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Ten Major Companies Describe Preparations for Space Age

43062558 Tokyo PUROMETEUSU in Japanese Feb 88 pp 52-56

[Excerpts] Japan's space development has been advanced entirely for peaceful purposes, and Japan has at last come to have a real ability to positively undertake international activities as a member of the group of advanced countries.

A long-term vision of the Space Activities Commission, stating that Japan should take a central part in world space development in the early part of the 21st century, has been reported.

Therefore, we have asked 10 companies that have played leading roles in Japan's space development to answer the following questions.

Question 1. What are you doing for the new era of space development?

Question 2. What do you expect of space policies?

Space Business Department, Ishikawajima-Harima Heavy Industries Co., Ltd.

The report on the Space Activities Commission's long-term policy meeting states that Japan will take a central part in world space development at the beginning of the 21st century. This report is considered very significant, for it clearly indicates the role and target hereafter of Japan, which has become a great economic power in international strategy.

1. We are proud that we are in the first line of space development at present, and at the same time, we harbor great expectations for the forthcoming space age. We would like to advance research investment and equipment investment, and to undertake the talent training required to deal with the vast, uncharted technical fields ranging from location utilization to environment utilization of space, and from unmanned to manned operations. So far, we have been directing our efforts to the rocket and satellite fields and space environment utilization, and in the future we intend to

expand our fields of development centering around these fields. In regard to the former, we are doing our best to develop the LE-7 engine for the H-II rocket, and at the same time, we have started research into space craft that will be the next generation transportation means. As to the latter, we are participating in research on construction of space infrastructure, such as space stations, platforms, and in-orbit working machines, and we are also trying to obtain the technology for experiment devices and experiments to be used in them. In this way we want to prepare ourselves to perform our international role, as well as to contribute to the space development of Japan in the future.

2. The epoch-making contents of this report on long-range prospects clearly indicate the direction Japan should take, and at the same time, the report points to the concrete means, including funds, that are required. We earnestly hope that Japan's space policy will be carried out in accordance with this concept. The biggest problem for the realization of this issue is considered to be the securing of long-range funding. We, corporations, will of course do our best, but we would like to ask the government to give further consideration to this point.

Space Development Office, Kawasaki Heavy Industries, Ltd.

1. The new space age is recognized as an era of space development based on manned activities such as planetary probing and space environment utilization. From another stand point, it can also be considered an age of reusing manned systems and means of transport. Basically, our preparations will be as follows. Our manned activities will be expanded to broad fields, with the environment control system in the space station plan which we are now studying as an impetus. At the same time, an important topic will be the construction of unmanned systems utilizing our own technology such as automated robotics and AI. The development of unmanned collection-type rockets and manned space craft as reusable transport means is important for securing the national interest in regard to utilization of the environment as well as to macropolicies such as international cooperation, and we consider it our social duty to become involved in this as an aircraft manufacturer. At the same time, we will also contribute to space utilization in the field of life sciences such as space medicine and physiology as manufacturer in that area.

2. Japan's space development is now truly facing a big bottleneck in the transition to the space age in the 21st century. It is significant that a vision of space development hereafter is summarized in a report on a long-term policy meeting at this time. The space development of the United States, the Soviet Union, and Europe is being carried out under their highly political national policies to raise national prestige. Therefore, Japan should also position its space development as a national policy. From this viewpoint, it is desirable that the vision be made clear as a program for the promotion of science and technology and the space industries.

Space development is the symbolic of intensive high technology. Developing manned activity technology hereafter will also be a challenge as it is a technology in which Japan lacks experience. Therefore, it is very important to secure the necessary funding for such development by means of a drastic financial policy. Personnel training is also a major subject. Clarification of a concrete space development program at the national policy level is very important for the enterprises that train staff and use them for such development.

Space Development Projects Department, Toshiba Corporation

1. At present, Toshiba is in charge of the development of the manipulator that is one of important items in the Japanese space station, as well as of bringing to completion Engineering Test Satellite VI for the development of 2-ton class large satellites in the future. We anticipate the need for high-level, large-scale space development in the future, and we are promoting such development in advance centering around basic technology. Broad, deep technology is required for the construction of space infrastructure, and a corporation such as Toshiba whose characteristic is overall high technology is suited for this construction. Therefore, we intend to continue positively to promote such development in the future.

Space development is the development of a new world, and its scope is wide and varied. More than a quarter of a century has passed since the launching of the first Sputnik, and its technology has been developed to take root as industries in such fields as communications and broadcast satellites. For example, the broadcast satellite "Yuri 2" developed by our company handles direct broadcasting by NHK. One of the channels offers NHK's original program, and commercial companies are competing in the development of inexpensive receivers, thus creating a new broadcast market. The services of commercial communications satellites are also planned in Japan starting next year. Private corporations are making efforts such as our participation in the field of earth stations, and new business fields are opening up.

The field of space environment utilization is at the stage in which every effort is being made to produce a new μ g environment with the cooperation of government and private corporations, and we are also actively participating in this.

We are advancing the construction plan for a large second space development building, and we are very actively carrying out space development with our superior staff.

2. As part of a long-term vision, the Space Activities Commission announced recently that the state would construct space infrastructure by investing ¥6 trillion looking toward the 21st century. This work is aimed at creating a basis for mankind to actively work in the new world in the future. It is truly a concept to be advanced on the national level from the standpoint of international cooperation. Therefore, we earnestly hope that this plan will be realized at the initiative of the state by all means. We will positively do our best in line with the policy.

Aerospace Projects Department, Nissan Motor Co., Ltd.

1. We think that the significance of space development lies in the space and development of mankind, and at the same time, it is an expression of national will.

In this content, the fact that Japan's space development has grown to the current level is significant, and we would like to pay our heartfelt respects to the various government agencies for their efforts.

We expect them to advance development will further as a national policy in the future, and we want to support them with all our might.

We began the development of rockets for space science observation about 1955, at the dawn of Japan's space development, and our technology has grown to the point that we now develop rockets for launching practical satellites. In this period of new development, we would like to actively engage in a wide range of development, such as that of space stations and space craft, looking toward the future.

The future of space development is greatly dependent upon the national will, and there are many long-term projects. Therefore, a long-term national concept should be established, and at the same time, policies should be decided at a high political level so as to obtain a national consensus.

Space development is a field in which the growth of industries is expected, but there are still many technical problems to be overcome before a real market is formed, and enormous investment is required for this.

The state and industry must move ahead in unity in regard to staff training, studies for the establishment of basic technology, etc.

It is strongly expected that at this time a powerful space policy will be established that will include industry support in order to promote space development activity corresponding to the national strength of present day Japan.

Space Development Projects Department, NEC Corporation

1, 2. It is really wonderful that Japan has taken a step forward in regard to the construction of an epoch-making space system, looking toward the start of the 21st century, and we want to do our best to assist in the complete realization of this concept. With the means of transportation to shuttle between earth and space, manned space activities become possible, and achievement of various missions will become possible with the advent of a complicated, large-scale space system unmatched by the present rocket/satellite systems. It may be said that Japan's role is very important in the new space development evolving on a worldwide scale. The new system will be based on the accumulated development up to now, and it will require technical progress in many new fields. We would like to make every effort to advance the development of technology to support this new system.

It is necessary to establish feasible medium- and long-term plans as soon as possible, supported by a budget sufficient for constructing such a magnificent system, and we strongly hope that this plan will not come to naught.

We believe that the fields that have reached a high level of technical and marketable maturity such as communications and broadcasting are entering a new age wherein the best use can be made of the accumulated technology and experience in commercial fields. However, there are still many areas to be reinforced in the overall competition with European and American manufacturers. We would ask the government to study plans to establish and maintain the competitive power of Japanese manufacturers also in the field of existing systems.

As we said, in preparing a new space policy, we would ask the government to make it a balanced policy by drawing up a feasible plan for the construction of future space systems, while strengthening the foundation by continuing to maintain the fields of the existing systems. We are determined as a maker to make the maximum contribution for the realization of the plan.

Space Technology Promotion Headquarters, Hitachi, Ltd.

1. The scope of technology in the field of space is wide, and very high reliability is required. We are challenging to the utmost a wide-range of technologies as an allround maker in the fields of electronics, electro-mechanics, system technology, etc.

In the field of space equipment, the development of various subsystems for communications and data processing are being advanced. Three kinds of devices, including bubble data recorders, were mounted on the "Ginga" scientific satellite launched in February, and they have been working satisfactorily. As part of a space station plan that is being jointly developed by Japan, the United States, Europe and Canada, we are developing various on-board experimental devices, in addition to sensors and end effectors of the manipulator system for Japan's experimental module. We are in charge of six devices, such as incandescence furnaces and collecting apparatuses, for a free-flyer (unmanned space laboratory) scheduled to be launched in FY 1992. In the field of space utilization, development of the ka/ku band satellite communication system and of image recording/processing/analysis systems for remote sensing is being advanced in preparation for the practical utilization era. We are also positively tackling the development of high-level technologies such as the creation of new materials utilizing a space microgravity environment and research into biotechnology.

"The long-term vision for space development" announced the other day mentions the development of space infrastructure. We are also thinking of undertaking activities making the most of our comprehensive technology in various systems centering around electronics, mechatronics and new materials processing technology.

2. As mentioned in the report of the long-term policy meeting, Japan's space development is now in a major transition period. We would ask the government to realize at any cost an investment plan that is based on the "national budget being increased by an average of 13 percent 15 years from now" in

order "to take a central part" in the international development of high technology for space. Private firms are also strengthening their technical power by continuing enormous preinvestment, but we believe that the cooperation of "government, academia, and industry" is very important to the success of the rapid development of such new technical fields. We also think it is essential to reinforce the engineering by the spread of space-related technical education.

Aircraft Business Department, Fuji Heavy Industries, Ltd.

1. In July 1987, we established a Space Technology Office in the Aircraft Technology Headquarters, whereby a full-scale space development system was set up to meet the new space age.

Our space business started with cooperation with Nissan Motor Co., Ltd, in developing the functional electric parts of the SRB for the H-II rocket and the design of structures of exposed portions of a space station. We intend to expand out space business, taking the opportunity to participate in the space plan of the National Space Development Agency.

We will have to accumulate results and experience in the field of space from now, and we would like to contribute to space development by making the best use of the aerodynamic, structural, control technologies, etc., we have acquired in the manufacture of aircraft.

Infrastructure construction is an important subject for future space development, and we want to make the best use of our technology in this field. Among other things, we would like to do our best in the field of a spacecraft that is developed as an extension of the aircraft line. We further intend to take the opportunity to participate in the development of space vehicles such as OTV and OMV.

We are therefore devoting efforts to various types of research work to be applied to space infrastructure. Structural materials, specially composite materials, technology is an important theme, so we are putting emphasis on research into characteristics and heat resistance in a space environment, including processing technology. We would like to use them in space structures such as spacecraft and space stations.

2. We want the space development concept planned with a view to the 21st century to be dealt with on the national level so that the plan will be developed both nominally and actually. The amount of expenditure for research and equipment to be borne by the private sector is very limited. We expect the government to call on enterprises widely to so as to concentrate the technical power of all of Japan when starting various projects.

Space Development Promotion Office, Fujitsu, Ltd.

1. It is necessary to concentrate technologies in a very wide range of fields and of a very high level. We consider that the development can be undertaken only by collecting and enhancing the special technologies of many organizations and enterprises.

We have experience only in comparatively limited fields of space-related technology such as ground information processing systems and infrared sensors. However, among our special technologies are communications, control (robotics), and devices and components in addition to information processing. The systems for information processing and an information network tend to become an indivisible whole, and we have manufactured many huge systems. We believe that our experiences in ordinary ground systems would be useful in the development of space systems.

Robotics technology is also important in space. The technology in FA and intelligent robots that we have cultivated would be useful for the highly self-reliant robots that support manned space activities and the teleoperations and telescience that permit smooth operation from earth, as well as for automation in future space facilities.

2. Space is a frontier that is worthy of challenge, and there are dreams of space development. However, the course leading from dreams to actual operation is a long one, and future prospects depend on completion of the infrastructure as a base. It is not likely that this work will make any progress unless the government leads it.

The demand for more funds for space development is becoming greater, at least among the space-related parties. However, since the government expenses are borne by the people, it is very important to disseminate information on space development to the general public.

Space Equipment Department, Mitsubishi Heavy Industries, Ltd.

1. We have been in charge of system integration centering around the field of rocket development since the beginning of Japan's space development and we are proud that to date we have been able to fulfill the national development plan without serious error.

We believe that the core of space development aiming at the 21st century will range from the field of unmanned rockets and satellites to the construction of manned infrastructure. In the future, we will continue to maintain our basic attitude of proceeding together with our country by freely using the technical power we have so far accumulated and by conducting research into essential high technology in advance. Specifically, we want to prepare for the completion of development of the H-II rocket, the successful completion of the space station plan, the development of spacecraft, and the smooth development of the space environment utilization project by every means with the responsibility and mission of a key manufacturer in the space development field.

Projects in space development hereafter cannot be accomplished without international cooperation. In the future, Japan must have special technology to participate in international cooperation, and we would like to take up the challenge to improve our technology under the guidance of the government.

2. The report on the long-term policy meeting of the Space Activities Commission announced the other day specified the "development and preparation of space infrastructure centering around Japan's own space stations and spacecraft by the beginning of the 21st century under the initiative of the government and the evolving of manned space activities," and we, makers, would like to pay our great respects to such a magnificent policy.

However, many such plans in the past were not realized for the reason that they lacked a supporting budget, and they disappeared while we were not looking. In order to realize this plan by all means, we would like to request the following: (1) publication of a revised major policy line at an early stage and a clear indication of the amount of development funds; (2) establishment of a medium-term plan of execution through the coordination of ministries and agencies; and (3) we would like to have some kind of higher political decision to secure the development budget.

Space Development Promotion Department, Mitsubishi Electric Corporation

1. The new space age requires technologies in the wide-ranging fields of machinery, electricity, electronics, materials, etc., greater than those required in the space development in which we have participated for more than quarter a century. We will deal with space development as a business field in which we will put special emphasis, recognizing that it is an age in which our power will be displayed as an allround electrical machinery and appliance manufacturer.

Space development so far has been conducted mainly at the level of research and development, but in the new space age, two lines--research and development and practical use--will become clear. We would like to take up the challenge to develop new technology and to make maximum use of already developed technology.

In the new space age, we will continue to attach importance to the existing fields of communication, observation satellites, etc., as practical fields, and at the same time, we will direct our efforts to space stations, platforms, etc., as new fields.

Overseas, we would like to utilize the superior technology developed in Japan, taking into consideration the conditions of the countries concerned, and we would like to positively promote international cooperation in the new space age.

2. We would ask the government to make concrete the long-term space development plan prepared by the long-term policy meeting as a plan of execution as soon as possible. For steady and sound progress, space development--requiring enormous personnel, materials and money--should be made an important national policy, similar to that in countries where space development is advanced. Consideration should be given to matters such as the following:

- (1) Industrialization of space development projects
- (2) Concrete measures to obtain national understanding
- (3) Measures for the training of space development engineers
- (4) Positive cooperation with other countries at the national and the private levels

Space development must rapidly be raised from its present level of some practical use in communications, etc., to a truly useful level for the people and the country.

We would ask the government to promote realization of the vision for space development of the long-term policy meeting by urgently drawing up a concrete state plan in the field of space development--attended by great risk, but also unlimited possibilities--in order to further encourage the research investment, etc., of private enterprise in space development.

20155/9986

National Aerospace Laboratory Projects Outlined

Low Gravity Experiments Using Aircraft

43062085 Tokyo KOGIKEN NYUSU in Japanese Mar 88 pp 1, 2

[Article by H. Uemura, Space Research Group: "Low Gravity Tests Using Aircraft"]

[Excerpt] From 4 February to 3 March 1987, continuing work begun in 1985 and 1986, we performed month-long low gravity flight tests using aircraft. The subjects for research and participating organizations are the same as those for the first aircraft experiments performed in 1985. The two test subjects in which our organization participated (both from the Space Research Group and the Fourth Research Group) were "The Maintenance of Droplet Non-Contact Using Triaxial Sound Waves" and "The Observation of Bubble Behavior Under Temperature Gradients and Ultrasound Stationary Waves."

The low gravity flight test site was above Ise Bay (flight zone K), the aircraft used was a Mitsubishi Heavy Industries MU-300, the method of flying was parabolic flight, the low gravity environment obtainable in one trial was 0.5×10^{-1} g x 20 sec, and we were given the opportunity to perform a total of 30 low gravity experiments with the various pieces of test equipment. These details are similar to those of previous tests.

For these tests we had to exceed the low gravity environment achieved in previous tests (10^{-2} ~ 10^{-1} g) and so we made some improvements. First, we made precise piloting on the parabolic flight possible by adding a fine/coarse, dual system accelerometer for the pilot and by using liquid crystals in the density displays. In addition, as in previous tests, we tried to fly more precisely not only by having the copilot observe the angle of incidence, but also by adjusting forward acceleration as we have done it heretofore (in actuality, increasing or decreasing engine thrust) by relying on a newly installed meter indicating airframe forward acceleration.

With these improvements, even with what might be called a maximum effort by the pilot, copilot, and ground crew, the acceleration environment we obtained was regrettably not as good as we had hoped for. The principal

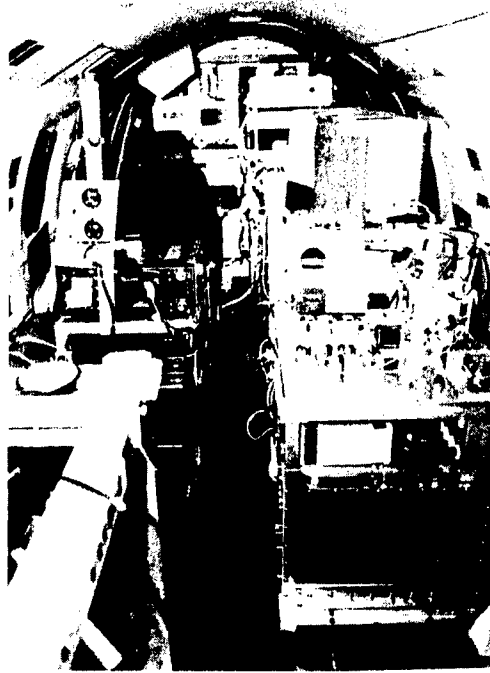
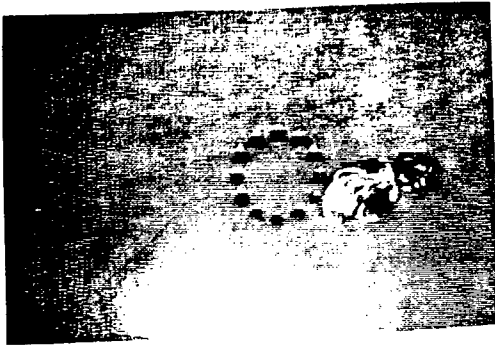


Figure 1. Triaxial Sound Wave Flotation Equipment Installed on the Aircraft

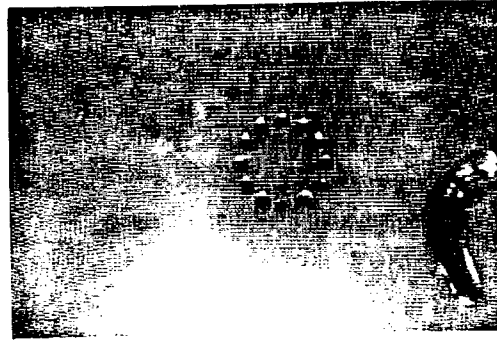
reason why noteworthy improvements in acceleration environment were not obtained is because, as stated in KOGIKEN NYUSU No. 327, the fuel supply system of the aircraft engine used did not respond to negative g's and thus constantly sought to maintain airframe acceleration on the plus side. Moreover, when we tried to find the problem with 10^{-2} g from the low gravity flight experiments whose total exceeded more than 120, we became aware, while operating the aircraft, that airflow had the greatest influence and that turbulence was steady at the 10^{-2} g level, even when weather conditions were favorable. According to the explanations of the experts, the Far East winter season is not the most favorable time to perform this kind of experiment. Although air currents are said to calm down during the summer season, this period is right in the middle of budget negotiations and thus winter was unavoidable because problems would have arisen over unsettled budgetary items.

In the experiment using triaxial sound wave flotation equipment (Figure 1), because we had already obtained the parameters for forming droplets, our goal this time was to maintain the droplets as long as possible in a chamber. Because 13 seconds were required until the droplets were separated during the experiment, the time which we could actually spend to maintain the droplets was 7 seconds during one of the parabolic flights.

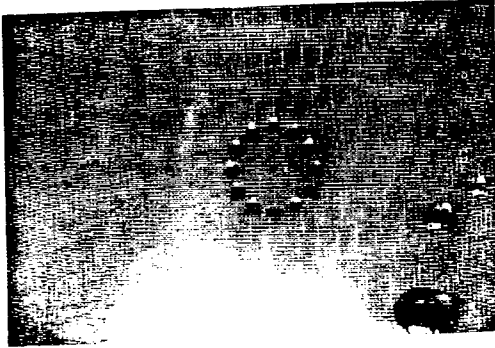
During the experiment, after the operator monitoring the accelerometer pulled the droplet injection switch, the equipment was all controlled by computer. This made it possible to independently control the various parameters such as the ejection speed and weight of the droplet, the frequency, phase, and amplitude (sound pressure) of the sound waves, etc. Although most of these parameters were either preset or had default values, if the need arose, an operator could intervene while viewing the progress of the experiment on a TV monitor.



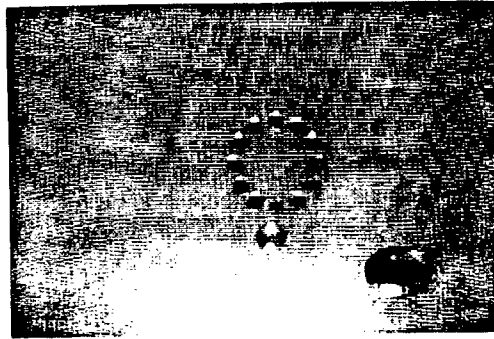
#1 Immediately after contact



#2 Great distort due to external agitation at separation



#3 It becomes three droplets, both large and small



#4 Two droplets are maintained



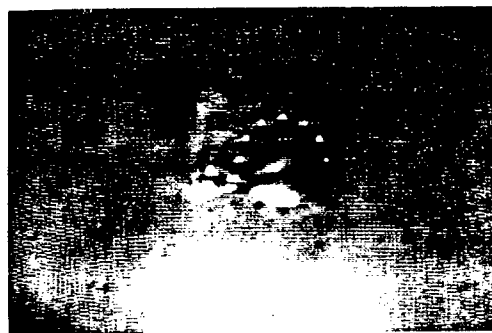
#5 Because of smaller surface tension, the larger droplet is crushed from above and below by sound pressure and takes an elliptical shape



#6 The droplets come close to each other



#7 Contact



#8 After contact, they maintain various shapes without fusing

Figure 2. Sequential Photographs of Droplets Making Contact in a Low Gravity Environment

Figure 2 depicts the time period when the large and small droplets were unexpectedly formed after droplet separation. The oil used was 20 cSt colored silicon oil, the passage of time from Frame #1 to Frame #8 was 7 seconds and the time interval between frames was not fixed. The acceleration for this interval was about 0.5×10^{-1} with an airframe vertical component with a very large residual value.

In ground-based experiments up to now, stability maintenance and rotational control have been performed on light weight solid samples, but with liquid samples like this, our tests showed that the triaxial sound wave flotation equipment functioned satisfactorily. These results are very significant because in the future this equipment will be developed into a non-contact reactor for use in space.

Space Shuttle Aerodynamics

43062085 Tokyo KOGIKEN NYUSU in Japanese Mar 88 pp 3-6

[Article by the Second Aerodynamics Section, the First Aerodynamics Section, and the Prototype Aircraft Research Group)

[Text] Although research to produce the space shuttle has proceeded for some time in various countries around the world, at the National Aerospace Laboratory, research activity led by the Space Shuttle Research Association, began in 1980. Since 1987 research and development has been performed by the Revised Aerospace Transport Technology Research and Development Team (ATAS). We have continued our active role in aerodynamic research through wind tunnel tests and numeric simulation to learn the shuttle's aerodynamic performance and aerodynamic heat characteristics at speeds ranging from low to hypersonic.

We performed aerodynamic performance tests on the single-stage space shuttle (SSTO) and here we will present a summary of the results of six part dynamic performance tests performed using four wind tunnels (gust-level, transonic, ultrasonic and hypersonic) at wind speeds ranging from low to hypersonic. The SSTO aerodynamic performance will establish the initial performance of the two-stage space shuttle (TSTO). Furthermore, because these wind tunnel models were constructed using numeric control process mechanisms from numeric simulation data, all have the same shape. In this way a detailed comparison between tests and numeric simulations will be possible.

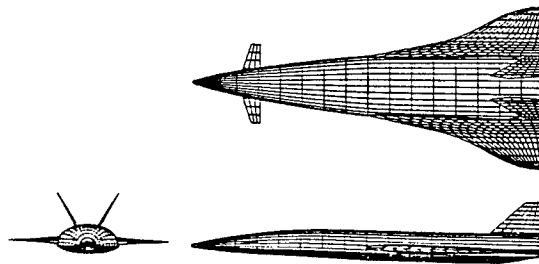


Figure 1. Three-Sided Drawings of Joint Experimental Models (Reference shape)

Figure 1 gives a three-sided drawing of the basic shape of the joint experimental models. Their various factors are given in Table 1. Three models were built for the four wind tunnels.

Table 1. Various Factors for Test Models (Reference shape)

	Gust-level wind tunnel	Transonic/ ultrasonic wind tunnel	Hypersonic wind tunnel
Total Height	1.155 m	0.54 m	0.30 m
Span	0.538 m	0.2515 m	0.1398 m
Main Wing Area	0.1706 m ²	0.03729 m ²	0.01151 m ²
Wing type	NACA 0005	NACA 0005	NACA 0005
Angle of incidence	1.0 deg	1.0 deg	1.0 deg
Dihedral angle	0.0 deg	0.0 deg	0.0 deg
Mean geometric chord length	0.3171 m	0.1483 m	0.0824 m
Elevon angle	-20 to 20 deg	-20 to 20 deg	-20 to 20 deg
Tail Wing type	NACA 0005	NACA 0005	NACA 0005
Crossing angle	60 deg	60 deg	60 deg
Canard Wing type	NACA 0005	NACA 0005	--
Angle of incidence	2.0 deg	2.0 deg	--
Dihedral angle	0.0 deg	0.0 deg	--

To produce these shapes, we made a base from reference shapes and with an elevon capable of altering the rudder angle discontinuously within a range of -20 to +20 degrees behind the main wing, we obtained structures with vertical airframe stability with the inclusion of a canard. Furthermore, in order to prevent the degradation of tail wing efficiency due to main wing vortices when the angle of attack is large, we also prepared a winglet-shaped main wing. A tail wing with a 90 degree angle of intersection was also prepared due to fears that the tail wing would contribute inadequately to vertical stability.

With the goal of improving landing and take-off performance, one of the key technologies for the single-stage space shuttle, we used a canard capable of varying the angle of incidence within a range of -20 to +20 degrees on the models for the low speed and transonic/ultrasonic wind tunnels. However, because aerodynamic heat is so severe in the hypersonic wind speed range, canards were shaped within the fuselage and were not used on the hypersonic wind tunnel model.

The range of maximum angles of attack which we tested were 40 degrees for the gust-level wind tunnel, 20 degrees for the transonic, 30 degrees for the ultrasonic, and 20 degrees for the hypersonic. The low speed, high angle of attack tests were not only performed in our gust-level wind tunnel, but we also used our low speed model unchanged in Kawasaki Heavy Industry's low speed wind tunnel as a part of a joint research effort.

As to the test results, adjustments were made with a stability axis system in all of the wind tunnels and in making the aerodynamic forces non-dimensional, we used wing area as the base area. As to base height, we used mean geometric chord length for the vertical aerodynamic coefficient and span for the horizontal aerodynamic coefficient. We also placed the moment reference point at 74 percent of the total length.

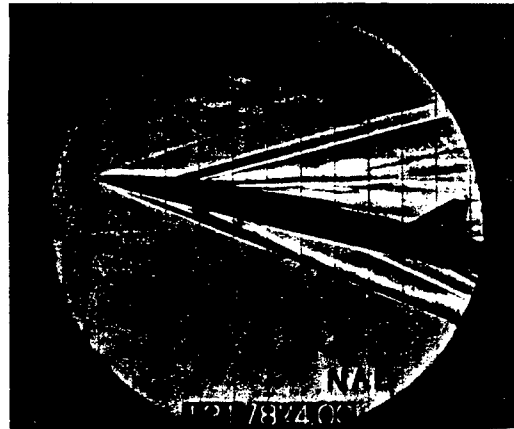


Figure 2. Schlieren Photograph of Space Shuttle Surroundings (Mach 4)

Figure 2 is an example of a schlieren photograph taken during tests at Mach 4 in the ultrasonic wind tunnel.

Figures 3 through 9 show six part force characteristics for standard shapes from our test results. Because the method of model support for the low speed wind tunnel was different from that for the other three, strut interference was fairly large and we had to correct our data.

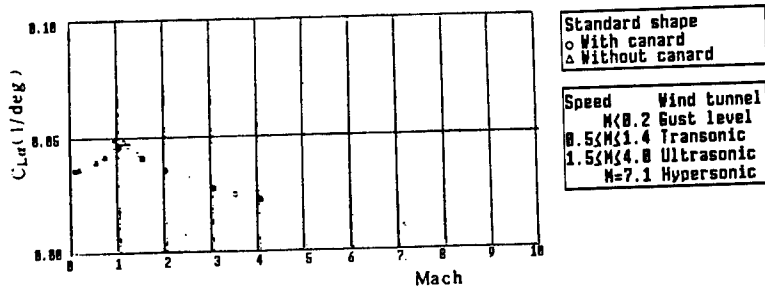


Figure 3. Resistance Coefficient ($\alpha = 0$)

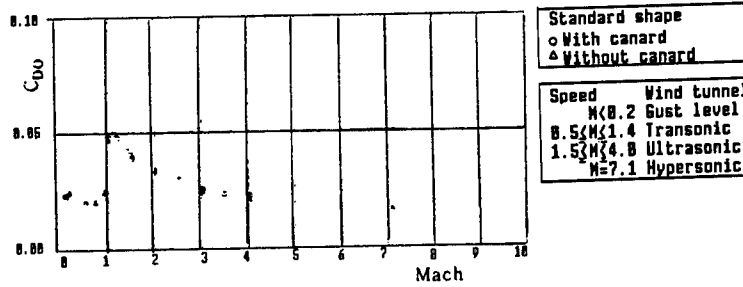


Figure 4. Lift Slope ($\alpha = 0$)

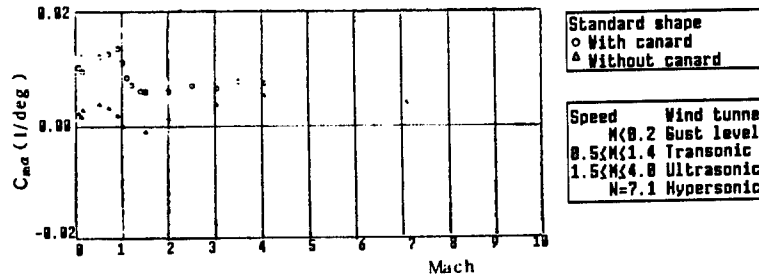


Figure 5. Pitching Moment Slope ($\alpha = 0$)

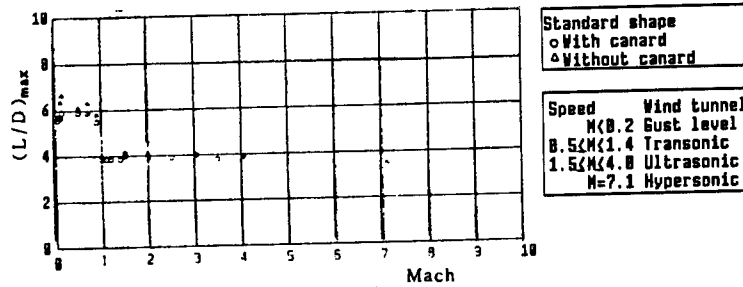


Figure 6. Maximum Lift Resistance

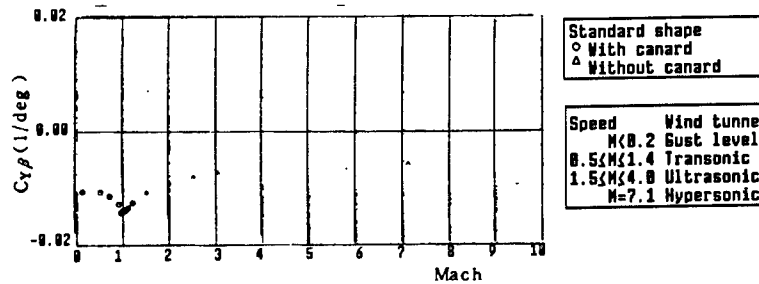


Figure 7. Lateral Force Slope ($\alpha = 0, \beta = 0$)

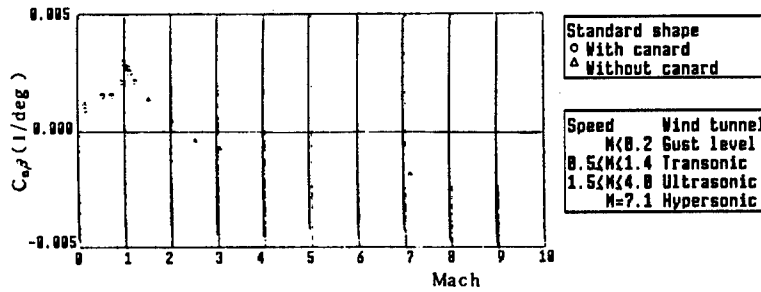


Figure 8. Yawing Moment Slope ($\alpha = 0, \beta = 0$)

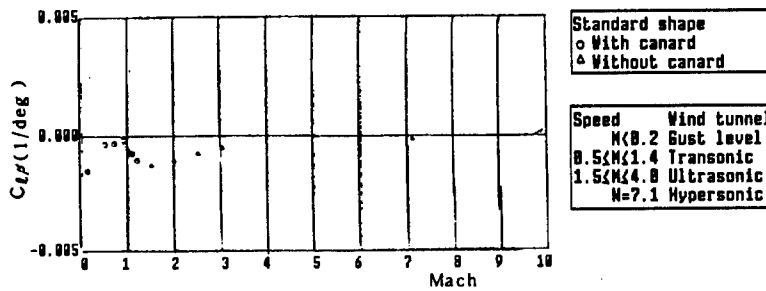


Figure 9. Rolling Moment Slope ($\alpha = 0, \beta = 0$)

As mentioned above, the center of gravity for the airframe shape was hypothesized to lie at 74 percent of the total length, but this figure will change as future investigations make progress. As seen in Figure 5, we learned from these test results that $Cm\alpha > 0$ at almost all wind speed ranges, regardless whether a canard was present or not, and that vertical stability was not obtained. We have not here published the fact that we could not measure stability, even with elevon control. This fact illustrates the point that reasonable advances in positioning the center of gravity will have to be made in order to make progress in system investigations. In regard to directional stability, we found that, as likewise seen in Figure 8, tail efficiency declined as Mach number increased, and at Mach numbers above approximately 2.2, $Cn\beta < 0$ and directional stability became unobtainable.

As to the shuttle's aerodynamic performance, we will mention connections between the data shared by the wind tunnels. The scattering of mutual wind tunnel data, caused by the fact that a single series of tests had different wind tunnels, models, and balances was very slight for this series of tests and taken as a whole, the results obtained are considered excellent.

In performing the experiments, the research offices which participated in the testing were Research Office 5 from the Second Aerodynamics Section, Research Office 2 from the First Aerodynamics Section, and Research Group 2 from the Prototype Aircraft Research Group. We obtained the first meaningful series of test results through the participation of a great many individuals in even the simplest of shuttle aerodynamic performance tests. The field of aerodynamics requires connections with a great number of other disciplines like thermal aerodynamics and computational aerodynamics. Moreover, aerodynamics itself requires intense collaboration among systems, construction, and guidance, and the systematic advance of aerodynamic research through ATAS will be necessary.

An Optical Vibration-Measurement System

43062085 Tokyo KOGIKEN NYUSU in Japanese Mar 88 pp 6-8

[Article by M. Minegishi, First Airframe Section: "A Vibration-Mode Measurement System Using an Optical Displacement Meter"]

[Text] When performing wind tunnel tests on scale models in order to evaluate aircraft wing flutter characteristics, it is normal practice to perform vibration tests beforehand in order to understand dynamic characteristics. Furthermore, there are various methods for measuring the vibration modes inherent in structural members and each has its strengths and weaknesses. In studies on aerodynamically flexible tailoring techniques for main wings, the models used in flutter wind tunnel tests are built with composite materials as their principal components. However, these models are of extremely light construction because of wind tunnel equipment performance constraints. Because of these restrictions, in our principal research, bearing in mind that vibration mode measurement by sine-wave vibration using non-contact sensors is a low efficiency, but nonetheless highly reliable and easily assessable method, we worked on system development.

The principal system components consist of a laser displacement meter and a triaxial table to operate it, a number of measurement devices, and a control/computational management section. Vibration was performed using external vibration equipment.

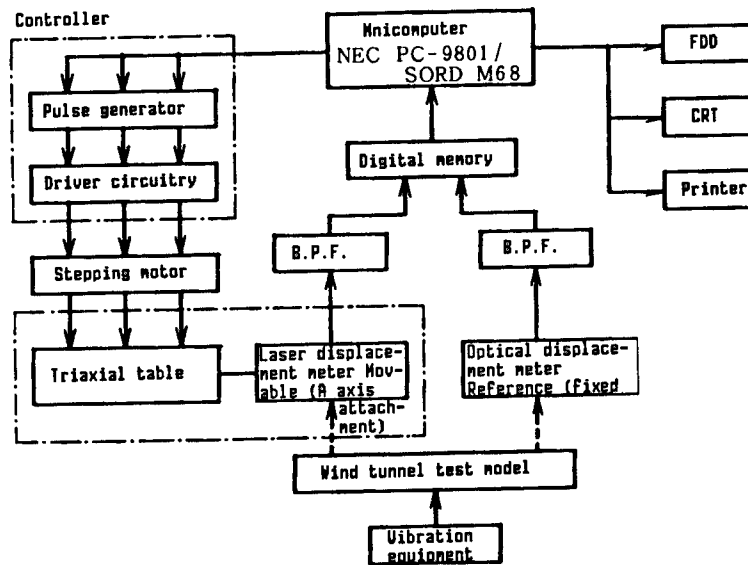
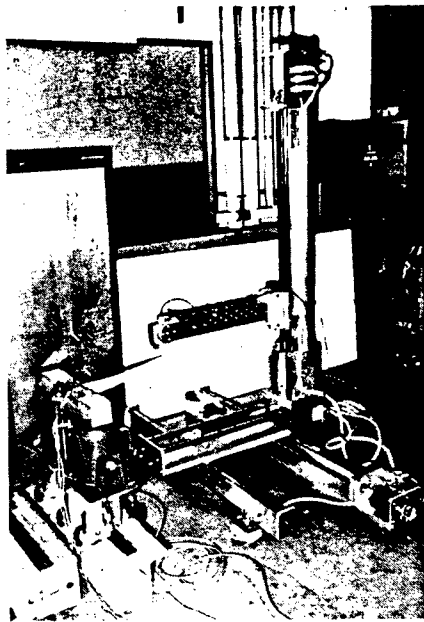


Figure 1. Block Diagram of the System

Figure 1 gives a block diagram of the system. The reason why a laser displacement meter was utilized as a vibration detection sensor is first that although contact methods (for example, an accelerometer) are fairly

effective when the weight of the sensor itself and its lead wires have no effect on the dynamic characteristics of the object being tested, they cannot be used on the light weight models mentioned previously. Furthermore, with non-contact methods, not only are those that utilize static capacity and eddy currents (and they often do) restricted as to measurement range and test object materials, but when surfaces are curved or materials non-homogeneous, output must be corrected for each of the points of measurement. They also have disadvantages such as the fact sensor shapes are relatively large and are not suitable for pinpoint measurement. On the other hand the laser displacement meter is virtually uninfluenced by object material, curvature, or room illumination and is capable of pinpoint measurement (its spotlight is less than 0.3 mm ϕ); static displacements can also be measured, it is convenient, and has many applications. As to the performance of the displacement meter that we used, its measurement range is ± 10 mm, resolution 2.5 μ m, and sampling speed 0.1 ms.

In order to set the wing vibration mode, measurements must be taken at a minimum of 10 measurement points. At this point measurement points must be set up while keeping the sensors at rated test distances. In order to measure with single sensors at all of the points, three dimensional movement must be accomplished with great speed and accuracy. Because this kind of position placement has always been done by hand, there have not only been problems with accuracy and repeatability, but it has also required time and effort. Accordingly, we developed and built a triaxial table with a stepping motor for moving the sensors. Keeping in mind the maximum values for models used in wind tunnel tests, the triaxial table's range of movement was set at X axis 1,000 mm, Y axis 600 mm, and Z axis 1,000 mm. Overall positional accuracy was better than ± 0.1 mm. An outline of the triaxial table is given in Photograph 1.



Photograph 1. Outline of Triaxial Table

Using a small computer, the control/computational management section controls the entire measurement process, including the control of the movement of the triaxial table, vibration mode measurement, data transmission, computational management, display of the results, and printer output. With this, because the latest vibration mode results can be automatically obtained by the operator merely entering commands in accordance with the CRT screen display, we achieved great improvements in speed and simplification. Moreover, because the system uses external vibration equipment, tests using the impact hammer and random vibration methods were possible through the incorporation and use of the triaxial table and other external modal analysis equipment. We can expect even higher reliability values because of comparative studies done on the results of multiple tests and reductions in testing time.

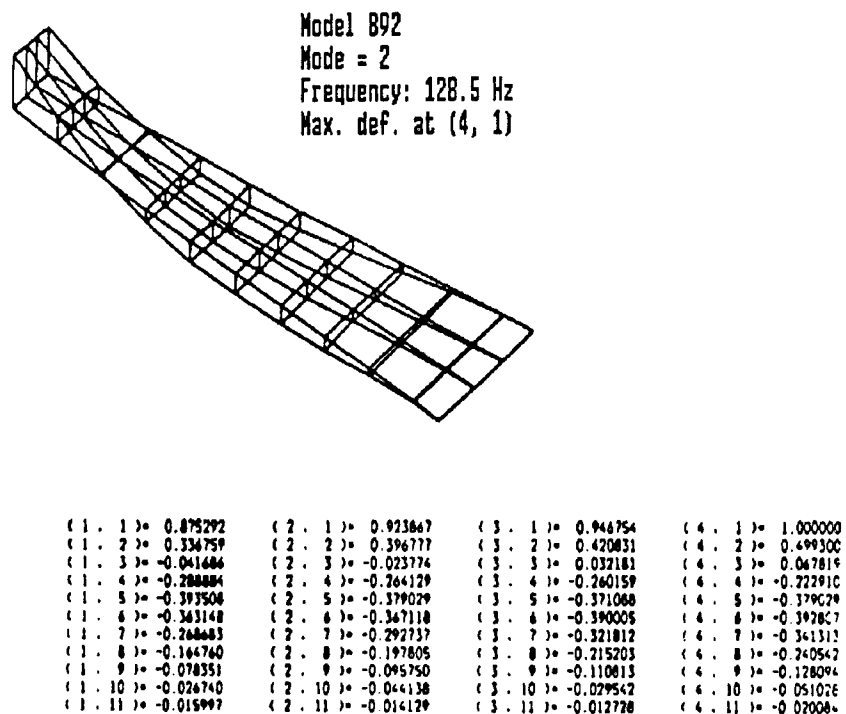


Figure 2. Example of Test Result Output

At this point, although we have taken vibration mode measurements on models for only one series of wind tunnel tests using this equipment, we obtained extremely good data, and verified its indispensability to flutter calculation data. Figure 2 gives an example of test result output. In the main system we used a common personal computer for the control equipment. The software that we produced was based on BASIC so it can be used by others and expansion is possible. Because the triaxial table is unitized and inspection is not necessary for movement and set-up, it also has the advantage of mobility. We are continuing with improvements in both hardware and software and plan to perfect the system.

Low Speed Wind Generator Completed

43062085 Tokyo KOGIKEN NYUSU in Japanese Mar 88 pp 8, 9

[Article by S. Suzuki, Second Aerodynamics Section: "Gust-Level Wind Generator Equipment for Aircraft in Large-Scale Low-Speed Wind Tunnels Completed"]

[Text] The principal gust-level wind generator equipment was planned to establish previously published ACT technology/gust-level load reduction tests (GLA).

Gust-level generation theory involves methods utilizing induction currents generated from one concentrated free eddy flowing from a wing tip. As shown in Figure 1, the main apparatus utilizes gusts from free eddy induction currents generated from four gust generator wings.

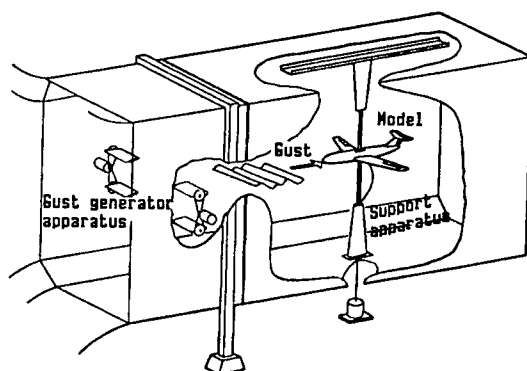


Figure 1. Conceptual Diagram of Gust-Level Wind Load Reduction Test

Assuming that the four concentrated free eddies flow back straight from the gust generator wing tips, we determined the design by calculating the proper aspect ratio, wing distance, and gust size, building scale models with four shapes based on these calculations, conducting preliminary tests on a pilot large-scale low-speed wind tunnel, and measuring gust airflow.

The installed gust generator was built with a maximum wind speed of 50 m/s and a maximum driving frequency of 10 Hz (sine wave $\pm 5^\circ$ amplitude), suitable not only for ACT technology tests, but for various other wind tunnel tests as well. By varying the driver signal, it can generate gusts ranging from sine wave to random wave, and the installation and removal of the generator wings can be performed easily. As a result of calculations and preliminary testing, the generator wings are type NACA 64012, rectangular, with a length of 0.9 m and a chord length of 0.5 m. Based on design values, wing interval was set at 0.91 m relative to the delivery mechanism. Figure 2 shows the installed gust generator on the left side. The power source for the gust generator driver is a 6 kW AC servo-motor. Transmission to the gust generator wings is via toothed belts.

Figure 3 shows the gust generator driver signals, the angle of attack for the generator wing, and the output waveforms in the center of the wind tunnel for a uniform wind speed of 35 m/s. Although very small higher

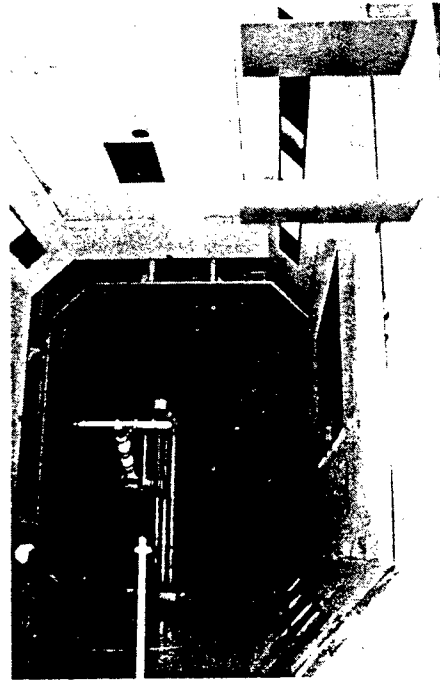


Figure 2. Installed Gust Generator Wings (Left-hand-side)
Speed Vector Determination Equipment Is in Back

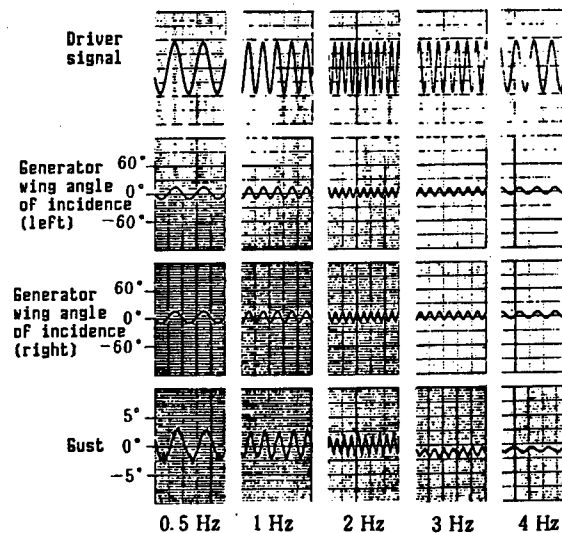


Figure 3. Gust Generator Wing Angle and Gust Output Waveform
for Generator Driver signals, 35 m/s Wind Speed,
Gust Output (Center of the wind tunnel)

harmonics lie within the fundamental wave of the gust output waveforms, these higher harmonics are wind tunnel flow variations originating in the number of blades and number of revolutions of the wind tunnel blower. Figure 4 shows the transmission relationship between generator wing angle

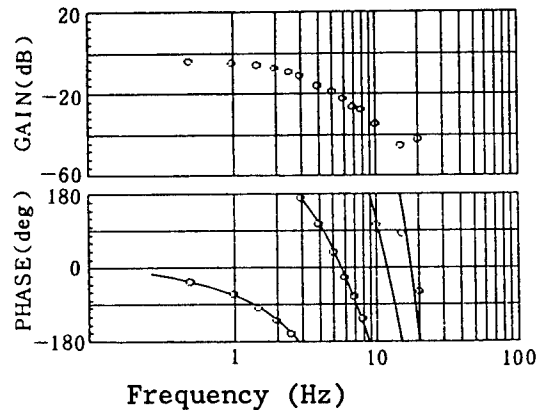


Figure 4. Transmission Relationship Between Generator Wing and Gust Flow, Wind Speed 35 m/s, Phase Lines Are Theoretical Values

of incidence and gust airflow; the top figure shows gain (amplitude rate) and the bottom figure shows phase. The solid lines in the bottom figure are expressed in the following equation by phase variations when eddy lines are assumed to flow in a uniform current.

$$\phi_g = 2 \pi Xf/V_\infty$$

X is the distance from the back edge of the generator wing to the measurement apparatus, f is the vibration frequency of the generator wing. Functional testing of the gust generator verified wind speed of 50 m/s with a generator wing driver of 10 Hz ($\pm 5^\circ$). Characteristic tests for gust airflow were performed at wind speeds of 25 m/s and 35 m/s. As a result of these tests, we confirmed that with generator wing angles of incidence of about 1/5, gusts in a range of nearly uniform airflow were 3.5 m wide and 1.2 m high in the center of the wind tunnel. This makes it adequate not only for ACT experiments, but for various other wind tunnel tests as well.

Our apparatus will be put to immediate use in GLA tests on the ACT aircraft elasticity models presented in a previous issue of the KOGIKEN NYUSU.

Numeric Simulation of Ultrasonic Combustion

43062085 Tokyo KOGIKEN NYUSU in Japanese Mar 88 pp 9-12

[Article by the Calculation Research Office, Numeric Analysis Section]

[Excerpt] In the research and development of the space shuttle and AOTV which are considered especially important to future space development, it is thought that there will be a very great role to be played by the numerical simulation of ultrasonic flows involving chemical reaction/vibration non-equilibrium. This is because testing under actual operational conditions is extremely difficult. It is also due to the fact

that because of recent astonishing advances in numerical computers, it has become possible to perform with relative ease flow calculations which heretofore would have been considered difficult.

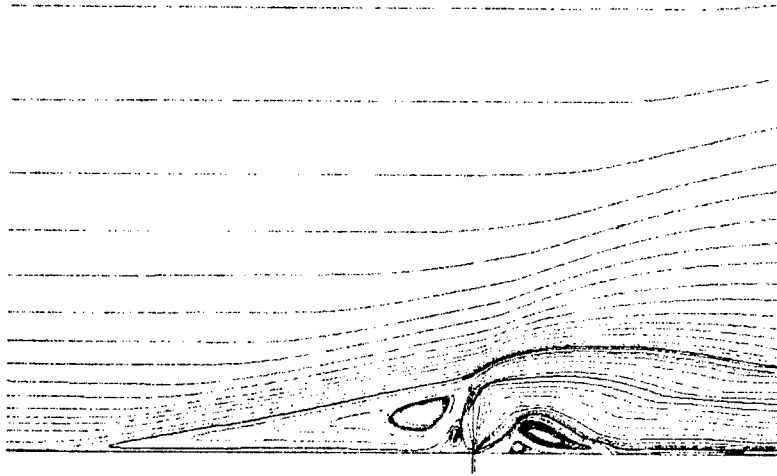


Figure 1. Example of Computations When Hydrogen Jets From a Slot on a Flat Surface (Non-combustion)
Main Flow Conditions: N_2 80%, O_2 20%, $M = 2.5$,
 $T = 130$ K, $P = 169000$ Pa
Jet Conditions: H_2 100%, $M = 1.0$, $T = 243$ K,
 $P = 728000$ Pa

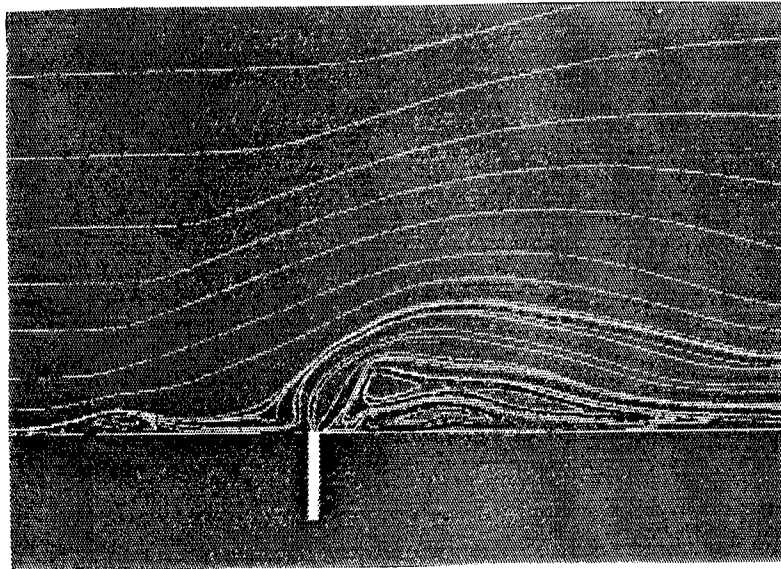
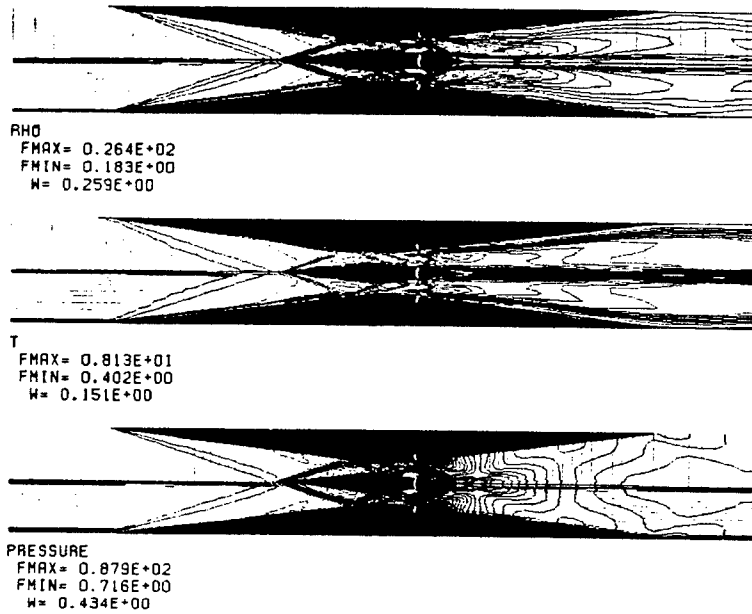
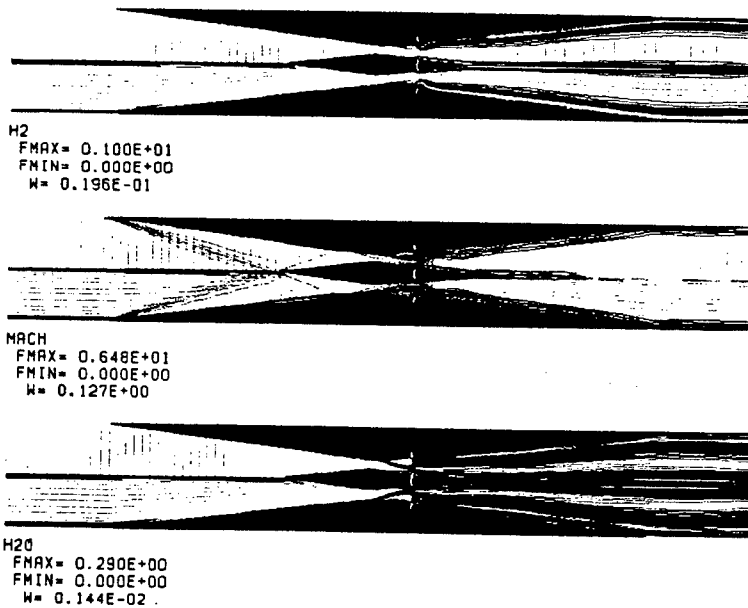


Figure 2. When the Hydrogen Burns
Main Flow Conditions: N_2 80%, O_2 20%, $M = 2.7$,
 $T = 800$ K, $P = 72800$ Pa
Jet Conditions: H_2 100%, $M = 1.1$, $T = 242$ K,
 $P = 728000$ Pa



(a)



(b)

Figure 3: Combustion Within a Strut Scram Jet Inlet
 Main Flow Conditions: N_2 80%, O_2 20%, $M = 5.03$,
 $T = 335$ K, $P = 3546$ Pa
 Jet Conditions: H_2 100%, $M = 1.05$, $T = 246$ K,
 $P = 254824$ Pa

We have recently brought forth in very general form an aerodynamic matrix for real gases with chemical reaction/vibration non-equilibrium and we successfully applied a TVD scheme which clearly captured the discontinuities in the physical quantities of the shock waves which have been used successfully on ideal gases. In ultrasonic combustion flow there have been cases where the solution either vibrated rapidly or sat dully under ordinary differential schemes in the presence of various discontinuities, so we really needed a TVD scheme for reactive liquids. For the most part, recent computations that we have performed have concerned problems in H_2-O_2 reaction systems, which are important to the research and development of the scram jet engine. We performed the computations according to the Rogers 2-step reaction model, the Westbrook 17-step reaction model, and the Oran 24-step reaction model. When performing three-dimensional computations, there are 10 independent variables for including inert gases in the Rogers model and there are 14 in the Westbrook and Oran models and it cannot be denied that these are unusually serious computations on present-day computers. One future subject for reaction models is which of their many many problems to choose. Numerical computation has been performed using generalized Harten-type TVD schemes generalized principally for real gases. In regard to terms generated in chemical reactions, we integrated using the point implicit method using LU decomposition and we used ADI and simplified Euler explicit methods for time integration. Figures 1 and 2 show the results of jetting hydrogen out of a slot on a flat surface. Figure 1 very clearly captures the well-known flow structure with shock waves and the peeling away of boundary layers in tests without combustion. Figure 2 is an example of analysis with combustion where flow conditions have changed. Figure 3 shows the result of analysis on flows with combustion inside a scram jet engine under conditions the same as those of NASA's Drummond. We also recently performed numerical computations for tests performed by the National Aerospace Laboratory's Sumida Branch Office's Solid Fuel Rocket Research Office and we found that in all cases we could perform the computations virtually without problems. We will try to send in a detailed report of the results at the next available opportunity.

Space shuttle research and development has begun at the National Aerospace Laboratory and the necessary research into ultrasonic combustion devices has been performed experimentally for the most part, led by the Sumida Group. We feel that this kind of numerical analysis has already advanced research and development and hopefully will perform some kind of role.

13008/9365

Biotechnology Applied to Fish Products

43066081 Tokyo KAIYO KAGAKU in Japanese Mar 88 pp 190-196

[Article by Oji Okada, Magari Branch Farm, Hokkaido Fish Hatchery: "Fish Breeding by Biotechnology"]

[Text] Abstract: New technology developed by chromosomal manipulation of fish is quite remarkable. Sex control and infertility techniques have been developed in the attempt to increase the efficiency of fish farming. Also, breeding using haploid formation is being developed. I report here on the status of the research and development on salmon trout and its application.

Introduction

Research and development of biotechnology on fish have been carried out mainly on sex control and chromosomal manipulation. Especially, the method of selecting male or female at will, and infertility techniques are close to commercialization and are receiving very much attention. There are also DNA level developments, such as the introduction of exogenous genes into the first stage embryo and the industrial production of growth hormone from *Escherichia coli* that contains the growth hormone gene introduced by recombinant DNA technique. Applying these techniques and using the materials produced by such techniques, it is hoped that the quality of breeding strains can be improved and the management of the industry will become efficient. Data on fish breeding, mainly about technological development and its application, are being collected throughout Japan.

Salmon trout are the author's research subjects. The development of three technologies: 1) sex ratio control technology using sex reversal, 2) infertility technology using polyploidy, and 3) development of a breeding method based on female sex generation will be described as well as the prospect for commercialization.

Sex Ratio Control Technology

The sex ratio in higher organisms is usually 1, and except for some exceptions, reproduction is carried out by a male and female pair to produce offspring. In commercial animals, however, due to differences in production efficiency, a choice is often made to breed only one sex or the other. In

chicken breeding and dairy farming, only the females are selected for breeding and the males produced in equal numbers are used for other purposes. Even in fish, there are many cases where the commercial value differs depending on the sex; especially in Japan, where fish roe is a favorite food, females cost more (such as salmon, pollack, herring, smelt, etc.). In the fish that are reproduced by artificial insemination, it is advantageous for egg production when there are many more females, making efficient production possible. Furthermore, in many fish species, the female and male show differences in growth rate, age of maturity, and survival rate. Thus one can expect increased production and more efficient production by determining the strain that is suited to the purpose and form of production. Thus, to increase fish culture and production, sex ratio control is regarded as a very effective technique, and has been well studied using such fish as salmon trout, tilapia, flounder, and loach. Sex control techniques on salmon trout, especially on rainbow trout, will be described.

1) Genetic Sex Determination and Sex Differentiation

Male and female are separate entities in most higher organisms, and the genetic sex is determined by the combination of sex chromosomes. There are two kinds of sperm with different sex chromosomes (X-sperm and Y-sperm) in the species of the male hetero-type (XX-XY type) organisms, and two kinds of egg with different sex chromosomes (Z egg and W egg) in the female hetero-type (ZW-ZZ type) organisms. In the sex where its sex chromosome is homogeneous, i.e., the gamete contains only one kind of sex chromosome, the gamete crosses with the two kinds of gametes of the sex that contains two heterogeneous chromosomes to produce the next generation of 1:1 male and female. Genetic sex is determined at the moment of fertilization. The reproductive cells at the early embryonic state, called initial undifferentiated reproductive cells, are undifferentiated. At a certain period during development the undifferentiated reproductive cells differentiate to the genetically predetermined sex according to the combination of sex chromosomes. This period is called the sex differentiation period. After the sex differentiation period, the genetic sex predetermined at the time of fertilization is expressed in the reproductive glands.

In many fish, male and female are different; however, there are many types of hermaphrodite fish such as the simultaneous development hermaphrodite, a hermaphrodite in which the female sex matures first, and a hermaphrodite in which the male sex matures first. Thus, fish are considered to be low in sex differentiation compared to other vertebrates. In the fish species whose male and female are separate, the genetic sex is determined by the combination of sex chromosomes. However, fish chromosomes are in general small and numerous so it is rather difficult to differentiate sex chromosomes from the nucleus type; there are only a few fish species whose sex chromosomes can be distinguished from the nucleus type (Thorgaard, 1977).

Sex chromosomes and sex differentiation in fish have been well studied in medaka (TN: killifish) and gold fish. Using these two fish as the materials, Yamamoto (1953, 1955) attempted the sex reversal with sex steroids in order to study sex chromosome types and the mechanism of sex differentiation. In

the experiments using medaka which is an XY type, genetic females (XX) were converted into functional males by oral administration of the male hormone, and in crosses with normal females, it was shown that all female F1 can be obtained. It was concluded that the production of all female F1 is due to the production of only X sperm by the converted male fish (XX). Similarly, genetic males (XY) were converted to functional females by the oral administration of female hormone, and when crossed with normal males, the ratio of one female to three males F1 was obtained, indicating that the F1 males are YY type. YY males produce only Y sperm, and when crossed with normal females, all male F2 can be obtained. Similar results with gold fish have been reported (Yamamoto and Kajishima, 1968), proving from the sex ratio in F1 of the conversion fish that the sex chromosome of the two fish is an XX-XY type.

From a series of studies, Yamamoto (1969) showed that by administering an appropriate amount of sex steroid during the sex differentiation period it is possible to reverse sex in either direction: to convert genetic females into males, or to convert genetic males into females, indicating that sex reversal fish can functionally mature. These experiments by Yamamoto were carried out to observe sex conversion, and the F1 sex ratio is used as a method to explain the mechanism of sex differentiation and the type of sex chromosome. However, the result obtained is not only interesting biologically; the technique is a very effective method to control sex ratio. Thus in recent years similar experiments have been carried out with many other fish. It has been shown that sex reversal and sex ratio control are possible in the following fish: guppy (Takahashi, 1975a, 1975b); tilapia (Nakamura and Takahashi, 1973, Nakamura, 1981); rainbow trout (Okada, 1973, Okada et al., 1979, Johnstone et al., 1978, Johnstone et al., 1979, Okada, 1985); Atlantic Ocean salmon (Johnstone and Youngson, 1984); sakura trout (Nakamura et al., 1974, Nakamura, 1981); and silver salmon (Hunter and Donaldson, 1982).

Using rainbow trout as the organism, the author studied the formation of all female fish from XX type male and all male fish from YY type male.

2) The Formation of XX Type Male and the Production of All Female F1

The general age of maturation for rainbow trout is 24 months for the male and 36 months for the female; the male matures approximately 1 year earlier than the female. Because of multiple spawning, the rainbow trout species does not die all at once like the salmon species which all die at maturation. However, there are many disadvantages during the spawning season, such as the stopping of growth and the qualitative deterioration and decrease in the meat. The 1 year slower maturation time of the female is an advantage for farm production compared to the male. The increase in female ratio in seed egg production is also linked directly to production increases.

The sex chromosome type in rainbow trout was unknown, but the formation of XX type males from genetic females was attempted, assuming that it was an XX-XY type sex chromosome. First, in order to clarify the right period for

the administration of the male hormone, oral administration of the male hormone was carried out at various stages during development. The male hormone used was 17 alpha methyltestosterone (MT). It was added to commercial food at a concentration of 5-0.8 ppm. The fish confirmed to be genetic females were used as the test fish, which were divided into four test groups after floating. Fish were raised as usual throughout the period except for the period of hormone administration. The conversion to males was examined after 12-15 months in search of the effective administration period for the conversion to males.

(a) In the eight test areas where MT administration began after floating, the administration period was delayed for a week for each area.

(b) In the eight test areas where the start of MT administration was delayed for a week for each one, the administration was completed at the 8th week after floating.

(c) In the nine test areas where the MT administration period was fixed at 8 weeks, the beginning of administration was delayed for a week for each area after the floating.

(d) In the seven test areas where the MT administration period was fixed at 2 weeks, the administration was done at a different period every 2 weeks after the floating. The MT concentration in the food was 5 ppm for groups (a) and (b), and 0.8 ppm for groups (c) and (d).

The results are shown in Figure 1 [not reproduced]. When the oral administration was started within 2 weeks after floating and continued for 8 weeks, a conversion rate of more than 90 percent was obtained, showing clearly the appropriate period of administration for the male conversion.

Next, to study the proper concentration of male hormone, the test administration was carried out on two steroids, MT and 11-ketotestosterone (11KT). Genetic females were used as the test fish, and oral administration was carried out 8 weeks after floating. In 19 test areas the MT concentration in the food was in the range of 0.01-100 ppm, and in nine test areas the 11KT concentration in the food was in the range of 0.01-100 ppm. Each area was observed for the rate of male conversion. The result is shown in Figure 2 [not reproduced]. With MT, the rate of male conversion showed a curve with a peak at 0.5-1 ppm, whereas with 11KT, the peak appeared at 5 ppm, and when the concentration was below or higher than this concentration, the rate decreased rapidly, indicating an extremely narrow range of effective concentration.

The technique for the formation of XX type male sex conversion at a high rate in rainbow trout was established by these two experiments. Hormone administration is needed only once during the young fish period, and thereafter with continued usual feeding, the fish mature into functional males. XX type males produce sperm and function as males, but their sex chromosomes are female and therefore, they are in general called pseudo-males. Some pseudo-males show abnormal spermat ducts, but most of the pseudo-males

mature like normal males, and it is possible to collect sperm. In crosses with normal eggs, no abnormalities such as the reduction of hatching or the appearance of abnormal fish can be found. Solely by performing the usual fertilization, all female fish can be obtained. The females thus obtained are all normal females genetically as well as functionally, and when crossed with normal males, a 1:1 next generation is produced, confirming the fact that there are no problems in the use of this technique.

Using pseudo-males in rainbow trout, mass production of an all-female seed strain is in progress, and in private salmon trout farms, the technique is already being utilized on a commercial scale. The all-female strain technique is quite effective for the production of the large fish recently in great demand and for the production of breeding strains. In addition to the realization of efficient breeding and production, great hopes exist for management in the reduction in the work load for selection, and for achievement of a system for year-round shipping. Figure 3 shows schematically the production of all females from pseudo-males.

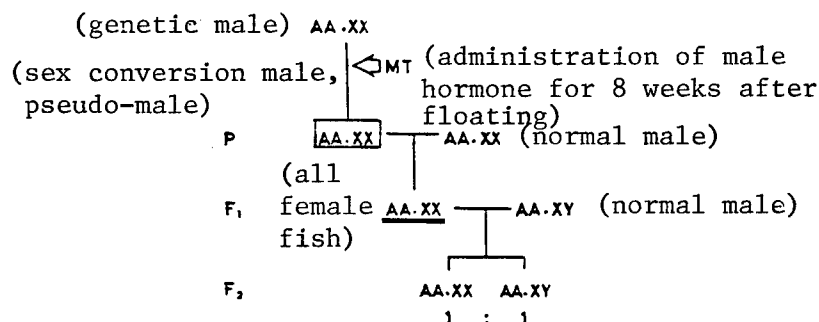


Figure 3. Production of all female fish by XX type male (pseudo-male).
AA: normal chromosome; XY: sex chromosome.

3) Formation of YY Type Male and Production of All Male Fish

We next worked on the formation of YY type male that forms only Y sperm, and on the technique of all male fish production. It is clear from earlier experiments that the sex chromosomes of rainbow trout is an XX-XY type. When a genetic male (XY) is sexually converted to a functional female to form an XY type female (pseudo-female) and crossed with a normal male, there will be YY type males in the F1 males.

With a mixture of male and female young rainbow trout as test organisms, female hormone (esterone, Est) added to the food at the concentration of 10-200 ppm was orally administered 8 weeks after floating. After the completion of administration, the usual feeding was continued and at 36 months of age, the sex ratio was examined. The results showed an increase in the female ratio observed at the 50-200 ppm high concentration area, suggesting a conversion to female. Mature females were taken from each test area, and the eggs from each individual fish were crossed with a normal male and the F1 sex ratio for each individual was examined. Among the 17 females

tested, 14 produced 1 : 1 F₁, and three produced 1 female : 3 males F₁. This is consistent with the sex ratio produced by the cross of XY (pseudo-female) and XY (normal male), confirming that the three females were XY type females (pseudo-female) formed as the result of the conversion of genetic males into functional females. In the F₁ males produced by pseudo-females, it was hypothesized that XY males and YY males would appear with a ratio of 2 : 1, but no differences were recognized by external observation. After the maturation of the F₁ males, 12 were crossed individually with normal females and the sex ratio of the F₂ was determined. Three males produced all male F₂, confirming that these were YY type males. The YY type male is generally called "super male," but the reproductive function is normal and its external appearance shows no differences from that of the XY male.

The YY type male is lethal to *Drosophila* and mammals; in this experiment, however, all survived without significant differences from the theoretical value. Yamamoto (1969) reports the production of YY type males in medaka and gold fish, and the YY male reported here is the third case reported. All groups of males produced by super male had normal reproductive functions and produced the next generation at a ratio of 1 : 1. Such males have been confirmed to be functionally and genetically normal. The growth of male rainbow trout during their youth is considered advantageous for the production of small fish for cooking with a sweet sauce. Figure 4 shows schematically the production of all males by YY type males.

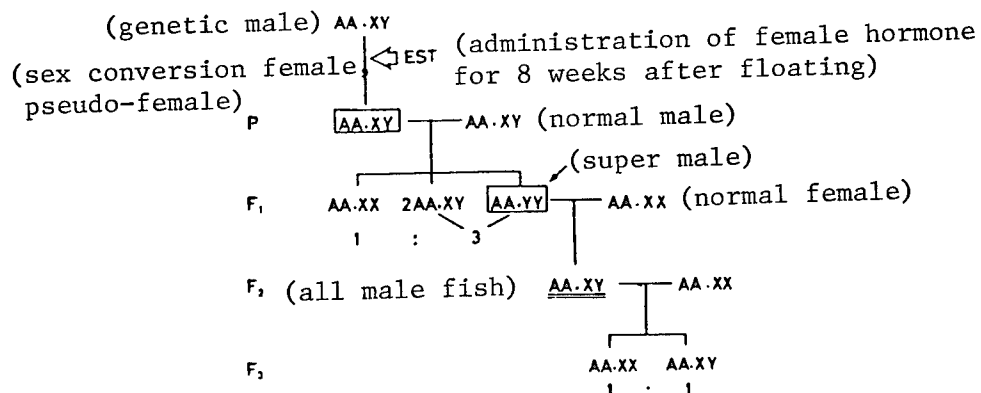


Figure 4. Production of all male fish by YY type male (super male).
 AA: normal chromosomes; X,Y: sex chromosomes.

4) Application to Other Salmon Trout

Techniques using pseudo-male or super male to produce female or male at will have been developed for rainbow trout. Similar attempts have been carried out on other salmon trout fish; and it is now possible to produce all female by pseudo-male in silver salmon (Hunter, 1982) and in Atlantic salmon (Johnstone and Youngson, 1984). In recent years, the sea farming of silver salmon is flourishing in Japan, and therefore, the introduction of the all female technique would be a big plus for efficient production. Large-scale

sea farming of Atlantic salmon is being carried out mainly in Northern Europe. The fish size in this farming is large at 2-4 kg, and greatly influenced by the maturation of sex. Together with infertile fish strains, the demand for the technology for all female fish is quite strong and is being studied for commercialization.

The sakura trout is a unique resource of the Far East and has a complicated ecology depending on the sex, such as the appearance of the O^+ early matured male, and the difference in migration to the sea by the male or the female. The increase of the resource by the release of eggs produced in a pond is also actively carried out; thus, the introduction of all female fish will be quite effective to increase business efficiency. Based on the knowledge obtained with rainbow trout, we have undertaken the work for the production of all female sakura trout.

Sex reversal by sex hormone must begin with the dosage during the sexually undifferentiated period and continue until the completion of sex differentiation. Namely, one must grasp the period of sex differentiation, and administer at the right period, otherwise no effect can be obtained. Using the differentiation of the primary oocyte into the secondary oocyte as an index, the sex differentiation into a female was observed on such salmon species as sakura trout, salmon, and silver salmon. The result clearly indicated that these fish differentiate early compared to rainbow trout. In rainbow trout, the secondary oocyte appears 1-2 weeks after floating, whereas in the salmon species many secondary oocytes are found in the ovary at floating, indicating that the sex differentiation has already started. Accordingly, in such fish species, no sex conversion occurred with oral administration after floating. Thus, the hormone was administered by soaking in hormone solution prior to floating. Sakura trout confirmed to be genetically female were used in the test. Right after hatching, they were soaked in the MT solution of 1-10 ppm for 2 hours at 5 to 7 day intervals. Five or six treatments were done before floating, and after floating, food containing 1 ppm of MT was given for 60 days. A more than 90 percent conversion rate was thus obtained, and functional pseudo-males were formed. In the cross between pseudo-male and normal female, all female F1 was obtained just as with the rainbow trout. Similar to sakura trout, the technique for the production of all females has been established, and it was confirmed that the sex chromosome type is the XX-XY type. It was also confirmed that all F1 females are genetically and functionally normal females. Sakura trout live in the river for a year and then move to the ocean; however, in contrast to the females, all of which move to the ocean, most of the males remain in the river. Therefore, the increase of ocean resources by the release of young fish will be more efficient if all female young fish are released. This station is producing seed eggs from parent fish raised in a pond. The increase of females in the ratio is favorable for the increase in the production of seed eggs. A large amount of pseudo-males of sakura trout has already been produced, and several million all-female seed eggs have been produced.

Using similar technique, attempts are being made to produce pseudo-males in silver salmon, salmon, and Karafuto trout. It probably is possible to produce all-female seed eggs and to use the technique in large-scale business.

Infertility Technique by Increase in Chromosome Number

Sex maturation is required for reproduction; however, it is an inconvenient physiological phenomenon from the viewpoint of meat production or meat quality. Much energy is consumed in the maturation of reproductive glands and in reproductive behavior. During the spawning season, growth is suspended, meat quality deteriorates, and the number of dead fish increases, all adverse to fish meat production. The lower production efficiency related to maturation, and the cessation of shipping are large obstacles for management. Thus strains that do not mature are greatly desirable.

It is known that the infertile fish which occasionally appear in the hatchery are triploidy (3n) (Thorgaad and Gall, 1979). In recent years, the technique artificially to increase the ploidy of the chromosome has been developed, and thus it is possible to create artificial triploid infertile fish strains. The infertile technique combining chromosomal polyploidy and sex ratio control in rainbow trout is described here.

1) Infertility by Triploidy in All Female

Salmon trout eggs are spawned at the second maturation division period. After the spawning, the invasion by sperm becomes the stimulus and the maturation division that had been stopped at the mid division period is resumed to complete the maturation division by releasing the second polar body (n). Inside the egg the female pre-nucleus (n) fuses with the male pre-nucleus (n) to form a fertilized egg (2n), and soon the division of the egg begins.

A technique was developed to keep the second polar body inside the egg by obstructing the action of mitotic spindle in mature division by using high water pressure treatment immediately after fertilization (Onosato, 1983) or by using high water temperature treatment. When the egg is treated at a pressure of 650-700 atmospheres for 5-7 min by water pressure, or at 28-30°C for 7-10 min by high water temperature within 15 min after fertilization, the release of the second polar body can be prevented. Thus, the egg will contain the female pre-nucleus, n, the male pre-nucleus, n, and the second polar body, n, and these will fuse into one nucleus to form triploidy (3n) (Figure 5).

The rate of development for triploid fertilized eggs will be lowered somewhat, but in spite of the drastic treatment, young fish can be obtained at a high rate. The triploidy thus formed contains the same number of triploid females (XXX) fertilized by X sperm and of triploid males (XXY) fertilized by Y sperm.

Triploidy is assumed to be infertile because of the inhibition of maturation division due to the polyploidy of the chromosome. We therefore examined the maturation of each female and male. Unexpectedly, triploid fish produced mature fish after 24 months, and the secondary sexual characteristics were markedly expressed as in a normal male (2n male). At 36 months of age all males were confirmed to be mature. The sperm of triploids is presumed to be

abnormal in chromosomes, and in fertilizing normal eggs, the rate of hatching was very much reduced. The small number of young fish hatched were all abnormal and all died soon after. It is clear therefore that triploidy shows no infertile effect, and that because of the formation of sperm with abnormal numbers of chromosomes, they are genetically extremely harmful.

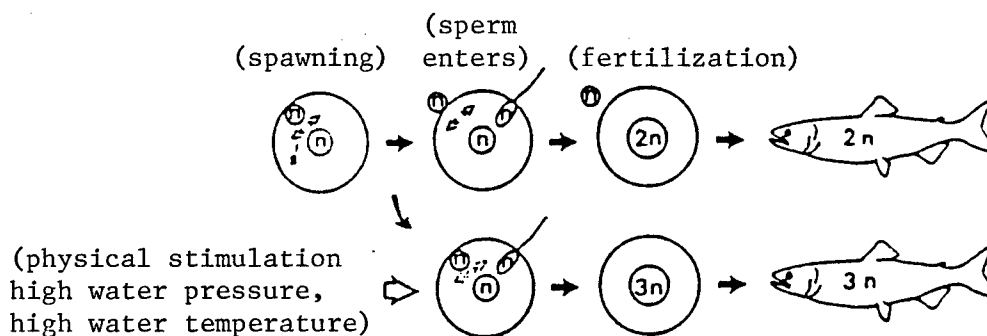


Figure 5. Triploidy based on physical stimulus. Top: Usual formation. Bottom: Polyploidy treatment S: Mitotic spindle.

On the other hand, triploid females ($3n$ female) did not produce mature fish up to 48 months of breeding. Most of the reproductive cells remained at the stage of primary oocyte, and although secondary oocytes could be seen occasionally, they had degenerated as seen from histological examination, confirming complete infertility. Accordingly, the simple formation of triploidy, because the male half of the triploidy will mature, will be of little practical effect; for complete infertility, the triploidy must be all female. Thus attempts were made to produce all female triploids by using chromosome polyploidy treatment after fertilization by pseudo-male sperm. Since pseudo-males produce only X sperm, XXX triploidy should be formed by polyploidy treatment. When the ploidy was examined, there were 85-90 percent triploidy with 10-15 percent diploidy, and thus infertile fish were produced at a high rate. The reason for the mixture of diploidy is unknown and should be improved in the future. This technique, however, appears to be an extremely useful infertile technique, because more than 85 percent of the fish produced are infertile and the remainder, 15 percent, are all diploid female. In the near future, as polyploidy is improved, the chance of commercialization will be increased by the development of mass production techniques.

2) Breeding Characteristics of Infertile Young Fish

Because a triploid contains 1.5 times the number of normal chromosomes, the diameter of the cell and the nucleus is correspondingly 1.5 times larger than normal. Therefore, the multiplicity is determined by measuring the diameter of red blood cells. Each cell should be 1.5 times larger, and therefore, if the number of cells is the same, the triploid should grow 1.5 times larger. However, as the cell grows larger, correspondingly the number of cells decreases; therefore, the growth during the immature period shows

little difference from that of diploidy. The growth acceleration effect based on infertility is due to the absence of growth cessation in the spawning period, and therefore, after the maturity, its growth is superior. Therefore, infertility is effective for the production of large fish that require continued rearing after the maturation age.

It has been pointed out that the ability of triploidy to transport oxygen is poor. Presumably, this is because of the corresponding decrease of the ratio of the surface area to the unit volume of the cell due to the increase in size of red blood cells. From the observation of their behavior, a decrease in tolerance has also been pointed out. The infertility technique based on all female triploidy is an effective method to produce large fish, but, except for maturation, there are still many unknowns in their physiology. One should understand clearly the characteristics of triploid young fish, and then plan their use.

New Breeding Technique by Female Development

The next generation produced by the fertilization of male and female gametes inherits the genes equally from both parents. If the next generation is obtained only from female gametes (egg) or from male gametes (sperm), they contain only the gene from one side, and the offspring will be very similar to the parent. The phenomenon of development from a gamete without fertilization is called parthenogenesis: female parthenogenesis develops from female gametes, and male parthenogenesis develops from male gametes. In either case, since only one parent's genes are received, the genes become progressively homogeneous, and by the second parthenogenetic generation, the organism is cloned. Those characteristics are useful to improve breeding, and the development of new breeding techniques is flourishing.

1) Technique for the Production of Female Parthenogenesis

The female parthenogenesis technique was developed in salmon trout (Onosato, 1983), and used in the production of young fish that contained only the egg's genes. In salmon trout, the entrance of a sperm into the egg is the stimulus to initiate the release of the second polar body, the fusion of the male and the female pre-nucleus, and the division of the fertilized egg, as previously described. Prior to the introduction of the sperm, the sperm is irradiated with gamma-rays or UV light to destroy the DNA in the head of the sperm. The irradiated sperm remains physically active, but is genetically inactivated. The inactivated sperm will enter the egg by active movement to trigger the fertilization phenomenon, but its DNA has been destroyed, and therefore cannot fuse with the female pre-nucleus of the egg. The egg remains haploid, and soon the development will stop. By reverting to diploid, the development continues, hatching resumes and young fish can be obtained. Thus, after insemination with inactivated sperm, when the eggs are treated with high water pressure or high water temperature to prevent the release of the second polar body, the female pre-nucleus (n) and the second polar body (n) will re-fuse and female parthenogenic fish (2n) can be obtained. Using this technique, female parthenogenic fish are obtained in salmon trout, such as rainbow trout, sakura trout, salmon, and

silver salmon. In others, this technique is also successfully used to obtain female parthenogenic fish in loach, gold fish, flounder, and tilapia.

The rate of development for female or male parthenogenesis is low, and the rate of mutation is great; therefore, there is room for improvement. However, when female parthenogenesis is taken as a technique for the production of breeding stock, the low development is not a big problem. It is important to unravel the mechanism of the low development rate and to quickly grasp the various characteristics of female parthenogenic fish.

2) Development of Breeding Method by the Female Parthenogenesis Technique

There are two characteristics in female parthenogenic fish. The first is that every gene is completely homogeneous. When the female parthenogenic fish is allowed to grow, and then the second generation female parthenogenic fish is produced, a clone with gene composition completely identical to the mother is obtained. Second, in the fish whose sex determination mechanism is the XX-XY type, all the female parthenogenic fish will be female. Since there is no genetic influence of the male Y chromosome, only females will be produced.

The first characteristic is extremely effective for breeding improvement which seeks homogeneity of the gene. The formation of a pure line by selective breeding takes 15-20 generations, and the permanent fixing of the strain takes years of time and enormous labor. When female parthenogenesis is used, genetically homogeneous individuals can be obtained in one generation, and a clone is formed at the second generation, achieving early fixing of the strain. There is promise of the creation of superior breeds by crossing the pure line produced by female parthenogenesis with others to make hybrids using conventional breeding methods.

The second characteristic of producing only females may appear to be useful for the production of all female young fish. However, the development rate is low and the technique requires complicated procedures; therefore, mass production is difficult. Furthermore, it introduces the different problem of homogeneous genes into the control of sex ratio. Thus, direct use of female parthenogenesis for the production of all female fish is unrealistic. The primary purpose of female parthenogenesis is as a technique for breeding. It is important, therefore, to elucidate the genetic mode in female parthenogenesis and to study its application for breeding.

Conclusion

New techniques of chromosomal manipulation are described, mainly on rainbow trout. The technique for the production of all female young fish using pseudo-males is firmly established and is at the stage of application. The production of pseudo-males requires time and labor; however, after the formation, just by carrying out the usual artificial insemination, all female young fish that are functionally and genetically normal can be obtained. It is a simple and sure technique. In the future when freeze preservation of sperm is developed, the spread of the technique will become

easier. The application of the infertility technique is near, though a few problems exist and the development of mass production methods need to be improved. In recent years, the demand for rainbow trout farming reached the limit, and thus it is hoped that the demand can be met by expanding the production of large fish. It is thought that by the use of the all female fish strain and an infertile fish strain, the efficient production of large fish will be realized and linked to the increased production. These techniques, just like the chick sexing technique in chicken farming, will become indispensable for the farming of rainbow trout.

The application of the techniques developed with cultivated fish can be applied to increase fish production. Mass production of an all female fish strain and an infertile fish strain is already being carried out in sakura trout, and the same situation will probably be seen in salmon and silver salmon within several years. In the farming and mass production industry, it is required to handle differently the organisms produced with these techniques. For the introduction into the mass production industry, it is necessary to examine, in addition to the assurance of safety as a food, the influence on ecology and the genetic effect on the naturally reproducing groups. The introduction of these techniques must be done on the premise of evaluation of each characteristic of the organism produced under the breeding environment and the accumulation of the data obtained by experimental release. These are the tasks that must be undertaken actively.

The study on the breeding by female parthenogenesis has not yet produced tangible results. Attempts are being made to explain the cause for the unstable development rate, the maturation of female parthenogenic fish, and the production of the second generation. The genetic characteristics are being unraveled. Advances in the research and development of breeding by female and male parthenogenesis are expected.

The breeding of aquatic animals is far behind agricultural products. Most production in the fishing industry is the catching of naturally produced wild organisms, and the introduction of strains is technically difficult and meaningless. However, in aquatic farming and fish cultivation, the quality of the strain is a big factor that affects the business. By using the new technology introduced here and conventional breeding techniques, it is possible to produce excellent strains. The advance of the research fields related to the breeding of aquatic organisms or genetic management is eagerly awaited.

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Nikkei Biotechnology News Update

D-Amino Acid-Specific Aminopeptidase Found

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 pp 4-5--FOR OFFICIAL USE ONLY

[Excerpt] Y. Asano, et al. of the Sagami Chuo Research Laboratory discovered an aminopeptidase specific to D-amino acids in a soil microorganism and succeeded in purifying it. The discovery of a peptidase that specifically recognizes D-substances is probably the first report in the world. "We searched the literature from the last 10 years and examined 2,000 aminopeptidases but found none that recognizes a D-substance" (Asano).

The use of this enzyme will allow the efficient production of D-amino acids from racemic mixtures of DL-amino acid amides. In addition, depending on conditions, it specifically binds D-amino acids, which is applicable to the synthesis of peptides containing a D-substance. However, they have not yet succeeded in peptide bonding the amino acids.

Asano, et al. screened enzymes that specifically act on D substances using D- and L-alanine amide as the substrates. The isolated enzymes were purified to about a 2,800-fold increase in specific activity in seven steps, which resulted in one uniform electrophoresis band. The molecular weight was 122,000, and the molecule is composed of two subunits of approximately 59,000. They have already determined a 30-amino acid sequence from the N-terminus. Heat resistance is up to 45°C. Asano stated "Since we determined that D substance-specific peptidases exist, we are continuing our screening in search of even better enzymes. We also found an enzyme that is stable at 50°C."

Applicable to a new mechanism for D-amino acid synthesis

Since D-alanine amide was used as the substrate for screening, the enzymes discovered were most active with D-alanine. However, they were also active with other D-amino acids and peptides having a D-substance at the N-terminus. On the other hand, they were totally inactive with L-substances or D-substances with a blocked N-terminus. By using this hydrolysis reaction, D-amino acids can be produced selectively from DL-amino acid amides. This procedure entails one less processing step than the method using L-substance-specific amino peptidases

developed by the Dutch firm, DSM. Kanegafuchi Chemical has a technique involving asymmetric hydrolysis of hydantoin it uses for manufacturing D-amino acids. However, Asano said "The manufacturing process using a D-amino acid-specific amino peptidase is advantageous for amino acids such as alanine that are produced in low yield by the hydantoin method."

Peptide synthesis still requires improvements

In addition, they also succeeded in inducing a peptide synthesis reaction in a water-saturated organic solvent by immobilizing this enzyme. When the methyl ester of DL-alanine and 3-aminopentane amide were added as substrates, only D-alanine was recognized and the two substances were amide-linked. However, success was limited only to highly reactive amino groups such as 3-aminopentane. They were unable to make a polymer using a D-alanine methyl ester as the only substrate. Asano explained, "Based on the reaction mechanism, it should be possible to synthesize all amino acids. The problem lies in the reaction conditions and equilibrium shifts." If reaction conditions are studied by setting specific goals, synthesis of D-amino acid peptides with enzyme technique may be realized.

New mechanism for D-amino acid synthesis

A racemic mixture of DL-amino acid amide can be synthesized in two reaction steps from aldehyde. The process is the same as the conventional method up to this point. Amino acid amide is a substance having ammonia which is an amide bound to the carboxyl group of the amino acid. When this amide bond is hydrolyzed with aminopeptidase, an amino acid results.

When a D-amino acid-specific aminopeptidase is used, it specifically recognizes only D-amino acid amides from the racemic mixture and converts them to D-amino acids. Following the reaction, D-amino acids are separated from L-amino acid amides. The L-amino acid amides separated are chemically racemized and reused. Thus, theoretically, it is possible to recover 100 percent of the mixture as D-amino acid.

On the other hand, a method using L-amino acid-specific aminopeptidase inversely produces L-amino acid and D-amino acid amide from DL-amino acid amides. Subsequently, the D-amino acid amide is converted to a D-amino acid by a chemical reaction. Thus, it requires one additional reaction process.

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Developing Disease-Resistant Carrot

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[Text] Yokohama Ueki is developing a disease-resistant carrot using a technique of cultured cell selection in a medium containing leaf blight toxin. They confirmed that the toxin produced the diseased sign in the carrot's true leaves and succeeded in selecting cultured cells with partial resistance. Details of the

study will be presented at the meeting of the Japanese Society of Breeding.

Leaf blight is one of major diseases of carrots. It kills leaves by turning them black and causes damping-off. Occasionally, it leads to a sharp reduction in yield. The causative agent of the disease is a toxin, "ziniol," secreted by *Alternaria carotae*. Usually, the presence of more than 1.0 mM ziniol in the medium inhibits callus growth and colony formation of suspended cultured cells. Therefore, the above company treated suspended cultured cells of 5 varieties for cultivation by immersing them in a 4-mM ziniol solution for 24-48 hours and selecting colonies that continue to grow. Although the majority of the cells used in the experiment died, they were able to obtain a colony from among the "5-inch US spring-sown" varieties ("US" is the brand name for Yokohama Ueki) that continued to grow even after treatment.

"We would like to study whether it is a stable resistance character by repeating the selection process 2-3 times more," said the laboratory chief, T. Oridate, of the Yokohama Ueki. "Despite our persistent search so far, no line resistant to the leaf blight has been discovered. There may not be a gene for true resistance. However, we are hopeful that we may be able to obtain through cell selection a line that shows only slight symptoms even when infected" (Oridate).

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Short-Stem Rice Plant Developed

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[Text] Mitsui Toatsu Chemical succeeded in selecting a short-stem strain of rice plants from cultivated varieties by using cell mutation through tissue culture. They have already repeated selections in the field, and the results so far show that the character is stable. They will experiment with the strain in a greater scale this year and plan to register it as a variety as early as this year. The short-stem rice plant is less likely to lodge, making it easier to cultivate. It is also suitable as a mother plant for hybrid rice. The company presented the results at the meeting of the Japanese Society of Breeding held in Utsunomiya on 2-3 April.

Hybrid rice is produced by heterosis and has the potential for record-breaking yields compared to existing varieties. Especially for a firm planning to enter the rice business, it is analogous to holding a trump card. The rice research group of Mitsui Toatsu is also expending its entire time and energy in the pursuit of a hybrid rice from cultivated varieties.

However, individuals produced by heterosis usually grow taller than the parent strain. Tall rice plants are susceptible to lodging, which makes cultivation difficult. Therefore, they began to produce a short-stem strain by using anther and protoplast cultures.

Two rice varieties, "Nipponbare" and "Sasanishiki" were used. They cultured the "Nipponbare" anthers and selected eight short-stem plants from the

redifferentiated individuals as new strains. In addition, they cultured both "Nipponbare" and "Sasanishiki" protoplasts and similarly selected 18 and 37 strains, respectively. By sowing the seeds harvested from these strains, they obtained progeny for further selection. All progeny maintained the short-stem character, which averaged 6.8-cm shortening for the "Nipponbare" anther cultured strains and 10.18-cm shortening for the protoplast cultured strains. An average of 7.55-cm shortening was confirmed with "Sasanishiki," as well.

This year, they planted a strain with relatively high yield at the experimental field (2.5 ha) in Higashi-mura, Ibaraki Prefecture and plan to gather data such as yield and character stability. S. Fujii, chief investigator of the Life Science Development Division of Mitsui Toatsu Chemical disclosed an outlook stating, "The past results show that uniform quality has been achieved in the number of grains or grain length. We will wait for this year's results, but we expect to file for variety registration before the year ends."

On the other hand, the company established a technique to produce cybrids by asymmetric cell fusion as a method to transduce the male sterile gene required for the development of a hybrid rice maternal line. They presented the results at the meeting of the Japanese Society of Breeding. In addition, they disclosed that they have begun research to identify a gene for recovering fertility in order to develop a paternal line. Mitsui Plant Biotechnology Institute, which was organized by the Mitsui Group, is currently learning techniques, and the company is also considering that the Institute adopt the cloning of the above recovering gene as a research project.

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Indica Rice Regenerated from Protoplast

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[Text] The Plant Engineering Institute succeeded in regeneration of a plant from the protoplast of indica rice, a major cultivation species, and reported the results at the meeting of the Japanese Society of Breeding held in Utsunomiya on 2-3 April. In the past, regeneration from protoplasts was limited to japonica rice and there were no reports on regenerating indica species. It has been pointed out that there is the possibility that the indica species successfully regenerated this time has some characters similar to the japonica species. Having discovered an indica species that regenerates, it is now possible to improve on indica by cell fusion or gene recombination and a path has been opened for transduction of indica species genes into japonica species.

A technique to regenerate a plant from protoplasts has not yet been established in many grain species. However, in recent years, there has been a growing impression that the regeneration of rice plants is exceptionally easy. However, this is true only in the case of japonica species. The japonica species used as food in Japan represent, in fact, only a small number among the world's grains. In addition to Japan, it is cultivated only in Korea and the northeastern region of China. More than 80 percent of the 300 million tons of rice produced in the world comes from

indica species. Consequently, an improvement in the indica species has a big ripple effect on the world's vast market.

The Plant Engineering Institute began regeneration experiments on the 14 varieties gathered from all over the world. As a result, they successfully regenerated four varieties: "Chinshiborrow [phonetic] II" (Indian origin), "63-83" and "IRAT109" (African origin), and "Chokoto [Chang hsiang tao]" (Chinese origin). These four varieties had features in common in that their calluses resembled those of the japonica species and could be readily cultured in suspension. Eight of the ten species that did not regenerate formed white compact calluses, and the two remaining varieties formed both types of calluses.

K. Tanaka, chief of the Development Division of the Plant Engineering Institute, stated "We are not yet at a stage to challenge any indica varieties. It is not yet clear how close the regenerated indica is to japonica species. If a regeneration system can be established using a protoplast as in this case, it will also be possible to improve indica by genetic manipulation. In addition, the limit in crop improvement by genetic exchange among japonica varieties may be overcome by introducing genes from indica." The company will proceed with the studies on differentiation conditions for the indica varieties that failed to redifferentiate and is also considering cell fusion experiments using indica and japonica species. Normally, indica and japonica species cannot be crossed.

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Fertility Found in Some Somatic Hybrids

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[Text] The Plant Engineering Institute disclosed that they confirmed the presence of fertile individuals among rice hybrid plants produced by cell fusion of cultivated and wild varieties and are currently test-cultivating the progeny obtained from the seeds. Expectations are being focussed on cell fusion as a technique to introduce disease-, cold-, and salinity-resistant characteristics of wild varieties into cultivated varieties. However, hybrids between too distant species frequently do not bear seeds and infertility has been the source of the problem.

In 1987, the above company used cell fusion to produce various combinations of three varieties, "Nipponbare," "Aoi-sora," and "Tsuki-no-hikari" and seven wild varieties of African, Madagascan, and Sri Lankan origin, which were supplied by the National Research Institute for Genetics and successfully regenerated plants from fused cells. The results of protein analyses confirmed that the regenerated plants were all hybrids. However, the favorable results ended there; "Virtually no fertility was found" (K. Tanaka, chief, Development Division, Plant Engineering Institute).

However, among the plants were hybrids having "Nipponbare" as a parent that bore seeds which they could harvest. The names of the wild varieties were not revealed. The above seeds sprouted and juvenile plants are now said to be

growing. If the merits of a wild seedling are found in the seedlings somehow obtained in this manner, there is the possibility that they can be used as intermediate mother plants in the future to introduce new genes into cultivated varieties.

Aside from this research, the Plant Engineering Institute is developing a new plant "hine" produced by cell fusion of a C3 plant, "ine [rice plant]" and a C4 plant, "hie [millet]." However, because of the parents being taxonomically too remote, the problem of juvenile plants dying off still persists. Nevertheless, while the plants at the time of the initial report in 1986 died after 1- to 2-cm growth, "they now grow up to this long," gestured Tanaka spreading his thumb and index finger all the way.

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Fused Protein Secreted Using E. coli

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 p 8--FOR OFFICIAL USE ONLY

[Text] With the cooperation of the Research Institute for Polymers and Textiles, Agency of Industrial Science and Technology, MITI, H. Nishimura, professor, and others at the Faculty of Engineering, the University of Tokyo, successfully produced a fused protein representing a section of dihydrofolate reductase (DHFR), an E. coli intracellular protein, and the C-terminus region of alpha-hemolysin by secretion using the E. coli secretory mechanism for alpha-hemolysin. The results of secreting the outer membrane structural protein, OmpF using the alpha-hemolysin secretion mechanism were reported in 1987 by the group of Holland, et al of Leicester University in England. However, this is the first time that an intracellular protein was secreted. Since the molecular weight of alpha-hemolysin is 107,000 (1,023 amino acid residues), there is a possibility that a fairly large fused protein can be produced by secretion. Alpha-hemolysin is secreted through two unique kinds of secretion systems (membrane proteins), and no signal peptides are required. It is not yet clear how universal this secretion mechanism is, but it is likely to attract attention in the future as a technique to produce a designed protein alone by secretion using recombinant E coli. These results were presented at the 53rd annual meeting of the Chemical Engineering Association held at Tohoku University in early April.

Alpha-hemolysin (HlyA) having hemolytic activity is uniquely secreted through the channel between the inner membrane protein (HlyB) and the outer membrane protein (HlyD), and it is known that the C-terminal side of HlyA is particularly indispensable. Therefore, Nishimura, et al introduced a plasmid that expresses a fused protein of HlyA C-terminus and DHFR and a plasmid that expresses HlyB and HlyD into E coli and discovered that a fused protein was secreted. The fused protein successfully secreted contained the 322 amino acid residues at the HlyA C-terminus fused with the E coli DHFR (molecular weight of about 18,000) C-terminus lacking 19 amino acid residues. As a result, they found that at least the region required for secretion is contained in the 322 amino acid residues at the HlyA C-terminus. The fused protein containing the entire DHFR is not secreted extracellularly; the reason is assumed to be that the DHFR C-terminus is a

repetition of a beta-sheet structure. The secretion mechanism for alpha-hemolysin may not be suitable for secreting a protein that is structurally rigid.

Regarding the secretory production of a protein using recombinant E coli, there is a report of collaborative research by Teijin Limited and H. Horikoshi, chief investigator at the Institute of Physical and Chemical Research on a technique using the kil gene that relaxes the outer wall structure of E coli (See 23 Mar 87 issue, p 4). In this case, they used a signal peptide for secretion into the periplasm between the outer and the inner membranes, and the kil gene causes all the periplasmic substances to leak out.

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Immobilizing Alginic Acid Optimized

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[Text] With the help of K. Hashimoto, professor, and others at the Kyoto University Faculty of Engineering, Kibun Food Chemifa Company determined the conditions to optimize the space formation important in immobilizing adherent animal cells in culture using alginic acid. Based on this research achievement, the company intends to supply alginic acid having a composition suitable for the immobilization of animal cells.

Critical concerns in the immobilization of animal cells with alginic acid are concentration, composition, and degree of polymerization of alginic acid as well as the type and concentration of gelled metal salts, etc. Kibun Food Chemifa and Kyoto University examined the effects of these variables and discovered optimal conditions for them. They found that, for immobilizing adherent animal cells, it is especially suitable to use alginic acid with a constituent ratio (M/G) of the two types of sugar composing alginic acid (alpha-1,4-L-(gluronic) acid (G) and beta-1,4 D-mannuronic acid (M)) of less than 0.3 and form a gel with strontium. These results were presented at the Japanese Society of Agricultural Chemistry meeting held in Nagoya early April. Kibun Food Chemifa has established a technique to produce alginic acid of less than 0.3 M/G ratio through the selection of raw materials.

Kibun Food Chemifa is a leading manufacture of alginic acid in Japan and is ranked third or fourth in the world. It has a facility capable of producing 800-900 tons annually and supplies about 35 percent of the domestic annual market of 2,200 tons. In addition, it annually exports more than 200 tons of alginic ester, a food stabilizer. However, in recent years, inexpensive imports produced in China and Korea have increased, which have come to hold 40-45 percent of the domestic market, pressuring them to make distinctive alginic acid and high value-added products. For now, since the imported products are inconsistent in quality, their use is restricted to products other than food such as paste for dyes. However, the price is about Y800/kg, which is less than half the cost of domestic products selling at Y1,800/kg and used for food. If the quality of the imported products improves in the future, it is inevitable that they will be expanded into food use.

Kibun Food Chemifa signed a business agreement in 1987 with a Norwegian firm, Protan, the world's second largest manufacturer of alginic acid; this is a part of their effort to strengthen the alginic acid business steering toward high value-added products. In February 1988, the company exchanged bioreactor information with Protan in Japan.

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GRF Derivative Increased Milk Production

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 pp 8-9--FOR OFFICIAL USE ONLY

[Excerpt] K. Hodachi, et al of the First Physiology Laboratory at the National Institute of Animal Industry, Ministry of Agriculture, Forestry, and Fisheries (MAFF), administered a human growth hormone releasing factor (GRF) derivative to cows and confirmed the release of growth hormone and increased milk production for the first time. The above group has been conducting basic research on the release of growth hormone induced by GRF or its derivatives in cows. The above results confirmed the effectiveness of the technique on an industrially profitable form of increased milk production. This research has been conducted within the ordinary research budget, but starting in FY88, a newly established budget, "General research on the development of new agricultural, forestry, and fisheries technologies by elucidation and control of biological information" will be allocated. Although MAFF was cool toward applied research of growth hormone and GRF, which may become a competitive force against fertilized egg transplant techniques, it finally recognized its value with the budget.

The derivatives used in the experiments are peptides of 1-29 amino acids at the N-terminus of human GRF (44 amino acids) with the second amino acid, alanine, replaced by a D-substance and the 15th glycine, by alanine. A subcutaneous injection of 2 mg of a GRF derivative was administered once a day per one cow. As a result of 2-week consecutive use, the blood growth hormone level of the experimental group increased 5- to 6-fold compared with the control group, and milk production increased approximately 12 percent. Notably, during the last 7 days, an increase of about 19 percent was found. However, there was no change in the amount of feed ingested, and no influence on weight was found. The ratio of milk components, fat and protein, did not change, either.

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TGF-Beta₁ Cloned for Reagent, Etc.

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 pp 9-10--FOR OFFICIAL USE ONLY

[Text] The Central Research Laboratories of King Jozo (Kakogawa City, Hyogo Prefecture) successfully cloned human transforming growth factor-beta₁ in collaboration with the Houston Medical Center (Houston, TX) in the U.S.A. Currently, they are developing a purification technique for the recombinant TGF-beta₁ expressed in Chinese hamster ovarian cells. For the time being, their goal

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is to market it as a reagent by combining it with TGF-beta₂ extracted from animal tissues. In addition, they are now studying the relationship between TGF-beta₁ and cancer formation. The company, primarily a manufacturer of sweet sake and food products, has entered into the development of anti-cancer drugs and reagents using the growth inhibitory factor, TGF, as its pillar.

TGF is a proteinous factor that promotes or inhibits cell growth. It is secreted from normal as well as cancerous cells. There are TGF-alpha and -beta_{1,2} types; TGF-alpha is called fetal epidermal growth factor (EGF) and promotes epidermal growth the same as EGF. TGF-beta promotes the growth of fibroblasts, and it is said to have an indirect effect by interacting with other cell growth factors such as platelet-derived growth factor (PDGF). Recently, the direct action of TGF-beta has come to be considered as a growth inhibitory factor of various normal and cancerous cells. The TGF-beta receptor is present on virtually all cell surfaces, and it is a basic factor that widely controls cell growth along with other growth factors. Subsequently, there is a good possibility that TGF-beta will provide a clue to the development of new anti-cancer drugs. Genentech and Oncogen in the United States have already successfully cloned TGF-beta₁ and TGF-beta₂, respectively, ahead of the King Jozo group.

TGF-beta₁ and -beta₂ are homodimers (a compound protein with two identical peptides linked) composed of peptides of 112 amino acids each. There is a 71.4 percent homology in the amino acid sequences of the two substances.

T. Ikeda, chief of the third laboratory at the company's Central Research Laboratories is attempting purification of TGF-beta₁ activating factor using a monoclonal antibody. He and his colleagues elucidated the mode of TGF-beta₁ production using 10 cancer cell lines and 6 normal cell lines. TGF-beta₁ existed in three forms: precursor, inactive and active substances. Although the number of cases studied is still low, the cancer cells were found to be less efficient in activating inactive substances compared to normal cells and, unlike normal cells, were able to inactivate active substances. It is not yet known why the inactive substances occur. However, since the inactive TGF-beta₁ is activated by acid, it seems to be different from other hormones that are activated when the prepeptide is cut from a simple precursor. They are now preparing monoclonal antibodies against the activating factor of the inactive substances. The inhibitors of this factor and the factor that inactivates the active substances have the potential to become new anti-cancer agents. In addition, the company also succeeded in extracting a new TGF fraction from bovine bone marrow. Both substances still require basic research, but they are likely to become developmental materials for new anti-cancer agents.

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Plan to Establish "MAFF Edition BIDEK"

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 p 12--FOR OFFICIAL USE ONLY

[Text] The Agriculture, Forestry and Fisheries Research Council of the Ministry of Agriculture, Forestry, and Fisheries (MAFF) has a plan for a new organization

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of firms related to agriculture. Its intention is to embark on specific organizing work before the year ends and it is now in the process of interviewing parties involved. The name of the organization is "Agro High Technology Center." This is the so-called "MAFF edition of BIDEDEC," which had been under consideration chiefly by the Ministry's Biotechnology Division. Since BIDEDEC (Bioindustry Development Center) is a MITI-line, MAFF decided to organize its own industrial body.

The agricultural administration is currently exposed to criticism from both at home and abroad. Consequently, the Agriculture, Forestry and Fisheries Research Council at MAFF is very eager to promote leading-edge technologies and reform Japanese agriculture. There are expectations for the "Center" not only to establish and spread technologies, but also to serve as a window for industry desiring a relaxation of various regulations that are currently restricting private firms to go into agriculture. On the other hand, the participating BIDEDEC member firms are lamenting the situation of having to pay duplicate membership fees. Consequently, reaction to the news is mixed. Details for the organization's activities are still to be worked out.

There is a MAFF-related body that funds and finances agriculture-related businesses called Bio-oriented Technology Research Advancement Institution (BTRAI). Officials at BTRAI say that, basically, their tasks will not overlap those of the planned body. "Public symposia may be duplicated, but other activities can be conducted entirely independently. Since BTRAI already holds basic assets, there will be no problems arising from the collection of operating capital. We would like the results of the studies at the Center to be brought to BTRAI to be used as ideas for forming new companies," stated a BTRAI official.

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Safety of Recombinant Release Studied

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 25 Apr 88 p 12--FOR OFFICIAL USE ONLY

[Text] The Science and Technology Agency will select "Basic research on the safety of a recombinant DNA technology open system" as a new project for the "FY88 Adjustment for the Science and Technology Promotion Fund." The studies are assigned to various ministries and agencies such as the Science and Technology Agency, Environment Agency, Ministry of Health and Welfare, Ministry of Agriculture, Forestry, and Fisheries, and MITI. The results are to be reflected in the guidelines on environmental release.

The duration of the research is 3 years ending in 1990. Specific decisions such as the method of evaluation testing and the formulation of guidelines on environmental release by The Science and Technology Agency will follow. The Organization for Economic Cooperation and Development is also planning to study the guidelines for environmental release during the next 5 years, and it is likely that they will keep pace.

The research subjects include the development of risk evaluation techniques and

risk management techniques. The former is a study of marker gene for detecting recombinants, and the latter, of recombinant growth control and gene stabilization. The targets are restricted to microorganisms, plants, and live vaccines; animals are excluded. Behavioral experiments in a simulated ecosystem will be conducted, but no environmental release experiments will be carried out.

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Hepatitis B Vaccine Application Submitted

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 5--FOR OFFICIAL USE ONLY

[Text] At the end of April, the Osaka University Research Group for Microbial Diseases (Foundation) submitted an application to the Ministry of Health and Welfare for manufacturing the hepatitis B vaccine being developed. The above research group began clinical trials in November 1986 and has been conducting phase III trial since September 1987. The hepatitis B vaccine they developed was produced by incorporating 9 of the 55 amino acids in the pre-S2 region into the HBs antigen gene and expressing it in yeast. A vaccine with the pre-S2 region is also being developed by Takeda Chemical, but the above research group is the first to apply for manufacturing approval.

The HBs antigen with a pre-S region is believed to be the portion of hepatic cells to which hepatitis B virus adheres and is believed to play a more direct role in defense against infection. The chief organizer, H. Nagashima, professor emeritus of Okayama University, stated "The phase III trial was conducted using a total of 1,668 persons nationwide. A high rate of antibody production, 96.5 percent, was found following three subcutaneous injections of 10 microgram vaccine per dose. The antibody titer was also high. Side reactions were found in 13 percent of the group treated, but were slight and temporary. A very good feeling was obtained from the results of the clinical trials." However, regarding a cause and effect relationship between the addition of the pre-S region and the high rate of antibody production, he said "We cannot say one way or the other since high antibody titer were also obtained even without pre-S."

Meanwhile, the hepatitis B vaccine being developed by Meiji Milk Products has just undergone phase I trial and is now entering the phase II. The vaccine was developed by the Japanese Foundation for Cancer Research and the Chiba Prefecture Serum Research Institute and involves the expression of HBs antigen in cultured human hepatoma-derived cells. Clinical trials began in December 1986. The chief organizer of the clinical trials, A. Taniuchi, professor of the First Internal Medicine Department, Sapporo Medical College, stated, "The results were about the same as previous vaccines. There were no side effects that were serious. The phase II trial is scheduled to be completed by about March next year. The trial scale is about 100 subjects and if possible we would like to include relatively older subjects in their 50's. We have not decided whether to conduct the trial nationwide or restrict it to Hokkaido."

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EGF Involved in Compensatory Nephromegaly

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 pp 5-6--FOR OFFICIAL USE ONLY

[Text] In an experiment using mice, O. Tsutsumi of the Department of Obstetrics and Gynecology, Faculty of Medicine, Tokyo University, proved that epidermal growth factor (EGF) is involved in compensatory nephromegaly, a hypertrophy of a kidney upon excision of the other kidney. The use of EGF may become possible as a treatment of renal failure or as an auxotherapy following nephrectomy. These results were presented at the meeting of the Japanese Society of Clinical Metabolism held in Tokyo on 23 April.

When one kidney was excised in mouse, compensatory nephromegaly occurred involving an approximately 15-percent increase in kidney weight and an increase in protein content, followed by the appearance of the EGF precursor. Tsutsumi constructed an animal model in which blood EGF level decreases to almost zero following an excision of the submandibular gland. When one kidney was excised in the same mouse, signs of renal failure such as elevated blood urea nitrogen and deterioration of creatinine clearance occurred. Meanwhile, the subcutaneous injection of EGF into the mouse having the above-mentioned state of renal failure resulted in positive therapeutic effects such as reduced blood urea nitrogen and increased creatinine clearance.

In these experiments, although the blood EGF level in mice was virtually zero, the urea EGF level was maintained. Consequently, while the remaining kidney was producing EGF, it was eliminated directly, and compensatory nephromegaly did not occur. It is not clear why nephromegaly does not result when that organ itself is producing EGF.

Tsutsumi stated "Because EGF is produced in diverse tissues, I don't think we can expect therapeutic effects by simply supplying it from outside. However, EGF may be useful in persons with a kidney removed for transplant, who fall into kidney failure without developing compensatory nephromegaly, or in persons who must have dialyses due to renal failure of unknown etiology."

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Fatty Acid Metabolic Anomaly Gene Cloned

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 6--FOR OFFICIAL USE ONLY

[Text] Y. Matsubara, assistant in the Department of Pathological Metabolism, Tohoku University School of Medicine, successfully cloned [the gene that codes for] acyl-CoA dehydrogenase, an enzyme governing the first step of beta-oxidation of fatty acids, in humans. When this enzyme is lacking, symptoms resembling Reye's syndrome appear, occasionally causing sudden death in children. Discovery of the gene may lead to the development of early diagnostic procedures.

Acyl-CoA dehydrogenase is an enzyme that acts when fatty acids are used as energy

as a consequence of a reduced sugar level in the body. There are three types, a short-chain type (SCAD) that acts on fatty acids of 4-6 carbons (mainly 4), medium-chain type (MCAD) that acts on 6-10 carbons (mainly 6 and 8) fatty acids, and a long-chain type (LCAD) that acts on the fatty acids with more carbons (mainly 16). Matsubara succeeded in cloning [the genes for] these three types. Aside from the agreed facts that each translated portion consisted of 421 amino acids of which 25 were for the leader peptide, homology among them was not that high. The chromosomal locations of [the respective genes] were: SCAD [gene], No. 12 (12q22 - to the end of No. 12); MCAD [gene], No. 1 (1p31). The LCAD [gene] location has not been determined as yet.

The deficiency of this enzyme is caused by a point mutation of the genes. As is clear from the chromosomal locations of the genes, the trait is inherited as an autosomal recessive. Of the three enzyme types, MCAD has the highest deficiency frequency. Disease onset occurs at several months after birth to about 2 years of age with symptoms such as hypoglycemia, clouding of consciousness, hepatomegaly, liver function disorders, etc. The general opinion among researchers is that once onset occurs, fatality is extremely high, being about 50 percent. In addition, because of the rapid progress of the disease, it causes sudden death. The disease frequency is 1 in about 10,000. LCAD has more serious symptoms than MCAD but occurs less frequently. Only two cases of SCAD have been discovered in the world.

Matsubara stated, "Although only two cases of reported MCAD anomaly occurred in Japan, there may be cases that escaped diagnoses due to the fact that its symptoms resemble Reye's syndrome. Currently, diagnosis is made by determining enzyme activity, but the technique is difficult making early diagnoses difficult. Now that the gene has been identified, genetic diagnosis will be feasible in the future."

In addition, Matsubara also successfully cloned [the gene for] isovaleryl-CoA dehydrogenase, an enzyme in the metabolic pathway of isovaleric acid, which is similar to fatty acids. This gene is located on chromosome No. 15; 30 of the 424 amino acids were for the leader peptide. Homology with the medium-chain acyl-CoA dehydrogenase was 33 percent.

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Tissue-Cultured Ginseng Extract in Wine

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 pp 6-7--FOR OFFICIAL USE ONLY

[Text] Kikkoman produced a wine by blending the extract of ginseng produced by tank tissue culture by Nitto Electric Industrial Co, Ltd [Nitto Denko] and will begin marketing it in mid-May. It is the first commercialized plant tissue culture food (see 28 Mar 88 issue). The Tax Administration Agency treats tissue-cultured ginseng as plants and approves its addition to wine. The trade name is "Manzu-Chojusen [spring of longevity]." It is a very sweet, fruity wine, and a 550-ml bottle retails for Y2,000.

Since 1983, when Nitto Denko succeeded in the tissue culture of ginseng, Kikkoman

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has been jointly developing it for commercialization with wine as the target. The label on the back reads "An extract of ginseng produced by biotechnology (manufactured by Nitto Electric Industrial Co, Ltd) is added."

Chojusen contains a mixture of both extracts made from natural and tissue-cultured ginseng. The tissue-cultured ginseng has the advantage of containing a large amount of saponin, one of the effective components of ginseng, in a stable state; it has less of the medicinal smell or bitter taste unique to ginseng. Since there are many who like the peculiar taste, they added natural ginseng as well. The cost is about the same.

Since tissue-cultured ginseng extract has no peculiar taste and is easily usable as a food material, it may not only substitute for existing ginseng used in food, but also create a new market. It will be essential to prove the uptake of saponin and have it certified as a functional food.

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Importing Drugs for AIDS-Related Tests

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 7--FOR OFFICIAL USE ONLY

[Text] Regarding the applications filed by Dainabot Co, Ltd, the Ministry of Health and Welfare (MHW) approved the importation of an AIDS virus (HIV) antibody testing drug, "HIV (envcore), EIA [enzyme immunoassay] 'Abbott'," and an antigen detecting drug, "HIV antigen, EIA 'Abbott'," as of 5 and 20 April respectively. The approval restricted the use of the antibody testing drug to following the progression of the disease in infected persons and the antigen testing drug to evaluate the efficacy of therapeutics and to test persons at high-risk. These testing drugs were developed by the parent company of Dainabot, Abbott Laboratories. Dainabot announced that they will begin marketing these products on 23 May. The price for the antibody testing drug is Y88,000 per 1 kit for 50 tests; for the antigen testing drug, Y95,000 for 50 tests.

("Envcore") is an EIA kit using antigens GP41 and P21 of HIV produced by genetic recombination. It can separately determine the level of antibodies against HIV outer protein and nuclear antigen. Dainabot submitted the application for the drug in 1987 for verification use for HIV antibody tests. However, MHW did not approve it; the approval this time was for following the progression of the disease.

The approval hurdle is easier to overcome for following disease progress than for verification tests. However, an antibody testing drug using recombinant antigen is not approved in the United States, either. In the past, when a U.S.-made HIV testing drug was submitted for approval in Japan, the U.S. clinical trial data were attached, and MHW tended to blindly emphasize the U.S. examination results.

MHW's Biologics and Antibiotics Division explained "The reason it is not approved in the United States may be that an application for testing use has not been filed. Besides, although we use U.S. information as a reference, as a rule, we

conduct our examinations independently." The recent approval strengthened the view that MHW tacitly established a policy for independent approval.

The other "HIV antigen" is an EIA kit that detects antigen using an antibody against HIV. In the United States, it is marketed as a research reagent, but it has not been approved as a diagnostic. The uses of diagnostics recently approved in Japan are all restricted to evaluation of therapeutic drug efficacy or to obtain indexes for predicting disease onset among infected individuals. The high-demand uses, blood screening and verification tests, have not been approved.

The Biologics and Antibiotics Division at MHW stated, "Although the drug can be sold in the United States as a research reagent, it cannot be sold in Japan due to regulations. The recent approval is at an approximately equivalent level of treatment as the U.S. reagent for research use and emphasizes that "the treatment is equivalent to U.S. research use."

Dainabot plans to market these kits to practicing physicians.

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HIV Antibody-Positive Sera for AIDS Therapy

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 pp 7-8--FOR OFFICIAL USE ONLY

[Text] In collaboration with its U.S. subsidiary, Alpha Therapeutic (Los Angeles, CA), Green Cross Corporation administered HIV antibody-positive sera to AIDS and AIDS-related conditions (ARC) patients in preparation for therapy and onset control clinical trials. Their plan is to make use of the anti-HIV antibody-positive blood accumulated in large quantities in the United States.

What Green Cross is planning is a type of globulin therapy. Trials for gamma-globulin administration to AIDS and ARC patients have begun in several Japanese universities and in the United States. However, these preparations are all made from HIV antibody-negative blood, and the major focus is the prevention of opportunistic infections introduced by immunodeficiency. In contrast, Green Cross's plan is to attack HIV directly by using globulins extracted from HIV antibody-positive blood.

M. Nishida, an executive director of Green Cross and the chief of Research and Development Division stated, "First, we wish to conduct a thorough safety study. It is necessary to prove that live HIV is not present in the preparation, and that it contains antibodies that inactivate HIV. In addition, speaking of specificity, I believe it is necessary to have a clear understanding as to the target of specificity."

Despite the fact that there is a high titer of antibody against AIDS [virus] in the bloodstream, the reality is that it cannot overcome the onset of disease. Consequently, some researchers question the therapeutic effects of the antibody. Against such concerns, a recent explanation is that "the reason the antibody is powerless is that diverse strains of HIV exist and while an antibody is attacking

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one strain, a different strain appears which attacks immunocompetent cells." In other words, it is due to attacks by multiple strains over time. Therefore, through the extracorporeal administration of a reverse transcriptase with relatively low interstrain specificity, antibodies against regulatory genes, or multiple antibodies prepared in advance present the possibility of being able to cope with multiple strains simultaneously.

Clinical trials include not only the elucidation of therapeutic methods, but also the screening of effective antibodies (or an antigenic determinant on HIV that the antibody recognizes). In other words, Green Cross is trying to find an antibody having HIV-inactivating activity by focusing on the "natural antibody." Nishida said, "We would like to begin clinical trials as early as this year. The company is studying anti-HIV chimeric antibody jointly with Alpha Therapeutics. If an effective antibody is discovered in the globulin preparations, it can also be applied to chimeric antibodies.

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English Newsletter on Biotech Patents

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 8--FOR OFFICIAL USE ONLY

[Text] The Technology Public Relations Office of Fujiwara Kagaku (Kamakura, Tel. No. 0467-31-7833) has started to publish an English language newsletter on biotech-related patents, "Biotechnology Japanese Patent Alert" (Microorganism-related subjects of the Kokai Bulletin Classification 1(1), International Classification, C12M-R). Special features include timely information and accurate reporting since abstracts are prepared by A. Fujiwara, formerly a microbiology and biotechnology research worker at the laboratory of Nippon Roche.

The actual contents consist of 4-6 pages of patent claims of Kokai Bulletins and summaries of the texts. English translations are prepared within 2-3 days of Kokai Bulletin publication and combine 1.5 to 2 Kokai Bulletins together. It is published in 32 issues/year, and the annual subscription fee is Y90,000. It is an ideal fast bulletin not only for persons in charge of biotechnology in European and American firms located in Japan, but also for biotechnology patent "watchers" in Japanese firms.

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Livestock Improvement Corp Funds Research

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 8--FOR OFFICIAL USE ONLY

[Text] It has been revealed that the Livestock Improvement Corporation invested Y800 million to the Bio-oriented Technology Research Advancement Institution on 11 April. This resulted in the basic assets of the above organization to be Y7,863 million. Due to the lowered interest rate, the operational profits from basic assets are lower than initially expected. The Y800 million is meant to compensate for that.

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New Products Survey for R&D Automation

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 9 May 88 p 8--FOR OFFICIAL USE ONLY

[Excerpt] According to a new products survey of biotechnology-related machinery and reagents recently compiled (March-April 1988) by Nikkei Biotechnology, it is evident that, as of this spring, machinery and reagents for automating biotechnology research and development have expanded rapidly. The proper selection of machinery and reagents is essential for upgrading the speed of research and development. There is an increased need for information to compare various products. A special Nikkei Biotechnology issue, "Latest Information on Biotechnology Machinery and Reagents, '88," in which the detailed results of this survey were reported was published by Nikkei Magurohirusha on 25 April.

For the determination of DNA base sequences, three companies began marketing DNA sequencers with automated processes ranging from electrophoresis to the input of analytical data of separated bands. On the other hand, six firms are marketing systems that automate the reading of bands separated by electrophoresis, one of the routine series of tasks required for a determination of base sequences. In the basic work of biotechnology to determine DNA base sequences, various automated systems are also made into products by many companies, thus greatly expanding the latitude of selection by users.

Even in the electrophoretic separation work indispensable to DNA and protein analyses, ready-made electrophoresis gels are marketed by six companies in 24 or more varieties, which is contributing to uniformity of the work and increased speed. In the past, the preparation of electrophoresis gels was time-consuming, and the level of a researchers' skill greatly influenced both the reproducibility of analyses and analytical ability.

In addition, it has become evident that numerous models for the technique are being produced including 19 genetic transduction systems using electric stimulation sold by 17 companies, and 14 cell fusion systems sold by 12 companies. It is a reflection of successive reports of results achieved with microorganisms and even plants using genetic transduction and cell fusion technologies.

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Research Increasingly Gearing for Business

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[Excerpt] The reorganizations and personnel changes that took place during March-April 1988 in major biotechnology-related businesses and research institutes are summarized.

Notable among corporate reorganizations is the establishment of research structures into departmental units gearing up for business. In particular, Takeda Chemical and Japan Tobacco, Inc created a structure in their agribusiness division that includes both animal and plant biotechnology research. Takeda Chemical has been breeding plants for raw drug materials. With the recent start-up of the agribusiness division, the company also plans to enter plant biotechnology targeted at crops in general. They plan to develop agricultural chemicals, animal drugs, and seeds/seedlings centered overseas.

On the other hand, the strengthening of basic research is advocated by Shimadzu Seisakusho, Taiyo Fishery, and Japan Tobacco. Taiyo Fishery rebuilt its research structure not only in basic research but also merchandise development. Research on tuna growth hormone, for example, will be charged to the newly established basic research laboratory. The Life Science Research Laboratory of Japan Tobacco will inherit the basic research mandate without regard to product development from research previously conducted by the Central Tobacco Research Laboratory.

With respect to personnel changes, the move by Y. Karube of Tokyo Institute of Technology to Tokyo University is noteworthy. At Tokyo University, the trouble related to the refusal to appoint S. Nakazawa to the College of General Education and Sciences caused a sensation. A talked-about topic in biotechnology would be Karube. There is a problem of similar nature in the background, i.e., "Even Tokyo University needs a star-quality instructor." The Leading-Edge Science and Technology Center to which Karube moved will actively engage in joint research with industry. Since it was a newly established division, the move was easy. With the leveling off of research funds and the reduction in number of students as the backdrop, even a national university is likely to actively look for instructors who can attract money and people.

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IL6 Receptor Gene Cloned

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[Text] T. Kishimoto, professor, and his group at the Osaka University Cellular Engineering Center, successfully cloned the receptor gene for human interleukin (IL) 6 for the first time in the world and presented an abstract of their work at the International Conference on Immunopharmacology. Along with the IL1 receptor, this is the first time that receptors for lymphokines which regulate the immune system have been cloned. Although part of the IL2 receptor, tac antigen, was cloned several years ago, there is doubt that it is a true IL2 receptor that binds IL2 and transmits the signals into the cell. Lymphokine receptors bind highly specifically with lymphokines. Consequently, the recent achievement provides a clue for developing an inhibitor ("receptor drug") specific to lymphokines using a soluble recombinant receptor. Based on a soluble IL6 receptor, it may be possible to develop a therapeutic for autoimmune diseases, especially chronic articular rheumatism where increased IL6 has been reported.

IL6 was initially cloned as a B-cell differentiation factor that induces antibody

production. Subsequently, its versatile functions have been revealed including (1) a protein-inducing factor during the acute stage of liver [disease]; (2) a myeloma growth factor; (3) beta-2 interferon; (4) a growth factor for undifferentiated T-cells; and (5) a mediator for bacterial shock. In addition, Kishimoto, et al. reported at the above meeting that the level of IL6 contained in the articular fluid of chronic articular rheumatism patients was 50 nanograms/milliliter, more than 1,000-fold higher than the normal level (20-40 picograms/milliliter), and there is a strong correlation between the etiology of this disease and IL6. Since IL6 has diverse functions, for now, soluble IL6 receptor is likely to be used initially for topical administration to the joints of rheumatism patients. Caution is required in the development of an anticancer drug or a shock therapeutic that must be used systemically.

Kishimoto, et al. expressed a cDNA candidate of the IL6 receptor on the cell surface of African green monkey cells. Subsequently, they separated cells that bound fluorescein-labelled recombinant IL6 using a cell sorter and successfully cloned the cDNA of the IL6 receptor from them. There are several hundred lymphokine receptors on a normal cell surface. However, that represents only about 1/100-1000 the number of receptors for insulin or growth hormone. Therefore, the recent success is "like winning a lottery, we were lucky," said Kishimoto. However, the technique they used is directly applicable to lymphokines for which pure recombinants have been obtained such as IL1, 2, 4, 5, and CSF. Consequently, the cloning of lymphokine receptor genes will no doubt progress rapidly in the future.

The Osaka University group isolated the IL6 receptor cDNA from a human NK cell-like cell line, YT. It is a single-chain protein of 449 amino acids with the N-terminus sticking out of the cell membrane. The part external to the cell, the membrane part, and the part internal to the cell correspond to 339, 28, and 82 amino acids, respectively. Based on the structure, it was found to be a member of IgG supergene family. This is similar to receptors for IL1, macrophage, and colony stimulating factor. For the present, this cell which expresses the cDNA does not bind lymphokines other than IL6, and the specific binding with IL6 was confirmed. Furthermore, it was found to show both high- and low-affinity binding to IL6 as does the natural IL6 receptor.

However, there is no tyrosine kinase activity in the cloned IL6 receptor. In order for the IL6 receptor to exhibit biological activities, an as yet undetermined mechanism of signal transmission into the cell or involvement of unknown tyrosine kinase protein is possible.

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Reovirus Adhesion Site on Neurons Found

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[Text] A totally new method has appeared for utilizing monoclonal antibodies. It has become possible to elucidate the stereostructure of protein binding sites using an anti-idiotypic (Id) antibody. This established the prospect for

efficiently determining the structure of peptides that control the core of diverse actions shown by biological proteins such as the binding sites for viruses, lymphokines, hormones, and their receptors, as well as for proteolytic enzymes and substrates. The prospect is for accelerated developments of peptide vaccines, lymphokines, peptides showing enzymic activities, and their inhibitors. In addition, it certainly is a breakthrough for protein engineering where trial and error is the present technique used. Needless to say, it would push the creation of "receptor drugs" which were brought into the limelight at the recent meeting.

The principle of this technique is very simple. It assumes that the amino acid sequence of the antigen binding site of an anti-Id antibody matches the amino acid sequence of a protein showing the same antigenicity as the anti-Id antibody. The actual technique involves first immunizing with the desired protein and preparing a monoclonal antibody against that protein (MAB1); then selecting an anti-Id antibody that inhibits the desired protein from binding to the receptor on the cell from among the anti-Id antibodies prepared using MAB1 as the antigen, i.e. an anti-Id antibody having the same structure as the desired protein binding the receptor. Next, this anti-Id antibody gene is cloned, the amino acid sequence of the antigen binding site is compared to the amino acid sequence of the desired protein, and if a common amino acid sequence is discovered, it indicates the site where the desired protein and the receptor bind.

At the International Conference on Immunology, Mark Greene from the School of Medicine at the University of Pennsylvania in the United States identified the structure of the cell adhesion site of reovirus that infects the central nervous system using an anti-Id antibody. He prepared an anti-Id against the reoviral hemagglutination protein (HA) and using the above technique, discovered a four-amino acid sequence identical to HA at the antigen binding site of the L-chain of the anti-Id antibody that inhibits viral adhesion. In addition, they confirmed that the structures of the HA and anti-Id antigen binding sites are very similar by x-ray diffraction. In fact, when a peptide of nine amino acids containing the above amino acid sequence (beta-sheet structure) was synthesized, it inhibited viral adhesion to neural cells. Furthermore, this peptide successfully replaced the biological activities of reovirus such as inhibiting fibroblastic cell growth and inducing differentiation of neural glia cells.

Greene has already synthesized a derivative with a more than 10-fold higher activity by binding a cystine at the N-terminus and artificially formulating a dimer. As a result, he proved that an even better derivative can be synthesized by replacing the functions of biological proteins, giant molecules, with peptides.

"This presentation is the third example proving that an anti-Id has the same amino acid sequence as the protein it replaces. It is an epic technique that enables the elucidation of the peptide structure of a functional site with anti-Id so long as the amino acid sequence of the protein is known. Molecular biology and monoclonal antibody technology were combined, and a new era is about to begin. We are now studying the applicability of a similar technique in CEA," stated K. Imai, a lecturer at the Department of Internal Medicine, Sapporo Medical College.

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Alpha- and Beta-IFN by Hayashibara Approved

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 p 4--FOR OFFICIAL USE ONLY

[Text] The Hayashibara method, a unique cell culture method even by global standards, was approved as a process for manufacturing pharmaceuticals. On 10 May, the pharmaceuticals special meeting of the Central Pharmaceutical Affairs Council approved the manufacturing of "Hayashibara" alpha-interferon (IFN) and Mochida alpha-IFN manufactured by the Hayashibara method and Mochida beta-IFN manufactured by a cell culture method, respectively, as anti-cancer agents. With the approval at the next regular meeting of the above Council, their production is expected to be formally approved before the year ends. Marketing will begin as early as the end of the year or early next year.

The "Hayashibara" alpha-IFN and Mochida alpha-IFN recently approved were developed jointly by Hayashibara Biochemical Laboratories, Inc, Otsuka Pharmaceutical Co, and Mochida Pharmaceutical Co. The Hayashibara Biochemical Laboratories transplanted lymphoblasts into newborn hamsters and allowed them to grow in vivo (the Hayashibara method), after which the alpha-IFN was induced by virus. Marketing will be undertaken by Mochida and Otsuka Pharmaceutical. The approved efficacy was only for renal cancer.

Since the Hayashibara method involves in vivo culture, in addition to eliminating hamster-derived impurities or viral contamination, the maintenance of constant productivity have been barriers in technical development. The recent approval made it official that the Hayashibara method is trustworthy as a manufacturing process for pharmaceuticals. Issues to be tackled in the future include competitive cost-cutting against the recombinant alpha-IFN (E. coli-derived) on the market since 26 January of this year and elucidation of qualitative difference in efficacies compared to alpha-IFN produced by a cell culture method and marketed by Sumitomo Pharmaceutical since 1987 (a mixture of multiple subtype alpha-IFN's), etc.

On the other hand, Mochida Pharmaceutical obtained an approval for beta-IFN ("Mochida beta-IFN") manufactured by the mass culture of fibroblasts. It is indicated for treating malignant melanoma and glioblastoma. Initially, the company had a technical agreement with G. D. Searle of the United States, but it dissolved the contract in 1983 and has been producing beta-IFN by its own technology. More than 50 percent of the beta-IFN sales of the forerunner, Toray, are as a therapeutic for hepatitis B. Consequently, Mochida's future project is to expand therapeutic use against hepatitis B.

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Nursery Technology Gains New Participants

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[Text] The joining of the Hiroshima and Saga Prefectural Economic Federations in

Nursery Technology was revealed on 1 April. An economic federation is a superstructure of the Federation of Agricultural Cooperative Associations (FACA) at the prefectural level and is responsible for businesses and distribution functions. FACA with a deepening sense of crisis involving open market demands and revisions in the food control system, etc. is showing signs of earnest participation in biotechnology research and development.

The Nursery Technology was established in 1987 funded 70 percent by the Bio-oriented Technology Research Advancement Institution and the remainder by Kirin Brewery, Kyowa Hakko, Taisei Construction Company, and Nippon Steel Corporation, etc. It is a research enterprise for developing a system for culturing F₁ rice plant seedlings in a tank and marketing them to farmers. Beginning this year, both Hiroshima and Saga prefectural economic federations also began funding the project and plan to study a system for efficient distribution of F₁ rice plant seedlings within their respective prefectures. Consequently, both prefectural economic federations will supply research staff as well. Utilizing its strength as a distribution network in farmlands, FACA is trying to find a way to enter the seedling business with a potential for exchange as the biotechnology make progress in the future. On the other hand, the FACA's organizational power, to collect over 95 percent of rice shipments excluding free market rice (black market rice), is essential for the practical application of biotechnology to rice plants.

Currently, the funding companies are conducting research in their own laboratories, but are looking for a construction site for a pilot plant where newly developed elemental technologies can be brought together.

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Suntory Pharmaceutical Center Completed

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[Text] Suntory completed its pharmaceutical center in Ohra-gun, Gunma Prefecture and held a ceremony for the completion on 17 May. With the completion of the center, the company has established a structure for development work at two research laboratories; basic research and pre-clinical trial stages at the Biomedical Research Institute and clinical trial stages at the Pharmaceutical Center.

The Pharmaceutical Center consists of three research wings: Biotech (culture tanks), Chemotech (chemical synthesis), and Pharmatech (drug preparations). The Biotech is equipped with one 1000-liter and two 300-liter computer-controlled culture tanks. Two kinds of biotechnology pharmaceuticals can be produced concurrently.

The Biotech plant is equipped with products from Alfa-Laval AB of Sweden, Biolink of Switzerland, and Hitachi, Limited. The Chemotech plant is equipped with 100-liter and 50-liter chemical reactor systems. The company is spurring pharmaceutical development using a sword in each hand, biotechnology and chemical synthesis technology.

Suntory has four pharmaceuticals currently in clinical trials: antiarrhythmia agent, SUN1165 (Phase III), anticancer drug, SUN4800 (recombinant gamma-interferon, phase III), autism therapeutic, SUN0588 (Phase II-III), and human atrial diuretic hormone, SUN4936 (hANP, latter phase II). In addition, they will begin clinical trials of an anticancer drug, SUN4599, before long, and penem antibiotics, SUN5555, in the spring of 1989. They say there are an additional 6-7 items in the preclinical trial stages at the Biomedical Research Institute.

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Otsuka Begins Genetic Diagnosis

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[Text] Otsuka Pharmaceutical's diagnostics business division, Otsuka Assay Laboratory, has entered the genetic diagnosis business. The company signed a technical agreement in March with Collaborative Research (CR, Bedford, MA) of the United States and began a window service this month for a CR consignment of genetic diagnostics. One step ahead, the Special Reference Laboratories signed a similar contract with CR and has been mediating genetic diagnostic consignment tests since last year. Although only samples are currently being mediated to CR, we can see the beginning of genetic diagnostic business development in Japan as well when the two leading Japanese reference laboratories began handling genetic diagnostics. In the United States, CR and Lifecodes developed consignment genetic diagnostic tests into a business in 1986.

Tests they can begin to consign at this time include those for cystic fibrosis, polycystic nephrosis, Y-chromosome aberrations, identification of marrow-derived cells (check for contamination of cancer cells) for myelocyte transplant, monitoring of marrow transplant, etc. In all cases, restriction fragment length polymorphism (RFLP) is used to diagnose genetic aberrations or to distinguish differences in the origin of the gene. CR is one of the forerunners in developing genetic diagnosis using RFLP. In 1987, it published a genetic map of human chromosomes (Oct 87 issue of Cell). However, the map has caused a dispute that precision is inadequate.

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Shonai Biotechnology Promotion Center

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 p 6--FOR OFFICIAL USE ONLY

[Text] On 31 May, 14 cities, towns, & villages, 27 agricultural cooperative associations (ACA), and 2 chambers of commerce will jointly establish the Shonai Biotechnology Promotion Center. The Shonai District noted for rice production, began to tackle biotechnology in earnest. The tasks of the center include biotechnology-related information gathering, seminars, nurturing talent, referral and mediation of research on consignment. The operating expenses for this fiscal year are Y3.84 million. The source of funds is assessed membership fees. The

office will be established in the Yamagata Prefectural Shonai Economic Federation. T. Soma (mayor of Sakada City) will serve as president. The principal members of the Center include Sakada City, Tsuruoka City, Tachikawa-cho, Sakada City Sodeura ACA, Sakada City ACA, the Yamagata Prefectural Shonai Economic Federation, the Yamagata Prefectural ACA Central Chapter, the Yamagata Prefectural Fishery Association, the Tsuruoka Chamber of Commerce, and the Sakada Chamber of Commerce.

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Ube Kosan/Fujisawa to Develop Clinical SOD

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 pp 6-7--FOR OFFICIAL USE ONLY

[Text] Ube Industries, Ltd [Ube Kosan] signed an agreement with Fujisawa Pharmaceutical for the clinical development of recombinant human superoxide dismutase (SOD). Now that an agreement has been signed with a pharmaceutical firm, Ube Kosan's SOD has taken a step towards practical application. They expect the clinical trials to begin in early 1989.

Although there is no mistaking the importance of SOD in the maintenance of life, difficulties into development as a pharmaceutical are also expected. The issue is how to prove the efficacy of SOD administered. In that respect, Fujisawa Pharmaceutical has an accumulation of basic studies on diseases caused by free radicals and SOD as a therapeutic, from which a bright idea may emerge for clinical development.

In Japan, Nippon Kayaku has already begun clinical trials of recombinant human SOD. They have already completed phase I, and are currently preparing for a small scale phase II trial.

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Fierce Price War in L-Lysine

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[Text] The price war is getting fierce for an essential amino acid, L-lysine, whose market is expanding as a feed additive. As a consequence of improved productivity using a fermentation process and the shifting of fermentation production sites overseas, the enzyme process is placed in a difficult situation. Toray, the only commercial producer using an enzyme process has already retreated one step from full-scale production, apparently facing an inevitable reduction of L-lysine business.

U.S. L-lysine Export Priced Below Y400/kg

At present, there are three companies, Kyowa Hakko (fermentation process, annual production scale of 10,000 tons), Ajinomoto (fermentation process, similarly 10,000 tons), and Toray (enzyme process, similarly, 8,000 tons), with combined L-

lysine production facilities capable of an annual production close to 30,000 tons. However, the domestic demand for L-lysine is estimated to be 3,000 tons or less per year. Led by the United States, the sales of L-lysine overseas has rapidly increased reaching approximately 100,000 tons/year. Inevitably, most of domestic production is allocated for export. However, with the strong yen, the export price dropped, averaging below Y400/kg since the beginning of the year. For the biggest market in the world, the United States, the price was below Y390/kg (Customs Statistics, Jan-Mar 88).

Due to the rapid rise in the value of the yen, a dual-pricing structure was formulated for L-lysine; export price and domestic price. The domestic price, although on a downward trend, is still maintained at about Y700/kg. If they are able to sell in Japan, it is still cost-effective. However, Toray's domestic share is estimated to be about 10 percent. Most of the production is geared for export and cost-effectiveness is deteriorating. Furthermore, even domestic sales are entering a volatile period. This is due to the importation in March 1988 of as much as 157 tons of Korean L-lysine produced by fermentation at the low price of Y555/kg. Since importation statistics are not yet published, subsequent imports are unknown. Even the dual pricing structure of domestic and export prices is about to collapse.

Strong yen hits by-product manufacturing in domestic plants

Using alpha-aminocaprolactam (ACL) chemically synthesized from a by-product of the nylon manufacturing process as a raw material, Toray established a technology to produce L-lysine using two kinds of enzymes and has been producing it commercially since 1979. Toray, the biggest nylon manufacturer, has the strength to acquire a large quantity of alpha-ACL at a low price. Consequently, the company's process (enzyme process) was competitive with respect to manufacturing cost compared to the fermentation process of Kyowa Hakko in 1959 and Ajinomoto in 1965 when respective industrial production began. However, productivity of an L-lysine-fermentation producing strain was later sharply upgraded using planned mutagenization based on elucidation of biosynthesis pathways of amino acid-producing bacteria. On the other hand, although Toray has developed production cost reduction methods such as research on the concurrent production of two enzymes using a recombinant bacterium (1 Jul 85), they have not reached the stage of practical application. Those having interests say in unison that "the difference in manufacturing costs using a fermentation process and an enzyme process has broadened considerably." In addition, the unparalleled strength of utilizing a by-product of its own factory in Japan is now inversely hampering their production overseas.

On the other hand, the fermentation production process always relied on the importation of the raw materials from overseas areas such as Southeast Asia. Consequently, L-lysine production plants using fermentation process are rapidly shifting to local production overseas where demand is high and production cost is low. Kyowa Hakko began L-lysine production in Mexico (6,000 tons/year), the United States (operating since 1984, 7,500 tons/year), Hungary (scheduled for operation in 1989, 5,000 tons/year); and Ajinomoto, in France (established in 1974, enlarged the facility to 40,000 tons in the fall of 1987), the United States (operating since November 1986, 6,000 tons/year), Thailand (operating since

December 1986, 2,500 tons/year). At present, the price of soy bean meal, a competitor to L-lysine as a feed additive, is high, and the L-lysine market is sailing smoothly. The manufacturing capacity is barely able to keep up with demand. For Kyowa Hakko and Ajinomoto, it is better to focus on global market expansion even though the export share of the domestic production is not cost-effective. Both companies are currently operating their domestic plants at full capacity.

Although Toray owns nylon factories jointly in Korea and Thailand, the scale of production is less than a half of domestic production. It seems difficult to move the base of L-lysine production abroad.

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Liquid Crystal Using Chiral Substances

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[Text] Fujitsu will commercialize a liquid crystal display utilizing optically active (chiral) substances early next year. A prototype was exhibited at the '88 Fujitsu Technological Exhibition held at Fujitsu's Kawasaki Plant on 9-15 May. The chiral substance used in the above product is a chiral alcohol, a chemically synthesized product. However, inexpensive samples of high-purity, biologically-produced chiral substances using microorganisms are available. Therefore, the possibilities for future practical applications to liquid crystals are highly likely. By blending many kinds of substances, liquid crystals can exhibit high performance. Fujitsu is recruiting supplies of even more varieties of chiral substance samples.

This liquid crystal display is called a phase transition type and was developed at the Organic Materials Research Department of the Materials Research Division, Atsugi Research Laboratory, Fujitsu Research Institute. Thus far, the biotechnologically-produced chiral substances are attracting attention as raw materials for ferroelectric liquid crystals. In addition to Ajinomoto's collaborative research being pursued with Matsushita Electric, Nippon Mining Company is making sample shipments. However, the practical application of ferroelectric liquid crystals is estimated to be 2-3 years away at the earliest, and the commercialization of a phase transition type liquid crystal is likely to come first.

The mechanism of the phase transition type involves changing the voltage applied to liquid crystal in order to cause changes in the molecular aggregation of the liquid crystal and change the wavelength of light transmitted. By combining a multiple number of panels with different wavelength characteristics and projecting light onto it, color images can be produced. Since polarizing plates are not required, an image as much as 5-fold brighter than produced in a conventional black and white picture is obtainable. Moreover, the system has been miniaturized, and the price is about the same as the conventional technique. Applications expected include the production of electronic information recorded in a personal computer, etc. either directly or by way of an overhead projector on a screen, and in the future, as a display for personal computers.

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Plant Protection Treaty Reviewed

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 pp 10-11--FOR OFFICIAL USE ONLY

[Text] The International Union for the Protection of New Varieties of Plants (UPOV) held a meeting on 18-22 April in Geneva, Switzerland where it is headquartered and began working on a partial revision of the treaty to reinforce the protection of varieties. The major revisions proposed by the executive office are: (1) reinforcement of protection forces, (2) extension of the protection period, and (3) for some member states having an extremely low number of protected crops, urge an expansion of the number of protected crops. As soon as the treaty is revised, the Ministry of Agriculture, Forestry and Fisheries will work on a revision of the seedling law. The revision of the treaty is expected to take at least 3 years or more.

The protection system of the new varieties by UPOV contains two stipulations; seedlings must be registered by the growers of the varieties, and the compensated transfer of registered seedlings without the growers' consent is prohibited. The latter stipulation is where the UPOV executive office saw a need for recent revision. It is aiming to reinforce specific protection forces. The existing system requires citing each article for prohibition such as third party's use of registered seedlings for production, sales, and parent strains for F₁ variety production without the permission of the grower. The executive office revised this method and broadened the definition of prohibition. They wish to change the system to list exceptional items.

Regarding the reinforcement of protection, no disputes are expected from member states. Discussions will be narrowed to what should be approved as exceptions. For example, it is not clear how far the currently-allowed "use as breeding material" for developing new varieties using registered varieties will be allowed as exceptions. However, it is highly likely that "collecting seeds from the seedlings that individual farmers grew" would continue to be allowed even after the revision of the treaty.

The executive office further proposed extension of the protection period from the current 15 years or more (18 years plus for perennial crops) to a longer term. In addition, it is advocating a revision of the articles to stipulate the number of protected crops, i.e., to recommend an increase in the number of protected crops in countries having an extremely low number of them. The object is to correct the irregularity among nations; e.g., Japan recognizes crop registration of 420 plants, while Spain recognizes only 20 plus varieties. UPOV meetings are generally held twice annually. The next meeting is scheduled in October.

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Tissue Culture Consignment Service

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 p 12--FOR OFFICIAL USE ONLY

[Text] Kurume Floriculture Agricultural Cooperative Association (ACA) in Kurume City, Fukuoka Prefecture, began services for propagating flowering plants of the cooperative members using a tissue culture facility. At present, the services are only for the tissue culture of Cymbidium and papilionaceous orchids, but they plan to begin the mericlone culture of papilionaceous orchids as well. They say they have acquired techniques to cope with flowers in general, i.e. carnations, lilies, azaleas, etc.

Supported by the foundation, the Kurume-Tosu District Promotion Center with a grant of Y4 million, the above ACA constructed in March 1985 a laboratory with two clean benches and a floor area of about 70 m² at a total cost of Y8 million. Its goal was to provide technical training to members and to open it for voluntary use by individual members. However, "Members are restricted by time, and only several members are actually using it. Therefore, we decided to begin consignment culture," stated M. Iwasaki of the Guidance Department of the above ACA. The ACA is conducting this work by hiring part-time workers.

The above ACA is an exclusive ACA covering one-third of the area in Fukuoka Prefecture (eight cities and seven counties). It also operates the Kurume floriculture regional wholesale market. Membership size is 860. The 1987 sales were Y1.7 billion in cut flowers and Y.9 billion for potted flowers.

Since the ACA has its own market, it has the advantage of obtaining consumer information from the distribution side. On the other hand, it must work to satisfy retailers by carrying a full line of stock. However, "Of the flowers produced by the members, only about one half come to this market. High quality products end up in large markets in Kansai or Kanto without going through ACA," explained Iwasaki about the difficult situation in which the ACA is placed. Furthermore, unlike general ACA, Floriculture ACA cannot serve as a window for subsidies. The tissue culture service may be called a survival strategy for the ACA trying to show a *raison d'etre*. Iwasaki said "A major goal is for ACA to develop new varieties and create a product locale. However, that is an ideal. First, we wish to supply the members with seedlings at a slightly lower cost than copier entrepreneurs and have them bring the product to Kurume market." However, the association cannot force its members to bring their shipments.

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Recombinant DNA Drugs To Be Manufactured

43066082 Tokyo NIKKEI BIOTECHNOLOGY in Japanese 23 May 88 pp 12--FOR OFFICIAL USE ONLY

[Text] At the Biotechnology session of the Central Pharmaceutical Affairs Council, the Ministry of Health and Welfare confirmed manufacturing plans for five drugs using recombinant DNA technology by four companies. This is the sixth such

confirmation and followed the last one in February 1988.

Suntory's alpha-human atrial natriuretic peptide (alpha-hANP) is produced by genetic recombination (see 15 Feb 88 issue). The hANP produced by chemical synthesis is on the last leg of phase II trials, but trials have not yet begun for recombinant hANP.

Asahi Chemical Industry's cytidine-5'-diphosphate choline is generally referred to as cyticholine or CDP choline. It is widely used as a therapeutic for consciousness disorders and is already commercialized by close to 30 firms. Asahi Chemical is supplying CDP choline in bulk produced by fermentation using yeast. The recent announcement is believed to be aimed at strengthening recombinant DNA production. Regarding the production strain established, no details have been revealed since it has not yet been presented at scientific meetings, etc. For Suntory's gamma-interferon (gamma-IFN), Fujisawa Pharmaceutical's somatomedin C, and Sumitomo Pharmaceutical's TPA, the confirmation was made for the second time. Confirmation for manufacturing was received for gamma-IFN at the Tatebayashi Pharmaceutical Center in addition to the previously-confirmed Biomedical Research Institute; for somatomedin C, in addition to the previously-confirmed Osaka Plant, the Nagoya Plant was also confirmed. TPA confirmation was for a scale-up from pilot plant to a factory scale.

Manufacturing plans for MHW-confirmed recombinant pharmaceuticals (May 1988)

Corporation	Products	Development Stage	Uses	Host	Genes from
Asahi Chemical	Cytidine-5'-diphosphate choline	-	Functional improvement of brain disorders	Yeast	Yeast
Fujisawa Pharmaceutical	Somatomedin C	Clinical trial planned in '88	Treat Dwarfism	E coli (K12)	Chemical synthesis
Sumitomo Pharmaceutical	TPA	Phase II trial	Thrombolysis	CHO cells*	human epithelium
Suntory	alpha hANP	Before pre-clinical trial	Improvement of cardiac functions	E coli	human cardiac cells
Suntory	human gamma interferon	Phase II trial	Anti-malignant tumor	E coli	Chemical synthesis

*Chinese hamster ovarian cells

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Characteristics of a Sintered Iron-Nickel Battery for Electric Vehicles: Honda Denki Company

43062083 Tokyo BOEI GIJUTSU in Japanese Apr 88 pp 46-49

[Text] 1. Introduction

In the 5-year period from 1982 to 1986, research and development has been performed on electric vehicles by the Electric Vehicle Technical Research Association under the guidance of the Ministry of International Trade and Industry. Honda Denki joined the association in 1982 and performed research and development with the goal of developing an iron-nickel battery. We achieved energy densities of greater than 60 wh/kg and lifetimes of more than 1000 cycles. We also achieved travel distances of more than 190 km on one charge in vehicle load tests.

In this paper we will present the history and theory behind the iron-nickel battery and will give the various characteristics of the electric vehicle battery produced by Honda Denki.

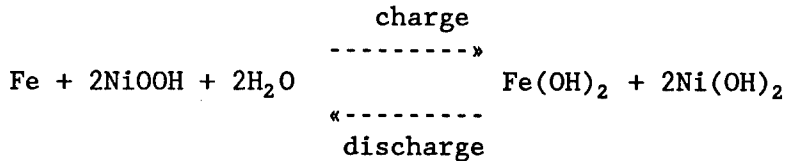
2. Special Features of Iron-Nickel Battery

(1) History

The iron-nickel battery was made practical by Edison in 1900.¹ Because it was of solid construction, it had long life and was capable of more than 2,000 charge/discharge cycles. In 1938, Honda Denki made practical use of a pocket-sized iron-nickel battery in safety lamps for mines. In 1949, pocket-sized Honda Denki iron-nickel batteries, the first produced domestically, were put in the Eidan subway.² Later, they were gradually replaced by nickel-cadmium batteries and by the 1970's there was no iron-nickel battery production in the free world. However, in recent years electric vehicles have received attention from a low pollution and energy conservation standpoint and research into iron-nickel batteries began once again. In Japan, under the big project system, sintered iron-nickel batteries were studied for use as electric vehicle batteries³ and research has continued in Europe and the United States.^{4,5}

(2) Theory of Operation

The negative electrode of the battery is made of iron, the positive of nickel, and alkali solution is used as electrolyte. At the negative electrode iron reacts with ferrous hydroxide and at the positive electrode nickel oxyhydroxide reacts with nickel hydroxide. Electromotive force is 1.37 V. Theoretical energy density is 267 wh/kg, a large value compared to 175 wh/kg for lead batteries.



(3) Special Characteristics

The general features of iron-nickel batteries are that they have high energy and output densities and long cycle lifetimes; overcharge and overdischarge are high; they are safe, do not pollute, and operate at room temperature. They are compared to lead batteries in Table 1.

Table 1. Comparison of Iron-Nickel Batteries With Lead Batteries

	Energy Density and Lifetime (wh/kg)(Cycles)	Output Density (w/kg)
Iron-nickel batteries	30--3000 51--2000 60--1000 80--1300	94--125
Lead batteries	25--2650 40--1000 50--500	98--165

(4) Battery Construction

The construction of the electric vehicle battery produced by Honda Denki is as follows:

a. Iron Electrode

Fine iron powder was sintered and made into plate. Forty percent of the iron powder was used as active material and the rest acted as electrode support.

b. Nickel Electrode

Fine nickel powder was sintered until porosity reached 80 percent and this was impregnated with active nickel. Four-five percent cobalt was added to improve use rates and lifetimes.

c. Electrolyte

We principally used alkali solution made from potassium hydroxide. We also added lithium hydroxide and potassium sulfide to improve battery capacity and lifetime.

d. Separator

We produced it from synthetic resins, paying attention to their electrical resistance, alkali resistance, and liquid maintenance and gas removal characteristics.

e. Battery Case

We formed a battery unit by stacking eight cells into a polypropylene case using heat welding.

f. Cumulative Exhaust Apparatus

The gases generated in each of the cells during charging are gathered in the cumulative exhaust apparatus, passed through a sintered alumina filter, and vented to the outside.

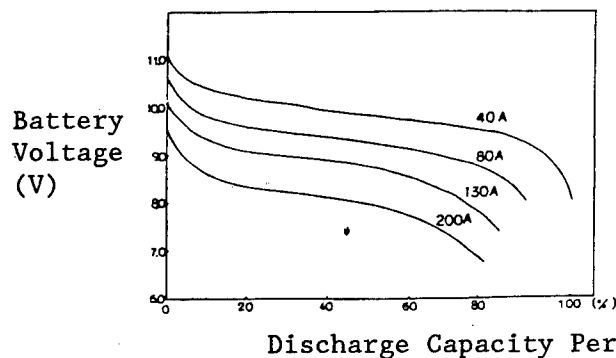


Figure 1. Discharge Current and Discharge Capacity

3. Battery Capabilities

(1) Discharge Ability

Figure 1 gives the percentage of discharge capacity for various discharge currents. Battery voltages in the figure are for the battery unit. When discharged at 40 A, discharge capacity was 225 AH. Average discharge voltage was 9.86 V. Energy density at this time was 61.8 wh/kg.

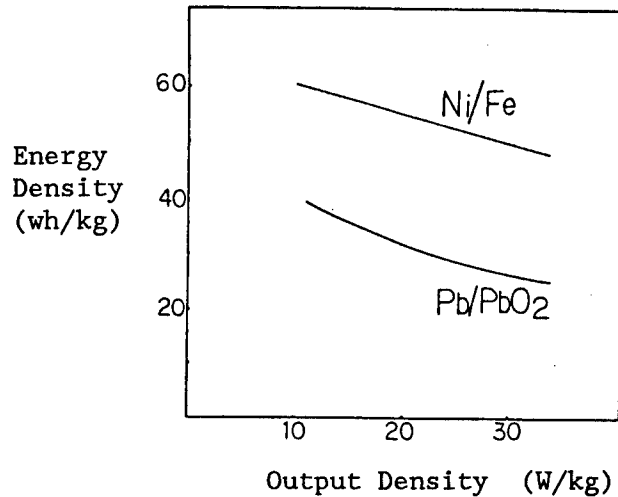


Figure 2. Energy Density and Output Density

(2) Energy Density and Output Density

Figure 2 shows the relationship between output density and energy density. These correspond to vehicle speed and distance travelled. When compared to values obtained from lead batteries, iron-nickel batteries have proven superior.

(3) Temperature Characteristics

We investigated battery discharge capacity at 0°C, 25°C and 45°C. Average battery voltage decreased at low temperatures. Voltage for the battery unit dropped about 0.4 V between 0°C and 45°C. There were almost no differences in discharge capacity due to temperature.

(4) Self-discharge

We measured battery capacity after 1 month of storage at 0°C and 25°C. Capacity reduction was 10 percent at 0°C and 30 percent at 25°C. This capacity reduction was due to self-discharge by the nickel electrode. Nonetheless, even after storage for more than 3 months, normal use was still possible after charging.

Figure 3 shows the results of charging cycles with a fixed current of 40 A, a discharge depth of 60 percent, and a temperature of 25°C. Even after 1,000 cycles, we were able to maintain capacity at 60 percent of its rated capacity. Toward the end of battery life the charging efficiency of the nickel electrode decreased. As a result of inspections after dismantling, the strength of the nickel electrode was seen to have decreased, but the iron electrode showed little damage.

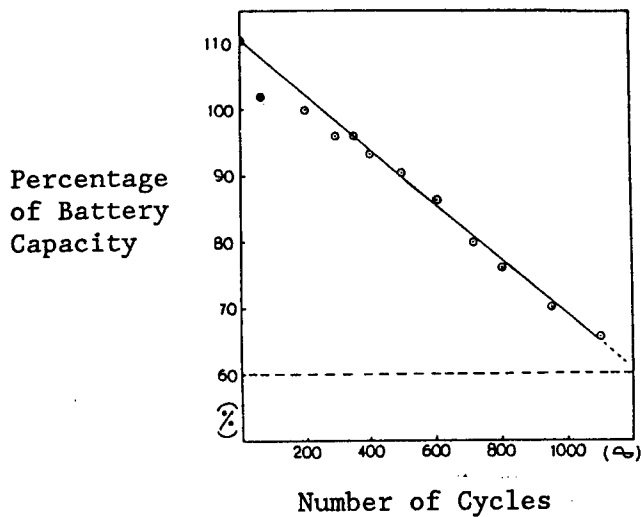


Figure 3. Cycle Life Tests

(5) Cycle Life

4. Battery Specifications

The specifications of a battery for installation on electric vehicles are given in Table 2. The overall weight of the battery when installed on a test vehicle (a remodeled Mazda Familia) was 1,440 kg. Evaluation of the iron-nickel battery in various types of vehicle driving tests showed that we had achieved our original goals.⁷

Table 2. Battery Specifications

Battery	Nominal voltage	9.6 V
	Number of cells	8
	Rated capacity (5HR)	200 AH
	Dimensions (L x W x H)	467 x 140 x 317
	Weight	36 kg
Battery group	Total voltage	96 V
	Number of battery units	10
	Total number of batteries	80 cells
	Total battery weight	360 kg

5. Conclusion

The iron-nickel battery has superior energy density and life when compared to lead batteries. In the future it will be able to replace lead batteries in areas which can take advantage of its light weight and long life. Future topics for study will be improvement of charging efficiency, temperature management during discharge, improving low maintenance characteristics, lowering nickel electrode costs, etc.

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13008/9365

Industrial-Use Robot Technology, Applications

Bin Picking Robot

43063808 Tokyo, Nagoya SANGYOYO ROBOTTO RIYO GIJUTSU KOENKAI in Japanese
19 Apr 88 pp 16-19

[Article by Yoshito Kato and Hajime Amano, Factory Automation Development Section, Toyota Motor Corp.: "Bin Picking System (Bin Picking Robot)"]

[Text] 1. Introduction

The automation of automobile manufacturing plants is steadily progressing, but flexibility is particularly required as current needs become diversified. In robotized handling operations, it is now important to handle workpieces whose types, positions, and attitudes are uncertain, and much is expected of their picture processing. The subject here concerns bin picking, which has hitherto been deemed to be the most difficult of all robotized operations, using picture processing, and we have automated the bin feeding, as indicated in Figures 1 and 2, into the processing machine.

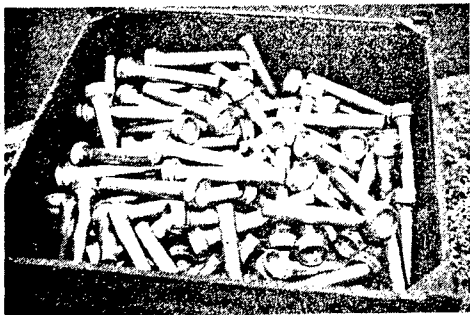


Figure 1. Sliding Shaft Packing

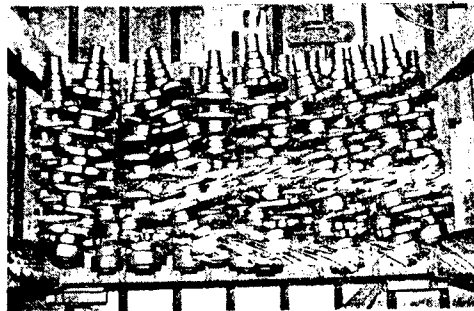


Figure 2. Crankshaft Packing

2. Development Technology

The composition of the system developed is shown in Figure 3. Components loaded in bulk in a pallet are photographed with a TV camera, components to be taken out are grasped by the robot after recognizing their position by picture processing and are supplied for the subsequent process after their

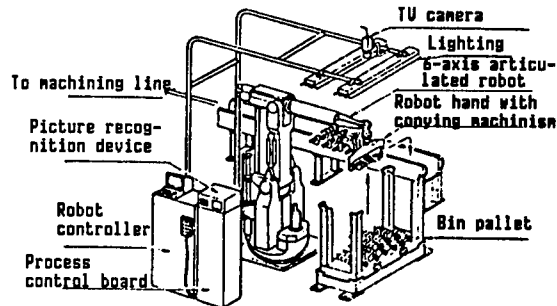


Figure 3. Composition of Picking System

attitude has been made uniform. Problems to be solved to realize this system may be generally divided as follows:

- (1) Picture recognizing technology
- (2) Component holding technology
- (3) Interface between the picture processor and the robot.

These are described below.

2.1. Picture Processing

In recognizing bulk-loaded components, characteristic parts in component shapes are first located within the field of vision, and then the position and attitude of the components to be removed are determined from these relative positional relationships. But, if the picture processing function were exclusive for each specific workpiece, a vast number of development man-days would be necessary for the introduction of each workpiece, and, as a result, it would be impossible to contribute much toward automation. Therefore, we used the technology of recognizing cylindrical shapes and round holes, as shown in Figure 4, as the nucleus, devising it so that it could be widely applied to any object containing such shapes. In the case of shaft components, for example, which generally are cylindrical, having different diameters arranged on an axis, they can be recognized by first locating individual cylindrical shapes and then checking to see if these cylindrical shapes are arranged similarly to the subject components.

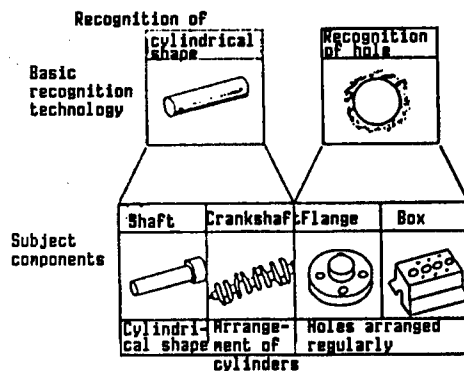


Figure 4. Stratification of Subject Components

(1) Recognition of cylindrical section

The brightness of each pixel of an image captured by a TV camera (Figure 5(a)) is shown in Figure 5(b). Noting only the data found on the scanning line (Figure 5(c)), the coefficient of correlation between these and the brightness change pattern model data in the cylindrical section of the subject workpiece, which was memorized in advance (Figure 5(d)), is determined. In other words, the coefficient of correlation, $C(k)$, is determined (Figure 5(e)) using

the brightness of each picture element of the model data,

$$M(i): i = 1 \sim m, \text{ and}$$

the brightness of each picture element on a certain scanning line

$$V(i): i = 1 \sim n$$

$$C(k) = \frac{\sum (M(i) - \bar{M}) * (V(i+k) - \bar{V}(K))}{\sqrt{\sum (M(i) - \bar{M})^2} * \sqrt{\sum (V(i+k) - \bar{V}(K))^2}}$$

Here, $k = 0 \sim n-m$

\bar{M} : average of $M(i)$, $i = 1 \sim m$

$\bar{V}(k)$: average of $V(i)$ and $i = k+1 \sim k+m$

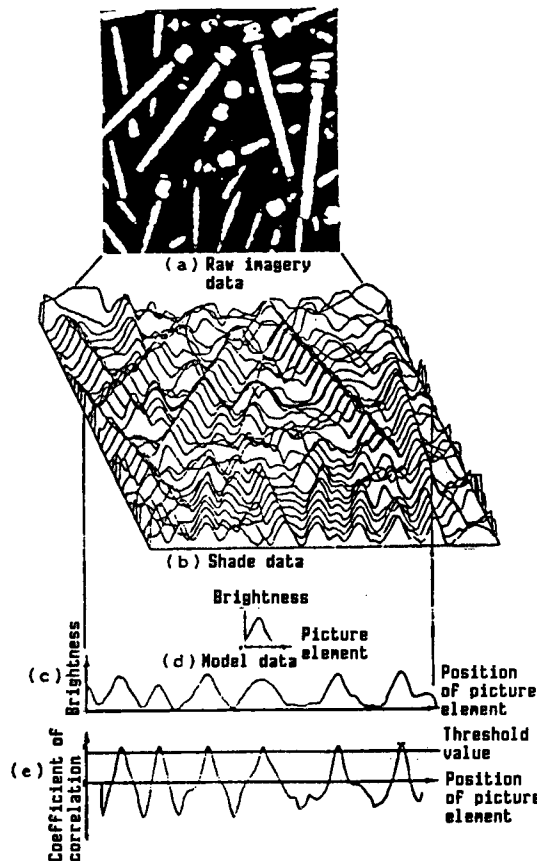


Figure 5. Cylindrical Shape Recognition

First, the cylindrical shape is determined to be at the position where the coefficient of correlation exceeds a certain specific threshold value. Then, a search for the range of cylindrical shapes is made and, if its length has the prescribed value, it is recognized as the cylindrical section of the subject workpiece. The model data are designed to be easily indicated by enclosing the cylindrical section of the workpiece in the picture plane by cursor operation. Incidentally, the cylindrical shape sometimes appears with different measurements, depending on such conditions as the relative distance to the TV camera and the inclination or overlapping of the work. Since it is difficult to discern these from the picture image, the allowable size range is set in advance along with the workpiece size, as shown in Figure 6, and only that shape falling within this range is treated as the cylindrical section of the subject work.

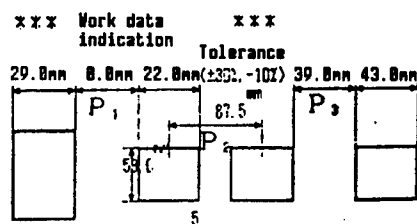


Figure 6. Setting of Workpiece Shape

(2) Recognition as Subject Components

The example of the crankshaft will be used to explain how to recognize the row of cylindrical shapes. In Figure 7(a), first obtain the coefficient of correlation (c) on the axis by matching the cylindrical shape model pattern and the brightness (b) of the journal section by the method stated in (1), then search for the journal, the large end and the small end. Then, confirm that the interval between journals is P2 in Figure 6, the interval between the large end and the nearest journal is P1 and the interval between the small end and the nearest journal is P3, recognize this crankshaft as the subject crankshaft, and compute the position and direction of the center of gravity in the two-dimensional plane.

2.2 Component Holding Technology

Even if the two-dimensional position and attitude of a component is recognized by picture processing, such problems as the following remain:

- (1) No information regarding the height of the workpiece can be obtained; and
- (2) It is definitely necessary to grasp a workpiece in the involved or inclined state.

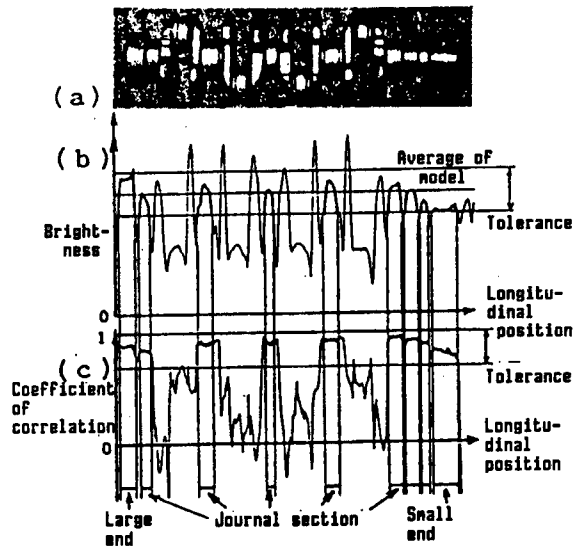


Figure 7. Recognition of Crankshaft

Here, we coped by improving the mechanism of the robot hand and controlling robot operation according to signals from the sensor attached to the hand. Robot hand structures are shown in Figures 8 and 9. In the sliding shaft, an electromagnet was used so that workpieces arranged closely together could be removed from above, while in the crankshaft, we employed a system that held it at both ends of the axis because, due to its complex shape, it was impossible to grasp the journal section. In addition, mechanical copying for workpieces inclined in the vertical direction was rendered possible by giving the hand two degrees of freedom--one for rotation and the other for sliding. To enable the robot to slow down and stop according to the height of the workpiece, it was provided with a proximity sensor to detect the contact of the workpiece and an expansion/contraction mechanism in accordance with the control distance. If misrecognition were to occur during picture processing, the expansion/contraction mechanism would operate by hand interference. This displacement would be confirmed by the proximity sensor, the robot would be temporarily pulled back, and the steps beginning with picture recognition could be taken again safely.

2.3. Picture Processing and Robot Interface

In robot operation using picture processing, it is necessary to

- (1) execute data communications between the robot and the picture processor; and
- (2) coordinate the calibration of the robot and the picture.

To join various robots and this picture processor in arbitrary combinations, not only communications hardware and basic protocols but also the forms of the data must be standardized in advance. In this system, data transmission and reception are handled by making standardized biquadratic matrix expressions of robot positions and attitudes by means of

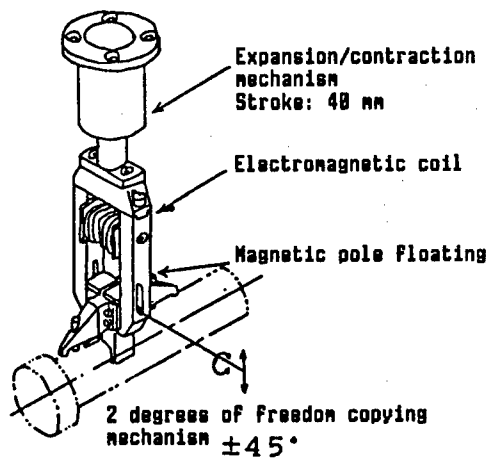


Figure 8. Sliding Shaft Hand

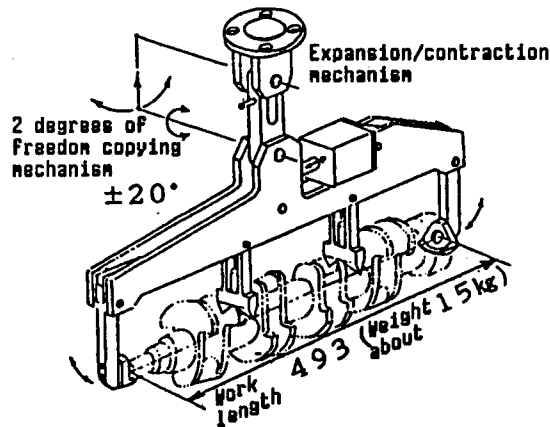


Figure 9. Crankshaft Hand

the function of coordinate transformation given to the picture processor and using serial communications of the RS422 level 9600 BIT/SEC. Furthermore, cycle time has been reduced by making possible the parallel processing of robot action, picture recognition and data communications.

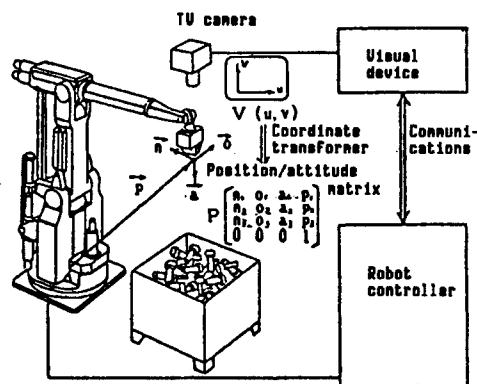


Figure 10. Interface

3. Bin Picking System

Bin picking is performed as indicated in Figure 11. First, picture recognition occurs while the robot is waiting at position (1), the coordinate values of points (2) and (3) on the line connecting the camera center and the recognition workpiece are computed, and the robot receives them. Then, the robot descends along this line, slows down, stops and, when its hand makes contact with the subject, holds the workpiece. The robot brings the workpiece to the supply point and picture processing for the next picking starts when the robot arm leaves the field of vision of the TV camera. In the case of a sliding shaft, the recognition time is 2-7 seconds and the bin picking time averages 15 seconds (Figure 12: 50 min/pallet (200 workpieces)). In the case of a crankshaft, the recognition time is 4-16 seconds and the bin picking time averages 40 seconds (30 min/pallet (45 pieces)).

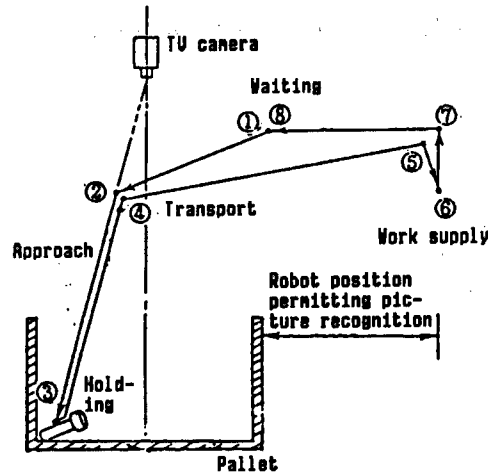


Figure 11. Action Pattern

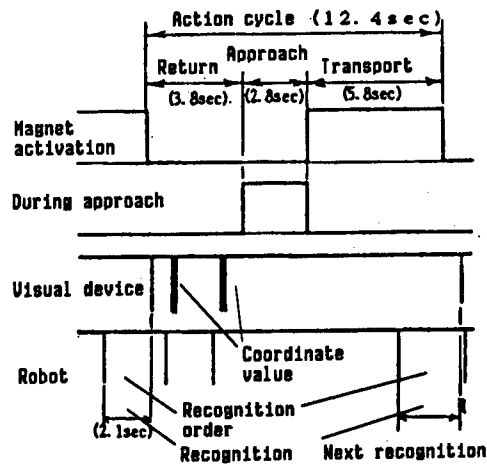


Figure 12. Bin Picking Cycle

4. Summary

- (1) We developed a robot system using picture processing for bulk bin picking.
- (2) We succeeded in designing a system that can be widely used for components with cylindrical shapes or round holes.
- (3) Our technology involving selecting only target objects from a complex background is expected to find many future applications for such purposes as automatic assembly and setting.

Development of Assembly Robot

43063808 Tokyo, Nagoya SANGYOYO ROBOTTO RIYO GIJUTSU KOENKAI in Japanese
20 Apr 88 pp 25-29

[Article by Nobuyuki Fujita, Production Technical Research Institute, Toshiba Corp.: "Jisedai (Next Generation) Assembly Robot ARI"]

[Text] 1. Introduction

Many industrial robots have been adopted by Japanese factories and have contributed to the production of goods that are competitive in price and quality. In such areas as welding and painting, after relatively small investments, robots can far surpass people from an efficiency standpoint. But it is now known that problems are involved, especially because the production of many types in medium or small quantities, rather than mass production, has recently become necessary. These problems include the following:

- (1) Robots must have peripheral equipment supplied as components and are not adequately flexible to cope with changes.
- (2) They require programming and instruction for each work assignment.
- (3) Robots cannot work without the accurate positioning of their components, etc.
- (4) If robots fail in their work, they cannot salvage the situation themselves.

The main trends of industrial robots during the past several years have involved job acceleration and price decreases. Some attempts to solve the above-mentioned problems have been made, but have not yet exerted any significant impact.

Therefore, we have researched a robot that can solve these problems once and for all, and have developed a next generation robot, ARI (assembly robot with intelligence), to realize some robot functions. Developed by referring to the methods of work by people, this robot has the following functions, which the conventional industrial robot lacks:

- (1) As a principle, it does not require peripheral equipment.
- (2) It determines its own work and prepares a program automatically.
- (3) With the help of a sensor, it can operate without accurate positioning.

As for problem (4) above, the self-recovery function, we decided to leave it for future resolution.

2. Basic Functions of ARI

As an autonomous assembly robot, it has been given the following functions:

- Recognition of what should be done
- Automatic preparation of assembly programs
- Assembly

Specifically, we picked a job that involved assembling toy blocks identical to the sample shown. The robot first estimates the structure of the assembled blocks visually. Then, it automatically prepares the action program necessary to perform the assembly and, according to that program, assembles the blocks identical to the sample.

3. Composition of System

3.1. Composition of Robot

The robot itself was developed with the upper half of the human body used as a model.

Arms: It has two arms, each with seven degrees of freedom, as in the human body. The three degrees of freedom of the hand and the one degree of freedom of the elbow are driven by, respectively, wires and a parallel link mechanism. The three degrees of freedom of the shoulder are manipulated at the speed of general harmonic deceleration. The seven motors for these seven degrees of freedom are attached in the vicinity of the shoulder. Therefore, a thin and light arm, similar to a human arm, has been realized.

Hands: The robot has a hand with three fingers and four degrees of freedom at the top of each arm. (The three fingers move inward in parallel, while the interval between any two of the fingers can be changed.) The motor for this is attached to the waist and driven by wires. Each finger carries a sensor (strain gauge) to detect the grasp required and is controlled so that the blocks can be grasped with a certain force.

Eyes and neck: The robot has two eyes so that it can detect three-dimensional positions. Two CCD cameras are used for the eyes. The zoom ratio, focus, diaphragm, vertical, and horizontal directions of the line of sight and the crossing position of the lines of sight of both eyes can be changed according to such conditions as the position and distance of what is seen.

Force sensors: The wrist of each arm is provided with a force sensor to detect force in the triaxial direction as well as moment in its vicinity.

Trunk: The trunk supports both arms and the neck, and can turn right and left.

The overall size is several ten percent larger than the upper half of the human body. This is because the arms must reach the appropriate working area without a forward bend of the trunk and because interference by such things as the motors in the shoulder must be avoided.

3.2. Composition of Control System and Function Apportionment

The ARI control system is shown in Figure 2. The engineering workstation, AS3000, handles such artificial intelligence-using processes as the overall control and the automatic preparation of programs. The picture processing computer, TOSPIX-II, edits picture data absorbed by the two eyes. ARI handles line detection and searches for specific patterns. The other microcomputers are used to control the servomotors for the arms and hands. For the arm controller, a high-speed computing processor, Am29325, is used in addition to two 16-bit microcomputers, MC68000, to increase the computing capacity.

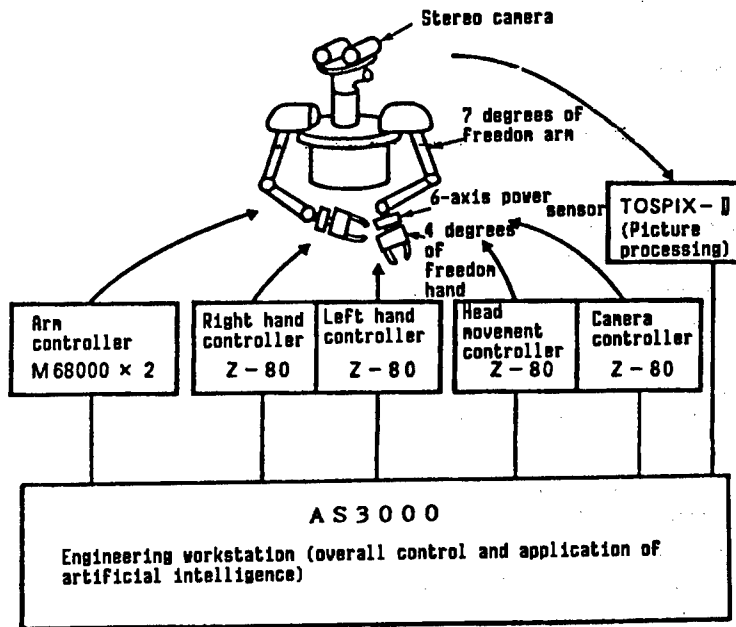


Figure 2. Composition of Control System

4. Work Production Involving ARI

4.1 Outline of Work

Industrial robots, in general operate simply as instructed by teaching or programming. However, ARI can understand its work from samples shown and

prepare an action program for itself. In this respect, it is basically different from the conventional robot, although the work it can perform is limited. In addition, ARI stores in its computer the knowledge of what exists and where and, if something obstructs the locomotion of an arm or a hand, it can avoid it while operating. Also, when detecting an obstacle visually, ARI describes what it should look like and institutes a search according to this information. Therefore, ARI is not only human-like in appearance, but in substance it is far more advanced in intelligence than is the conventional industrial robot, although its ability cannot be compared with human intelligence.

ARI's work procedure and characteristics are shown in Figure 3, while details are given individually below.

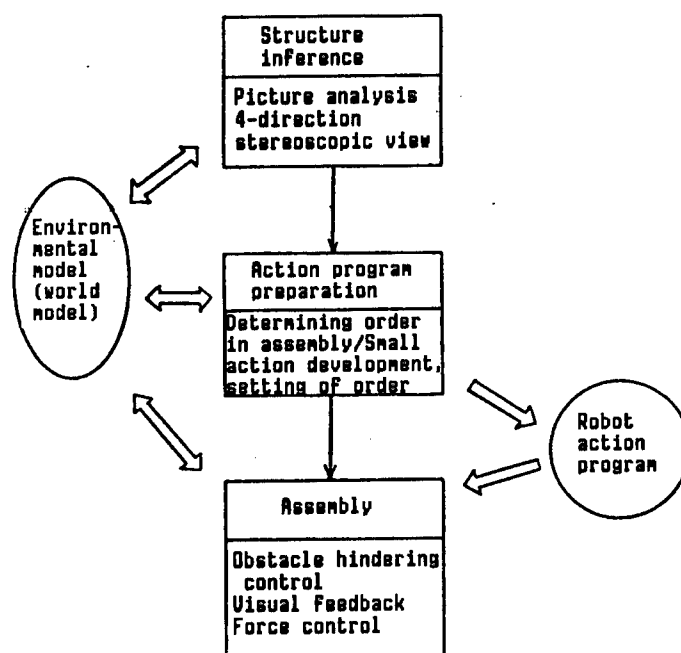


Figure 3. Work Procedure and Individual Characteristics

4.2 Inference of Structure

ARI views a sample with both eyes and infers the structure of blocks, namely, the mutual positional relationship among the assembled blocks.

It first detects the ridge lines of component blocks and, taking advantage of the parallax with both eyes, computes their three-dimensional positions. It views the sample from all four directions, turning it 90 degrees at a time, and determines the structure of the entire block formation, using inference for the part hidden behind other blocks. Results obtained are shown in (1) of Figure 4.

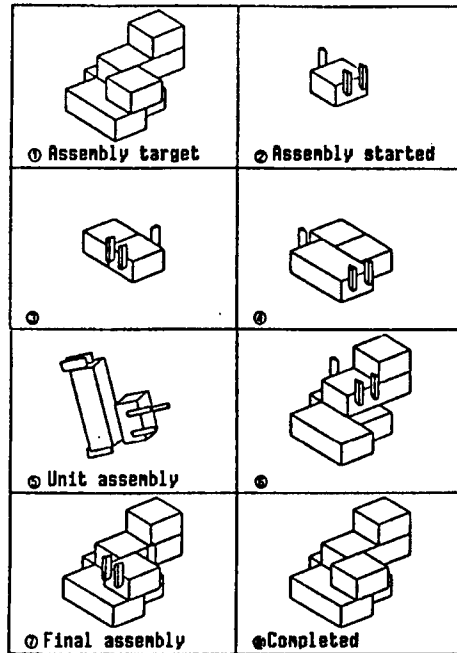


Figure 4. Assembling Procedure (Example)

4.3. Planning Work and Forming Action Program

First, the order in which the blocks are to be assembled is determined. In Figure 4, (1) is the assembly target, the assembly progresses as shown in (2), (3), (4), ... (7), and is completed in (8). Then an action program incorporating the arm and hand motions, visual action, etc., is devised according to the order of assembly. The triangular poles in Figure 4 indicate the positions at which the fingers can grasp.

The order of assembly has been determined as follows: The block on the right side in (5) of Figure 4 cannot be directly set by itself if a supporting block is not under it. For such a block, consider an assembly procedure in which it is attached to another block in advance, and the combination is regarded as a unit. Then, the order for assembling each block or unit is determined. An order more convenient for the robot's observation is preferred if either alternative is acceptable in light of the necessity of sequence in assembling each.

To prepare an action program from the assembly order, a sequence must be adopted after searching for a knowledge database registered as a hierarchization from rough to fine actions and reconsidering whether fine actions already researched may be executed at the same time or in what order they can be executed efficiently. Finally, an action program, including the parallel actions of both arms, both eyes, the trunk, etc., is derived.

4.4. Assembly

The assembly is performed by executing the prepared action program. This job consists of grasping a block in the right hand, bringing it to the prescribed position and setting it, and assembling a unit with both hands and setting it.

Since each arm has seven degrees of freedom, in the majority of this task both arms are controlled by the potential method, through which the robot can avoid obstacles as it moves.

During assembly, the robot uses vision and the force sensor. When grasping a block and before setting it, the robot visually confirms the positions of the block and other objects and makes corrections. In this case, data on what it should look like is computed from environmental model information, and picture searching is initiated based on this data. In the setting action, force is measured with the force sensor installed in the wrist, and this information is used to control the arms and complete the job. If, for instance, entry by pressing with a certain amount of force does not succeed, somewhat shifted positions are tried. Also, when setting a new block next to one already in place, insertion occurs using the block as a guide. The value measured by this sensor is used to determine whether or not the setting has succeeded.

5. Conclusion

ARI illustrates what assembly robots of the future will be like. In order for it to be used at factories, it is necessary to solve the problems involving the universality of work and the price, and we believe that the factory use of robots, such as this, is unlikely for some time to come. However, we also believe that the technology used in ARI can have many applications in developing and applying the assembly cell, etc.

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Fifth Japanese Robotic Society Conference advance print; 35th Information Processing Society Conference advance print, 1988 CIRP ANNALS, etc.

Visual Assembly Robot

43063808 Tokyo, Nagoya SANGYOYO ROBOTTO RIYO GIJUTSU KOENKAI in Japanese
20 Apr 88 pp 30-34

[Article by Kazuo Watanabe, Production Technical Division and Ryoichi Hisatomi, Electronic Applied Equipment Design Division, both of Tochigi Plant, Hitachi, Ltd.: "Assembly Robot System With Vision"]

[Text] 1. Introduction

Applications of the visual sensor include position detection, type discernment, and appearance inspection for components in assembly work and the inspection process, and there is strong demand to automate more advanced work by adding a visual sensor to the assembly robot. To meet these needs, we have developed and industrialized HV/R-2, a visual sensor, with such standard equipment as bulk cargo component recognition, composite windows, and other functions, and have also developed an FIC loading work cell using a visual sensor and an educational robot system to assemble bulk cargo components. These are outlined below.

2. Visual Sensor HV/R-2

The visual sensor, HV/R-2, is a visual device with advanced functions and high cost performance, developed to handle position detection, type discernment, and appearance inspection, etc., in assembly work and the inspection process. Its exterior is shown in Figure 1 [not reproduced], an example of its system composition in Figure 2, and its principal specifications in Table 1.

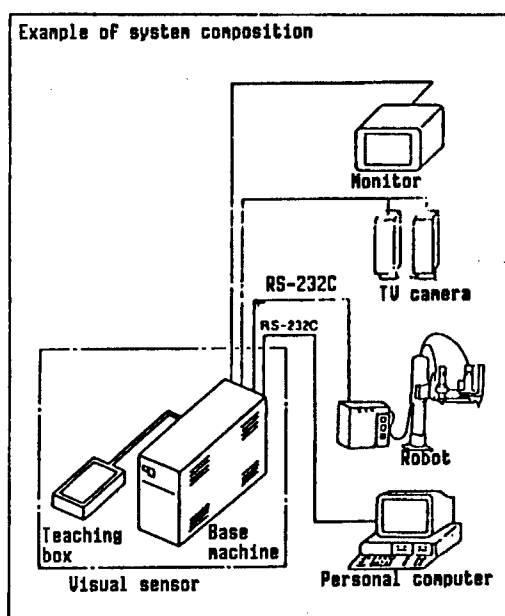


Figure 2. Example of System Composition

Table 1. Principal Specifications

o Basic Specifications

Item	Specification
Central processor	High-speed 16-bit microprocessor (HD68000, 12 MHz)
Picture memory	Multivalent 256 x 256 x 1 picture plane Bivalent 256 x 256 x 3 picture planes
Picture input	Two TV cameras can be connected
External interface	RS-232C: two channels
Outside dimensions of base machine	120(W) x 320(D) x 240(H) mm
Weight of base machine	5.5 kg
Teaching box	Separation type; flat panel keyboard
Power	AC 100 V \pm 10 percent, 50/60 Hz
Ambient temperature	0-40°C
Ambient humidity	30-90% RH (There should be no bedewing)

o Functional Specifications

Item	Specification
Objects of recognition	Form Color shade Fixed form, stationary Something that can be discerned by contrast with background and lacks reflected light
Recognition velocity	0.3-1.0 sec/component (varies with such factors as number in picture plane and shape)
Output data	o Type of component o Position coordinate of component o Attitude angle of component
Recognition function	Types of shapes recognized Maximum of 200

[continued]

[Continuation of Table 1]

Item	Specification
[Continued]	
Recognition function	Recognition formula Formula to compare with teaching aids o Numeric value of geometric characteristics o Superposition of component contour shapes o Setting of a multiple number of windows (Rectangle, circle: maximum 200 Polygon)
Teaching function	Formula Object teaching by dialogue menu selecting formula
Brightness adjusting function	Types o Correction of specific reference point by illumination o Correction in field of vision by illumination histogram analysis

o Options

Item	Specification
Parallel I/O	Insulation type: input 12 points output 12 points TTL type: input 8 points output 8 points
External memory	IC memory card
Software	FA-BASIC/V

The characteristics of this system are as follows:

(1) Two software items: bulk cargo component recognition function and composite window recognition function are provided as standard equipment, thereby enabling the system to handle advanced identification.

Bulk cargo component recognition function

The system can recognize randomly disposed components by TV camera, identify shape types in a two-dimensional plane, detect positions and attitudes (ΔX , ΔY , and $\Delta \theta$) and output these to the robot, etc., thereby grasping the positions and attitudes of specific components as corrected values.

The recognition method, for which the formula comparing geometric characteristic quantities with teaching data and that comparing shared areas at the time of contour shape superposition can be used together, makes more accurate recognition possible.

Composite window recognition function

This method follows the formula to set a multiple number of windows at specific places when comparison of the shapes of all components is difficult and to recognize windows by combining the simple characteristic quantities for shapes limited to individual windows, and can handle not only the determination of types of components and their quality, but also such work as discerning seven digit numerals and measuring lengths and widths. A maximum of 200 rectangular, circular, and polygonal windows can be set.

(2) Two RS-232C serial interface channels are provided as standard equipment and a parallel I/O can be provided as an option. These can be freely connected to the robot, the personal computer and the sequencer, etc. Teaching data can be preserved in the external memory of the IC memory card formula (option).

(3) Small size (width 120 x depth 320 x height 240 mm) and light weight (5.5 kg) have been realized by high integration through the use of an exclusive gate array. Therefore, the system is compact and can be installed at any position desired.

(4) The system is operated by the formula of dialogue with the monitor, and consists simply of selecting an item by a portable teaching box while viewing the operation menu display.

(5) The user's own recognition software can be developed for FA-BASIC/V (option).

3. Vision-Using Robot System

3.1. FIC Loading Work Cell

(1) Outline

This is a system to carry with high precision such face mounted components as QFP and SOP by recognizing the misregistration of the substrate pattern and the component lead by means of the visual sensor, HV/R-2. The exterior of the FIC loading work cell and the hand are shown in Figures 3 and 4, respectively.

The system is composed of, similar to the assembly robot A4010SL, a visual sensor, two types of cameras for recognition use, a tray or stick-type component supplier, a 4-directional positioner and a base conveyer for conveying substrates. The hand, meanwhile, is composed of a camera for recognizing substrate patterns, a syringe for applying soldering paste, an

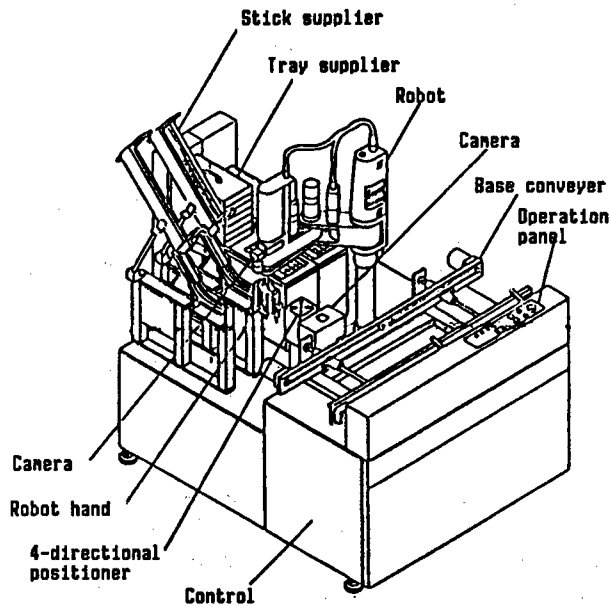


Figure 3. FIC Loading Work Cell

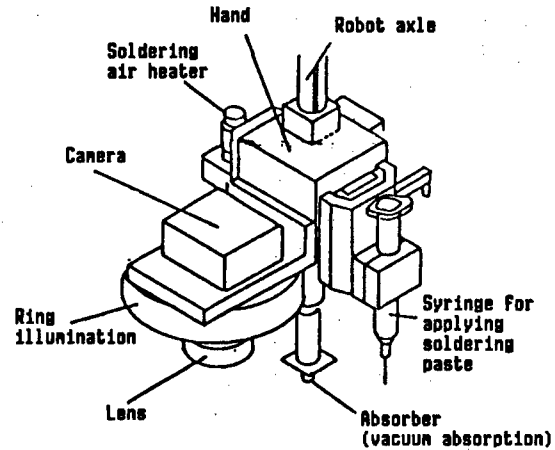


Figure 4. Hand Exterior

absorber, a soldering air heater, etc., and has the following characteristics:

(1) A single unit can handle the application of soldering paste, IC loading and soldering, therefore, it is suitable for smaller production purposes.

(2) Either the stick-type or tray-type can be used for component supply. Also, suppliers of both types can be mounted, making it possible to meet production flexibility.

(3) For recognition, the system uses the single field of vision change point detection method, which positions by putting all component leads and substrate patterns in one field of vision. The positioning accuracy is as high as less than ± 0.01 mm.

(2) Specifications

The principal specifications of the FIC loading work cell are shown in Table 2. The components covered are QFP and SOP with lead pitches of 0.8 mm or more, and the loading accuracy is ± 0.1 mm.

The total precomponent installation time for the QFP6P is about 55 seconds, which consists of 12 seconds for solder paste application, 8 seconds for IC loading, and 35 seconds for soldering.

Table 2. Principal Specifications of FIC Loading Work Cell

Item	Specification
Robot	A4010SL (with visual interface)
Visual sensor	HV/R-2
Method to attach subject substrates (mm)	MAX-450 x 330 MIN- 90 x 60
Subject components	QFP and SOP (pitch: up to 0.8 mm)
Loading accuracy	±0.1 mm
Number of types of components that can be loaded	Tray: 4 Stick: 6 Mixed loading is possible
Solder application formula	Syringe, dispenser
Component loading	Vacuum absorption
Soldering formula	Heated air
Installation time	Solder application 5-10 seconds Loading 6-10 seconds Soldering 20-90 seconds
Power	AC 100 V 50/60 Hz
Outside dimensions	1,200(W) x 2,000(D) x 1,900(H)

3. Recognition Method

As indicated in Figure 5, QFP substrate patterns and leads are recognized by photographing all patterns and leads in one field of vision and setting criterion lines on the field of vision. Boundary points of the patterns and leads (M1, M2, M3, ...Mn) are determined by the degrees of brightness on these criterion lines.

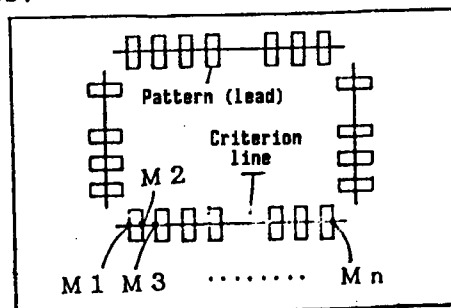


Figure 5. Picture in Field of Vision

From this information, points A, B, C, and D in Figure 6 are obtained as center points (mean value) of patterns and leads on the criterion lines. The center point O of QFP is obtained from the intersection of AC and BD. Also, the vector bisecting $\angle BOC$ is used as the QFP direction.

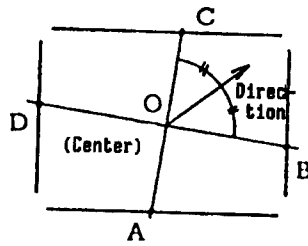


Figure 6. Center and Direction Determination

From this, accuracy can be improved by averaging, even if the picture element resolution is 0.125 mm. Therefore, the measuring accuracy of ± 0.01 mm has been satisfied.

3.2. Educational Robot System

A diagram of the educational robot system is shown in Figure 7.

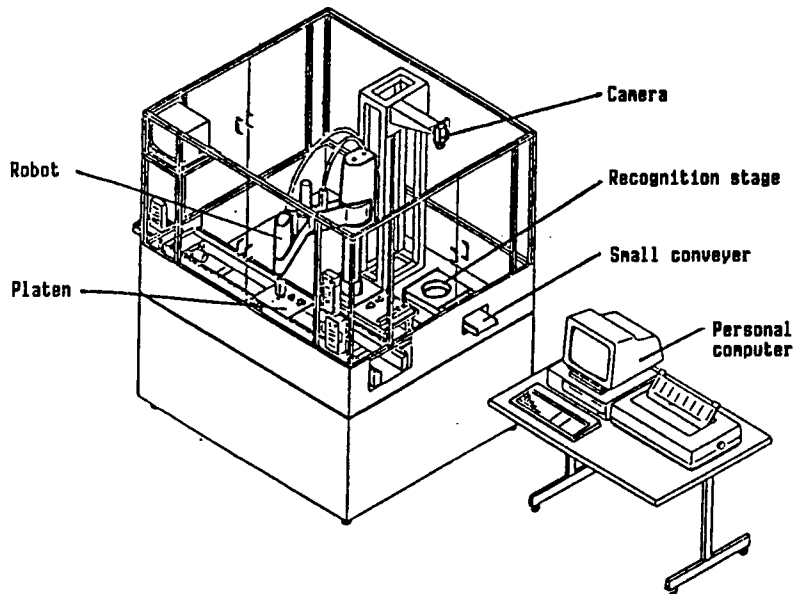


Figure 7. Educational Robot System

This is a system developed for educational use relative to robots, visual sensors, off-line programming, etc. Bulk cargo component assembly demonstration can be studied using the visual sensor. Specifically, three types of workpieces of different shapes are used. A workpiece is supplied to the small conveyer from outside the safety cover and, after causing it to stop at the recognition stage, its position and shape are recognized. Then the workpiece is removed by the robot and assembled at a prescribed position on the platen.

4. Conclusion

As sequels to the above-outlined visual sensor HV/R-2 and vision-using robot system, we hope to develop visual sensors and vision-using robot systems with higher efficiency and higher cost performance, and meet the needs for automating diverse assembly work.

Variantly Shaped-Component Inserting Robotized System

43063808 Tokyo, Nagoya SANGYOYO ROBOTTO RIYO GIJUTSU KOENKAI in Japanese
26 Apr 88 pp 35-39

[Article by Kiminobu Sue, Technical Section, Production Technology Center, Pioneer Electric Corp.: "Robot Using Variantly-Shaped Component Inserting System--Outline of Variantly-Shaped Component Inserting System Using Scalar Robot and Rectangular Coordinate Robot and Examples of Its Application"]

[Text] 1. Introduction

In the past few years, inserting variantly shaped-components into printed circuit boards has become absolutely necessary in improving the automatic mounting ratio of components, and related technologies have made remarkable progress. Pioneer Electronic has been operating effectively with the newly-adopted variantly shaped-component inserting machine using a scalar robot, but has developed a new, more advanced system using a rectangular coordinate robot. This report describes the above developments.

2. Outline of Variantly Shaped-Component Inserting System PIM-4120

This system is composed of a printed circuit board conveyer, which positions circuit boards with high precision, a pair of rectangular coordinate robots, upper and lower, which swiftly move between the component supplier and the insertion position, a chuck to grasp a component, a component supplying machine to separate components, and a control section. It is shown in Figure 1. The rectangular coordinate robots are arranged one above the conveyer and the other below, thereby using the robot work area most effectively. A large space for installing the component supplying unit is provided outside the conveyer, and the operations system is concentrated on the front side to facilitate teaching and other work.

Special mention must be made of the fact that the developmental period for the system was much shorter than it has been in the past because it was intended as a means of standardizing the scalar robot variantly shaped-component inserting system that the company had been developing.

3. In developing the system, care was exercised to:

- (1) Be able to flexibly meet the need for ocean development of many types in small quantities.
- (2) Ensure high reliability.

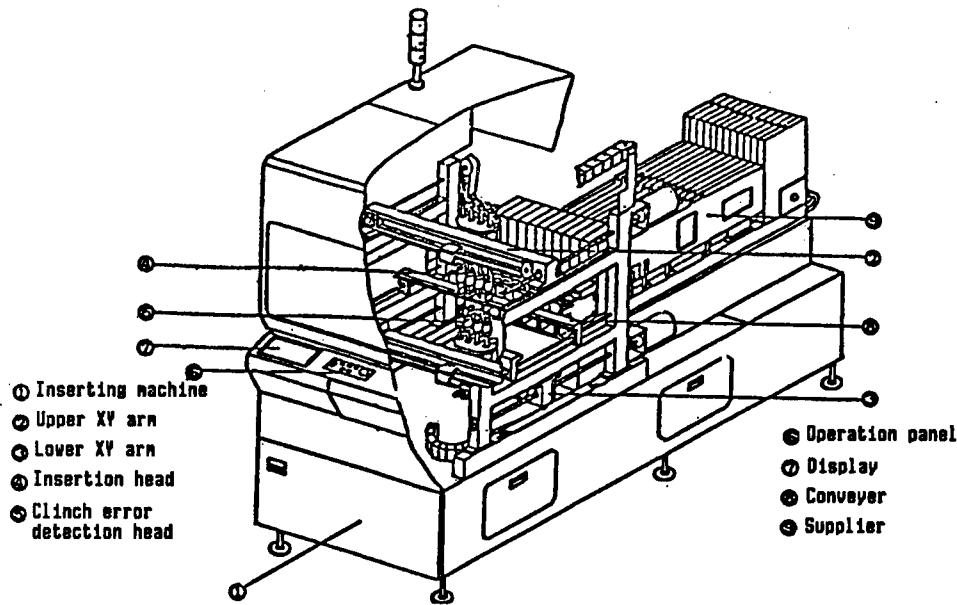


Figure 1. PIM-4120

- (3) Achieve small, compact size.
- (4) Easier change in setup.
- (5) Ensure balance in operation rate, etc., with other machines during use.
- (6) Ensure standardized system composition.

4. Specifications

Table 4.1. Specifications of System

Outside dimensions	750(W) x 2,210(D) x 1,690(H) mm
Size of circuit board	MAX: 400 x 300 mm MIN: 120 x 80 mm
Types of component	MAX: 12 types (up to 4 shapes)
Insertion direction	$\pm 180^\circ$ 0.2° pitch
Insertion tact	About 1.2 ~ 2 sec/component
Component supply formula	Stick, taping, etc. (30~12- mm width)
Data input	Tabular form (indicated in 9-inch display)
Machine type data	999 point/type RAM disk carries data for 10 types
Others	Clinch error detection; removal function

5. Characteristics

(1) Use of a pair of XY arms, upper and lower

The upper and lower XY arms, each carrying an insertion head and a clinch error detection head, excel in space efficiency and can effect high-speed locomotion. In teaching, they are safe and highly operable due to the complete freedom experienced by the operator.

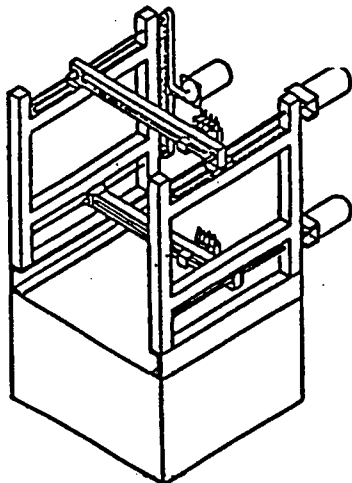


Figure 5.1. Upper and Lower XY Arms

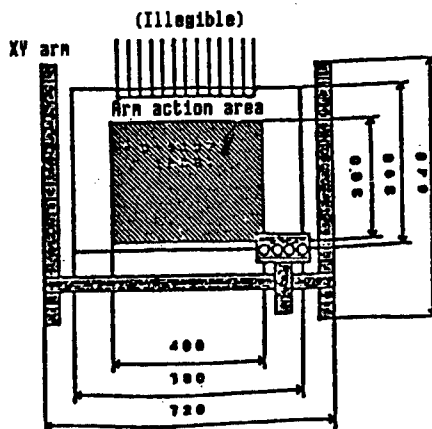


Figure 5.2 Arm Action Area

(2) High-speed multihead insertion

The insertion movement is speedy: about 1.2 seconds for a 4-component simultaneous chuck and about 2 seconds for single component insertion. More efficient insertion is possible if insertion data is optimized.

(3) Available for clinch error detection

The clinch error detection head of the lower XY arm is provided with an insertion error detecting mechanism, using an optical fiber sensor, and a 2-pin clinch mechanism, and these enhance the reliability of the system. Since insertion errors of all components can be checked, unmanned operation is possible by combining this system and an error stocker.

(4) Facilitating data preparation

Inserting positioned data can be input by circuit board coordinates. It is, therefore, not necessary to heed the positional relationship characteristic of the machines. So, off-line teaching using a digitizer, etc., is possible, thereby increasing the efficiency in data preparation.

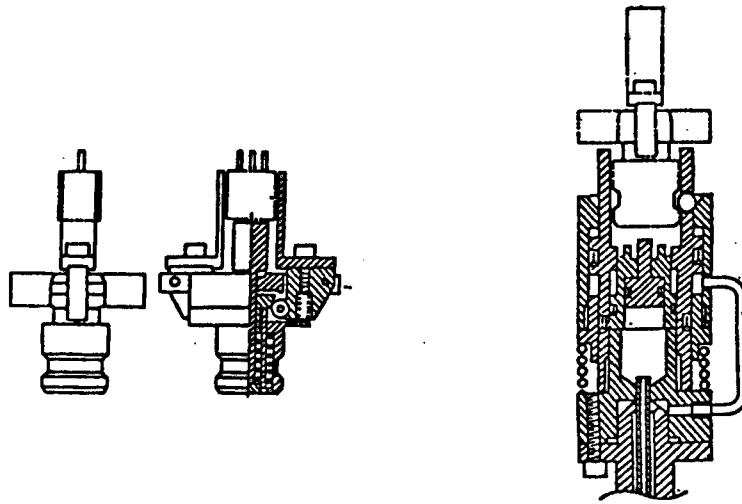


Figure 6.1. ATC Chuck

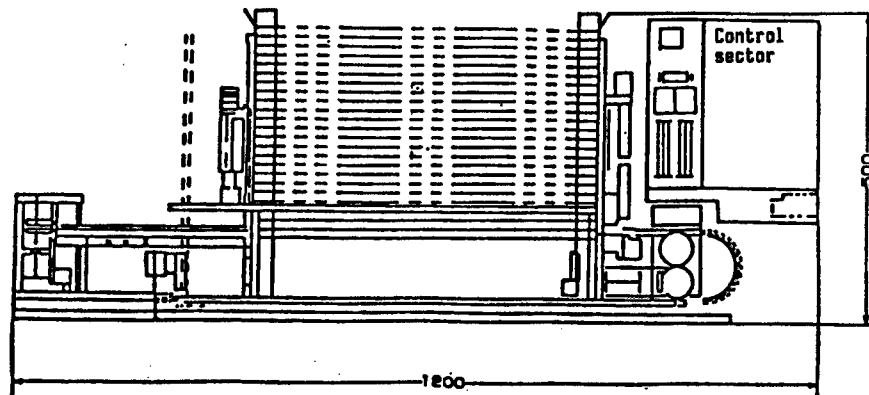


Figure 6.2. Diagram of Standard Supply Unit

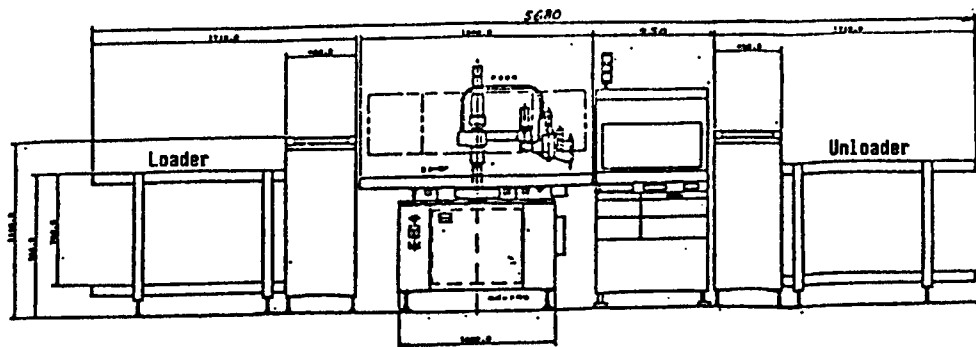


Figure 6.3. Line Composition

7. Conclusion

The ratio of automatically mounted electronic components on printed circuit boards has greatly improved as the result of the dissemination of electronic component automatic mounting machines. Various companies have commenced the automatic insertion of variantly shaped-components, and the component manufacturers are promptly coping by producing automatically inserted components.

The units of our new system were developed based on technologies accumulated while developing the scalar robot using a variantly shaped-component inserting system, with a view to make variantly shaped-component insertion more efficient, inexpensive, reliable, and easier to use than ever, and particularly taking the increase in its universality into account. It was designed to dispose of the component supply unit, the chuck, and the clinch unit in the center of the variantly shaped-component inserting system, and to enable the rectangular coordinate robot to move efficiently between the units. In order to expand the variantly shaped-component inserting system in the future, it will be absolutely necessary to achieve low-cost production of a very reliable component supply unit. It is our desire to proceed with this development so that all units are standardized and serialized, and system composition will be made according to individual needs.

Burring Robot Z-1

43063808 Tokyo, Nagoya SANGYOYO ROBOTTO RIYO GIJUTSU KOENKAI in Japanese
27 Apr 88 pp 51-55

[Article by Shinohu Kawase, System Equipment Development Section, Production Technical Division, Yamaha, Ltd.: "Development of Burring Robot Z-1 (Zeta One) and Its Applications"]

[Text] 1. Introduction

News of the robotization of burring work has rapidly increased in recent years with the progress in production rationalization and factory automation. Yamaha marketed a universal robot, λ -1 (Lambda One), and polishing robot, K-1 (Kappa One), in 1984. K-1 in particular, which has enabled robotic work to have the precision of a skilled worker, has opened the unique area for a polishing robot and enjoys a high reputation.

Z-1 is a robot used exclusively for burring, developed through the tool holding formula based on λ -1 and through the expertise cultivated through the development and sale of the K-1, and offers many characteristics that other industrial robots lack. Here, we shall discuss the mechanism- and control-related characteristics of Z-1 and applications that take advantage of these characteristics.

2. Mechanism

Z-1 is a robot with five degrees of freedom equipped with the use of a rotary tool. A λ -type arm structure, in which we had previous experience while developing λ -1 and K-1, is used for the three degrees of freedom for position (R, θ , and Z axes) while, for the two degrees of freedom for the wrist (α and β axes), a newly-developed machining point intersection structure (Figure 2) is used. With these structures, Z-1 has the following characteristics:

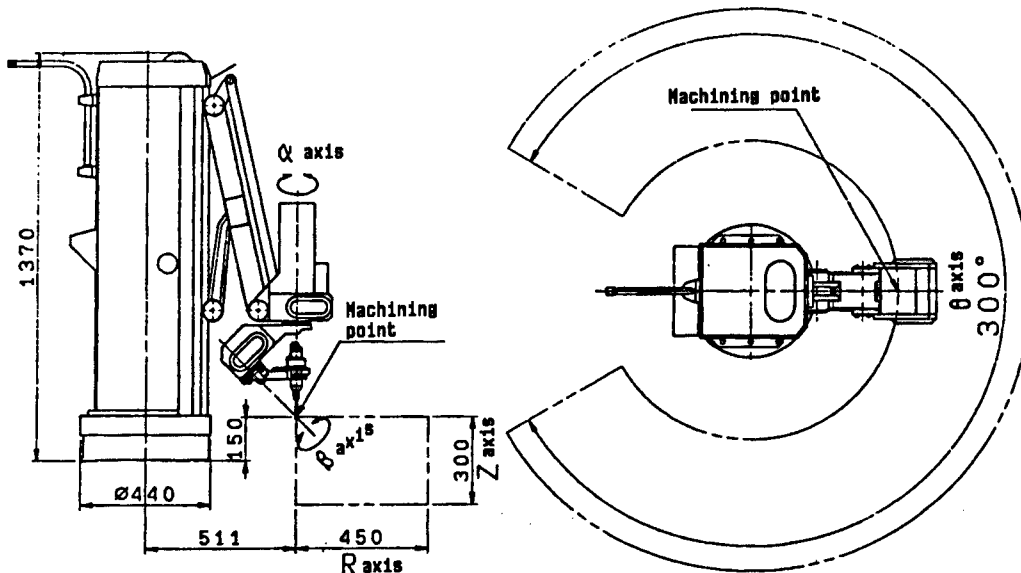


Figure 2. Z-1 Mechanism

- (1) High rigidity (load capacity: 30 kg).
- (2) High accuracy (positional repetition accuracy: less than ± 0.1 mm).
- (3) The position of the machining point (tool tip) does not change if the attitude of the tool is changed.
- (4) The machining load does not fall on the wrist servomotor and the speed reducer.
- (5) The tool can have any attitude at any position within the movable range of the three positional axes, therefore, the movable range of the robot can be used effectively. However, the tip of the tool cannot be directed above the horizon.
- (6) Wiring and piping, necessary for tool driving, and the sensor are housed in the robot.
- (7) The infiltration of burring dust, etc., into the interior of the robot is prevented by drawing air into the robot through the filter on the robot's back and discharging it from the front.

Table 1. Specifications of Mechanism Section

		Operating range	Maximum speed (PTP)
Position	R axis	450 mm	1,760 mm/s
	θ axis	300	100 /s
	Z axis	300 mm	400 mm/s
Wrist	α axis	720	225 /s
	β axis	380	225 /s
Driving formula		DC servomotor	
Load capacity		30 kg	
Positional repetition accuracy		± 0.1 mm	
Weight of robot		220 kg	

Table 2. Specifications of Control Section

Main controller	16-bit CPU
Position controller	8-bit CPU x 5 (maximum 6)
Number of control axes	5 axes simultaneously (up to 6 axes simultaneously is possible)
Position control formula	PTP control CP control (linear interpolation with adaptive control function) Remote control by unilateral servo
Position teaching formula	Teaching playback Coordinate value input (MDI)
Programming language	Language exclusively for burring
Programming formula	Key operation procedure guidance programming
Number of program divergence	Maximum 255
Memory capacity	About 2,000 points (with battery backup)
Auxiliary memory	Bubble cassette (option)
Number of input/output points	Standard equipment: input 16 points/output 16 points (can be expected to input 48 points/output 48 points)

[continued]

[Continuation of Table 2]

Control box structure	Sealed type (forced air cooling by heat exchanger)
Control box weight	250 kg

3. Control System

Z-1 is basically a robot of the playback type and has the following control characteristics:

(1) It has a language exclusively for burring use and its work routes and machining conditions can be easily taught or changed.

(2) Various operations and commands can be easily input by a key operating procedure guidance formula.

(3) It permits connection of a teaching device using the remote control formula (unilateral servo) previously used for K-1, and teaching time can be reduced to one-fifth to one-tenth that using the conventional joystick or jog key formula.

(4) CP control is by linear interpolation, even taking tool attitude changes into consideration. The maximum speed is 300 mm/s.

(5) The point data are not affected by the robot mechanism because the position of the machining point (tool tip) is of the orthogonal coordinate system and the attitude of the tool is described by the angles of transverse and reclining (Table 3). Therefore, the robot can readily switch to MDI or off-line teaching.

(6) The robot can handle advanced programming by its offset, coordinate change, interrupt control and other functions.

o Offset function: It sets any offset quantity at any place of a program and in any direction.

o Coordinate change function: It changes the real-time coordinate of teaching data and carries it out.

o Interrupt control function: It describes interrupt handling concerning user I/O.

(7) It has an adaptive control function to detect machining load and change machining speed.

(8) The NC1 axis can be added for use as peripheral equipment for work indices, reversal, etc.

Table 3. Point Data

Axis	Minimum set unit	Meaning	
X	0.01 mm	X coordinate of machining point	Position of machining point
Y	0.01 mm	Y coordinate of machining point	
Z	0.01 mm	Z coordinate of machining point	
A	0.01°	Angle of transverse of tool	Attitude of tool
B	0.01°	Angle of reclining of tool	
G	0.01	Optional axis	

4. Floating Tool Holder

This is a tool holder developed for Z-1. It has a mechanism with two degrees of freedom and houses an air motor (number of revolutions without load: 20,000 rpm) and a displacement sensor (Figure 3; patent pending). Its characteristics are described below.

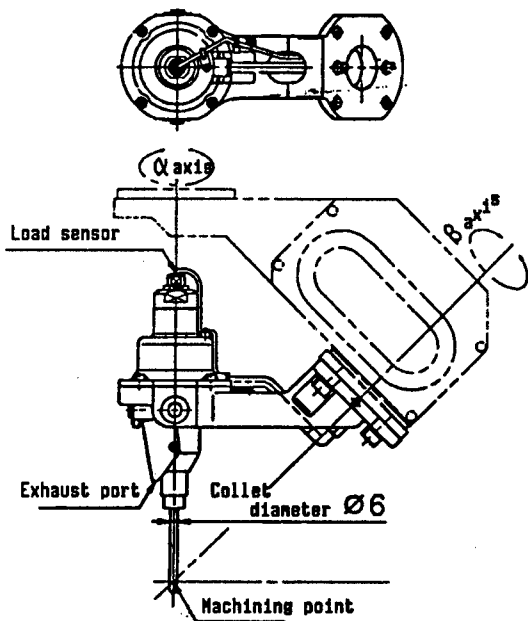


Figure 3. Tool Holder

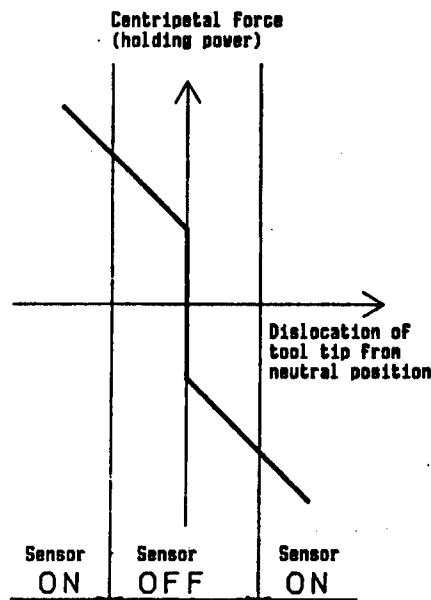


Figure 4. Dislocation of Tool and Centripetal Force

(1) Its mechanism is such that a certain centripetal force (holding power) works, even if the tip of the tool is at a neutral position (Figure 4).

(2) The dislocation from the neutral position of the tool tip can be detected by the built-in sensor. However, at the present stage, this is only possible for on/off output.

(3) The centripetal force (holding power) at the tool tip can be easily altered (maximum: 10 kgf) by changing the built-in spring and damper.

(4) The tool can be cooled by discharging air motor exhausts toward the tool tip.

(5) This tool holder can handle ATC.

In addition to the exclusive floating tool holder, a marketed tool can be attached to Z-1.

5. Adaptive Control

In burring work, it is necessary for the robot to move at a machining speed in accordance with the cutting capacity of the tool. Where burrs are small, the machining speed may be high, but where large burrs exist, machining must be slowed accordingly. Generally, the shapes of burrs and places with burrs vary. If a slow machining speed is set for all places with burrs, the overall machining time is prolonged.

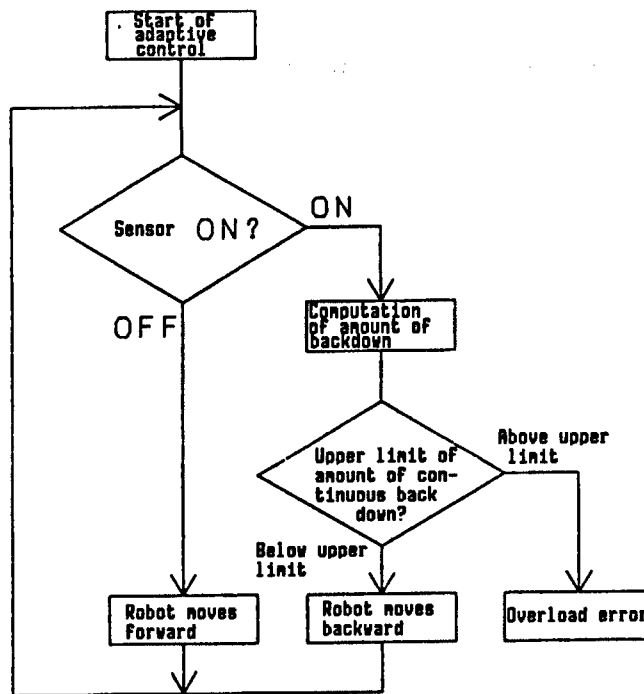


Figure 5. Flowchart for Adaptive Control

In Z-1, burr dispersion is tackled by load detection through the exclusive tool holder and control, causing the robot to move back along the teaching route when a load is detected (when a large burr is encountered) (adaptive

control). The flowchart for adaptive control is shown in Figure 5. The sensor of the tool holder is set so that it may be ON when the tool tip is dislocated from the neutral position by more than the prescribed value. The upper limits of backdown speed and the amount of continuous backdown are programmable and are set according to the cutting capacity of the tool and the teaching route.

Machining Experiment

A machining experiment was conducted to prove the effectiveness of the adaptive control function (see VTR). Two points: both ends of the work were used as teaching points for machining.

Sensor: It was set so that it would be ON if the tool tip was dislocated from the neutral position by 1 mm or more

Material of work: Aluminum casting (grand piano-shaped miniframe; Figure 6 [not reproduced])

Type of burr: Cutting lane of pouring gate (maximum: 10 mm (W) x 4 mm (H) x 22 mm (L))

Tool: Carbide cutter

Machining speed: 12 mm/s

Where large burrs existed, the robot automatically repeated forward and backward movements and scraped them all. The residue after scraping represented less than 0.2 mm (measured value)--a value considerably smaller than the set value of the sensor (1 mm). This is because, when encountering a burr, a tool is often dislocated not in the direction in which it is mounted, but in the direction in which the tool is delayed while the robot proceeds.

6. Applications

Burring was conducted, taking advantage of the adaptive control function (see VTR). Points were taught along a workpiece from which burrs had been scraped. About 300 teaching points were used.

Sensor: It was set so that it would be ON if the tool tip was dislocated from the neutral position by 1 mm or more

Material of work: Aluminum casting (Figure 7 [not reproduced])

Type of burr: Casting fin (maximum: 2 mm (W) x 20 mm (H) x 20 mm (L))

Tool: Carbide cutter

Machining speed: 15 mm/s to 100 mm/s

Machining time: About 90 seconds (depends on size of burrs)

Deflashing: Less than 0.2 mm

As in the machining experiment described in the preceding section, the robot repeated forward and backward movements, removing burrs, where large burrs were present.

Z-1 has also been used in burr iron castings, magnesium alloys, etc., to dispose of gouges and finish surfaces after spot welding, remove beads after welding and cut resin moldings.

7. Conclusion

As seen above, a relatively low-cost and high-quality burring system can be composed, taking advantage of the characteristics of Z-1. Its adaptive control function, in particular, is believed to provide an effective means of robotizing burring work.

Generally, several tools are used in burring work. In addition to burring, buffing and sanding machines, etc., and cutting by drills, and mills, etc., are conceivable as Z-1 applications. We will develop better systems in the future by accumulating technologies and expertise in these areas.

20108/9365

New Laser Application Technology

Monitoring Ultrasound During Laser Processing

43064056 Tokyo 14th ST SQUARE 'LASER APPLICATION TECHNOLOGY'-Symposium
Material in Japanese 15 Mar 88 pp 1-2

[Article by Yoshio Koda, doctor of science and manager of the Extreme Engineering Section, Production Engineering Department, Machinery Technology Research Institute, Agency of Industrial Science and Technology: "Methods to Monitor Ultrasonic Sound Generated in the Material During Laser Processing"]

[Text] 1. Preface

As can be assumed from the origin of the word--Light Amplification by Stimulated Emission of Radiation--lasers possess monochromy, high directivity, and high energy characteristics. Laser application technology properly uses the above characteristics. In this paper, discussions are focused on laser processing defined as thermal laser processing and are limited to processing using the high energy characteristic of lasers.

2. Laser Processing

Co₂ lasers and YAG lasers account for a majority of the lasers used for such processing as drilling, cutting, welding, and surface reforming. Of these processes cutting and welding have already reached the stage of practical application and it appears that the utilization of accumulated data for new processing is becoming an important technology. About 40 percent of the theses issued at LAMP 1987 are concerned with surface reforming, which is in the research and development stage. There are very few examples of practical application currently.

The following three items can be cited as future research targets:

- 1) Achievement of highly accurate processing
- 2) Development of new processing technology, including combined processing
- 3) Application to new materials.

It should be noted, however, that there are many processing factors which may affect laser processing characteristics. Therefore, in carrying out highly accurate laser processing, it is necessary to monitor the progress of processing as well as to study the individual processing factors.

3. Optoacoustic Image Technology

It is well known that the intermittent irradiation of light to a specimen generates ultrasonic waves. Using such an optoacoustic effect, flaws formed on a material surface are investigated. As described in the attached information, basic experiments on optoacoustic image technology have already been reported in the February issue of MACHINERY RESEARCH NEWS 1986. According to the above experiments, the depth of a hole could be measured using acoustic signals. In addition, a hole was drilled, a Q-switch YAG laser with a small output was irradiated into the hole and the amplitude of the acoustic signals produced was investigated. As a result, it was confirmed that the amplitude of acoustic signals could become a standard for detecting the depth of a hole. Consequently, research on the monitoring of laser processing using acoustic signals produced during laser processing was initiated.

4. Acoustic Monitoring of Laser Processing

It is well known that sounds are produced during laser processing. However, little correlation between acoustic signals and the processing progress has been obtained and applied to the control of laser processing. Sounds produced during YAG laser processing, therefore, were detected and the correlation between the acoustic signals and progress of the processing was obtained. Then, the applicability of such a correlation to controlling the processing was studied. The results are set forth in the attached information.

5. Conclusion

With respect to the progress in general laser processing, please refer to a feature article in Volume 35, No 14 of MACHINE TECHNOLOGY, entitled "Great Progress in Laser Processing Technology."

Optically-Excited Acoustic Image Technology

43064056 Tokyo 14th ST SQUARE 'LASER APPLICATION TECHNOLOGY'-Symposium Materials in Japanese 15 Mar 88 pp 4-5

[Text] The intermittent irradiation of excitation beams, such as light and electron ions, generates ultrasonic waves. Using such ultrasonic waves, the surface and inner structure of a material can be investigated. This is a new analytical method that is currently being developed. In the new analytical method, ultrasonic waves are produced due to thermal distortion inside the material, unlike the conventional ultrasonic flaw detectors and ultrasonic microscopes which apply ultrasonic waves from outside the material for detection. The new analytical method is, so to

speak, an internal ultrasonic wave generating method. Consequently, information in which the optical properties and thermal characteristics of materials are incorporated is obtained from ultrasonic wave signals. This new analytical method is expected to become a new form of evaluation.

The Extreme Engineering Section of the Production Engineering Department has initiated research to apply the beam excitation acoustic technology to controlling large output laser processing, surface reforming using ion beams and the evaluation thereof, with the cooperation of the Tribology Section of the Material Engineering Department.

Concepts on the beam excitation acoustic technology are first described herein. If beams such as light are intermittently irradiated to a specimen, part of the light energy is absorbed by the specimen and turns to heat. Elastic waves (ultrasonic waves) are produced by intermittent thermal expansion and contraction and propagate in the specimen. Such a phenomenon is called "optoacoustic effects." It is also known that excitation beams other than light beams produce ultrasonic waves. Such ultrasonic waves are detected and analyzed by piezoelectric elements, such as PZT. Therefore, various informative items concerning the specimen can be obtained (Figure 1).

In the case of light beams, the following expression can be established as the output voltage V,

$$V \propto \frac{P}{\omega} \cdot \beta \cdot \frac{1}{\rho C} \cdot a_t \cdot M$$

where P = light energy

ω = modulation angular frequency

β = specimen's light absorption coefficient

ρ = density

C = specific heat

a_t = coefficient of linear expansion

M = detection sensitivity of piezoelectric element

The light energy ($\beta P/\omega$) per absorbed cycle is converted to heat ($1/\rho C$) and thermal distortion (a_t) occurs. Such thermal distortion is converted to voltage (M) due to piezoelectric effects. When taking this principle into account, the above expression can be understood.

The range in which heat diffuses is determined by the parametric thermal diffusion length $\mu = \sqrt{2\kappa/\rho C\omega}$ in the thermal diffusion equation where a specimen having a thermal conductivity of κ is used. The thermal diffusion length is closely connected with resolution when an optoacoustic phenomenon is used as a microscope. The thermal diffusion length of ceramics and aluminum, where modulation frequencies are 15 Hz and 10 kHz respectively, are given in Table 1.

Using ceramics with a satisfactory cutting performance as the specimen, optoacoustic signals were measured. The components comprising the experiments are shown in Figure 2. Optoacoustic signals, although weak,

are very stable with respect to time (Figure 3) and may be used for analyses and controls. Changes in the signal amplitudes have been plotted in Figure 4 with changes in the intermittent frequency $f = (\omega/2\pi)$ of light. The figure shows that signal amplitudes are proportional to the inverse number of frequencies.

In addition, Figure 5 shows changes in the signal amplitude when the power current of a 1-kw Xenon lamp (used as a light source) was changed from 32 A to 45 A. When an aluminum specimen was used, signals became weaker and it was difficult to measure them. It appears that since light was strongly reflected on the aluminum surface, the light energy was not absorbed effectively by the aluminum. The above results support the theoretical formula.

The piezoelectric element used in a PZT with a diameter of 8 mm. PZTs, however, are characterized by the fact that the central part is more sensitive but the portions away from the central part have less sensitivity (Figure 6 (a)). Therefore, where PZTs are used microscopically, it is necessary to correct their sensitivities. Three holes (each having a diameter of 2 mm), the depths of which were 1 mm, 1.5 mm, and 2.6 mm respectively, were provided for ceramics (with satisfactory cutting performance) at intervals of 5 mm. Light was then irradiated to the ceramics through a slit 2 mm in diameter. Therefore, optoacoustic signals obtained when the specimen was scanned one-dimensionally are shown in Figure 6 (b), and those from (a) are shown corrected in Figure 6 (c). If the specimen is scanned two-dimensionally and the luminance is modulated based on the strength of optoacoustic signals, two-dimensional images will be obtained. Preparations for these experiments are being made to include the utilization of other beam sources.

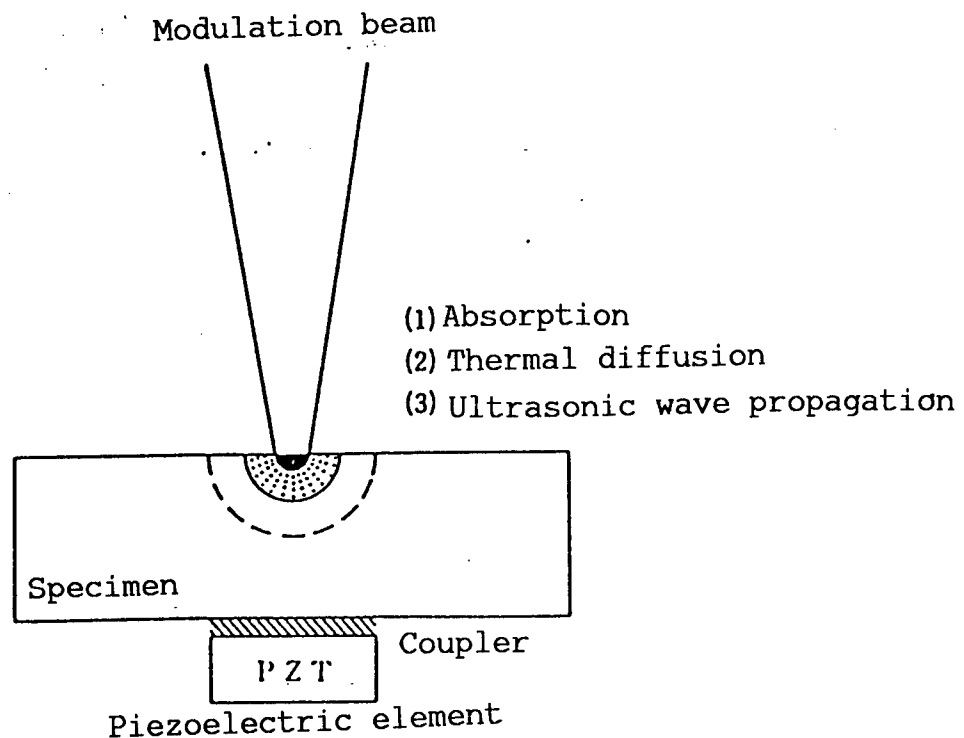


Figure 1. Concept of Beam Excitation Sound

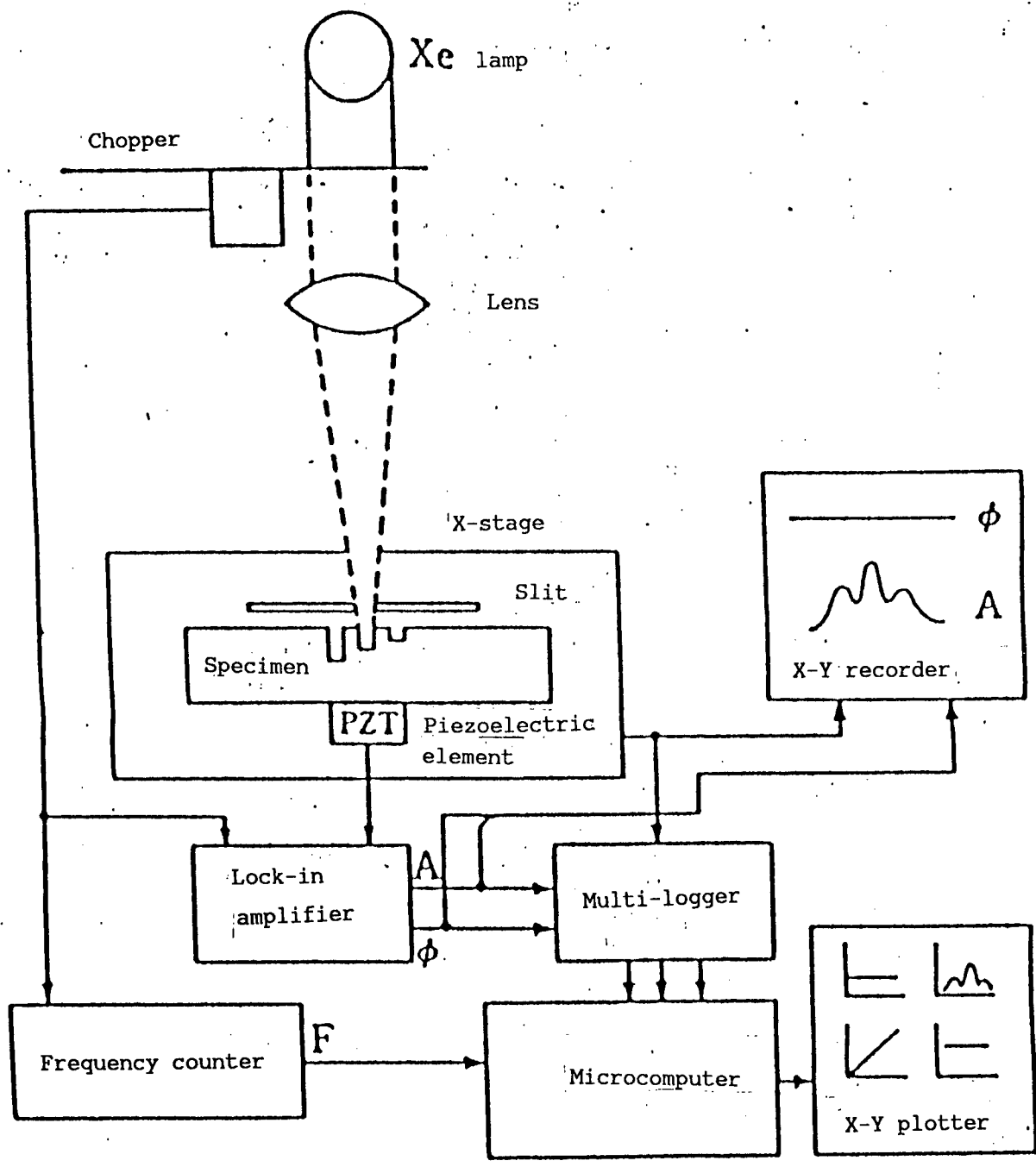


Figure 2. Experimental Components

Table 1. Thermal Diffusion Length (example)

	Density ρ g/cm ²	Specific heat C cal g. deg	Thermal conductivity κ cal/s. cm. deg	Thermal diffusion length μ μ m	
				15Hz	10KHz
Ceramics with satisfactory cutting performance	2.52	0.23	0.004	120	4.7
Aluminum	2.70	0.214	0.487	1.300	52

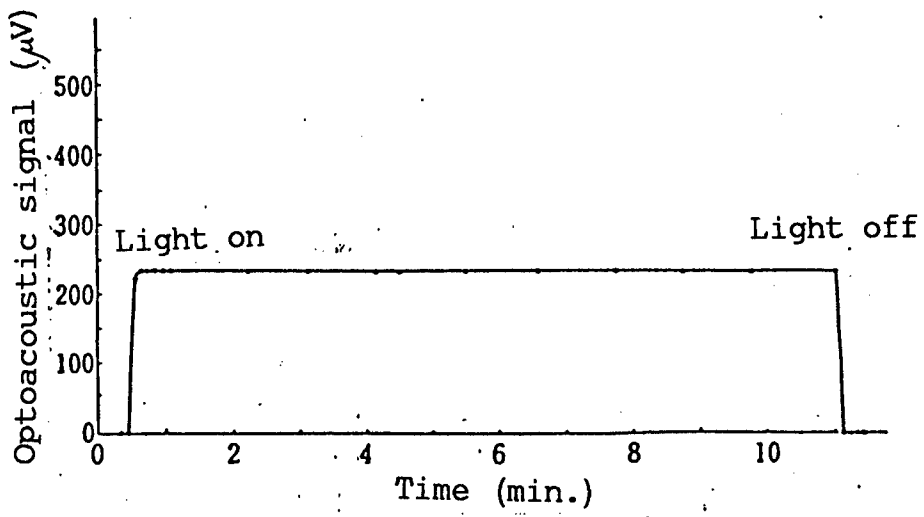


Figure 3. Time Variation of Optoacoustic Signal

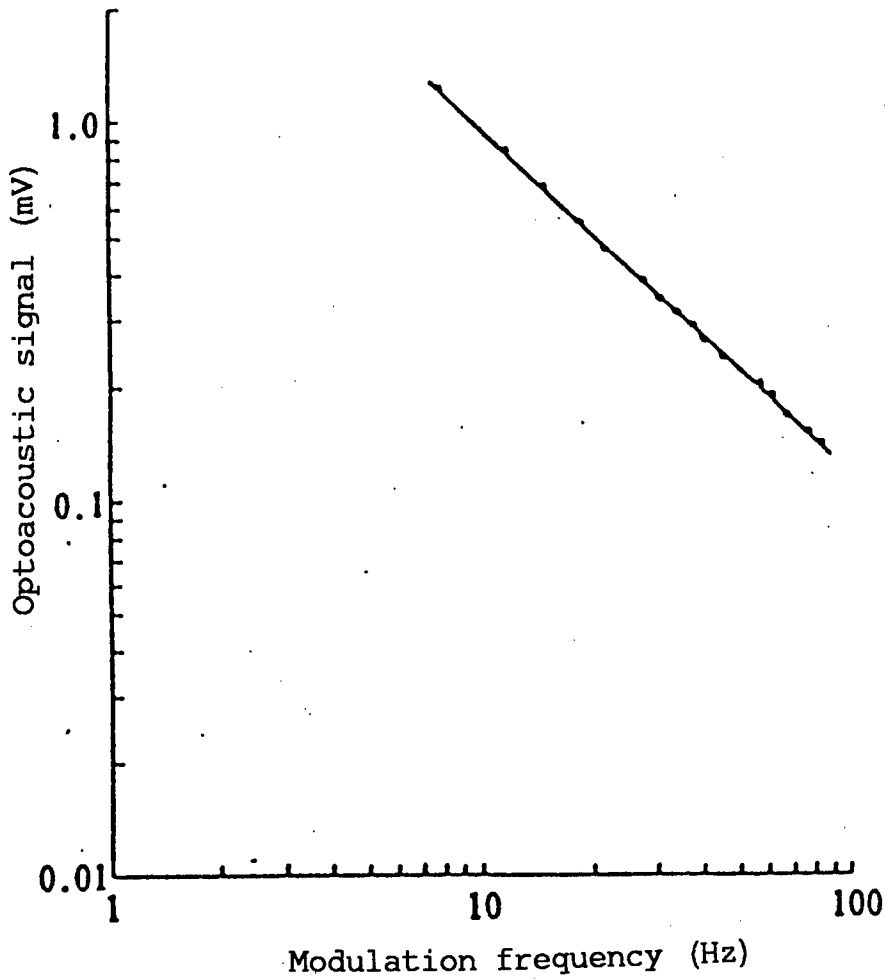


Figure 4. Dependence of Optoacoustic Signals on Modulation Frequency

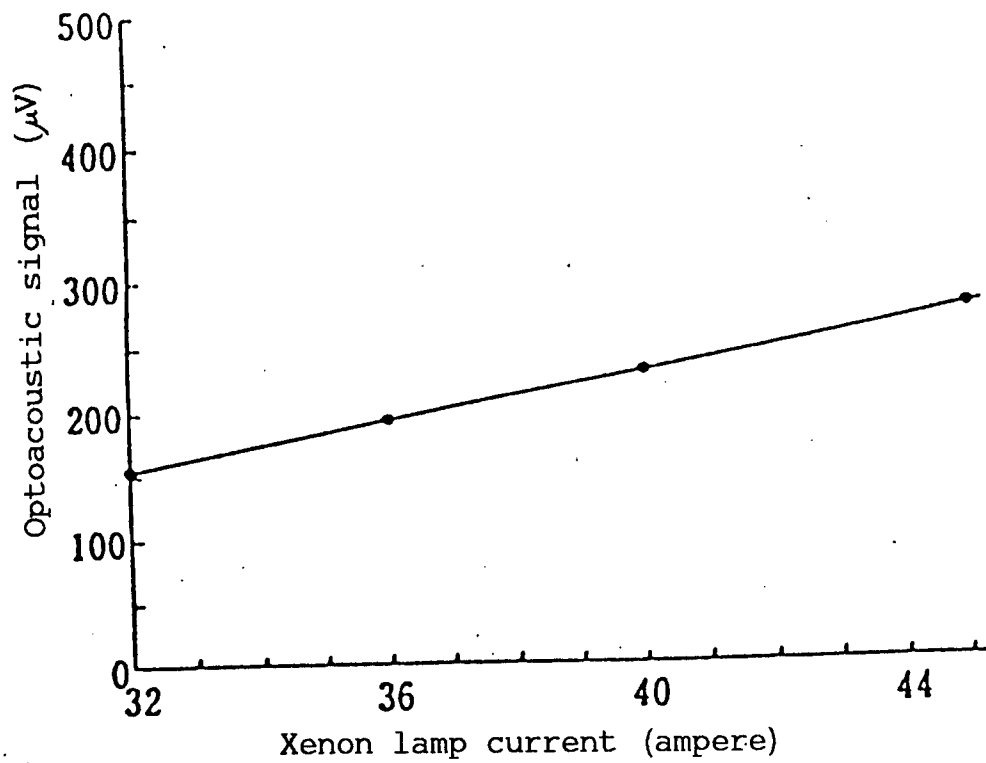


Figure 5. Dependence of Optoacoustic Signals on Xenon Lamp Excitation Current

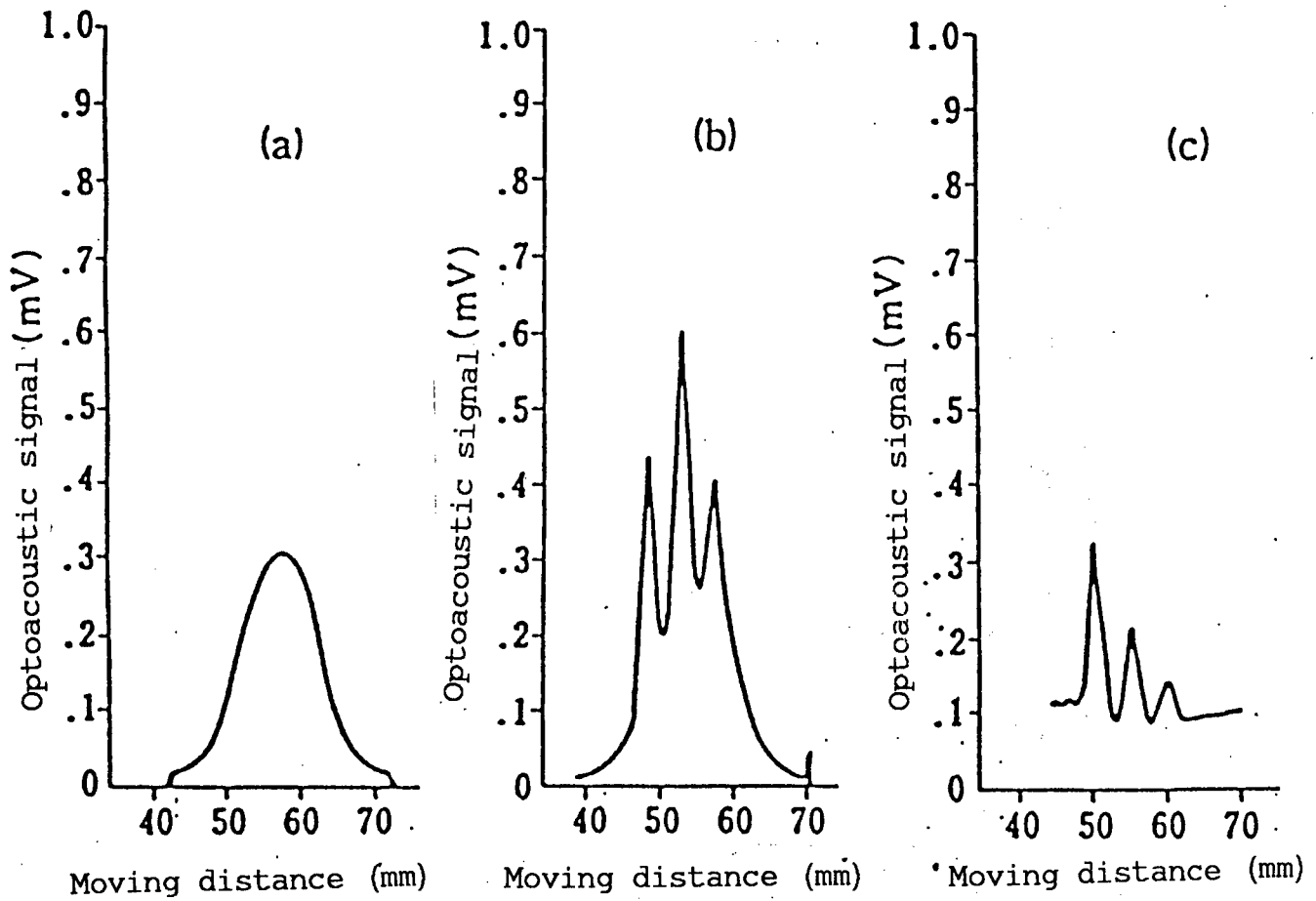


Figure 6. One-Dimensional Optoacoustic Image

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Large-Capacity Optical Transmission System Status Examined

43066551 Tokyo OPTRONICS in Japanese Feb 88 pp 61-62

[Excerpts] Preface

This year, two important optical communication systems using optical fibers will be put to practical use. One is the F-1.6G system established by NTT. It is the world's largest capacity transmission system using multiple optical fibers, and is designed so that some 46,000 persons can speak to each other by telephone.

The other is a project that KDD and others will realize by the end of the year: the third Pacific undersea cable, which will link Japan, Hawaii, and Guam for the first time by means of optical fibers. A communication system using undersea cables possesses an advantage over satellite communications systems in that it can reliably provide high-quality voice transmission regardless of meteorological conditions. However, it is necessary to lay down a number of repeaters (amplifiers) on the sea bottom, because the signals become attenuated in the course of communication. When the repeaters get out of order, they must be taken up from the sea bottom and repaired. In order to do this, it is necessary to provide a special ship equipped with facilities for taking up and repairing these repeaters, and the special ship involves a huge cost. Accordingly, the repeaters need a high reliability whereby they get out of order at a rate of once in several thousand years, and the entire system needs high reliability whereby it gets out of order at a rate of less than once in 10 years.

Optical signals transmitted through optical fibers must be amplified because they are gradually absorbed, scattered, or reduced in the optical fibers. No practical technology for amplifying light without change has been established up to now. Light is changed from optical signals to electric signals and is amplified, and the light is again changed from electric signals to optical signals by means of a semiconductor laser and is fed out into fibers which have been coated. At this point, photodiodes convert the attenuated optical signals into electric signals, and repeaters emit optical signals at the original intensity from the attenuated optical signals. Signals can be transmitted a distance of several thousand kilometers by using such repeaters. The repeater not

only amplifies signals, but it also shapes pulses deformed during transmission through optical fibers. All these functions are executed in electronic circuits.

As indicated above, the present fiber optics communications system consists of a semiconductor laser as the light source, optical fibers, photodiodes, and electronic circuits. All of the electronic circuits are IC, which require a very high degree of amplification and speed. The IC is a very important component supporting fiber optics communication technologies, and it has developed rapidly along with the fiber optics communication technologies.

Coherent Optical Communication

Fiber optics communication technology has realized systems that cannot be realized with conventional coaxial cables, but it does not make use of all the latent capabilities of optical fibers. At this point it is equivalent to a person travelling by bicycle on an expressway. Nevertheless, by means of such fiber optics communication technologies, a great deal of information at a time can be transmitted. In order to fully utilize these technologies, research on new methods is being conducted.

One method is to increase the speed at which pulses flash on and off. The objective is to increase the present speed by 10 times (10 billion times per second). In order to realize this, it is necessary to increase the speed of the semiconductor laser, the photodiodes, and the electronic IC's.

A second method is to simultaneously transmit a large amount of light to a destination by means of an optical fiber. This method is called "wavelength multiplex transmission."

A third method is not to only make light flash on and off, but to use the same method as that used in radio and television broadcasting and microwave transmission. That is, light is used just like electric waves. This method is called "coherent optical communication." The use of this method will result in lengthening the interval between repeaters, because the receiving sensitivity can be increased by 10 to 100 times as compared with the conventional method in which light is flashed on and off. In the present system, the interval between repeaters is 40 to 50 kilometers, and even if light with transparency greater than that of optical fibers is used, the interval is about 100 kilometers at most. But using coherent optical communication, it will be possible to lengthen the interval to 200 to 300 kilometers. If such lengthening is realized, it will not be impossible to cross the Pacific from island to island. Economical undersea cables can be realized without expensive repeaters having to be laid down for use on the sea bottom.

Coherent optical communication requires extremely stable light frequency, because information is transmitted to receivers by means of changing optical frequency, phase, etc. In the case of the conventional method

in which light is flashed on and off, it is permissible to keep the fluctuation of optical frequency or wavelength at about 1 percent, but in the case of the coherent optical communication, it is necessary to hold this fluctuation to 0.0001 percent or less.

The frequency of light emitted from a semiconductor laser is sensitive to temperature change. Accordingly, in order to stabilize the frequency, it is necessary to keep the temperature change of a semiconductor laser at one-hundredth of a degree or less, regardless of peripheral temperature change.

In any event, the establishment of light stabilizing technologies opens up wonderful possibilities for coherent optical communication. The possibility is that many light frequencies can be put into an optical fiber and transmitted to receivers. Even if optical frequencies are used at an interval of 0.01 percent, by using an optical fiber it will be possible to transmit more than 1,000 optical frequencies to receivers, because the respective optical frequencies are stabilized at about 0.0001 percent. Furthermore, even if the optical frequency is changed by some 10 percent, the transparency of the optical fibers is changed only slightly. Assuming that at present TV images for 10 channels are transmitted to receivers on one optical frequency, by using an optical fiber it would be possible to transmit TV images to receivers for more than 10,000 channels. Considering that even the previously mentioned NTT system can transmit TV images to receivers only for 16 channels (48 channels in the case of compressed images), it can be appreciated that the coherent optical communication opens up marvelous possibilities.

Application of Optical Fiber Transmission

Research on effective use of optical fibers is also being carried out enthusiastically from other standpoints, taking advantage of the large capacity and long distance transmission peculiar to optical fibers.

One is an application of optical fibers to CATV systems. The CATV system in Japan was developed as a means to reach places that TV electric waves cannot reach satisfactorily due to obstacles such as buildings or mountains. But recently, two-way city type CATV has been in the limelight as a result of the development of communications satellites. Two-way city type CATV can realize various services, such as TV shopping; personal computer communication between households; automatic inspection of the water, electricity, and gas meters of the respective households; and offering of TV and movie programs.

Also, wideband ISDN is being studied and standardized. If wideband ISDN satisfies the user's needs, it will become possible to uniformly handle various media, including the offering of entertainment programs to households on public communications networks, by the use of digital technologies. In line with this, various enterprises are making efforts to realize CATV by using all digital optical communication technologies.

Also, the establishment of a flexible network is being studied using optical fiber telecommunication lines whereby the wide band of optical fibers would be fully utilized. Such telecommunication lines are different from those of services that directly offer TV images to the respective households in that they are connected to telephone stations dotted over the cities. The flexible network differs from the existing network, which is strung like mesh mainly with copper wires, in that it is strung like a ring or a bus with optical fibers. It is designed so that optical signals can be transmitted via these optical fibers at very high speed, and these optical signals can be input and output freely with devices called "nodes" installed in the respective telephone stations. With the establishment of such a new network, more flexible than conventional ones, it would be possible to freely change telecommunication line capacities among nodes in accordance with the requirements of the respective telephone stations.

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