targeted market." It will market its devices to personal computer manufacturers through a local sales subsidiary, OSI (Oki Semiconductor, headquarters in Santa Clara, California) while expanding publicity concentrating on the company's IC products in order to increase local awareness of Oki Electric.

The 64 K RAM is used as part of the computer's main memories and is viewed as the foremost form of VLSI (very large scale integration) and the latest in technological products. Oki Electric's policy is to begin full-scale operation under a wholly owned subsidiary, Miyazaki Oki Electric (located in Kiyotake-machi, Miyazaki Prefecture), and start the largest mass production in the industry, 300,000 units per month.

However, the present uses of the 64 K RAM include only Nippon Telegraph and Telephone's digital communications processing computer, the "DIPS11 series" and parts of the digitalized electronic switching apparatus, and Fujitsu's first personal computer, the "FM-8" which is equipped with internally produced 64K RAM's. The demand from mainframe manufacturers, which are expected to be the chief users, has yet to materialize in either Japan or the United States.

Therefore, Oki is concentrating its marketing approach on U.S. manufacturers of personal computers and electronics parts such as Apple and Commodore, which are expected to purchase large amounts of the 64 K RAM very soon. Samples are already being shipped through OSI, and if possible, Oki would like to work out long-term supply contracts before the year is out.

Also, in conjunction with sales to these specialized manufacturers, President Miyake has determined that "it is urgent to increase the local awareness of Oki Electric as an IC manufacturer," and publicity concentrating on IC's is being carried out vigorously. Results have appeared quickly. According to President

Miyake, U.S. professional trade journals and magazines "always mention the name of Oki Electric when they run a special section on VLSI.

Hitachi

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 10 Jun 81 p 5

[Text] Hitachi, Ltd is the leading manufacturer of VLSI's (very large scale integrated circuits). In order to establish a mass-production capability for 64 K RAM's, it will begin production next year at a Kofu branch plant (located in Ryuocho, Kyoma-gun, Yamanashi Prefecture). At present, it is producing 200,000 units a month at the Musashi plant (located in Odaira city, Tokyo), a "new plant" of the Kofu works. According to Executive Managing Director Hiroshi Asano, the policy is to "begin full-scale mass production in the latter half of this fiscal year." It has been decided that the monthly production of the Musashi plant will be increased to 600,000 or 700,000 units in the last half of this fiscal year. This will be further expanded when production starts at the Kofu branch plant, so Hitachi is expected to emerge as the industry leader in 64 K RAM's.

The 64 K RAM, used in the computer's main memories, is an advanced technological product which is viewed as the "next-generation strategic product." The industry leader, NEC, along with Hitachi, Fujitsu, and Toshiba is now carrying out trial mass production at the rate of 100,000 to 200,000 units a month.

Oki Electric Industry and Mitsubishi Electric are attempting to increase their share of the 64 K RAM market at one blow by building advanced manufacturing plants: the Miyasaki Oki Electric plant (in Kiyotake-machi, Miyazaki Prefecture) and the Kumamoto No 2 plant (in Nishiai-machi, Kumamoto Prefecture). Until recently, it seemed that they would take a leading position in the industry when they completed these plants and put them into operation this summer. However, at this point, the large manufacturers that had already begun making these devices began to assert their leadership with the 64 K RAM.

A good example is the number two company in the industry, Hitachi. According to Executive Managing Director Asano: "Actual demand for the 64 K RAM has already begun to appear and the period of real demand will start next spring." Therefore, a decision was made to increase production at the Musashi plant in the last half of this fiscal year to 600,000 or 700,000 units a month. This is certain to be the largest amount of mass production in the industry. But Hitachi will also install a mass-production line at the Kofu branch plant for 64 K RAM's.

Details such as the exact volume of mass production and production startup time will be worked out later. However, when the production line at the Kofu branch plant goes into operation, Hitachi's 64 K RAM production is expected to exceed 1 million units per month next year.

If this happens, Hitachi will be the largest supplier in this field among the IC manufacturers of both the United States and Japan.

Mitsubishi Electric

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 17 Jun 81 p 5

[Text] Mitsubishi Electric has decided to begin a second construction project (an addition) in Building C of the Kumamoto No 2 plant (located in Nishiai-machi, Kumamoto Prefecture) in order to establish a better mass-production capability for the "next-generation strategic product," the 64 K RAM. When this plant goes into operation next month, it will produce 100,000 64 K RAM's a month, and this will be expanded to 200,000 by the end of the year. The second construction project, which is scheduled for completion in June of next year, will increase production to 400,000 units per month.

Mitsubishi Electric's "brain plant," the Kita Itami works (in Itami City, Hyogo Prefecture), produces 30,000 to 50,000 64 K RAM's per month. The recently completed Building C of the Kumamoto No 2 plant was built as a mass production plant for these devices and when it goes into operation in July it will produce 100,000 64 K RAM's per month.

The company's policy, according to Semiconductor Division General Manager Hiroo Sato, is to "raise monthly production to 200,000 64 K RAM's when mass production gets into high gear around December." The second construction project was decided on in order to increase the monthly production to 400,000 units.

This project will place a new 64 K RAM mass-production line in Building C (a three-story reinforced concrete structure) which has already been constructed. Operation of the line is scheduled to begin in June of next year.

The reason Mitsubishi decided to begin the second construction project before production even got underway in Building C is that the demand for the 64 K RAM, "the first generation of VLSI," is expected to expand rapidly next year. Application of this part to Mitsubishi's office computer, the MELCOM series, and mainframe computer, the COSMO series, has already begun. After next year, "all Mitsubishi computer memories will be converted to 64 K RAM's."

In addition to this internal demand, Mitsubishi is shipping samples to personal computer manufacturers on the west coast of the United States and believes that they will begin using the devices soon. That is why the company is expanding its production capability for the 64 K RAM.

When the No 2 plant is finished, the production equipment in Building C of Kumamoto No 2 plant will be capable of combined production of "64 K class IC's" such as the 16 K static RAM and the 64 K EPROM (erasable and programmable read-only memory) as well as the 64 K RAM.

9651
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AUTO MAKERS ADOPTING FRONT-WHEEL DRIVE SYSTEM

Tokyo NIKKEI SANGYO SHIMBUN in Japanese 19 Jun 81 p 8

[Article by group of reporters investigating the auto industry]

[Text] The world's largest auto makers are actively engaged in an "FF competition". Heretofore, most automobiles have had the engine in front connected with a rear-wheel drive system. This is known as the FR system. Now the leading role is about to be taken over by the FF system which has a front-wheel drive system combined with forward engine placement. Japanese manufacturers are now completing, one after the other, the first facilities connected with investments in the FF system. And it appears that in the late 1980's, the FF car will be viewed as an ordinary automobile.

Specialized Factories Built One After Another

Between January and this month, Mitsubishi Motor Industries, the Nissan Motor Company, and the Honda Motor Company all completed construction and began operation of FF parts plants. Mitsubishi previously purchased synchronized joints, which are essential to the FF car, from outside suppliers. In order to produce a portion of the synchronized joints internally to meet the expanding demand, in January Mitsubishi completed construction of a plant capable of producing synchronized joints for 7,000 vehicles per month (14,000 units) at its Mizushima works.

Last month Honda finished constructing an addition to its synchronized joint plant at its Maoka works which was started last year and cost 5 billion yen. The previous 40,000-vehicle capacity was increased to 50,000 and full operation began immediately. This month Nissan finished construction of the Kamahara plant, a specialized plant for production of trans-axles (part combining the transmission and axle). This plant has a site area of 7,300 square meters and a building floor area of 4,900 square meters. Construction began the year before last and cost 17.2 billion yen. The assembly line has a monthly capacity of parts for 50,000 vehicles. A second construction project requiring approximately the same scale of investment is scheduled to begin in March.

The Japanese manufacturers were motivated to take up the FF concept by the world's top auto maker, GM. In connection with coming programs, the U.S. auto industry

was surveyed and it was found that the U.S. manufacturers are going ahead with a program of down-sizing and GM is carrying out a dramatic conversion to the FF system.

Up to 1979, GM had no FF cars except for a few luxury models. However, after the unveiling of the X car, one new model after another was designed with the FF system. By 1985, 95 percent of all of the models will be FF. It is planned that the only FR cars remaining will be sports cars such as the Camaro. Although not as extreme as GM, Ford also has a clear policy of producing more FF cars.

75 Percent of Japanese Cars by 1985

According to a U.S. think-tank survey, 35 percent of all 1981 model Japanese passenger cars sold beginning last fall have been FF cars. It is estimated that this will grow to 50 percent by 1985, which is held to be the critical year in world automobile industry competition. The report suggests that the U.S. side can triumph over the Japanese and make a recovery by using the FF system, which is particularly advantageous with compact cars.

Will the FF competition proceed as the U.S. auto industry expects? Making a bold guess, we would have to answer "no". That is because there is a good possibility that by 1985, 75 percent of the Japanese models will have been converted to FF. The large auto companies have a strong desire to use front-wheel drive and the smaller manufacturers are already moving ahead rapidly to produce FF vehicles.

The FF programs of the Japanese automobile manufacturers include more than Nissan's second construction project at the Kamahara plant. Last November the Toyota Motor Company began construction of a third plant at its Kinuura works to specialize in FF-oriented parts such as synchronized joints and trans-axles. Completion is scheduled for this October. The production capacity is not yet known, but the plant and equipment investment has amounted to 70 billion yen in 2 years. This is roughly twice the amount spent by Nissan for both the first and second Kamahara projects, so the capacity is estimated to be on a corresponding level.

Toyo Kogyo is expected to make its Hofu plant, now under construction, into an FF vehicle plant. Although the company has not made clear what sort of vehicle is to be produced when the Hofu plant goes into operation, most observers believe it will be a new FF model. The new "Familia," which has been Toyo Kogyo's biggest hit product, is an FF car. Sources connected with the company are saying: "The next model will probably be a Capella-class passenger car which will utilize the results obtained with the Familia." This also indicates that the Hofu plant will produce FF cars.

Boom Period for FF Technology

"If we consider the two factors of GM's influence and the fashionability of passenger cars, we must conclude that the FF car will become the main product of the future world auto market. Japanese auto makers will also have to build them," says Nissan president, Takashi Ishihara. Neither Nissan nor Toyota has made clear statements about their future plans for the FF car, but both companies have tacitly

affirmed the intention of making two-thirds of their production FF cars by 1985. Members of the management of both companies predict: "The time is coming when at least all the cars under 2,000 cc will be FF."

As can be seen from the FF trend in domestic automobiles, the FF contest is mainly an issue for the large manufacturers, with the exception of Isuzu Motors. Companies like Daihatsu Kogyo which concentrate on automobiles with small amounts of exhaust emissions already have a product line consisting mostly of FF cars. Fuji Heavy Industries has been making FF cars for 15 years.

Executive Managing Director Nagashima says: "We believed that some specialty was necessary to compete with the big companies, so we developed the FF car. Now the FF technology is enjoying a boom period." Today, smaller manufacturers accept the need to begin selling new FF models as a matter of course.

The advantage of the FF car, even more than making a larger interior possible, is a smooth ride. The big manufacturers must make huge investments in order to convert from FR to FF because of their large-scale facilities. There has been some resistance, such as the Toyota statement that "FR has its good points too." However, a rapid rate of changeover to the FF car is expected.

9651
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SCIENCE AND TECHNOLOGY

BRIEFS

FACTORY ENERGY SAVING SYSTEM--Toshiba Corp has developed an energy saving system for large-scale plants that have independent electric generating units. Such factories control the output of private generators or purchase electricity, as plant operations fluctuate. The new system minimizes energy costs by linking the following functions hierarchically: (1) long-term maximum use calculation; (2) short-range maximum use calculation; and (3) momentary efficiency. The company has delivered the first system to the Tomakomai plant of the Oji Paper Co., Ltd. It uses hydroelectric/thermal power generation and can purchase electricity from other sources. It should be operable by this spring. Thereafter, Toshiba will begin selling the system to the iron & steel, chemical, and paper pulp industries. The system installed in the Tomakomai plant controls around twenty new and old thermal and hydroelectric power generating units and also a frequency converter, to minimize energy costs. This includes steam control by optimized distribution of electricity. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 56] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

ESTABLISHING COM-DEALING COMPANY--Seven enterprises, including the Tokyo Electric Power Co., Tohoku Electric Power Co., and Electric Power Development Co., have established a new corporation to produce and handles coal oil mixtures (COM). This became effective April 1, and the new firm is called "Japan COM." It is capitalized at ¥18 billion with an invested capital of ¥7 billion. Fifty-one percent of the invested capital came from Tokyo Electric Power Co., 19% from Electric Power Development Co., 10% from Tohoku Electric Power Co., 7% from Mitsubishi Corp., 5% from Fuji Kosan Co., 4% from Mitsubishi Chemical Industries Co., and 4% from Nippon Kasei Chemical Co. The plan of operation calls for the startup of a plant in FY1984. The plant will require an investment of ¥90 billion and will be built in Fukushima Prefecture. Annual COM production will be 5 million tons, and this will be used to replace fuels presently being used in thermal power plants of both the Tokyo and Tohoku Electric Power Companies. COM is a new fuel consisting of pulverized coal mixed with heavy oil, and its practicality was proven by the Electric Power Development Co. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 56] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

COAL GASIFICATION POWER PLANT--The electric power industry will jointly develop a coal gasification electric power plant that uses jet floor method and is to make a formal decision at a president's meeting by this summer. The plan will first call for drawing up the plans for a pilot plant with a throughput of 200 tons of coal/day (equivalent to 20,000kW_e). This plant will be operable within 2 years. The estimated cost of this plant development is about ¥22 billion,

but it is very probable that the project will be expanded to a 100,000kW-range large-scale demonstration plant, since this method of generating electricity is recognized as one of the effective, new post-oil technologies. The Coal Mining Research Center, Japan, commissioned by the Ministry of International Trade and Industry, began studying a pressurized, fluidized floor gasification method in fiscal 1974. Followed by the test startup of 40 plants, the Electric Power Development Co. is working on the conceptual design for a 1000 ton demonstration plant. In contrast, the jet floor method injects pulverized coal into a furnace where it is instantly gasified at a temperature of 1200-1700°C. Molten ash is removed from the bottom of the furnace. The characteristics are: (1) a wide range of coal can be used; (2) easy shutdown and load-follow operation. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 56] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

HEAT PIPES TO COAL UNDERGROUND CABLES--The Furukawa Electric Co. has recently developed a system that removes heat from underground transmission lines with heat pipes instead of cooling tubes. As demand for electricity increases in urban areas, large-capacity electric power cables are crisscrossing the earth, creating high temperature heat. The company has successfully manufactured the world's first long-span heat pipe which previously was considered too difficult to manufacture in lengths longer than 10m. The newly developed heat pipe is about 200m long and can be laid alongside the cables. This reduces construction costs by half that of conventional cooling methods using water cooling pipes, and also eliminates circulating pumps and refrigeration units, thus saving a large amount of energy. Underground cables can generate temperatures upto around 60°C. With the heat pipes this should drop to 45°C or less. Features of the long heat pipe are: (1) uniform cooling of the cable; (2) energy saving because circulation pumps and other hardware are not needed; (3) eased installation; (4) good maintainability; (5) construction costs are one half that of water cooling systems. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 56] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

HIGH PURITY PLASMA ATTAINED--A research team of the Japan Atomic Energy Research Institute (JAERI), working under a Japan-U.S. joint study on nuclear fusion, has achieved the world's highest purity plasma needed for efficient fusion power generation. The experiment was conducted using the "Doublet III," nuclear fusion test facility of the General Atomic Co. (GA) in San Diego, California. When metallic impurities, such as iron and stainless steel, from the internal wall of a fusion reactor enter the core plasma, the temperature drops suddenly thereby preventing the fusion process. This problem caused researchers in many nations to seek ways to eliminate impurities. JAERI succeeded in reducing the contamination of plasma by 4/5 by using the force of a magnetic field. Doublet III is the world's largest TOKAMAK type experimental device. It was built in 1978 based on a design by Doctor Chihiro Okawa of GA. The Japanese and U.S. governments began the joint research using Doublet III in September 1979 under the "Energy Research Development Cooperation Agreement" signed in May 1979. This tie-up study will continue through fiscal year 1983, followed by more experiments to attain the "critical plasma conditions," required for sustained thermonuclear reactions at the JAERI's test facility, "JT-60." [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 58] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

LASER OSCILLATION BY HYDROGEN PLASMA--The Institute of Physical and Chemical Research has succeeded in oscillating a "plasma dynamic laser" that could be used to measure temperatures in nuclear fusion reactors and in space. In the tests, a hydrogen plasma jet was used to cause an infrared laser to oscillate for about two-thousandths of a second. Existing lasers are usually oscillated in solid, liquid, and gaseous states; the fear in plasma, called "the fourth stage of substance," will add another feature to lasers. The infrared laser has a wavelength of 1.88μ and is expected to be applicable to instrumentation. One probable use is the measurement of hydrogen fuel for fusion reactors. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 58] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

REACTOR VESSEL COVER IMPROVEMENT--Three electric power firms and Mitsubishi Heavy Industries have jointly developed an improvement technique for covers of reactor vessels, and the three power companies have decided to use it hereafter in commercial reactors. Nuclear power plants must undergo annual inspections; this technical development was intended to shorten the inspection period and to reduce the radiation exposure of plant workers. The four firms have cooperated in developing the integrated structure of the vessel cover and the cooling duct of the control rod drive mechanism near the cover. In a full-scale model plant used for operationability tests, the uncovering procedure required only 6-7 days, compared with the current 10 days. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 58] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

GIANT ELECTRON LINEAC--The National Laboratory for High Energy Physics of the Ministry of Education is building one of the world's largest 'light factories," a radiation light experimental facility capable of producing a variety of light waves ranging from visible light to X-rays. Operation is scheduled to begin next spring, and the building to house the huge 400m long electron lineac has already been built, allowing the installation of some equipment. Performance tests for the facility will start in late November. This "light factory" will permit molecules and atoms to be observed in ways that to date have been hard to do. This will also allow further interpretation of materials structure and application in industrial technologies, such as VLSI production. The construction of the much awaited radiation light experimental facility began in 1978 at a cost of about ¥18 billion. The facility includes the 400m-long electron lineac, the world's second largest, coupled with an elliptical electron storage ring (major axis: 68m; minor axis: 50m) and a variety of measuring instruments. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 58] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

RADIATION-RESISTANT XMA--The Japan Atomic Energy Research Institute in collaboration with JEOL, Ltd., has developed and recently begun full-scale operation of a shielded X-ray microanalyzer (XMA) that can analyze elements or observe highly radioactive core materials. The apparatus can handle nuclear fuels of up to 10 curies irradiated in reactors whereby containing much fission products. It is the first attempt in the world to build an XMA with unique shielding that can fully protect the operator and the detector of the device from radioactive specimens. To remove possible contamination from the specimens, components such as the shield, electro-optical system, X-ray spectroscope, sample chamber, and

sample stage are completely independent to facilitate dismantling and assembling of blocks required for decontamination. Moreover, samples are treated with ultrasonic cleaning and are coated to minimize contamination. The device is expected to provide excellent data previously unavailable in the field of reactor core research. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 58] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

HEAVY GAS OIL HOT TRANSFER SYSTEM--Taisei Corp. has recently developed a hot transfer system for heavy gas oil using triple piping. The system consists of an inner pipe for circulating heated oil, a middle pipe for heavy gas oil and an outer pipe for maintenance and thermal insulation. Normally, the entire piping system is filled with Middle East crude oil which has a high solidification point. When starting transfer, the inner pipe is filled with heated oil (around 75°C) to heat the entire piping and then heavy gas oil is delivered from the heated tanker to heavy-oil shore tanks. Because heating causes the inner and the middle pipes to expand and protrude by about 60cm at each of both ends of the pipeline, the system is so designed as to allow the middle and inner pipes to slide freely in the outer pipe with the aid of special shoes (slipping pads) provided between the outer and the middle pipes. The system has been developed particularly for heavy crude oil (Taching crude oil solidifies at around 35°C) which is expected to be imported into Japan in increasingly larger quantities. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 68] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

ROBOTS ON BICYCLE PRODUCTION LINES--Yamaha Motor Co. has introduced robots of their own development into their bicycle production lines at their Head Office plant, achieving good results in production rationalization. A bicycle assembly line not only produces different models in succession but also deals with difficult to handle small products. Thus, it has been considered difficult to automate. Under these circumstances, Yamaha has developed "CAME (computer aided manufacturing equipment) No. 1", a multiarticulated assembling robot, and adopted it completely on its bicycle assembly line. This is the first attempt by the bicycle manufacturing industry in Japan. CAME No. 1 can work with higher accuracy and higher speed than human arms and hands, and 50 units of the robot are equal to 30 assembly workers. Also, it has another feature by being sufficiently universal to serve assembly lines for all of Yamaha products by simply changing programs for work procedures. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 68] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

LIQUID-HYDROGEN PUMP--Prof. Shoichi Kohama of Musashi Institute of Technology has developed a hydrogen engine system with an output 26% higher than that of gasoline cars. This has been achieved by establishing technology for manufacturing an injection pump with high environmental resistance, which injects liquid hydrogen as cold as -253°C into an engine. Liquid hydrogen is extremely cold and has low viscosity. To manufacture a pump for injecting liquid hydrogen into an engine, therefore, involves such problems as follow: (1) it does not allow the use of any lubricant; (2) it is likely to leak; and (3) it can hardly draw up liquid hydrogen because the boiling point of liquid hydrogen is dependent on variations in pump pressure, causing the liquid hydrogen to boil in the pump. The injection pump newly developed has solved these difficulties by using a material composed of a teflon resin and a copper alloy. It discharges liquid hydrogen with 10kg per cm^2 and withstands 1,200 cycles per minute operation.

Running tests with this pump installed in a 1,100cc engine have proved that no backfire, nor do preignition and knocking occur, and that the maximum output is 26% higher than that of and equivalent gasoline engine. The development of this liquid-hydrogen pump indicates that "as far as engines are concerned, hydrogen cars have been completed." [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 68] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

CODEC LSI--NTT has developed a small-scale and high performance CODEC LSI. CMOS technology is used to mount all the necessary circuits on one chip of size 4.35x7.0mm and to include it in a normal 16 pin DIP case. The new circuit configuration method has been developed to reduce the number of devices and circuits because of incorporation in a single chip. Special consideration to design has been made to prevent problems such as interference between the analog and digital portions and noise, etc. For achievement of high performance, new circuits have been developed by using the analog CMOS technology on the amplifier to achieve a reduction of power requirements and to reduce the number of pieces from 20 to 15. The powerdown circuit is added to reduce power requirements if no input signal exists. This results in 35mW, which is about one half of the conventional power requirement. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 71] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

COMPUTER NETWORK--The Agency of Industrial Science and Technology of MITI has started a study for a computer network program in which the Information Center of Tsukuba Science City and seven local research institutions of the Agency are linked via a communication satellite. A network using optical fibers has already been established between nine major research institutions of Science City. Furthermore, a new work for a wider area covering local institutions will use a communication satellite as well. The Agency also expects that the progress of this program will clarify technical problems underlying a computer network formation using a satellite, and find other areas of application for the same kind of technology. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 72] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

PRACTICAL USE OPTICAL FIBER--NTT will use on a practical basis an optical fiber method for inter-office transmission lines with a total length of 110km in respect of 12 sections of Tokyo, Osaka and other areas. It will use 32Mb/s and 100Mb/s medium capacity methods, in which new aspects of technology, such as long wave length elements of about 1.3μm, as well as optical fiber manufactured by the VAD method, will be employed. NTT is expected to start construction in March, 1981 and complete it at the end of the year for service commencement. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 72] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

ARTIFICIAL 'EYE' DEVELOPMENT--Nakano, assistant Prof. at the General Laboratory of the Faculty of Engineering of the University of Tokyo has started to develop an artificial "eye" which can catch a moving object and see what shape it is. He has already developed an eye which can catch a moving object and answer, through learning, what it is. This eye mainly consists of, 1) 121 photo-transistors instead of the retina which normally catches objects, 2) elements which can perceive 9 kinds of movement instead of nerves and simple cells, 3) a circuit consisting of about 6000 elements instead of complicated and ultra-complicated cells which catch meandering and clockwise movement and, 4) a learning

machine (percention). On the basis of these achievements, Nakano has plans to develop an eye, similar in function to the human eye, which distinguishes shapes of objects, displays answers as to how they move and learns corrected errors. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

INFORMATION RETRIEVAL--The Data System Laboratory of the Engineering Department of Hiroshima University has developed and put into operation a pilot system for a relational data base model which is capable of more advanced information retrieval. The principle of the system consist of coding in advance of the relations between data items in the unit of attributes. Two dimensional signs nearly located are assigned to closely related items. The system is designed to make allowances in terms of "approximately" for individual requirements and to show all items which meet a number of requirements evenly, to enable preferred items to be selected from among them. For inquiry, the system uses QBE, a kind of table system, for ease of use. For ambiguous items, the system is designed to learn the level of ambiguity the user feels sensitively via visual expressions. Because in the design the laboratory incorporated a special computer system for the processing of the ambiguous expressions, a special-purpose computer (data base machine) for the data base is required in order to obtain proper processing capacity. Thus, the laboratory intends to develop a general-purpose data base management system (DBMS) which can be used in conventional general-purpose computers, while at the same time developing a special-purpose data base machine. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

R&D PROCESSOR--Fujitsu has recently developed "FACOM 9440L Laboratory System," a processor designed specifically for research and development. The processor not only has FORTRAN77 prepared as a development language and can debug in a conventional manner but also uses a multiple imaginery memorization system. This enables the user to use it without being conscious of the program size and easily perform technical computations. Also, the processor can be used for instrumental control and can collect analog signals into 9440L magnetic disks continuously for 100 sec. at 100kHz, max. Thus, it can record at high speeds various types of test data, such as noise and vibration, and is capable of analysis using FORTRAN programs. With the processor now available, the company is prepared to make a full-scale launch into the laboratory and design automation markets. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

VERY LARGE COMPUTER SALES--If the 1980's is the age of electronics, the essence of the electronics industry at the highest level is very large computers. Hitachi's "M-280H Processor" is one, IBM's "3081 processor" is another and Nippon Denki's "ACOS 1000," still another. Very large computers are equipped with technically strikingly improved VLSI elements as the central parts and are the products of several years of strenuous research and development efforts by the "brain groups" of computer companies. NEC has already obtained an agreement to deliver product No 1 of its "ACOS 1000" to Tohoku University. Japan IBM has already received orders for more than 100 units of the "3081 processor" and intends to recommend a lottery to determine the actual purchaser of product No 1.

In this connection, Hitachi has lately received an order for product No 1 of its "M-280 H processor" from Tokyo University, an establishment ranking top in academic circles. In addition, Fujitsu is developing, at full speed, "S," a prototype. Now, with the activities of this company involving its international selling power for very large computers, a sales war has almost begun. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

FUJITSU M SERIES WITH 64K--Fujitsu has recently announced that the capacity of the main memories of the smaller "FACOM V850" and all models of the general-purpose computer "FACOM M series" have all been replaced with a 64K bit LSI. This is to meet recent rapidly increasing demands from users for the enlargement of memory capacity as well as because of decreasing costs of 64K memories, due to the company's starting mass production at the level of over 150,000 units. Computer makers in general are gradually replacing 16k with 64k memories, while hesitating to attempt complete replacement because of the still costly 64k memories. Under these circumstances, Fujitsu's decision is a daring one worthy of note. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

SCHEMA DESIGNING-DRAFTING SYSTEM--Mitsui Engineering & Shipbuilding has recently developed "SCHEMA" Designing and Drafting System," a conversational type software package. The SCHEMA is a low-cost conversational type system which utilizes an ARS80 graphic terminal (see Photo [not reproduced]) previously developed by the company as a graphic display. The system has introduced the concept of "design model" in order to correctly describe designing information mainly consisting of figures and has a data base established which can be utilized not only for the drafting of design drawings but also widely for estimation, arrangement and production. Again, different from conventional CAD systems, it is a portable software unit which does not put one computer model ahead of others. Also, it has the potentiality of expansion as it enables the user to set in a specific system, because a model handler, which permits easy access to the data base, has been installed. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 74] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

HIGHLY EFFICIENT ELECTRON MICROSCOPE--Science and Technology Agency will start development of a highly efficient electron microscope with a resolution power which will enable direct observation of small atoms such as oxygen, nitrogen, and carbon. The resolution power of the currently most powerful electron microscope is 2Å, and it can thus clearly resolve only heavy metal atoms such as iron and tungsten. Therefore, it is necessary to improve the resolution power to more than double the current power in order to observe small atoms such as oxygen and nitrogen. For enhancement of the resolution power, it is required to significantly increase the acceleration voltage of the electron beam and to develop a lens with smaller aberration and an electron beam source with higher luminosity and interference. The Science and Technology Agency will invest ¥67M over two years starting this year to conduct a feasibility study of a high performance electron microscope centering around a super-conductive lens electron microscope as a pre-survey, together with an electron beam layer, lens system, material stage, image recording, and element study of the analysis system. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 76] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

DISTORTION MEASUREMENT INVERSION GAUGE--The National Aerospace Laboratory of Science and Technology Agency has developed a new type of distortion gauge "Inversion Gauge" that can make almost any measurement within an error of ±40μ if temperature is below 300°C. Since the conventional gauge is used assuming that 1.0 pieces per set are the same, an error occurs due to unequality of those pieces. It is common that the error range is ±1μ at 1°C. In a high temperature environment, an error of 200μ was observed. The inversion gauge developed by National Aerospace Laboratory can be reused to measure an object after the gauge is brought into a furnace and removed. The gauge can be pasted with adhesive, but once the surface is pasted, it cannot be reused. Thus, it is reversed for further use, but the general distortion gauge cannot be turned over for use because the upper and lower parts are not symmetrical. The laboratory has begun to practically use the gauge for the flap test of a short-distance take off and landing plane. The results are good and the gauge can be expected to be used widely in various fields such as cars and compound material. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 76] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

INFRARED INTERFEROMETER--The National Research Laboratory of Metrology has succeeded in trial production of an infrared interference length-measuring unit by the matching method that uses helium-xenon laser, simultaneously oscillating with two wavelengths, 3.51 and 3.37μ. Conventional interference length-measurement devices use a cadmium or mercury lamp, and only 20 to 30 centimeters in length can be measured. 5 to 10 minutes are required for each measurement. The interferometer developed by the laboratory simultaneously oscillates the two-wavelength infrared beam of helium xenon laser, and scans with the PZT device the phase of the interferometer drawn on a measured object by the beam with a different wavelength for reading. The 3-meter long block cage can be measured in 20 seconds, to a precision of 1/100μ. The infrared laser can measure in a wide range of environments, and can therefore be expected to be applied in the industrial sector. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 76] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

MICROWAVE RADIATION METER--Prof. Tsutomu Suzuki of the Applied Electronic Engineering Department at the University of Electro-Communication has developed a new type of microwave radiation meter. All materials in nature have a temperature, and emit to outside energy meeting the temperature. The microwave radiation meter is a sensor that detects the components of the microwave area in this radiation energy. The newly developed unit is called the "2 Calibrator-1 Reference Method," and is a Dicke type. A Dicke type of microwave radiation meter generally accompanies a gain variation which becomes a measurement error. However, the new unit is designed for better temperature resolution, stability, and accuracy without being affected by incorporating two noise sources for calibration if a gain varies. Concretely, noise sources for calibration of both high and low temperatures are used. The microwaves radiated from these noise sources are first detected, and immediately after that, the microwave from an object under observation is detected via the antenna. If it is made within the temperature range of both of the noise sources, the measured value for luminosity and temperature of these sources becomes still, and luminosity and temperature of an object under observation are thus obtained. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 76] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

PRACTICAL VOLTAGE STANDARD UNIT--Yokogawa Electric Works has developed a voltage standard unit by using the Josephson effect element. In general, factory voltage standards are based on standard batteries retained at each factory, calibrated by the Josephson voltage standard unit (a national standard). The principle of the new unit is the same as that of a national standard, and its precision is limited to 1/100M for small size, easy operation, and simple maintenance. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 77] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

INTELLIGENT SPECTRUM ANALYZER--Takeda Riken Industry Co. has developed the first "Intelligent SPEANA TR4172" in the world that incorporates functions of both spectrum and network analyzers. This analyzer combines in one unit the functions of the network analyzer such as phase measurement and group delay measurement, as well as the conventional functions such as spectrum analyzer, digital frequency measurement, and measurement of transmission characteristics. As SPEANA, a frequency measuring range of 50 to 1800Hz, and a mechanical dynamic range of 90dB, are realized. In addition, 95dB is recognized in the dynamic range of a logarithmic amplifier, and the frequency response is ±0.7dB after correction. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 77] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

VACUUM RESIDUE CRACKING PRODUCTION--The long-run (35-day) test of an atmospheric residue has been completed by using a pilot plant for heavy oil cracking having been propelled as one of the major projects of the Ministry of Industrial Trade and Industry. A test using vacuum residue as a raw material will be started. The plant can treat 120 tons of raw material a day, and the test for producing olefin was started last spring. The product distribution obtained from atmospheric residue closely corresponded to that from naphtha cracking. However, the yields of ethylene, propylene, B-B fraction and gasoline become low and cracked light oil and pitch are produced in large amounts when vacuum residue is used. Therefore, there are many problems in the operation, and the test results of vacuum residue cracking are anticipated. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 79] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

COMPOUNDING CARBON FIBER--Toshiba Chemicals has recently established a technique for compounding carbon fiber with epoxy resin, polyester resin, and polyimide resin, and has begun to establish a market. This activity answers a wide variety of needs of users. The company has devoted its efforts to the development of new techniques and new materials, and the demand is expected to build up rapidly. This technique has already been adopted partly for medical equipment, and also is expected to be widely used from now as a replacement of steel, diecast items, and asbestos, because carbon-fiber-reinforced-plastic material is light, and tough, and has superior moldability. As recent examples, one is a hotel bath unit which is a safe waterproof double structure, the design is unique and the maintenance is easy, another is a bath unit for ships, which satisfies Japan Ship Society Standards, and also for use as aircraft containers replacing the use of aluminum. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 80] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

VINYL CHLORIDE PROCESS HELP--Kanegafuchi Chemical Industries has recently developed and started marketing a process helping agent for acryl based vinyl chloride. When added in small quantities to various types from hard to semi-hard and soft-vinyl chlorides in forming processes, the agent is able to improve primary and secondary processing qualities and appearance of products, largely without affecting the chemical and physical properties of the vinyl chloride. In detail, the agent accelerates gelation, achieving the following effects: 1) it eliminates unevenness of paste, enabling products to provide their full properties; 2) it enables fillers to be included in larger quantities; 3) it permits complicated patterns and helps edging in profile extrusion. It also has the advantage of permitting long running and stable production, and is considered to be helpful in preventing surging, jetting, flow marks and silver streaks. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 80] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

SEMICONDUCTOR PACKAGE MATERIALS--As demands increase for semiconductors such as IC's, conductive polymers are attracting attention as packaging materials. Such substances as ethylene vinyl acetate copolymer (EVA), polystyrene (PS), polypropyrene (PP) and polyurethane foam (PU) which are made antistatic by an inclusion of carbon black or interfacial active agents are used for such packaging materials. Integrated circuits including LSI's have low operational voltage--occasionally less than IV--and suffer from effects of static electricity which can be caused during their transportation. Static electricity, at the lowest level, thus generated may cause erroneous operations and damage to circuits. Among IC's, MOS-IC's (metal oxide semiconductor IC's often used in desk computers) in particular are apt to be affected by static electricity. This is because static electricity accumulates in the insulation between the semiconductor substrates and the metal layers. If high-voltage static electricity is generated, it damages the insulation, damaging the products. Semiconductor packaging materials are generally made by including carbon black in resins. They are annually recording a nearly 20% growth thanks to the prosperity of the electronic age. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 80] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

LARGE-SCALE INTERFERON PRODUCTION--Hayashibara Biochemical Laboratories, Inc. developed a unique process for large-scale production of interferon. The process uses hamsters to obtain viable live cells. The company has succeeded in developing interferon at low cost, after five years of research and development. The system is based on the findings that large quantities of viable human lymphoblast cells are obtainable by transplanting human cancer cells into animals such as hamsters. More specifically, new born hamsters, less than 24 hours old, specifically bred and adapted for this purpose, are transplanted subcutaneously with human lymphoblast cells, while rejection by the animals is suppressed by injections of an immunosuppressant, anti-lymphocyte serum, and raised for three to four weeks under sterilized conditions until the transplanted cells grow to tumors, of 25-30 grams, approximating the animal in weight. An average yield of 50 million IU (international units) of interferon is obtainable from one hamster. [Text] [Tokyo TECHNOCRAT in English Vol 14, No 5, May 81 p 83] [COPYRIGHT: 1981 Fuji Marketing Research Co., Ltd.]

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