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GENERAL HEADQUARTERS
UNITED STATES ARMY FORCES, PACIFIC
Scientific and Technical Advisory Section

REPORT

ON

SCIENTIFIC INTELLIGENCE SURVEY IN JAPAN

September and October 1945

VOLUME III

Supporting Appendices 3 to 28

Covering Interviews and Other Material
Relating to
Wartime Research and Development
Outside of Military Institutions

1 November 1945

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E.O. 11652, Sec. 3(E) and 5(D) or (E)

Authority *NND 75012*

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SUBJECT: Conference with Dr YAGI
PLACE: YAGI's home (Minami, Office at Gakushi Senzoku 58
Kaikan Gakiyetau Shinko Kai)
INTERVIEWED: Dr YAGI
INTERVIEWERS: Drs COMPTON, MORELAND, SCHNEIDER, and GRIGGS
DATE: 11 September 1945

1. Organizations. The Nippon Technological Assn (Dai Nippon Gijitsukai) for working in the field and the Nippon Science Assn, for working in the laboratories, were formed late and played no significant part in the war.

2. Prof Nagaoka. Pretty old but still well informed.

3. Army, Navy, Civilian Cooperation in Research and Development.

a. Army and Navy did not cooperate. "A general and an admiral would rather lose the war than shake hands."

b. Army and Navy both treated civilian scientists "as if they were foreigners". They did not take them into confidence, and kept secret from them even information regarding enemy devices. They undertook to direct and order research work, which their officers were incompetent to direct.

c. The Army and Navy kept strict control of all research, giving orders as to what projects were to be undertaken by the civilian laboratories.

4. Transition from Laboratory Model to Manufactured Product.

a. Very slow owing (1) to slow or incompetent decisions by the military as to adoption and specifications, and (2) inability of manufacturers to get the jobs done, especially after bombing began.

5. Board of Technology.

a. Yagi retired as president last May.

b. It received about 1,000,000 yen for a year's budget. (Compare Gen TADA's statement of 30,000,000 yen.)

c. It handled several hundred projects in the various non-military laboratories. These were assigned to the Board by the Army or Navy, the Board having no power of refusal.

d. In Yagi's opinion, the effort was forced to be spread over too many projects, and the funds were inadequate. He feels that more progress would have been made by concentrating resources on a few top priority projects.

e. The Board would be asked to do a job on some part of a project, without being taken into confidence on the whole project or system. Hence work was inefficient and poorly coordinated. (See guided missile item below)

f. We were unable to get from Yagi any organization chart or list of the Board of Technology. His answers were always evasive as "We were too busy to prepare a description of our organization." "It might have handled a few things." "The military authorities might have the information; it should be sought through them."

6. Magnetrons

a. Two members of Yagi's staff (or former students) are Jap leaders in this field. Okabe wrote a book on magnetrons which has been published in English. He is with Nippon Musen Wireless Co., Tokyo. Also Kawanishi Machine Factory, Kobe.

b. Big magnetron (200 KW, CW output, 80 cm) development now going on under Yagi pupil in Noborito Laboratory, near Nagamo in town of Suiva (Nagamo is prefecture).

c. Magnetrons are of 4 cavity type.

d. In Yagi's opinion, a responsible officer in the Navy went to unwise extremes in the use of magnetrons. (We believe Yagi here referred to their use in communication, not radar).

e. Yagi said that he personally had not been concerned with magnetron developments.

7. Death Ray.

a. Experiments carried out by Yagi (or at least by scientists close to him) envisaged a death ray, acting through focusing of 80 cm radiation on target. Death by induction heating or absorbed energy.

b. Experimental set of a 3-4 kw, 80-cm wave length, about 4 or 5 ft disk, would kill a rabbit very quickly (at snap of finger) at 30 meters. A ground-hog was more difficult to kill.

c. The new set was also 80 cm, powered by a 200-kw CW magnetron (which is much more powerful than any magnetron produced in U.S.) and focused by a 10-meter diameter parabolic antenna. Yagi would, or could, not say at what distance this would be expected to kill a rabbit, saying only that the scattering due to non-point focal spot, made it less than theoretically effective. Our calculations indicate that extrapolation to 200 kw and 10 m dist would kill a rabbit at 1-2 km, based on Yagi's previous experiment.

d. Yagi said that no experiments had been made on human beings (rather evasively).

e. I gathered the impression that this was the war development in which Yagi was most interested.

8. Electromagnetic Shorting of Magneto.

a. A number of years ago, Yagi suggested that an automobile or aircraft motor might be stopped by illuminating it by a strong beam of electromagnetic waves, thus short-circuiting the spark set.

b. He was thus able to make an automobile engine knock, with the hood lifted.

c. He believes that the shielding of an aircraft motor would be too good to permit this method to be effective against aircraft, and said that no tests on aircraft in the air had been made.

9. Atomic Energy.

a. Two cyclotrons in Japan: one at the Institute for Physical and Chemical Research (a private institution, part of which was destroyed) under Dr Nishina, a pupil of Bohr; the other at a Governmental laboratory (not named) under Dr Kikuchi.

b. Some efforts were made to get U-235. Only 100,000 yen was made available and not much progress was made. Yagi said that he had not been in touch with the work, but thought that a diffusion process was used to effect separation.

10. Proximity Fuses.

The only successfully-developed proximity fuse was for use in bombs dropped from airplanes. It was a photoelectric device with a narrow beam of light directed out from the

nose and a photoelectric cell to be activated by light scattered back from the ground. A few hundred of these were made for experimental use, including experimental field use. (Apparently this is the type of bomb which was observed by our troops on Leyte.)

There were some attempts to develop a proximity fuse for antiaircraft shells, but they were never able to construct a device which would withstand the centrifugal force.

Because of the inability to develop a proximity fuse for a shell, attention was turned to the development of proximity fuses for antiaircraft rockets. Here again the development was carried part way through, but inability of the armed forces to make up their minds, plus the inability to get the device manufactured made this work abortive. In this connection, Yagi said that the military people generally behave as if they did not want new weapons or new ideas.

11. Guided Missiles. The Navy had a project for a heat-homing bomb for use against surface ships. Perhaps 200 of these were constructed for experimental test but the results were still very unsatisfactory when the war came to a close. The accuracy was poor and in many of the bombs the steering device failed to function. Yagi estimated that this bomb might have been about 80 per cent of the way toward successful development.

Yagi used this bomb to illustrate the very poor coordination in handling new weapon developments and also the extent to which civilian scientists were not taken into confidence by the military organization. One scientist would be asked to develop the most sensitive possible thermopile; another, the most sensitive bolometer; another, a sensitive amplifier, etc. None of these scientists were told what was the purpose of the development, nor were they told anything about the other components of the system in which their special device had to work. As a result, when the equipment was all put together in the Army or Navy laboratories, it generally failed to function. Then, the scientists were called on to make modifications but still without being told the purpose or nature of the total equipment.

12. Universities in Wartime.

a. Until the Universal Mobilization Act was passed last May (?), scientific and engineering students were permitted to pursue their regular courses to graduation, thence to go to Army, Navy, or war industry. During this period the technological schools were crowded, and the teaching loads were very heavy. After universal mobilization, the enroll-

13. Military Training in Colleges and Universities.

a. About 16 years ago, at the time of the 3-power move toward disarmament, and the 5-5-3 naval ratio, Japan reduced its standing army by several divisions. But it made up for this by introducing compulsory military training in all schools, public and private, and maintaining a big officer staff of instructors. A student in college put in about four hours per week on military training.

14. The Army.

Yagi made it clear that he blames his country's policies and ills on the Army, which for many years has dominated everything - even the "peace-loving" emperor and royal family.

SUBJECT: Interview with Dr H YAGI.
INTERVIEWERS: Drs Longacre, Harland, and Griggs.
DATE: 17 October 1945.

This second interview with Dr YAGI took the form of discussions of several different topics.

1. Atomic Bomb. Dr YAGI stated that about two years ago the Army and Navy asked about possibilities of developing atomic bombs. Dr NAZAKI reported that plans had been discussed by various nuclear physicists, but they had come to the belief that it was very improbable that one could be made. Dr YAGI used this as the basis of his opinion that there would be no hope of Japan completing the necessary investigations and development in time for this war. However, upon the Army's insistence, the Board of Technology gave some funds to NISHINA early in 1944. In February 1945, NISHINA reported to YAGI that he was not making very good progress with thermal diffusion of uranium and expressed the thought that there might be a limit to the concentration of uranium-235 which could be obtained.

On 15 August 1945, Dr YAGI found himself with a group of the Navy. Admiral OIKAWA, formerly Commander-in-Chief of the Navy, asked YAGI what he now thought about the possibilities of the atomic bomb, and YAGI repeated that he stuck by his former statement that it was impossible for Japan with her resources. Another member of the Navy whose name YAGI fails to remember told YAGI on 15 August that ARAKATSU had been working for the Navy right along on atomic problems, and that this had been kept secret from both the Army and the Board of Technology. YAGI suspects that this work was carried on under the Naval Technical Research Laboratory and believes the financial allotments to have been small, perhaps in the order of two to three thousand yen. His estimate is based upon the amounts they usually allotted for such projects. Actually YAGI doubts if Dr ARAKATSU had gotten any further than NISHINA since he believes that ARAKATSU's group was about 4 or 5 men while NISHINA had a group of about 15 to 20 men.

2. The 200-Kilowatt Neutron. Dr YAGI understood that a 200-kw neutron for the death ray was under construction at the end of the war. He believes that it may have taken the form of four 50-kw units in parallel.

3. The Proximity Fuse. Dr YAGI reported that a proximity fuse using a pulsed light beam was developed by Prof ASADA at Osaka Imperial University on 19 January 1944. This development was at least partially supported by the Board of Technology and had been proposed by the Army. It was probably supervised by the 7th Army Laboratory but may have been directed by the 5th Air Laboratory. The design was perfected and some experimental units were built. Dr YAGI believes that it may have been tried at Leyte.

4. The Heat-Homing Bomb. Heat-homing bombs were worked on by the Japanese and supported by the Riku-Kaigin Gijutsu Unyoiinka (The Army and Navy Technical Control Committee). Dr YAGI was at one time a member of this committee. He believes that the Navy took the leading part in originating the idea, but through this committee the Army was asked to undertake the development, primarily because they seemed to have more facilities available. The research was conducted in a private house in the vicinity of Tokyo under Col NOMURA (The 7th Army Laboratory is under Gen NOMURA, a different man). At one time Dr YAGI was taken to see the progress of the work. The Navy was interested in the development in order to apply the same control methods, if successful, to the control of small boats and torpedoes.

5. Riku-Kaigin Gijutsu Unyoiinka (The Army and Navy Technical Control Committee). This committee was set up in November 1944 by Premier KOISO. It was a small committee consisting of Army and Navy executive officers and seven specialists from the outside. This was the first time that civilians were brought in to an Army or Navy committee. YAGI was a civilian member of this committee. At the first meeting of the committee in December 1944, the services brought in about one hundred projects. YAGI considered these too many for their first session and mostly trivial, so they were rejected and the services asked to return with a new list of proposals, one month later. Actually they brought back about 90% of the original list, and the committee was forced to accept them. In these negotiations YAGI was supported by the Prime Minister but the power of the Army and Navy was successful to force through the revised list. When YAGI became head of the Board of Technology, he was forced to resign, because as head of the cabinet bureau, he outranked most of the Army and Navy members of the committee.

6. Board of Technology. When YAGI became head of the Board of Technology, he hoped to develop effective coordination throughout the sciences, military and civilian. He was not successful because of the Army and Navy and was eventually forced out by the opposition of the Army technical group. At no time did the services want to relinquish any of their prerogatives and used the exigencies of the war to force the hand of the Prime Minister.

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SUBJECT: Tokyo Shibaura Denki, K. K. (General Electric Affiliate)
DATE: 14 and 15 September 1945 at Mazda Bldg.
INTERVIEWED: Mr. Tsumori, President
Mr. Shoto Kagaya, Secretary to the President.
Mr. Tada (Interpreter, former student of Hebrew literature
at Harvard).
Dr. Kazaoka (Engineer), Asst. Dir. Research (Present on 15
September 45).
INTERVIEWERS: Drs. Compton, Moreland, Griggs.

1. Plants of Company:

a. At Kawasaki, five (5) groups:

- (1) Made watt-hour meters. (intact).
- (2) Made radio sets (burned out).
- (3) Made tubes: radio, radar, oscillograph (Braun). (Main shop escaped but subsidiary shops essential to production line were burned out).
- (4) Made tubes and metal parts. (Burned but can be repaired)
- (5) Made carbolloy. (Damaged)

b. At Tokyo, two (2) factories:

- (1) Made steel castings. (Damaged but can be used)
- (2) Made tungsten powder. (One-half damaged)

c. At Fuji, three (3) factories:

- (1) Made searchlights. (Intact). Will convert to make radio sets.
- (2) Oegawa factory made optical glass. (Intact)
- (3) Oichto factory made lighting equipment. (Intact)

d. At Tsurumi:

Factories making lighting equipment, fixtures, switches, glass.
Now studying other types of glass for new peacetime production.
Also made big motors, generators, and hydroelectric equipment
here. (One-half bombed.)

e. At Hochaido:

Now building at lamp factory.

f. At Kofu:

Factory making optical apparatus. (Burned out)

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g. At Nagano:

Factory for radio components and lighting fixtures.

h. Southern Korea (in American-held territory):

Factory for heavy electrical machinery.

i. Manchuria.

j. At Mie, near Nagoya:

Made motors. (Intact).

k. At Fuchu, two (2) miles west of Mitaka:

Made electric locomotives, power switchboards, and industrial heaters. (Intact)

l. At Aboshi, near Kobe:

Plant like Tsurumi, but smaller.

m. At Yobe:

Vacuum tube plant, just getting into production. (Intact)

n. At Osaka:

Lamp factory. (Burned out)

o. Recently bought Japanese interest from RCA-Victor and EMI (British) Columbia for records.

p. Numerous small affiliated plants.

2. Effect of Bombing on Production.

The over-all effect of the bombing was to cut production to 60 per cent of its war peak.

The last 6 months budget was 360 million yen.

The next 6 months budget is 114 million yen.

It is expected that the second 6 months' budget will be substantially larger than 114 million yen.

Before the war, 70 per cent of the company's total business was in the manufacture of lamps.

3. Research Laboratories.

HEAD OF RESEARCH? Dr. Kotaro Honda (old and not very active)

SUBDIRECTORS, Dr. Hamada for Electronics Laboratory

Dr. Kazaoka for the other laboratories.

Electronics Laboratory (Completely destroyed). This is operated practically independently of the rest of the research organization, principally "because its director, Dr. Hamada, is that kind of a person." We will see Hamada at 1400, 18 September at the Imperial Hotel.

Other Laboratories. Dr. Kazuo gave the following information:

There were four laboratories under the general name of the Consolidated Research Laboratories. These were:

- a. The Kawasaki General Laboratory (2/3 burned out).
- b. The Tsurumi Laboratory, near Yokohama (intact)
- c. The Chemical Laboratory (1/2 destroyed).
- d. The Communications Laboratory (completely destroyed).

The description of these four laboratories follows:

a. Kawasaki General Laboratory. This laboratory served all of the Kawasaki factories. Its director is Mr. Sadakiyo. It was divided in seven sections, as follows:

- (1) Central Laboratory, of which Dr. Honda is directly in charge, was being newly constructed but was burned out before coming into use.
- (2) Metallurgical Laboratory. This was not yet fully developed and is the only part left of the Central Laboratory. It was principally concerned with:
 - (a) Development of an iron-aluminum alloy, containing 14 per cent of aluminum as a substitute for nickel for magnetostriction.
 - (b) Very pure iron.
 - (c) Oxygen-free copper for leading-in wires.
- (3) Illuminating Industry Laboratory. Concerned with the development of fluorescent lamps and also high-pressure mercury lamps for collecting insects at night for fish food.
- (4) X-ray Laboratory. While this was built as an X-ray laboratory, its recent activities have not been concerned much with X-rays but rather with the development of a powdered colloid technique which was considered very important. This work was done under the direction of Prof. Dr. Miyagawa of Tokyo Imperial University.

(This is evidently work which has so interested Dr. Sanders and Dr. Moore, both of whom are already in close touch with it).

One of the early developments was the sputtering of antimony on to dextrose in a vacuum. This colloidal preparation of antimony was used for certain medicinal purposes.

Other developments were the sputtering of butter on dextrose in order to preserve vitamins; also, the sputtering of blood on dextrose, in which case the blood is kept alive for years at ordinary temperatures; also, the sputtering of vaccines on dextrose which are thus kept alive at medium temperatures indefinitely. In all of these cases the sputtering is done in vacuum and the products are kept under vacuum.

- (5) Silicate Laboratory. This laboratory was developed to:
 - (a) Filter glass.
 - (b) Fuse quartz.
 - (c) Artificial jewels, principally of aluminum oxide for use as bearings in instruments.
 - (d) Synthetic mica, of which the development effort was unsuccessful.
- (6) Electrical Ceramics Laboratory. This was devoted to the development of various products, steatite, and ceramics for condensers. There was also in development a stannous oxide condenser.
- (7) Chemical Laboratory. Here were developed fluorescent materials, rochelle salt (presumably crystals), and carbon suitable for anodes in vacuum tubes.

All of the above Kawasaki laboratories employed about 400 college graduates and about 300 workmen.

In addition to the above research laboratories, the Kawasaki group included a developmental laboratory which took products from the research laboratories and designed them for production in the plants.

b. Tsurumi Laboratory. This laboratory serves the heavy machine division of the company and employs about 200 college graduates and 250 workmen. Its principal war activities were the following:

- (1) Development of high-voltage mercury arc rectifiers for use in aluminum production plants. It had been hoped to develop these rectifiers to deliver 50,000 volts, but the

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development was successful only up to 35,000 volts. This laboratory had previously developed 3,000-volt mercury arc rectifiers for the electric railways.

- (2) Contactor-Type Rectifiers. These are based on a German invention and are somewhat like a Thompson machine. They did not get into production.
- (3) High-frequency induction heating for the surface hardening of steel.
- (4) Metal ignitrons for spot welding. Also the development of the pyrenol capacitor. Also, the development of copper graphite alloys of the general type of "grafoil" for use in heavy bearings. And finally, development of alloys as a substitute for nichrome because of the shortage of nickel.

c. Chemical Laboratories (NECO). These laboratories employed about 100 persons, including 10 or 15 college graduates. The principal activities were:

- (1) Attempts to produce boric acid from Japanese soil. (Not successful).
- (2) Development of primary batteries in the form of dry cells, where some advantage was found for use of exceedingly pure manganese oxide.
- (3) Production of artificial mica from the bonding of bentonite clay. (This development was apparently along the same lines as Professor Hauser's alsifilm.) The Jap development was not successful for production of high-grade insulation, but it was fairly successful in producing insulation for commutators and similar uses.

d. Communications Laboratory. This was Kawasaki and was completely burned out. Dr. Kazaoka knows little about the work which went on in this laboratory.

4. Exporting of Japanese Lamps to the U. S. - Prewar.

The Tokyo Shibaura Denki never exported incandescent lamps to the United States. This may have been owing to its agreement with the General Electric Company. The Japanese lamps exported to the United States were made by small "wild cat" companies, too small to make it feasible to control under the company's patents, and manufacturing a very inferior product.

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5. German Assistance. This company received no help whatsoever from German sources. Its prewar affiliations have always been with the United States. No German scientists ever came to the plant during the war. The company may have manufactured equipment based on German designs, but if so, these designs went directly from Germany to the Japanese Army and Navy through military channels or to the Nippon Musen Company through its German affiliate.

6. Magnetrons. This company did no development work in magnetrons, but it manufactured some magnetrons on specifications supplied by Nippon Musen or by the Army and Navy and under a license from Nippon Musen.

7. Use of the Board of Technology. This company did not make any use or receive any directions from the Board of Technology in Mr. Tsumori's opinion. The same statement applies to the other large manufacturers. However, some of the scientists connected with the Board of Technology were occasionally used as consultants. The policy of the company was to conduct its own research and not to farm it out to institutions.

8. Institute for Physical and Chemical Research. The statement made above applies also to this institute, which was not used by the company except that the company has purchased some of the patents on inventions made by the Institute for Physical and Chemical Research.

9. The Big Four Electrical Companies. Mr. Tsumori listed the four principal companies as:

- a. Sumitomo Tsushin (Western Electric affiliate).
- b. Nippon Musen (Nippon Wireless and an affiliate of Telefunken, making German tubes).
- c. Kewanishi Musen.
- d. Tokyo Shibaura Denki (General Electric affiliate, making most of the tubes, oscilloscopes, X-ray equipment, and lamps).

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Appendix 4-b-1

SUBJECT: Interrogation of Dr S. HAMADA, Director of the Electronics Research Laboratory of Tokyo Shibaura Denki

INTERVIEWED: Representatives of the Company present:
Dr HAMADA, Dir of Electronics Research and Mgr of Electronic Tube Manufacturing Division Laboratories
Dr KAZAOKA, Engineering Adviser to the President of the Company

INTERVIEWERS: Drs COMPTON, MORTLAND, GRIGGS, and LONGACRE
DATE: 18 September 1945

1. Manufacturing Divisions. The manufacturing of the company is done in the following ten divisions, of which the first four are large and the last six are much smaller:

- (1) Heavy Electrical Machinery
- (2) Light Electrical Apparatus (merchandise, domestic, etc.)
- (3) Vacuum Tube Division (electronic tubes and lamps)
- (4) Communication Sets
- (5) Hard Alloys (dies and machine tool)
- (6) Special Materials (pure iron, etc.: now turning to Tantalum, Beryllium, Zirconium, and rare metals)
- (7) Chemical Products
- (8) Glass
- (9) Refractories
- (10) Borax, for making hard glass

2. Research and Development Organization.

(1) The Tsurumi Research Laboratories (between Kawasaki and Yokohama). (This is very much like the general engineering laboratory of the General Electric Company and is concerned with such things as balancing of machinery, noise reduction, etc.)

(2) Electronic Laboratories at Karasaki. (This is for research and development on tubes and radio apparatus. It is very much like the Bell Laboratories on a small scale, but is not concerned with telephone equipment.)

(3) Kawasaki General Laboratories. (This is for development of the products of the other divisions and covers everything except electronics and heavy machinery. The basic research is under Dr Honda. Mr. Sadakiyo is Accounting Director. Dr. Honda is also in charge of the Tsurumi Laboratory which is under the Heavy Machine Division, but he is absent

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most of the time in Sendai. This laboratory is like an engineering department for the manufacturing divisions Nos. 4 to 10. This general laboratory does not do as fundamental work as the other two. It manufactures ceramics and does some research on colloids, X rays, and has one person, Dr Nonaka, working in nuclear physics.

3. Research Activities during the War.

(1) Magnetrons. Magnetrons of 3 to 10 cm wave length were finished experimentally but did not go into production. They had copper envelopes with metal to glass seals, with 12 cavities arranged in two rings. Sixteen cavities were also tried. This magnetron was characterized by the formula:

$$\lambda_1 = \frac{C}{H} \quad (C \text{ very small})$$

The 5 cm magnetron, for example, had a one-kilowatt peak pulse output, a microsecond pulse, operated between 10 and 20 Gauss.

Hamada, himself, never saw an American magnetron, but he thinks that the Army and Navy did see them.

The Army and Navy also requested Tokyo Shibaura to make 10 cm magnetrons to a design supplied by Nippon Musen, but these did not go into production.

Tokyo Shibaura never made any CW magnetrons for the Army or Navy, but they did show plans to the Army and Navy. Hamada believes that such magnetrons were used by the Army and Navy for accelerating the growth of plants (?), which was said to be very secret (!).

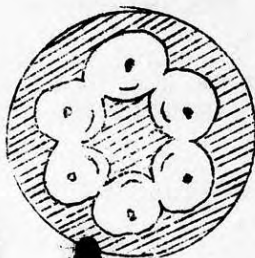
Hamada does not believe that a 200-kilowatt CW magnetron for 80 cm waves has been produced.

The principal companies making magnetrons were Sumitomo Tsushin (Ikuta), Nippon Musen, and Tokyo Shibaura. Hamada never saw the magnetrons made by these other companies. "Secrecy is very prevalent in Japan."

An earlier type of magnetron called the assymmetric operated inside a solenoid without iron and was about one foot in diameter. It has six cathodes arranged as follows:

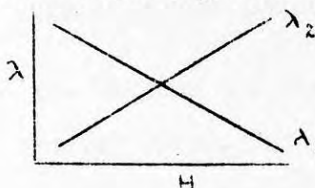
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This has a characteristic described by $\lambda_2 = \frac{H}{B}$.

The characteristic curves of this earlier type and the present type are of the following nature:



(2) Transmitters. Nippon Musen made all transmitters for radar and Tokyo Shibaura was not permitted to see either the transmitters or the completed sets.

(3) This electronics research laboratory was 80 per cent burned, and 20 per cent remains intact. This happened on 16 April. Several sections have been scattered into the country, but none have come into the country, but none have come into active operation.

4. Organization of the Electronics Research Laboratory.

This is divided into a research division under the charge of Dr Asao, and a development division.

The research division was divided into the following sections:

- a. Electronic Emission Section, under Dr Asao.
- b. Magnetron Section under Dr Shimazu.
- c. Television Section, under Mr. Nagashima.
- d. The Chemical Section, under Mr. Ohta. (Aquadag filament coatings, fluorescent materials, and all chemical materials for tubes.)

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e. Tube Design Section, under Dr. Okada.

f. Special Tube Section, also under Dr. Okada (Secondary electron amplifiers, miniature tubes, klystrons (no klystrons in production), triodes for decimeter sets, and magnetrons for local oscillators in the 20 to 30 cm range).

g. Ultra-short-wave Section, under Mr. Imai, interested in fundamental circuits.

(Note: No antenna research was carried on in this laboratory. It was done in the communication division and in the laboratories of the broadcasting corporation.) A company manufactured glow tubes to Army and Navy specification for work in the 20 to 30 cm range.)

In the development division under the charge of Mr. Ota, there are the following sections:

- a. Transmitter tubes, under Mr. Umada.
- b. Receiver tubes, under Mr. Naomi.
- c. Lamps, under Mr. Fujita.
- d. Tungsten and Molybdenum, under Mr. Sugetani.
- e. Set development, under Mr. Matsui.
- f. Equipment for production machinery, under Mr. Ikeda.

5. Budget. The entire annual budget for the electronics research laboratory amounted to about 6 million yen, of which about half came from sale or royalties on patents either to the manufacturing divisions of the same company or to outside companies.

The budget of the General Laboratory in Kawasaki was about the same size.

6. Present Status of the Sections of the Research Division.

a. The Electron Emission Section was burned out. It is now in Yamagata Prefecture, 600 km north of Tokyo, but it is planned to move it back to Tokyo by the end of this year.

b. The Magnetron Section was burned out and is now located at Kamisuwa in Nagano Prefecture.

c. The Television Section was one-half burned and is now at Niigata.

d. The Chemical Section was burned out and is also at Niigata.

e. The Tube Design Section was burned out and is now at Kamisuwa.

f. The Special Tubes Section was burned out and is now at Yamagata.

g. The Ultra Short Wave Section was not burned but is now at Yokohama.

7. Present Status of the Development Division.

a. The Transmitter Tube Section was burned and is now at Niigata.

b. The Receiver Tube Section is partly burned and is now at Niigata.

c. The Lamp Section is partly burned and is now at Niigata.

d. The Tungsten and Molybdenum Section is intact.

e. The Set Development Section is burned and is now at Yamagata.

f. The Equipment Development Section is burned and is now at Niigata.

All the above movements to disperse the laboratory to other sections have now been stopped and the entire outfit will move back to the Tokyo area as soon as possible.

8. War Research Developments. Following the numerical and letter notation of paragraph 4 above, the following developments were made in the laboratory sections as indicated by the letters 4a, 4b, etc.

4a. A caesium surface photo tube with grid was developed but the proposed military use was unknown to the company. The sets were manufactured by some other company. The Army provided the specifications which called for reduction of microphonic noise. There was no requirement to withstand unusual acceleration. The peak sensitivity was between 8,000 and 9,000 AU.

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4c. No more work was done on television.

4d. No more work was done on chemicals, and specifically there was no development of phosphors. All phosphors had been developed prior to the war.

4e. The Tube Design Section developed a pentode amplifying tube for universal use as an amplifier or detector. Its designation was "SORA" (meaning, air). It was used in an airplane set and is probably new only as regards the method of manufacture in Japan. It has an 8-point plug. It had been designed before the war and manufacture began just as the war started.

This section made miniature tubes just like the American acorn type.

Hamada has no knowledge of any tubes designed to withstand very high accelerations.

A few double diode tubes were made on Army specifications, probably for use in 20-cm radar detectors.

Trial manufacturing only was made of a triode for CW or pulse 2,000 meg. There was regular production of similar tubes for lower frequencies down to 200 meg.

No significant work was done on thyratrons or ignitrons.

4f. The Special Tube Section tried to produce a secondary electron amplifier of RCA type, but was unsuccessful.

It also tried unsuccessfully to build a power klystron for general purposes at 20 cm wave length. It also tried unsuccessfully to use a klystron or a magnetron as a detector tube for the local oscillator. A triode was used for longer wave lengths and a magnetron for 10 cm wave length.

No work was done on high-speed electronic counters.

4g. Nothing new was worked on in this section.

9. Short-wave Communication. The shortest wave communication set developed in the laboratory was 25 cm wave length, 6 channels. The highest frequency set actually manufactured was 50 cm w.l. for Army experimental use only and did not go into production. Between 2 and 3 meg was the highest frequency actually used by the Army and Navy. The Navy requested a lot of these, probably less than 1,000. Hamada has never seen this set.

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The company carried on no research on searchlight directors during the war.

A bolometer using nickel foil was developed for the Army. It consisted of multiple strips with a total area of about 3x8 mm. One or two people spent a little time studying an amplifier to go with this bolometer. The company supplied only the experimental set to the Army, and Hamada knows nothing about its intended use or if it was used.

The Set Development Section employed about 15 engineers.

The principal company profits came from the sale of communication sets for which the Army and Navy supplied designs which they might have gotten from any company or designed themselves. The company manufacturing division re-engineers these designs to satisfy the production methods of the company.

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Appendix 5-a-1

SUBJECT: Visit to the Tokyo Imperial University

DATE: 15 September 1945

INTERVIEWED: Dr Shozo Uchida, President
Prof Nagaoka
Dr K. Sano, Dir of Engineering
Prof T. Hirayama, Prof of Architecture
Dr Hishina

INTERVIEWERS: Drs Compton, Moreland, and Griggs

1. Organization of Research in University. Great freedom is allowed the professors to undertake research either for scientific or industrial objectives. In addition to the scientific and engineering department laboratories, there is a large building devoted exclusively to research by members of the faculty. This building contains 300 research groups which are assigned to members of the staff and in which they can conduct any type of research whatever without restriction, subject to physical and financial limitations.

Some of the research is supported by the funds of the Imperial University, some of it is supported by grants directly from the Ministry of Education, or from the National Research Council, or from the Society for the Promotion of Scientific Knowledge.

Outside of the Ministry of Education, the largest source of funds for scientific research in Japan is the Society for the promotion of Scientific Knowledge, whose president is Prince Kenryo and whose manager is Prof Nagaoka. It is supervised by the Ministry of Education and financed by appropriations from the government, from scientific societies, and any other source of funds. During the war, grants made by this society amounted annually to about 5 million yen, of which 3 million yen came directly from the government Ministry of Education and 2 million yen from societies and other ministries.

Very little money is available for scholarships and fellowships in Japan. It was stated that there was very little need for such financial aid to students.

2. Relative Importance of Research Agencies. It was stated that the industrial companies in Japan conducted far more research than did the universities.

There is no organized cooperation between the industries and universities, but the industries frequently call on university scientists as consultants, and these consultants frequently undertake research work for the industries in their university laboratories.

Probably the strongest single research organization in Japan is the Institute for Physical and Chemical Research on which is prepared a separate report.

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3. Cyclotrons in Japan. Dr Nishina stated that there are four cyclotrons in Japan, located as follows:

a. Two at the Institute for Physical and Chemical Research, one of which has a 60-inch pole piece, and the other a 66-cm. pole piece. The latter was destroyed in the air raids.

b. One cyclotron with a one-meter pole piece is under construction at Kyoto University, and there is a smaller one at the University of Osaka.

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Appendix 5-b-1

SUBJECT: Visit to Physics Laboratory of the Tokyo Imperial University

DATE: 15 September 1945

INTERVIEWED: Prof Segano, Head of Dept and son of Prof Hagaoka
Prof H. Hagaoka

INTERVIEWERS: Drs Compton and Griggs

The laboratory built after the great earthquake was large but very much run down as to upkeep and evidently had been very little used recently. Other than ordinary laboratory classrooms and some facilities for research in spectroscopy and a small X ray installation, we saw only two things of interest, as follows:

1. A large Vandergraff generator of the horizontal type, built by Herb but larger than Herb's. This was designed to operate at from 5 to 8 atmospheres pressure of air. The voltage was distributed by rings with corona points. The highest voltage obtained had been disappointingly small, only a little over two million volts. A little work had been done with it during the war to produce high voltage X rays for the examination of thick pieces of metal and satisfactory photographs had been obtained through six inches of steel. However, it was evident that very little use had been made of this.

2. A cleverly-designed electromagnetic spectrograph had been designed utilizing a nonhomogeneous, transverse magnetic field which was accomplished by having the diameter of the chamber considerably greater than that of the axially-mounted electromagnetic pole pieces. Because of the nonhomogeneous magnetic field rapidly moving, charged particles shot out from near the center of the apparatus, would travel through spiral orbits which would finally settle down into circular orbits at that radius at which the magnetic field had the proper strength for a circular orbit for particles of that mass, charge, and speed. A collecting electrode with a fine slit opening, when placed at the proper radial distance from this orbit, would receive the particles whose charge, mass, and speed were characteristic of that orbit. By moving the collecting electrode to different radial distances, particles of different properties would be collected.

This was essentially a focusing scheme to permit detection and measurement of very small numbers of emitted particles.

The particles were emitted from a target near the center of the chamber when it was bombarded by neutrons. By this means, the radioactive emission products arising from the disintegration of artificial radioactive elements produced by neutron bombardment could be studied.

Some very nice results had been obtained with a small apparatus and a larger one was under construction.

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3. Military Restriction on Research in Nuclear Physics. Prof Segano was much concerned to know whether his laboratory would be permitted to continue research work in nuclear physics. I told him that this was under the control of the military authorities but that, so far as I know, there would be no restriction, provided the work was not directed toward a potentially military objective. (I subsequently recommended to Lt Col Tait of G-2 and Col Kramer of the Economic and Scientific Section, that this laboratory not be restricted in its operations beyond the requirement of keeping the appropriate Allied control office informed regarding the research projects, keeping the laboratory available for inspection, and undertaking no work directed toward the concentration of substantial quantities of unstable radioactive materials.)

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Appendix 6-a-1

SUBJECT : VISIT TO THE INSTITUTE FOR PHYSICAL AND
CHEMICAL RESEARCH.
DATE : 18 September 1945.
INTERVIEWED : Viscount OKOUCHI, Dir of the Institute.
Dr NISHINA
Dr KINOSHITA
Dr TAZAMINE
Prof KAGAOKA
INTERVIEWERS: Drs Compton, Moreland, Lengacre, Maj Skipper,
Tec 4 Yagi.

DESCRIPTION OF INSTITUTE

The laboratory is divided into 26 divisions, each headed by a scientist. The scientists and their assistants work very independently on whatever research jobs they wish to undertake. The institute has been in operation for 29 years. During this time, it has published 16 large, bound volumes of research results. We were given the 1929 printed organization list. During the war the paper shortage has prevented publication.

During the war each member of the staff was permitted to undertake any war project which he might select of which he might be requested to do by government or industrial organizations.

(We had previously learned that this very interesting organization, staffed by about 300 research men, has been essentially self-supporting on the basis of its earnings from the sale or license or acquired stock in companies which undertake the manufacture of products developed in these research laboratories. In addition to this financial support, the scientists may occasionally receive grants of funds from the various sources supporting research work in Japan.)

Laboratory of Dr Nishina. (Nuclear Physics) We were given a number of reprints of Nishina's articles published before the war. He has done excellent work in cosmic rays, the discovery of the mesotron, and determination of nuclear energy levels.

During the war Nishina has worked on the following problems:

1. Diffusion of Metals. By use of activated tracer atoms, studies were made of such things as the diffusion of silver in iron or of zinc in copper at high temperatures. The active element was produced on one side of a thin film and its diffusion through the film studied. The atoms were activated by neutron bombardment. This work was requested by an air force officer; first, a colonel, and later Lt Gen Anosawa, neither of whom were scientists. Nishina turned over his data to these officers but he has no idea regarding the objective of the work or the use to which his results were put. The work stopped six months ago when his laboratory was destroyed by bombing.

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2. Fission of Uranium. Before and during the war, Nishina investigated qualitatively but not quantitatively the products of Uranium 235 fission and found some evidence of mercury and also of atoms of an atomic number of about 40.

He also undertook a study of the fission of thorium but without definite results because effects were very weak.

3. Atomic Power. No work was done toward the development of an atomic bomb, because theoretical calculations led Nishina and his colleagues to conclude that the rate of chain reaction would be too slow to produce an explosion. Consequently, all the effort of the group was directed toward developing an atomic source of motive power; for example, as a substitute for coal.

To separate U-235, a thermal diffusion apparatus was set up using uranium hexafluoride as the diffusing gas. This apparatus had only just been set up and no quantitative results had been secured when the laboratory was completely burned by bombing. Since that time no work on this subject was done. Dr. Nishina stated that no other actual work had been undertaken in Japan for the development of a source of atomic power, although a number of nuclear physicists had talked about it and proposed methods.

4. Uranium in Japan. Nishina said that he had about 10 kg of uranium for use in the above experiment which had been designed to develop a method of U-235 separation and had not been envisaged as a production plant. Nishina does not know of any large source of uranium available to the Japanese. He understands that there are no significant uranium deposits in Japan. It was hoped that the geologists might discover deposits in China or Manchuria. This, however, was not his problem, and he knows of no quantity in sight.

5. Radioactive Tracer Work in Physiology. Dr Nishina's group have carried out experimental work in physiology using radioactive materials produced in the cyclotrons as tracers and in this have cooperated with physiologists in the Institute and in the universities. They have also done some similar tracer work in studying the action of vitamins with the pharmacologists.

6. Financing. Most of the funds for Nishina's equipment and activities came from the funds of the institute itself. He got a little financial help from grants from the Ministry of Education.

7. Cyclotron. After the war, Dr. Nishina plans to devote his cyclotron entirely to the production of tracer radioactive materials for biological study. He is particularly interested in radioactive carbon.

Dr Nishina lost in the bombing his 60 cm cyclotron and his large magnetic apparatus for cosmic ray studies. Fortunately, his 60-inch cyclotron (which was built in cooperation from Prof. Ernest Lawrence) is intact.

8. Recommendation for U. S. Control. It is clear that the present equipment, as well as the present program of Dr. Nishina, are suitable only for purely scientific work and could not be used for any military preparation except in the very long range way in which any scientific advance may potentially be a basis for a war application. Dr. Nishina is an excellent nuclear physicist who has previously cooperated internationally. In view of the above circumstances, I would recommend that the U. S. authorities permit him to go ahead with his scientific work, but that they prohibit him or any other Japanese scientists from undertaking the separation of Uranium-235.

Laboratory of Dr. Kinoshita. (Kinoshita spent ten years on the staff of the University of London and also spent a few years in Germany)

Dr. Kinoshita made no apologies for work on war projects. He said the scientists did their best to help win the war, subject to the limitations to which they had to work. His principal war projects were the following:

1. Supersonics. For supersonic vibrations, a quartz oscillator was principally used. A Rochelle salt oscillator was also used. They were planning to use a magnetostriction oscillator in order to get greater power, but did not get to this.

Using under-water, 20 kilocycle vibrations, the laboratory was developing a method of location, depending on phase difference.

The laboratory also developed a method for rendering Jap submarine or mines undetectable by our sonar, by the device of covering the surface with alternate strips of sponge rubber and metal. Since sponge rubber reflects with a 180 degree phase change, the reflections from adjacent strips neutralize each other. Kinoshita hopes that this method may have been used by the Japanese Navy but has no information as to whether it was actually used.

Both of the above supersonic projects were of a defensive nature, the first for detecting our submarines and the second for protection against detection by our submarines. The laboratory did no work on devices to promote the offensive power of Jap submarines.

2. Lubrication. This had to do with the lubrication of bearings and also a study of molecular action at the surfaces.

3. Creeping of Metals and Alloys. All of Dr. Kinoshita's laboratory was burned down in the air raids.

Laboratory of Dr. Takamine. Dr. Takamine's war work had to do with determination of the limit of human vision for infrared light. He set this at 8,200 A.

Takanine's group knew that the Army and Navy were interested in infrared signaling devices. However, the Army and Navy officers appeared to be self-confident and did not take Takanine or his group into their confidence regarding the use to which infrared radiation was to be put.

Takanine's group also undertook some work in the development of Schmidt optics for cameras and for night vision. This work was just getting started. The principal work in this field was centered at the Imperial Astronomical University. Takanine's group also did a little work on the development of an interferometer method for correcting Schmidt plates.

Laboratories of Chemistry. Major Skipper arranged to visit the chemical laboratories at 0930, Tuesday, 25 September 1945. He will look especially into the work done there on gas warfare. We were told that the Japanese were very much afraid of gas warfare and carried gas masks regularly before the bombing raids. They worked hard on gas warfare research.

Military Policy on Draft of Scientists and Technicians. Approximately one-quarter of the staff of the laboratories was drafted for military duty as privates. Most of the rest were exempt for reasons of health or age. There was very little success in securing exemption on the basis of scientific ability or the military importance of the scientific work on which a scientist was engaged.

The Institute compiled a list of its scientists for whom exemption was requested. This list was handled through the Department of Education. The manufacturing industries made a similar effort through the Board of Technology, but the Army had the final decision and took many of these scientists for military duty as privates and others for work in government research laboratories. It was regretted that the men drafted from the laboratories were not generally used for work calling on their technical skills.

Quality of Army Scientific Personnel. In the opinion of these scientists, the Army did not secure the best grade of talent graduating from the universities. Furthermore, when young university graduates taken into the Army were promoted, they became involved in administrative work and quit their scientific work. As a result, the bulk of scientific talent in the Army was young and inexperienced.

Army-Navy-Civilian Cooperation. In the opinion of these men, cooperation between the armed forces and the civilians was poor. Only a few of the young scientific officers would come to the civilian experts to discuss their problems. This was a cause of Japanese failure, because the best scientists were not effectively used. There was better cooperation toward the end of the war when the Army realized that it needed help. It was only in the later stages of the war that civilian scientists were given any information on the use of their devices and very little opportunity to see the results of field tests.

In the war effort the industrial laboratories were more important than the university laboratories. The military research organization had a large staff of moderate quality, widely dispersed.

Funds for Support of Research. The principal grants for research were made by the Department of Education. During the last year of the war, these grants amounted to 18 million yen. (These sums grew rapidly after the war need increased. The figures for the past four years were respectively 3, 5, 12, and 19 million yen.) Lack of money was not the limiting factor in Japanese research. The limiting factor was the shortage of materials with which to work and the shortage of scientific personnel. The civilian research laboratories had no status of priority for materials or men.

The Board of Technology. made substantially no grants for research but used its funds to set up new war organizations. The Board of Technology has recently been dissolved.

List of Research Grants from the Department of Education. Most of the records were burned. Only one list of grants is known to exist. This was given by Dr. Kinoshita, at their request, to Mr. O'Keefe and Mr. Mastick, and Mr. Munich, interpreter from the U. S. Navy. This gives a full itemized record of all research grants as to amount, location, and purpose. The list is in Japanese. Dr. Kinoshita requested Messrs. O'Keefe and Mastick to return the original list to him after it had been copied. (We should by all means secure a copy of this list.)

SUBJECT : Chemical Research Carried Out at the Institute
of Physical and Chemical Research.
DATE : 25 September 1945
INTERVIEWED : Dr Masao KATAYAMA
Dr Isaburo WADA
Dr San-ichiro MIZUSHIMA
Dr Waro NAKAHARA
INTERVIEWERS: Maj Howard SKIPPER
Dr H. K. STEPHENSON
Tec 4 YAGI

Each of the persons interviewed heads a laboratory which is his to carry out any research he sees fit. The laboratory heads were asked in turn to describe the research carried out in his respective laboratory during the war with detailed description of any work done at the request of the Army or Navy.

Dr Waro Nakahara, Physiological Chemistry and Nutrition.

No work was carried out for the Army or Navy in his laboratory. The Army approached Dr Suzuki, former head of this lab, but after the death of Dr Suzuki, no further contacts were made by the Army.

Dr Nakahara's work was principally on nutrition and vitamins. He stated that he has discovered a new specific dietary requirement; a lactation factor made up of two constituents, one an adenylic acid compound and the other, peculiarly enough, ortho aminobenzoic acid.

When asked what he thought of the Japanese Army nutrition work, he said that he thought it very inferior. It was headed by one of Dr Suzuki's former pupils (Brig Gen SHIRO KANASHIMA), not a very outstanding student either. Dr Nakahara considers some of his publications subject to considerable criticism.

Two other problems under study in this laboratory were concerned with the constituents of saké and of Japanese tea. Synthetic saké appears to be of considerable importance. The interviewers sampled the synthetic sake and a synthetic whiskey produced in the lab and found them to be creditable beverages.

When asked if any biochemical or toxicological research for the Army CW Service had been carried out in his lab, the answer was "no".

There was little doubt in the mind of the interviewers that Dr. Nakahara was first a scientist of the highest order and second truthful in all his answers. Dr Nakahara speaks splendid English and possesses a very pleasing personality. He studied at Cornell University.

Dr San-ichiro Mizushima, Theoretical Chemistry

Work on Raman effect and dipole moment in relation to free rotation was discussed with special reference to Raman Spectrum of Gaseous 1, 2 Dichloroethane.

Dr Mizushima's laboratory carried out two pieces of research for the Army.

- (a) Analysis of gasoline samples by means of Raman spectroscopy.
- (b) Analysis of certain synthetic hydrocarbon insulators.

Dr Mizushima stated that polyisobutene was the best insulator they had found to date. This compound is flexible and makes a very good insulator for high frequency cable. It wasn't used in the war because it was just developed several months ago. It was developed by the Navy supposedly for submarines or warship cables.

Other studies carried out in this lab were on pure science and had nothing to do with the war effort. Subjects studied were:

- (a) Internal rotation investigated by means of electron diffraction.
- (b) Normal frequencies of n-Paraffin molecules. (It is interesting to note that this article was published in the Proc. Imper. Acad., Tokyo, Vol XX, in English, Feb 12 1944.)

Dr Isaburo Wada, Analytical Chemistry

Problems mainly pertaining to analytical chemistry were studied in Wada Research Laboratory. They may be enumerated as follows:

- a. A chemical method of determining nonmetallic inclusions in various kinds of steel.
- b. A chemical method which is to be accepted as an official standard method for separately determining zirconium contained in steel and ferrozirconium as the oxide, the nitride, the carbide, the silicate and in a form of metal.
- c. A chemical method which is to be accepted as an official standard method for determining various impurities contained in pure iron made from iron carbonyl and by an electrical process.
- d. Preparation of some kind of grease available for a special purpose.
- e. A best chemical method of analyzing various kinds of glass and the materials for manufacturing them.

f. Detection and determination of the variation in the quantities of substances in blood, which occurs in a human body when it is raised to a height. (This was initiated by Dr Wada and not at the request of the Air Forces.)

Concerning war work, Dr Wada stated that, "One day in November 1941, Mr. K. Bitch, a military officer, in the Army Institute of Scientific Research came to my office, and asked me to give suggestions, hereafter, pertaining to the microanalysis and the analysis of the rarer elements. He asked us also to practice the analyses of certain samples, which are almost impossible for his men in his institute. Since then we have given papers to him and his institute showing:

(1) A method of analyzing so-called zirconium metal, ferrozirconium, and natural zirconium silicate.

(2) Chemical methods for determining separately minute quantities of carbon, sulphur, copper, and manganese contained in so-called pure iron.

We have sent also the results of our analyses of many samples of ferrozirconium, zirconium metal, natural zirconium silicate, and pure iron, which was sent by him to our laboratory."

Dr Masao Katayama, Theoretical Chemistry.

Since Dr Katayama and Dr Mizushima worked in the same laboratory and since Dr Katayama is not very active in research any longer, he stated that he could add nothing to Dr Mizushima's summary of their work.

The conference ended at 1200 hours.

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SUBJECT: Interview With Nippon Musen Representatives.

INTERVIEWED: From Nippon Musen: Seingi NAKAJIMA, Managing Director;
Mr Shigeru NAKAJIMA, Chief Engineer Vacuum
Tube Dept;

Mr FUNABIKI, Engr and Interpreter

INTERVIEWERS: Drs Griggs, Moreland, Compton

DATE: 19 September 1945

NOTE: Nippon Musen is affiliated with the Telefunken Co. of Germany but has no affiliation with any American Company. Perhaps owing to this fact it seems to have been somewhat more closely in the confidence of the Japanese Army and Navy than its principal competitors, Tokyo Shibaura Denki and Sumatomo, which have American affiliations, and to have gotten the greater part of the Army and Navy business.

1. The chief factory at Nippon Musen is the Mitaka plant employing 8,000 men in the construction of vacuum tubes and parts of communications and radar equipments. Three factories are in Nagano province: 1) Nagano - radio locators for the Navy and portable communication sets; 2) Uyoda - airborne radio sets for the Army, primarily; 3) Kamisawa - (also written Suwa) vacuum tubes, production just beginning.

2. Research for Nippon Musen has been carried out at the Mitaka plant but in the process of dispersal it was being transferred to Makasawa. In vacuum tube research there are 25 engineers and 40 men. In systems research there are 25 to 30 engineers and 60 men. These figures are approximate.

3. The managing director, Mr Nakajimi, told us that no Nippon Musen factories were destroyed by bombing but that dispersal had begun following national policy. One factory which was being fitted out at Hamamatsu was burned out before it was completed. Nippon Musen factories were in the country and consequently were not hit by the fire raids. Although some of them had been designated as targets for B-29 attack, they had not yet been subject to attack while neighboring aircraft industries were severely damaged in precision bombing raids.

4. Before the war, vacuum tube production was largely monopolized by Tokyo Shibaura Denki, and Nippon Musen Co. was limited under license agreement to the production of only 100,000 yen per year. During the war this production grew to 96 million yen per year (nearly a thousand fold).

5. The Army and Navy gave Nippon Musen military characteristics of desired equipment, but Nippon Musen did most of the research and design of this equipment. The Navy was reported to be much more competent in engineering, research, and design than the Army. The Army and Navy were entirely separate in their

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Appendix 7-1

dealings with the company and had no coordination with the single exception of the Wurzburg contract discussed later. The Army and Navy developments were kept secret, each from the other. Mr. Nakashima thinks that the basic reason of non-coordination between the two services in electronic research and development was the fact that the Navy was far ahead of the Army and did not want to share their secrets. Nippon Musen had very little connection with university research laboratories.

6. The principal contracting agency in the Navy was the Second Naval Technical Institute, Communications and Radar Section, headed by Vice-Admiral Nawa. The principal engineers of this institute who dealt with Nippon Musen were Rear-Admiral Ikoya, Captain Ito, and Captain Takahara, all from Kanazawa.

7. The principal Army contracting agency was the Tama Research Laboratory. The principal engineers dealing with Nippon Musen were Major General Yamasaki, Colonel Satake, and Colonel Hatao. These officers were reported as inferior in quality to the Navy officers mentioned above.

8. The German influence on Nippon Musen Co. was discussed in some detail. Nippon Musen was an affiliate of the Telefunken Co. in Germany but before the war had little ability to introduce Telefunken devices into Japan, primarily because of competition from Tokyo Shibaura Denki and the Sumitomo Co. During the war, production of Telefunken products was greatly increased, the largest part of this was Telefunken vacuum tubes (i.e., the RE-3)

9. Fifty sets of Giant Wurzburgs were ordered jointly by the Army and Navy, to be built to Telefunken specifications. Three sample sets were constructed, of which only one was completely finished. This set is now at the Nagano factory, but is believed to be not in operating condition.

10. Tokyo Shibaura Denki is believed to have completed some sets of the Giant Wurzburg type, but made to Japanese design rather than Telefunken (perhaps it was one of these that was found by Section 22 at the Chigasaki radio locator site, near Hiratsuka). Nippon Musen production was held up by delay in production of several critical vacuum tubes.

11. During the war the Telefunken Co. sent no engineers directly to Nippon Musen Co. (it was stated this was because the Siberian route was closed); one commercial man was sent. The Army and Navy brought at least one engineer, Mr. Feders, who worked considerably with Nippon Musen.

12. Nippon Musen engineers were occasionally permitted to visit the Army and Navy testing laboratories in connection with equipment which Nippon Musen had under development for the Army and Navy, but not often. For example, although Nippon Musen built the D.F. equipment for submarines, all of the installation work was done by the Navy and no Nippon Musen engineers were over

allowed aboard a submarine. Similarly, in spite of vigorous pressure by the Nippon Musen Co., very few of their engineers were ever allowed in airplanes in connection with Radar equipment built by the company for aerial use.

13. Nippon Musen led Japan in magnetron development and production for micro-wave equipment. Mr Shigeru Nakajima is credited with the invention of the magnetron type which they are using. There are three production magnetrons of the same type electrically, consisting of four primary resonating cavities which alternate with four larger cavities "to supply a loose coupling which increases the stability of the magnetron." This is recognized as a Navy idea but director Nakajima gives engineer Nakajima the entire credit for making it work. Nippon Musen is in production on three types of magnetrons and in addition has two experimental types. The characteristics of these are listed in the attached table:

14. Nippon Musen did no research on antenna design or R.F. design. Lt Commander Sozio Mori, of the Second Naval Technical Institute, is believed to have designed the antenna.

15. The Navy 10cm airborne search set which we saw at the Mogura Laboratory, was built by the Nippon Musen Co. Their designation for it was M-51. It uses the M-314 transmitter magnetron and the M-60 local oscillator magnetron.

16. Mr Majima, assistant to engineer Nakajima, designed the coupling of the M-314 to the coaxial line. This increased the antenna output 50 percent. (We have a sample of the M-314 magnetron and this R.F. coupling.) The magnetron block is made by a broach to .1 millimeter tolerance. The slit between anodes is held to .01 millimeter tolerance.

17. Longacre and Griggs will get more of the technical information when they visit the Mitaka Research Laboratory, Friday, 28 September 1945.

TABLE 1.

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	M-312	M-314	M-60	NO NAME	NO NAME
Wave length	9.83-9.92 cm	9.83-9.92 cm	9.83-9.92 cm	5 cm	3 cm
Type of magnet	Stand Elect Mag	Solenoid	Stand Electro Mag	-	-
Type of cooling	Water	Air	Air	Air	Air
Anode voltage	11,000	11,000	210 volts	12,000	12,000
Anode current	2 Amp	5 Amp	1.7 ma.	3 Amp	2 Amp
Output	2 KW peak- 300 watt CW	6 KW peak - 60 watt CW	.001 watts CW	3 KW peak	2 KW peak
Field strength	1,000 Gauss	1,000 Gauss	690 Gauss	1,100 Gauss	4,000 Gauss
Filament volt- age	10 V	12 V	-	-	-
Filament cur- rent	19.5 Amp	1.7 Amp	-	-	-
Efficiency	30-40%	30-40%	-	-	-
Allowable anode loss	-	-	-	60 w	50 w

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JAPANESE WARTIME SCIENCE ORGANIZATION

The organization and direction of Japanese wartime science and technology grew along five lines - 1) The army research organizations, 2) The navy research organizations, 3) Cabinet level attempts at coordinating and support, 4) Ministry of Education support, and, 5) Non-government and civilian organizations.

The army and navy organizations developed during peacetime. They attracted scientific and technical graduates from the universities and technical schools by offering a full military career in grades up to Technical Lieutenant Generals and Technical Vice Admirals in military research work.

It is to be noted that throughout the war the service scientific and technical sections remained all powerful and never took real advantage of the academic, industrial and civilian scientists. This was materially fostered by the Japanese ego. They were able to resist all attempts by the non-military group to be of help no matter how much favor that group received from the Premier.

They assigned various types of problems to non-military science and technology, such as "Ions in the Air", "Thrust Meters, and Torque Meters", "Fog in the Kuriles and Hokkaido", "Wartime Food", "Mass Production of Gear Wheels", "Mounts for Remote Control of Guns of Aircraft", "Design of Super-large Planes", etc. These all received government support. As one can readily see they run the gamut from basic problems through industrial to specific problems and many were more appropriate for industry or the military design sections than civilian research. At no time were the tactical details associated with the problems. The specific problems were frequently given with preconceived notions as to the results and since there was very little exchange of information except by formal data sheets, the military were unable to utilize non-expected results.

The Cabinet level attempts start about 1937 with a Planning Board (Kikakuin) for mobilization of science and technology when Japan was becoming thoroughly engaged in China. The functions of this board were to plan the mobilization of materials, communications, electric power, industrial personnel, shipping transportation, etc. On November 1, 1943, there was a complete reshuffling of the government scientific and technological organizations. At that time the functions of KIKAKUIN were taken over by the newly created Ministry of War Supply.

In December 1940 the Scientific Mobilization Society, Kagaku Dojin Kyokai, was established with the Premier as ex-office president to register all civilian scientists and engineers, collect and distribute material for civilian research, collect and review scientific literature, raise the level of research and act as liaison with the government research agencies. It

was subsidized by the government to the extent of ¥ 3,000,000, eventually thru the Gijutsuin, and the rest by industry. Its board of directors consisted of vice ministers, service chiefs and civilians. It was occasionally effective in providing groups of specialists to review specific projects being considered by the Gijutsuin. It did a fair job collecting rare or scarce chemicals for research and making a roster of technical experts. This latter function was taken over in 1944 by the Ministry of Public Warfare and made compulsory for all scientists and engineers. Kagaku Doin Kyokai had no real power to effect army mobilization of science. It had no control power.

After Pearl Harbor the technical and scientific people renewed their effort to become an effective part of the national mobilization. On January 31, 1942 the Cabinet Board of Technology, Gijutsuin was established. Its purpose was to provide coordination, stimulation, direction and funds for civilian war research. This organization is described in greater detail in Appendix 8b.

In June 1942 the Scientific Technical Deliberative Society, Kagaku Gijutsu Shin-Kai, was established as a standing group of consultants on technological matters for the ministries. It was an amalgamation of three existing societies of experts: the Kagaku Shin-Kai, Science Deliberative Society; Koku Hyogyi-Kai, Aeronautical Deliberative Society of the Ministry of Education and Hatsumi Shorei Jinkai, Invention Promotion Committee from the patent office. As with the original societies, there was a liberal representation of the army and navy in Kagaku Gijutsu Shin-Kai. This society did not undertake any researches or investigations. The Premier was ex-officio president, and President of Gijutsuin, ex-officio vice president. It was administered by the Gijutsuin.

On November 1, 1943, several changes took place.

1. Abolition of Ministry of Trade & Commerce and transfer of its mobilization functions to the newly created Ministry of war time supply. Its other functions were assimilated by the Ministry of agriculture.
2. The abolition of the Planning Board mentioned above.
3. The establishment of the cabinet Research Mobilization Committee, Kenkyu Doin Kaigi which had the premier as its chairman and the president of Gijutsuin as vice chairman. The rest of the ten to twenty members were from the ministries save for two or three civilians, such as the head of the Institute of Physical and Chemical Research and the President of the Tokyo Imperial University. The action of this board was presumably binding on any ministry and the Gijutsuin.
4. Reorganization of the Gijutsuin and taking over of the Patent Bureau.

By October, 1944, it became apparent that the militaries were not putting much confidence in either the Kenkyu Doin Kaigi or the Gijutsuin and the

Ministries of Army and Navy jointly formed the Army and Navy Technical Control Committee, Rikukaigen Gijutsu Unyo Iinkai. This consisted of about four each Navy, Army, and University men of high caliber. It handled problems of greater secrecy, more nearly operational, than the services had entrusted to outsiders. In one instance, at least, it effected the Army developing a Navy suggested project because the Army had greater facilities. However, it was burdened by a lot of "trivial" problems from the services.

The Gijutsuin or Board of Technology financed civilian or university salaries and wages on Ministry fostered problems. The scarcity of many materials and instruments required that the sponsoring ministry provide for their projects. The Ministry of War Supply also had a fair block of materials which could be tapped by non service projects. The reservoir of scarce chemicals collected by the Science Mobilization Society was the only other source for items that could not be bought on the open market. On non-military originated projects all support had to come from the Gijutsuin or Gakujutsu Kenkyu Kaigi.

The Ministry of Education started in 1940 to allot funds for scientific research. These were administered by the Gakujutsu Kenkyu Kaigi, National Research Council through the Kagaku Kenkyu Doin Iinkai Committee for Scientific Research. This committee was headed by Dr. Hayashi and consisted of about fifty members drawn from the universities, army, navy, government research bureaus and Gijutsuin.

During the War most of the funds went to war research and especially those being conducted by university men or research institutions. The industrial developments were left to the care of the Gijutsuin. During 1944 they gave aids totalling 18.7 million yen. In practice the monies were appropriated upon review of requests from the army, navy and small groups of civilians.

There were principally two incorporated prewar organizations independent of the government that supported research. These were: 1) Nihon Gakijutsu Shingo-kai, Japanese Society for Promotion of Scientific Research, under the leadership of Dr. W. Nagaoka which is described in report No. 25, and, 2) Dai Nippon Koku Gijutsu Koikai, Japanese Aeronautical Engineering Society, with Dr. K. Wada as head. The latter was devoted to aeronautics. Like the former it was supported by income from endowment, donations from industry, and mostly by government subsidy. Its annual budget was about 6,000,000 yen. Also like the former, this society had less restrictions on its expenditures and types of projects supported. However, it had to depend largely upon the Scientific Mobilization Society for materials.

In the fall of 1944 the government sought to reduce the number of small independent scientific and technological organizations and forced amalgamations or cessation. One such case was the Dai Nippon Gijutsu-Kai, Japanese Technological Association, formed from three societies, 1) Ko Sei Kai, a Technical Policy Society; 2) Nihon Gijutsu Kyohai, Japanese Technical Association, and 3) Dai Nippon Kagaku-Gijutsu Todo-kai, Japanese Scientific and Technical Association. These three had all been interested in promoting the prestige of Engineers. The Dai Nippon Gijutsu-kai continued this and made its prime wartime contribution by setting up a traveling group of production experts that were to help various plants. It did not handle many cases. The Gijutsuin was the principal source of funds for Dai Nippon Gijutsu-kai.

SUBJECT: Gijutsuin (Board of Technology)

Established January 31, 1942 as a cabinet bureau under the Premier by Imperial Order 41 to foster and coordinate the Japanese scientific and technological wartime efforts. It was later revised by Imperial orders #734 November 1, 1942, #29 January 21, 1943, #301 November 1, 1943 and #420 July 19, 1945.

From January 31, 1942 until November 1, 1943 it consisted of: President, Vice President, and 4 departments. These were:

1st Department of 4 sections (a) To raise the level of science (b) To try and effect and coordinate scientific mobilization (c) To provide aid and guidance to civilian research and (d) To establish industrial standards.

2nd Department of 4 sections to coordinate advancement of aeronautical techniques, researches and theories.

3rd Department of 4 sections to coordinate and foster techniques, and researches accessory to aviation.

4th Department of 2 sections to keep informed on foreign and domestic scientific and technical techniques and literature.

On September 1, 1945 a personal counsellor to the president was added. On November 1, 1943 the Board was reorganized to consist of: President, Vice President, and departments. These were:

Presidential Secretariate

Administration (General Affairs)

Research Mobilization Department of 4 sections handled all matters pertaining to the mobilization, coordination promotion and liaison with the services of wartime scientific and technological researches with a separate section handling the aeronautical sciences. (5-6 million yen per year.)

Technological Mobilization Department of 3 sections. Handled matters pertaining to promotion of superior manufacturing techniques and transition of development to production in all fields including processing plants for fuels and foods. (700,000 yen per year).

Specifications Department of 2 sections. Coordinated and standardized specifications, terminology and standards of production.

Patent Department of 4 sections. Examination, granting of patents, and evaluation of inventions. (Amounted to about 67% of work of Gijutsuin though required only 200,000 yen per year).

(On October 1, 1945 the Gijutsuin was abolished).

It was envisaged that the Gijutsuin would support and coordinate all scientific and technological developments from the concept of the project thru the development. From then on the project would be transferred to the Ministry of War Supply which would guide the project through production. While it had funds it had no authority and no real check of the services. In practice the Gijutsuin handled two types of research problems. (1) Problems coming from the ministries (war, navy, etc.) and (2) problems coming from other sources. These were treated quite differently.

Problems coming from the ministries were reviewed and passed upon by the Kenkyu Doin Kaigi. The action of this body was binding on the Gijutsuin both as to the priority of the problem and the financial support to be given it by the Gijutsuin. It is to be noted that the president of Gijutsuin was ex-officio vice chairman of Kenkyu Doin Kaigi. In practice the ministry fostering the problem took care of the allocation of materials and instruments besides exerting considerable supervision and the funds allocated by the Gijutsuin went only for overhead, salaries and wages. Occasionally the Gijutsuin supported necessary buildings and other materials procurable on the open market. On the average about 10,000,000 of the funds of Gijutsuin were used in this way. Another 10,000,000 yen was provided directly by the government.

Problems coming from other sources were handled by the Gijutsuin directly without reference to the Kenkyu Doin Kaigi. In this, the department chiefs of the Gijutsuin acted as an advisory council to the president who retained the power to approve or disapprove a grant without the concurrence of the department chiefs. As the chief of the Research Mobilization Department was a General and the chief of the Technological Department was an Admiral, the military service kept an eye out for very worthwhile ideas. Such ideas might well then be taken to the interested service and come back from Kenkyu Doin Kaigi with a consequent increase in priority and reduction in funds needed. It is to be noted that ideas originating in academic circles often found their way directly into the services by means of the contacts of the professors. This function of the Gijutsuin consumed about two thirds of the total allotment.

Problems supported by the Gijutsuin without Kenkyu Doin Kaigi review had to be supported completely and generally handicapped by the scarcity of materials on the open market. Applications were made to the munitions ministry, which controlled a large block of materials and occasionally the office of Gijutsuin were used to emphasize the desirability of the work.

Through the handling of grants Gijutsuin gained control of many free lance scientific societies. Among these were:

Kogaku Gijutsu Shingi-hai (Scientific and Technical Deliberative Society) and Dai Nippon Gijutsu-kai described in 8a. Also on occasion it set up societies such as the Senji Enigen Kenkyu Kai, (War-time Resources Investigation Assoc. This one was set up primarily to justify the large expense of the collection and preservation of Agricultural Samples conducted by Professor Choogoru Tanaka.

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In order to encourage science and invention the Gijutsuin occasionally set up a prize committee that reviewed suggestions from the Research Mobilization Department, Technological Department, and Patent Department. The award of prizes was done with considerable fanfare.

On the whole the science and technology was never well coordinated nor brought directly to bare on war problems. No matter how well conceived the plans of the Gijutsuin seem to be, their efforts were effectively thwarted by the services. The reasons for this were given in different forms throughout all of our interviews and appear here and there throughout this report.

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RESEARCHES SUPPORTED BY THE BOARD OF
TECHNOLOGY (GIJUTSUIN) WITHOUT ORDERS
FROM THE RESEARCH MOBILIZATION COUN-
CIL (KENKYU DOIN KAIGI)

Research Subjects of Board of Technology.

I. General Researches.

<u>Topics</u>	<u>Researcher</u>	<u>Money granted</u>
1. Study concerning aviation.	Koku Gijutsu Kyokai (Ass. of Aviation Tech.)	¥ 3000,000
2. Research on airplane fuselage.		585,000
(a) Layer forming construction of airplane fuselage.	Fukuda, Hideo	
(b) Special combustion.	Honito, Shinkichi	100,000
(c) Plate forming patterns for airplane parts.	Fukui, Shinji	50,000
(d) Measuring of special vibrations.	Dobashi Hamo	30,000
(e) Automatic pilots.	Applied air electromagnetic	50,000
(f) Piloting and time limit devices based on sound wave phase.	Special machinery Research Laboratory.	350,000
3. Study concerning installations and auxiliary equipment.		410,000
(a) Special high pressure compression equipment.	Ono Yoshiji	300,000
(b) Intermediate cooler for supercharger.	Usui, Koji	10,000
(c) Portable oxygen generator	Fukuda, Yoshitami	100,000
4. Study concerning aviation installations.		22,000
Machinery for construction of underground installations.	Mishimura, Yeiichi	22,000
5. Study concerning prime movers		230,000
(a) Study of applicability steel parts for airplanes.	(Waseda University Casting Research Laboratory)	30,000
(b) Steel gear wheels by rotary manufacturing method.	(Aviation gear wheels)	200,000
6. Study concerning various machinery.		330,000
(a) Improvements on trailer	Hayade, Kuniyei	30,000
(b) The minute frequency analyzer.	Tokai Inst. (a foundation)	300,000
7. Study concerning measuring instruments.		57,000
(a) The pure iron plate for shielding of movable magnet type instrument.	Fuji Aviation Cooperation	10,000

(b) Method of printing on paper aviation instruments.	Taketomi, Riyozo	¥ 20,000
(c) Manufacture of aviation instruments by die cast method.	Hachishika Iron Works Limit Corp.	20,000
(d) Teeth thickness meter for the dial gage teeth.	Yanagita Scientific Corp.	5,000
(e) Examination device for MAGU type engraved line.	Kurckawa Mfg. Co.	2,000
8. Studies concerning electrical equipment.		26,000
(a) An experimental construction of "carbo meter"	(Benki Gijutsu Jitsuyoka Kyokai Electrical Technic Application Ass.)	10,000
(b) Electrical dehydration installation.	Shimizu Jinichi	13,600
9. Studies concerning optical instruments.		28,000
(a) Non-aberration photographic lise from green glass plate.	Gojo Optical Corp.	20,000
(b) Tin plating and blackening of lens tube.	Japan Typewriter Corp.	3,000
(c) Automatic camera for air test.	Endo, Teiichi	5,000
10. Studies on metals.		54,000
(a) The manufacture of lithium oxides from Lecianica.	Lkuda, Kozaburo	4,000
(b) Recovery of rare elements from slags.	Koga Iron Works Corp.	50,000
11. Studies concerning non-metallic materials.		339,500
(a) The utilization of poisonous elements in plants.	Suginome, Harusada	20,000
(b) High melting point paraffine.	Azuma, Kenichi	19,500
(c) Vacuum tube glasses.	Tominaga, Sai	10,000
(d) Electrical melting of glass.	Shimada, Hachiro	10,000
(e) The electrical method of salt manufacturing.	Nippon Paper Mfg Corp.	10,000
(f) Resistance type heat generating substance of silicon carbide.	Toho Sangiyo Corp. Research Lab.	200,000
(g) The concentration of sea water and mineral spring by freezing method.	Itsuhara, Itsuro	10,000
(h) Explosives using liquid oxygen for the source material.	Hinosoku, Shinto	50,000
(i) Explosives	Yosukawa, Kouzo	50,000

12. Studies concerning fuels and lubricating oils.		¥ 149,160
(a) Manufacture of lubrication oil for low temperature from camphor bark.	Uragami, Harusada	56,160
(b) Manufacture of fuel for internal combustion engines from leaves, branches and roots of "Hiba".	Kasamata, Jitsunel	10,000
(c) Collecting leak oil on sea water.	Hanachi, Sango	10,000
(d) The method of extraction of bone oil.	Oshima Meat Works Research Lab.	15,000
(e) Separation of superior bacteria in various fermentation.	Sakaguchi, Minichiyo	5,000
(f) Manufacturing of fuel oil from pine carbon oil.	Ogata, Meiro	4,000
(g) The oils for cutting and grinding.	Kobayashi, Yuzo	10,000
(h) Organic acid fermentation	Sakamoto, Yoshio	5,000
(i) The fuel from dry distillation of "Nemagari" bamboo.	Kikuchi, Konosuki	30,000
(j) Utilization of plant oil from Beechnut.	Kikuchi, Konosuki	4,000
13. Studies concerning domestic science.		96,000
(a) Increasing production of fibers and food products by smoke heat treatment.	Kishi, Ukitaro	20,000
(b) The prevention of insects from clothings.	Yamada, Yasuji	5,000
(c) Studies on properties of wood to withstand fire and to take fire.	Sato, Keizo	3,000
(d) Synthetic plant hormone.	Chem. Res. Ind. Corp.	4,000
(e) Utilization of factory wastes containing calcium oxide.	Oshiroto, Hitosuke	3,000
(f) Tuberculosis, Pathology and numurology.	Tamiya, Tokeo	10,000
(g) Purification, extraction and drying of anti-toxin serum.	Hosoya, Shogo	8,000
(h) Manufacture of serums.	Okamoto, Hiroshi	8,000
(i) Influenza virus	Kojima, Saburo	8,000
(j) Fatigue from heavy work.	Labor Science Research Lab.	4,000
(k) Utilization of bamboo fiber hamper.	Mabuchi, Usaburo	8,000
(l) Germ culture	Kawamori, Airo	2,000
(m) Emergency substitute medicine	Kariki Tatsukichi	3,000

(n) Emergency waterway sterilization installation.	Waterway Ass.	¥ 5,000
(o) Purification of drinking water.	Shimada, Shozo	5,000
14. Studies concerning increase production, treatment, storage of food.		933,000
(a) Improving the technic of low productive farmers.	Kondo, Yasuo	35,000
(b) Phosphoric acid fertilizer.	Fertilizer Research Lab.	70,000
(c) Potassium fertilizer	Fertilizer Research Lab.	20,000
(d) Fertilizer	Toho Sangyo Lab.	300,000
(e) Heredity of farm products and plants of special use.	Uyeda, Shizuo	25,000
(f) The distribution of field crops.	Konda, Seikei	10,000
(g) Pathology of crop seeds.	Tomikachi, Kokichi	5,000
(h) The mechanism of increased harvest by stimulation.	Noguchi, Yakichi	4,000
(i) Increasing production and storage of main food stuff.	Ohara Agri. Lab.	25,000
(j) Nourishing of strong sweet potato plants in bed.	Asami, Yoshicki	15,000
(k) To increase production of Rye, barley and red beans.	Toa Agri Res. Lab.	7,000
(l) On the feeds and on introduction of new kind of crops that can be efficiently grown by application of green grass fertilizer.	Nakatani, Toshio	10,000
(m) Synthetic meats.	Kawaguchi, War time Food Research Lab.	30,000
(n) Low temperature drying of vegetables.	Takahashi, Keishi	4,000
(o) Sweet potato treatments for emergency.	Ando, Kotaro	4,000
(p) Manufacture and application of malts.	East Asia (TO-A) Agri. Research Lab.	7,000
(q) Making use of the colloid property of soy protein.	Yasuda, Ken	4,000
(r) Manufacture of yeast from the warm liquid containing soy beans.	Mogi, Shichisaimon	5,000
(s) Making of yeast edible.	Nokamoto, Iwatoro	4,000
(t) The specifications on storage of sweet potatoes.	Matsumoto, Kumaichi	13,000
(u) Underground storage of main food stuff.	Ogo, Yoshiyasu	4,000

(v) "AMASAKE" (sweet sake)	Kawaguchi, Yonekichi	¥ 10,000
(w) Uses of various grains as stored food for emergency.	Sato, Kanesuke	10,000
(x) The food for recovery from fatigue.	Kawaguchi, Suikichi	10,000
(y) The food for preventing sleep.	Kawaguchi, Suikichi	10,000
(z) Fiber digesting micro-organisms.	Matsuzaki, Hansaburo	20,000
(a') Fiber digesting micro-organisms.	Nito, Masatsugu	10,000
(b') Prevention of change of quality of laminaria (a sea weed food).	Tokuhisa, Matane	2,000
(c') Antiseptics and germicides.	Tsukanoto, Hisao	2,000
(d') The from of emergency food plants.	Tanaka, Chosaburo	30,000
(e') Containers and wrapping material for food.	Kyuichiro, Inanaga	4,000
(f') Extermination of beans insects.	Kita Agri Ass.	5,000
(g') Rat prevention of sweet potatoes.	Takesaki, Yoshitoku	20,000
(h') On special cultivation.	Tsunematsu, Sakai	6,000
(i') On breeding of domestic rabbits.	Sasaki, Rinjiro	50,000
(j') On the practical uses of animals and plants resources.	Sasaki, Rinjiro	20,000
(k') The theory of soil improvement.	Shioiri, Matsujiro	10,000
(l') The practical uses of viscera of fish.	Kokura, Makoto	10,000
(m') Manufacture of nourishing substances from sweet potatoes.	Saigo, Yosukei	6,000
(n') Increase in yield of sweet potatoes in cold areas.	Yamaguchi, Iwataro	7,000
(o') Practical use of fresh sweet potatoes.	Yenouji, Matsuichi	1,000
(p') Increasing of production of beans for "Natto" (fermented beans).	Tanno, Chitaro	1,000
(q') On various cultivation methods of aquatic rice plants.	Kitachi, Yoshiyei	5,000
(r') Storage of sea foods.	Miyoshi, Masakiro	4,000
(s') Practical uses of whale gelatine.	Miyoshi, Masakiro	2,000
(t') Industrializing of yeast production.	Kawaguchi, Yonekichi	8,000

(u') Powdered food for infants during weaning period.	Matsusaka, Hansaburo	¥ 2,000
(v') Infants foods under the war time.	Shikata	8,000
(w') KAROGEN for infants.	Sasaki, Saburo	4,000
(x') Macaroni for infants during weaning period.	Oshiroto, Hitosuke	8,000
(y') Practical use of apples	Sato, Yasaku	5,000
(z') Alcohol from pears.	Shimura, Genichi	5,000
(a'') Practical uses of pears and other fruits.	KQA physical science Lab.	4,000
(b'') Saccharification of timber and plants.	Tomonaga, Tsukumo	5,000
(c'') Cultivation and practical use of erusalem artichoke	Sasakik Kow	5,000
(d'') On practical uses of decomposed sweet potatoes.	Katagiri Chemical Industry Corp.	5,000
(e'') Substitute for seasoning materials.	Osaka Domestic Science Res. Lab.	7,000
TOTAL		¥ 3,562,260

II. Invention Researches.

1. Electric bulb repairing and reviving method.	Kawoshima, Osada	¥ 15,000
2. Examining equipment for castings.	Ito, Gakuro	10,000
3. Rare elements separating method by magnetic extractors.	Okazaki, Rinsaburo	25,000
4. On equipment to bore straight hole in long timber.	Kanazawa, Ichitaro	30,000
5. Salt manufacturing method by motor power.	Tominaga, Yesaburo	20,000
6. On application of micro-organism in the treatment of cocoons.	Watanabe, Shizno	4,546
7. Reinforced curved bamboo plates and reinforced bamboo plates.	Maida, Yoshiynki	20,000
8. On the paper adjusting belt for friction conducting purposes.	Kuwata, Takeo	10,000
9. Manufactures of active carbon from silk-worm excrements.	Arai, Joe	30,000
10. Manufactures of terpene oil.	Hashiride, Chutaro	5,000
11. Manufacture of sulphur and carbon sulfides.	Haskiride, Chutaro	5,000

12. Manufacturing method for ship bottom painting.	Horiba, Shinkichi	¥ 5,000
13. Sand binding material for casting purposes.	Konakawa, Otomatsu	5,000
14. Automatic rice shoot planting machines.	Sasaki, Ojiro	20,000
15. Special "Mushiro" manufacturing machinery (straw carpets)	Deguchi, Yoshimitsu	4,000
16. On the wooden twisting part in straw rope manufacturing machine.	Hiraizumi, Oichi	1,000
17. Hatching equipment and fishery nursing.	Takahashi, Keiji	2,000
18. Roots infusing medicals for indeterminating insects for increasing of production, roots infusing fertilizers to increase resistances to diseases.	Kadomai, Hirota	4,000
19. Application of sodium salt of dehydro naphthoic acid.	Saito, Tetsuo	2,000
20.		
21. Manufacturing method of dried "Mourui" (spaghetti and others similar to it).	Murata Yoshio	4,000
22. Manufacturing of apple juice, filtering method and profitable use of compressed residue.	Shiroya Yoshimitsu	2,000
23. The practical use of KAKU (literally angle beans)	Umeda Isao	3,000
TOTAL		¥ 241,546.

III. Industrial Researches.

<u>Subjects</u>	<u>Experimenter</u>	<u>Money granted</u>
1. Method of rapid brewing of "miso" (bean paste).	Nakata Yeizo	¥ 40,000
2. Storage method of sweet potatoes by pressure.	Kubota Yeisaburo	30,000
3. Manufacturing method of storable main food substitutes.	Ito Heiji	50,000
4. Manufacture of aviation foods.	Hochitsuki Reyoza	40,000
5. Manufacture of sound damping and inflammable plate materials by use of various fibers.	Takada Shoichi	20,000
6. Manufacture of fructose.	Suzuki Food Res. Lab.	50,000
7. Manufacture of catalytic alumina for fuel from colloidal yellow soil.	Showa Petroleum	100,000

8. Manufacture of high grade lubricating oil from turpentine.	Daitoh Ind. Med. Mfg. Co.	¥ 20,000
9. Manufacture of working patterns for airplane parts by using sulfur and metallic fibers as the material.	Shutai Photographic Corp.	100,000
10. Manufacture of welding rods for airplane.	Welding Research Lab.	50,000
11. Manufacture of superior very fine wire.	Asahi Airplane Material Corp.	40,000
12. Manufacture of the heater for high speed cutting.	Elec. Tech. Application Ass.	50,000
13. Manufacturing of tools for sharpening.	Matsunawa Metal Industry Corp.	40,000
14. Manufacture of metallic nickel and iron of high nickel contents from poor grade native ore.	Heavy Metals Research Lab.	70,000
15. On the method of preparing aluminum skin.	Nihon Kika Kin Zoku Research Lab.	150,000
16. A simple smelting method of iron bands.	Toyo Satetsu Smelting Corp.	50,000
17. Manufacture of liquid fuel and solid fuel from grass-coal.	Iburagi Soten Research Plant.	20,000
18. Manufacture of granite propeller pressing patterns.	Chukanka Corporation.	30,000
19. Manufacturing method on quenched and high frequency tempering.	Nihon Koshuha Jyu Kogyo Kabushiki Kaisha (Japan High Frequency Heavy Industries Corp.)	50,000
20. Manufacture of super heat resistant materials.	Toda Industrial Corp.	20,000
21. Manufacture of steel pipes having bottoms.	Nihon Kotsukan	10,000
22. Manufacture of combustion engines.	Nihon Koutetsu Tokyo Plant (Japan Iron Works)	100,000
23. Manufacture of sodium directly from sea water.	Magnesium Refining Research Lab.	30,000
24. Electric Extraction.	Toho Sangyo Research Lab.	20,000

IV. Research Institutions.

<u>Name of Institution.</u>	<u>Addresses</u>	<u>Money granted</u>
Koku Jikuu Kenkyu Jo (Aviation bearing Res. Lab.)	674 Karasn Maru Inaidogaro Noboru Sogokuji Mon Mai, Kami Kiyoku, Kyoto	¥ 100,000
2. Nagoya Koku K. J. (Nagoya Aviation Res. Lab.)	13 Shimo Okuda Machinakaku, Nagoya	300,000
3. Kokku K. J. (Glider Res. Lab)	Daikouai 9 Hakozaicho Fuknoka Shi	- - -

4. Koku Seimitsu Keisoku K. J. (Aviation Precision Measuring Instrument Res. Lab.)	S Gojyo Tori Sendai Shi	- - - -
5. Koku Keisu K. J. (Aviation Measurements Res. Lab.)	36 Zaimoku Cho Azabu, Tokyo	¥ 100,000
6. Koku Kei Kinzoku K. J. (Aviation Light Metal R. L.)	2119 Shigi Cho Kita Ashitate Gun Laitema Ken	600,000
7. Kokuu Denji Oyo K. J. (Aviation Electro Magnetism Application R. L.)	122 Komagome Kamifuji Hoi Cho Hongo Ku, Tokyo	550,000
8. Kokuu Deuki Kinzoku K. J. (Aviation Electrical Metal R. L.)	80 Minami Cho Sendai City	600,000
9. Ko Ku Hoguruma K. J. (Aviation Gear Wheel R. L.)	1 San Men-cho Koju Machi, Tokyo	600,000
10. Ko Ku Hakko K. J. (Aviation Fermentation R. L.)	4-54 Jusan Nishino Machi Yodogawa Ku, Osaka	100,000
11. Rikagaku K. J. (Institute of Physical and Chemical Res.)	Koni Fujimae Cho Koishigawa-Ku Tokyo	200,000
12. Toho Sangyo K. J. (Toho Production R. L.)	Shigicho, Kita Ashitate Gun Saitama-Ken	300,000
13. Jukinzoku, K. J. (Heavy Metal R. L.)	1-1 Ishihara Machi Yokkaichi Shi	200,000
14. Chubu Kagaku K. J. (Central Area Scientific R. L.)	12-4 Isukihima Mishikawa gishi Kyobashi Ku, Tokyo	-----
15. Dai Nichon Gomu K. J. (Japan Rubber R. L.)	1-94 Koyama Dai Ibaraku, Tokyo	100,000
16. Kiryo K. J. (Fertilizer R.L.)	Imp. Univ. Of Tokyo Agriculture Sec., Yoyoicho Hongo Ku.	100,000
17. Kyoto Gijitsu Kagaku Kan. (Kyoto Technical Science Inst)		150,000
18. Nagoya Kogyo K. J. (Nagoya Industrial R. L.)		
19. Osaka Shi Kogyo K. J. (Osaka City Industrial R. L.)		
20. Kekkkaku Yobo Kai Kekkkaku K. J. (Tuberculosis Prevention Ass. Tuberculosis R. L.)		
21. Baisetsu K. J. (Baisetsu R. L.)	Iwato, Koyemura Kitatama Gun.	100,000
22. Oyo Kagaku K. J. (Applied Science R. L.)		100,000
23. Jin Katsu Geijitsu K. J. (Lubrication Technic R. L.)	841 Morikawa Cho Isoko Kn, Yokohama	50,000
24. Kensetsu Gijitsu K. J. (Construction Technic R. L.)	Kenchiku Kaikan 3-1 Genza Nishi Kyoboshi Kn	-----
25. Tokushu Kikai K. J. (Special Machine R. L.)		50,000

JAPANESE
GENERAL ORDER:

October 1945

NO 1:

BOARD OF TECHNOLOGY PROJECTS
APPROVED BY RESEARCH MOBILIZATION COUNCIL

Board of Technology BT
Ministry of War MW
Ministry of Navy MN
Ministry of Munitions MI
Ministry of Greater East Asia MA

Subject	Researcher	Notes
1. Elimination of airplane vibration	Tatsusuke Nakamura, Nagoya Imp Univ (Engr), MW	Completed
2. Air compressibility	Sanji Kawata, Aeronautical Research Lab, MW	Completed
3. Stability, maneuverability and performance of airplanes	Masaichi Kondo, Tokyo Inst of Tech, MW	In progress
4. Boundary layer	Ichiro Tani, Aeronautical Research Lab, MW	Completed
5. Tailless airplanes	Hidemasa Kimura, Aeronautical Research Lab, MW	Completed
6. Jet-propelled	Fujio Nakanishi, Aeronautical Research Lab, MW	Completed
7. Plane which takes off vertically (Chokujeki)	Tetsuo Miki, Osaka Imp Univ (Engr), MW	In progress
8. Fatigue caused by duplicate loading	Toshio Nishihara, Kyoto Imp Univ (Engr), MW	Completed
9. Super-large planes	Tanya Ota, Kyoto Imp Univ (Engr), MW	Completed
10. Steel planes	Tanya Ota, Kyoto Imp Univ (Engr), MW	In progress
11. Landing apparatus	Teichiro Ogawa, Aeronautical Research Lab, MN	In progress
12. High altitude propellers	Sanji Kawata, Aeronautical Research Lab, MN	Completed
13. Thrust meters and torque meters	Seitaro Kawaharada, Air Applied Electro-magnetic Res Lab, MN	In progress
14. Longterm preservation of liquid oxygen for use in engines	Shinichi Toyama, Tohoku Imp Univ, Metal Research Lab, MN	In progress
15. Substitutes for liquid oxygen in airplane engines	Sakujiro Kimura, Kyoto Imp Univ, Science Dept, Physiological Chem Lab, MN	In progress
16. Pre-ignition compound for engines	Sukenori Yamamoto, Tokyo Imp Univ (Engr), MN	Completed
17. Automatic control apparatus for engines	Mitsuyoshi Fukubu, Mitsubishi Hvy Industries, Nagoya Engine Factory, MW	In progress

Subject	Researcher	Notes
18. Combustion control apparatus	Mitsuyoshi Fukubu, Mitsubishi Hvy Industries, Nagoya Engine Factory, MN	Completed
19. Cooling of engines at very high altitudes (Part 1)	Sumao Saigenji, Nagoya Imp Univ (Engr), MN	In progress
20. Same (Part 2)	Otogoro Miyagi, Tohoku Imp Univ, MN	Completed
21. Same (Part 3)	Genichi Kodama, Osaka Imp Univ, MN	Completed
22. Ignition system for high altitude engines	Shigeb Mchizuki, Osaka Imp Univ, MN	Completed
23. Improvement of capabilities of airplane engine high-load shaft bearings	Risaburo Terikai, Tohoku Imp Univ, High Speed Research Lab, MN	In progress
24. Basic research on gas turbines for air use	Fukusaburo Munachi, Tohoku Imp Univ, High Speed Research Lab, MN	In progress
25. Diesel Engines	Toyozo Marita, Mitsubishi Hvy Industries, Nagoya Engine Factory, MN	Completed
26. Finishing of airplane engine parts	Shigeo Sasaki, Tokyo Inst of Tech, Precision Test Research Lab, MN	In progress
27. Combustion in rockets	Yasushi Tanazawa, Tohoku Imp Univ (Engr Dept), MN	In progress
28. Mass production of air-cooled crankshafts	Kinro Sanyoshi, Aeronautical Research Lab, MN	In progress
29. Mass production of air-cooled cylinders	Kinro Sanyoshi, Aeronautical Research Lab, MN	In progress
30. Ice formation prevention in aircrafts	Ukichiro Nakatani, Hokkaido Imp Univ, Low Temp Science Research Lab, MN	In progress
31. Fog in the Kuriles and Hokkaido	Ukichiro Nakatani, Hokkaido Imp Univ, Low Temp Science Research Lab, MN	In progress
32. Bullet-proof suits for air crew (Part 1)	Kozo Hara, Kobe Steel Works Co, Ltd, MN	Completed
33. Same (Part 2)	Naoyuki Watanabe, Tohoku Metal Industrial Co, Ltd, MN	Completed
34. Improvement of quality of substitute fibers, synthetic fibers (Part 1)	Tsukumo Tononari, Kurashiki Air Cnl Engineering Co, Ltd, Central Air Research Lab, MN	Completed
35. Same (Part 2)	Hasao Horie, Kyoto Imp Univ (Engr), BT	Completed
36. Same (Part 3)	Kotaro Tanemura, Toyo Rayon Co, Ltd, BT	Completed
37. Same (Part 4)	Tokiji Narita, Fiber Engr Testing Lab, MN	In progress
38. Anti-blind (Bogen) glass	Gundayu Aida, Iwaki Glass Research Lab, MN	Completed

Subject	Researcher	Notes
39. Elimination of brittleness in silk fiber	Bun Mihira, Fiber Engr Test Lab, MN	Completed
40. Portable oxygen generator	Yoshitani Fukuda, Tokyo Imp Univ (2d Engr), BT	In progress
41. Manufacture of air material with hardened fiber	Tsuikuno Tomonari, Kurashiki Air Cnl Engr Co, Ltd, Central Air Research Lab, BT	In progress
42. Strong raw silk	Junichi Suzuki, Silk Yarn Test Lab, BT	In progress
43. Making textile non-inflammable and able to prevent penetration of hot air.	Bun Mihira, Min of Agriculture and Commerce Fiber Engr Test Lab, MN	In progress
44. Increasing ability to withstand high altitude (Part 1)	Yoshio Kusano, Keio G Juko Univ, Med, MW	Completed
45. Same (Part 2)	Rinnosuke Shoji, Kyoto Imp Univ, Med, MW	Completed
46. Same (Part 3)	Kezo Kamishiro, Nihon Med College, MW	Completed
47. Same (Part 4)	Masao Ito, Aoyama Scientific Research Lab, MW	Completed
48. Same (Part 5)	Takashi Minoshima, Hokkaido Imp Univ, MW	Completed
49. Same (Part 6)	Shingo Sakurai, Jap Physical Cnl Engr Co, Ltd, MW	Completed
50. Low temperature and low pressure equipment and apparatus	Kashira Fujii, Mitsubishi Hv Industries, Fujii Research Lab, MW	In progress
51. Nature of air fatigue (Part 1)	Fusao Ishikawa, Tohoku Imp Univ, Science, MW	Completed
52. Same (Part 2)	Seizo Katsunuma, Nagoya Imp Univ, MW	Completed
53. Same (Part 3)	Nikichi Okumura, Kyushu Imp Univ, Med, MW	Completed
54. Same (Part 4)	Sukeoyuki Uchinura, Tokyo Imp Univ, Med, MW	Completed
55. Same (Part 5)	Aizaburo Seo, Kyushu Imp Univ, Med, MW	Completed
56. Same (Part 6)	Sukeoyuki Uchinura, Tokyo Imp Univ, Med, MW	Completed
57. Same (Part 7)	Tokuyi Fukuda, Tokyo Imp Univ Med, MW	Completed
58. Same (Part 8)	Sukeoyuki Uchinura, Tokyo Imp Univ, Med, MW	Completed
59. Same (Part 9)	Shuji Fujita, Itasato Inst, MW	Completed
60. Same (Part 10)	Shigeo Okinaka, Tokyo-Shiba Denki, MW	Completed
61. Same (Part 11)	Kikujiro Nishimura, Nihon Med College, MW	Completed

Subject	Researcher	Notes
62. Effects of acceleration on the body (Part 1)	Saburo Iwa, Tokyo Shibaura, MN	Completed
63. Same (Part 2)	Haritoshi Nishi, Tokyo Imp Univ, Med, MN	Completed
64. Same (Part 3)	Shunichi Hashita, Kyoto Imp Univ, Med, MN	Completed
65. Same (Part 4)	Tosyjiro Kato, Tohoku Imp Univ, Med, MN	Completed
66. Medical research on flight food and clothing (Part 1)	Korehiro Otaga, Manchukuo Med College, MN	Completed
67. Same (Part 2)	Toshiyuki Hashima, Osaka Imp Univ, MN	Completed
68. Same (Part 3)	Osao Kodama, Kyushu Imp Univ, Med, MN	Completed
69. Same (Part 4)	K Med Otaga, Kyoto Prefectural Med College, MN	Completed
70. Same (Part 5)	Isamu Yakata, Kyoto Imp Univ, Agriculture, MN	Completed
71. Effect of sound-deadening	Kinji Kaeda, Tokyo Imp Univ, Med, MN	Completed
72. Malaria (Part 1)	Yasuhiko Asahina, Tokyo Imp Univ, Emeritus-Prof, MN	In progress
73. Same (Part 2)	Heizaburo Kondo, Otsuu (Otsu) Research Lab, MN	In progress
74. Same (Part 3)	Yasuhiko Asahina, Tokyo Imp Univ, Emeritus - Prof, MN	In progress
75. Same (Part 4)	Koaru Harishita, Tohoku Imp Univ, MN	In progress
76. Same (Part 5)	Tenji Taniguchi, Osaka Imp Univ, Med, MN	Completed
77. Tuberculosis (Parts 1 and 2)	Taizo Kuragai, Tohoku Imp Univ, MN	Completed
78. Increase in low vision	Shiro Hirano, Sankyo Co, Ltd, Takamine Research Lab, MN	In progress
79. Physiological studies on increase of visual power	Kunihiko Hashida, Air Tech Depot, Air Med Sec, MN	In progress
80. Increase of hearing power and hearing	Kinji Kaeda, Tokyo Imp Univ, Med Dept, MN	In progress
81. Eruptive typhus inoculation	Takeshi Teriya, Infectious Disease Research Lab, BT	In progress
82. Wartime food	Yoshito Shinoda, Osaka City Domestic Science Research Lab, BT	In progress
83. Use of whale products	Hajime Okamoto, Infectious Disease Research Lab, BT	In progress
84. Scientific study of wartime food policy	Kunihiko Hashida, Tokyo Imp Univ, BT	In progress
85. Manufacture of nitric acid directly from nitrogen in the air	Harunari Inouye, Tokyo Engr Test Lab, MN	In progress

Subject	Researcher	Notes
86. Potassium resources	Shoichiro Nagai, Tokyo Imp Univ, 2d Engr Dept, MM	Completed
87. Manufacture of coke for use in iron manufacture	Hideonori Matsunani, Nihon Kika Fuel Co, Ltd, MM	Completed
88. Manufacture of high-pressure lubricating oils	Tokio Kawamoto, Japan Camphor Oil Engr Co, Ltd, MM	Completed
89. Chinese coal for use in iron manufacture	Yoshinori Tatsumi, Japan Iron, various research labs, MA	In progress
90. Fuel from northern pine, oak, and plant resources	Harusada Sugimoto, Hokkaido Univ Science Dept, MW	In progress
91. Utilization of pine root oils	Yoshihiko Kano, Mitsubishi Petroleum Co, Ltd, MM	In progress
92. Manufacture of heavy oil from thick tar for use in drums	Shimpei Ando, Tokyo Imp Univ, 1st Engr Dept, MN	In progress
93. Manufacture of alcohol from liquid pulp residue	Haruo Akiyama, Oji Paper Research Lab, MN	In progress
94. Saccharification and fermentation of cellulose products.	Kinichiro Sakaguchi, Tokyo Imp Univ, Agriculture Dept, MN	In progress
95. Preventing corrosion of apparatus for treating tar acid oils	Norio Sato, Tohoku Imp Univ, Engr Dept, Metal Engr Sec, MN	In progress
96. Use and effectiveness of various pine root oil ingredients	Shinichiro Fujise, Tohoku Imp Univ, Science Dept, Chemistry Sec, Futase Research Lab, MN	In progress
97. Production of lubricating oils from shale oils	Tsutomu Kuwada, Tokyo Imp Univ, Engr Dept, MN	In progress
98. Extraction of oil from pine and oak leaves	Moriaki Yokoyama, Kanatawa Engr Sch, BT	In progress
99. Increase in production of petroleum in northeastern areas	Kenzo Ikeda, Akita Sch of Mining, BT	In progress
100. (a) Extraction of oil from oil sand and oil mud in the Higashiyama oil fields	Michizo Tsuboi, Nagasaki Engr Sch, BT	In progress
(b) Utilization of birch oils (Part 1)	Yukio Inai, Yokohama Engr Sch, BT	In progress
101. Same as 100 (b). (Part 2)	Harusada Sugimoto, Hokkaido Imp Univ, Science Dept, BT	In progress
102. Utilization of synthetic plastics	Tadanori Shono, Osaka City Engr Research Lab, BT	Completed
103. High frequency insulating materials	Sakaji Kanagata, Electrical Test Lab, BT	Completed
104. Utilization of rubber	Yoshio Tanaka, Japan Rubber Research Lab, MW	In progress
105. Improvements in industrial manufacture of carboric acid	Shinjiro Kodama, Kyoto Imp Univ, Engr Dept, BT	In progress
106. Automatic sight for fixed guns	Tsutomu Ito, Bd of Communications, Electrical Test Lab, BT	Completed
7. Measurement of airplane machine gun recoil and vibration	Shoichi Mashima, Tokyo Imp Univ, 1st Engr Dept, BT	Completed

Subject	Researcher	Notes
108. Mount for remote control guns for aircraft	Keiki Miyamoto, Electrical Test Lab, MN	In progress
109. Control of speed and range of electrical motors, DC and AC	Keiki Miyamoto, Electrical Test Lab, MN	Completed
110. Electric control apparatus for airplane machine cannon	Hikaru Nagamino, Army Tech Research Lab, MN	Completed
111. Machine gun muzzle withdrawal control device	Manzaburo Aikawa, Tokyo Imp Univ, 2d Engr Dept, MN	In progress
112. Construction of duplex revolving electric motors and control of speed by electromagnetic brakes	Hideo Yamashita, Tokyo Imp Univ, 1st Engr Dept, MN	Completed
113. Simple airplane measuring methods	Shoichi Mashima, Tokyo Imp Univ, 1st Engr Dept, MN	Completed
114. Construction of airplane machine gun carriages	Shiro Sasaki, Tokyo Inst of Tech, MN	Completed
115. Flare bomb experiments on strain to IG parts	Jiro Tsuji, Inst of Phys & Cml Research, MN	Completed
116. Stranded wires and springs	Shoji Ikeda, Railway Tech Research Lab, MN	In progress
117. Mass production of gear wheels	Masa Naruse, Tohoku Imp Univ, Engr Dept, BT	In progress
118. Use of electrolytic polishers	Yohsei Yamaguchi, Toyoda Phys & Cml Research Lab, BT	In progress
119. Bomb penetration mechanism	Shoichi Tashima, Tokyo Imp Univ, 1st Engr Dept, BT	Completed
120. Damage caused by bombs	Otakeo Miyagi, Tohoku Imp Univ, Engr Dept, BT	Completed
121. Measuring devices for air cut-off time setters on gyroscopes	Masataro Kawarada, Air Electromagnetic Application Research Lab, BT	Completed
122. Accelerators which can automatically measure accelerations from 100 to 1000 G	Masataro Kawarada, Air Electromagnetic Application Research Lab, MN	In progress
123. Methods of torpedo release	Hajimu Nagatani, Meiji Robber Research Dept, MN	In progress
124. Simple and speedy investigation for unexploded bombs	Toru Watanabe, MN	In progress
125. Brushes	Shoji Sato, Tokyo Imp Univ, 2d Engr Dept, MN	Completed
126. Electrical phenomena at high altitudes	Kenji Honda, Tokyo Imp Univ, Science Dept, MN	In progress
127. Methods and measurement devices for airplane short wave and ultra short wave	Hikaru Okada, Electrical Test Lab, MN	Completed
128. Elimination of electrical static	Kenzo Nagai, Tohoku Imp Univ, Engr, MN	Completed
129. AC Power source on plane	Shoji Sato, Tokyo Imp Univ, 2d Engr Dept, MN	In progress
130. Special vacuum tubes	Hiroshi Kiyomiya, Electrical Test Lab, MN	In progress

Subject	Researcher	Notes
131. Conductive materials	Natsujiro Oyama, Tokyo Imp Univ, MN	Completed
132. Materials for electric contact points and circuits	Takashige Noguchi, Bd of Com, Elec Test Lab, MN	In progress
133. Airplane generator voltage regulator	Takashige Noguchi, Bd of Com, Elec Test Lab, MN	Completed
134. Making of radio wave and radiation charts	Eitiro Yokoyama, Radiowave Physics Research Lab, MN	In progress
135. Aircraft antenna	Yasutaro Kato, International Elec Com Co, Ltd, MN	In progress
136. Wireless operation over long distances	Kanichi Ohashi, Elec Test Lab, MN	In progress
137. Ions in the air	Toshio Aoki, Elec Test Lab, MN	In progress
138. Doppler effect formula	Kinjiro Okabe, Tokyo Shibaura Denki Co, Ltd, Electronics Research Lab, MN	Completed
139. Measurement of ultra-high frequency changes	Sadao Matsumoto, Elec Test Lab, MN	Completed
140. 3-Dimensional circuits (including wave guides and resonators)	Shinobu Sonoda, Production Science Research Lab, MN	Completed
141. Alomite conductors	Satoshi Miyata, Inst of Phys & Cml Research, BT	Completed
142. Mica compounds	Inekichi Noda, Nagoya Imp Univ, Engr Dept, BT	In progress
143. Durable and reliable relays for use at high altitudes	Masahisa Matsudaira, Tohoku Imp Univ Com Research Lab, MN	In progress
144. Superior Telephone system based on type 4 Mk 3 wireless	Kenzo Nagai, Tohoku Imp Univ, MN	In progress
145. Increase of transmitting capacity by boosting pressure of existent 140,000 volts senders to 200,000 volts	Eishiro Fukao, Min of Trade & Industry, Elec Power Bureau, MN	In progress
146. Design and operation of electric furnaces for manufacture of iron alloys	Takeshi Takei, Tokyo Inst of Tech, MM	In progress
147. Use of the ground in AC circuits in power transmission	Tsukasa Fujinami, Kanto Power Dist Transformer Sta, Asahi, MM	In progress
148. Large chlorination furnaces for processing of magnesium	Risaburo Takase, Kanto Electrification, Shibukawa Plant, MM	In progress
149. Manufacture of silicon carbide resistor heaters	Michiharu Jeko, Toho Production Research Lab, MM	In progress
150. Manufacture of electrodes by use of kokusu burisu	Takeichi Imura, Steel Control (Tekko Toseikai), MA	In progress
151. Performance of diesel engines operating on powdered coal	Yoshisada Ban, Fuel Research Lab, MM	In progress
152. Extraction of metallic sodium hydride from caustic soda and its special application	Shigeyuki Kitaara, Formerly Monopoly Bureau Technical, MM	In progress

Subject	Researcher	Notes
153. Cement which saves fuel in making concrete	Shunkichi Yamauchi, Tokyo Inst of Tech, Ceramics Dept, MMI	In progress
154. Quick runway construction methods in warm climates	Kozo Mai, Hokkaido Imp Univ, Engr, MW	Completed
155. Methods of quick construction of large tunnels	Iwao Kuginiya, Tokyo Imp Univ, 2d Engr Dept, MW	Completed
156. Simple apparatus for measuring supporting strength of ground	Sanji Matsumura, Civil Engineering (Doboku) Test Lab, MW	Completed
157. Airfield soil stabilization	Tajiro Ishinara, Kyoto Imp Univ, Engr, MW	Completed
158. Quick construction methods for important materials used on runways	Kusuo Aoki, Min of Internal Affairs, Civil Engineering (Doboku) Test Lab, BT	In progress
159. Construction of underground factories	Komuro Ono, Tokyo Imp Univ, 2d Engr Dept, Constr Sec, MW	In progress
160. Cement substitute	Minoru Harada, Tokyo Imp Univ, 1st Engr Dept, MW	In progress
161. Quick cement composed largely of sulphides	Katsunaga Koizumi, Kanobuchi Industries, Inst of Phys & Cnl Research, BT	In progress
162. Control of flares during air raid warning	Hideo Mori, Shomei Gakkai (Illumination Society), MMI	In progress
163. Increase in rice yield by repair of damaged chemical factories	Matsuzaburo Shioiri, Tokyo Imp Univ, Agriculture Dept, BT	In progress
164. Methods of transplanting rice	Hiroshi Torao, Min of Agriculture and Commerce, Ag Expt Sta, BT	In progress
165. Prevention of plagues of insects harmful to rice crops	Kohei Yuasa, Min of Agriculture & Commerce, Ag Expt Sta, BT	In progress
166. Manufacture and use of new agricultural chemicals	Shotaro Sato, Min of Agriculture & Commerce, Ag Expt Sta, BT	In progress
167. Chemicals and seeds for increase in plant health and productivity	Yoshichi Asami, Tokyo Imp Univ, Agriculture Dept; Min of Ag & Commerce, Horticultural Expt Sta, BT	In progress
168. Measures against the potato virus	Yakichi Nozuchi, Tokyo Imp Univ, Ag Dept, BT	In progress
169. Increase in production of potatoes and sweet potatoes	Yoshitsugu Tagari, Min of Ag & Commerce, Ag Expt Sta, BT	In progress
170. Prevention of rice blights	Shunsuko Kusano, Tokyo Imp Univ, Ag Dept, BT	In progress
171. Production and use of nitrates and potassium phosphorites	Shinichiro Kasugai, Tokyo Imp Univ, Ag Dept, BT	In progress
172. Increase in soil productivity (Part 1 - Improvement of soil)	Issui Kawamura, Kyushu Imp Univ, Ag Dept, BT	In progress
173. Same (Part 2 - Soil activity)	Shingo Mii, Min of Ag, Agricultural Expt Sta, BT	In progress

Subject	Researcher	Notes
174. Prevention and cure of blood diseases in horses	Susumu Ishii, Min of Ag & Commerce, Ani Disease Investigation Lab, BT	In progress
175. Heavy grass feeders	Michio Saito, Osaka Nutrition Research Lab, Tokyo Imp Univ, Ag Dept, BT	In progress
176. Prevention and cure of blood diseases in horses.	Susumu Ishii, Min of Ag and Commerce, Animal disease Investigation Lab, BT	In progress
177. Increase in cultivation of aquatic animals.	Takashi Hayashi, Osaka Imp Univ, Production Science Research Lab, BT	In progress
178. Conversion of rivers and water sheds into pasture.	Shibata, Resource Science Research Lab BT	In progress
179. Regulations and specifications for aviation optical glass.	Shiro Takahashi, Engr Test Lab, MN	In progress
180. Taking of superior aerial photographs with insufficient light (at night, dawn, or dusk) or when cloudy or misty or under adverse weather conditions.	Shoichi Mashima, Tokyo Imp Univ, MW	In progress
181. Gradual improvement in visual power of optical equipment.	Heigoro Yanada, Tokyo Optical Co, Ltd., MW	Completed
182. Making of sensitive materials for fine grain or no-grain aerial photographs.	Naoto Kameyama, Tokyo Imp Univ, MW	Completed
183. Manufacture and finishing of permanent magnets for use in aircraft instruments	Kotaro Honda, Tohoku Imp Univ, Metal Research Lab, MW	In progress
184. Simple measurement of altitude, direction and ground speed from airplanes.	Tatsujiro Sasaki, Tokyo Imp Univ, Engr Dept, MW	In progress
185. Apparatus for determination of air position by use of radio wave.	Minoru Okada, Electrical Test Lab, MN	In progress
186. Determination and elimination of nonmetallic elements in steel processing.	Sasauro Kobayashi, Japan Iron Wanishi Plant, BT	Completed
187. Elimination of arsenic in iron ores used in this country and effect and reduction of effect of arsenic on steel.	Tatsuyuki Fujimura, Japan Iron (Nihon Seitetsu) Technical Research Lab, MW	In progress
188. Use of rare elements.	Reikichi Tada, Former President, Bd of Technology, BT	In progress
189. Manufacture of pure iron.	Harunari Inoue, Tokyo Engr Test Lab, BT	Completed
190. Quantity production of magnetic distribution materials (AF alloys)	Hakaru Masumoto, Metal Research Lab, BT	Completed
191. Rare metals found in ores other than principal ores.	Eijiro Ogawa, Kyushu Imp Univ BT	Completed

<u>SUBJECT</u>	<u>RESEARCHER</u>	<u>NOTES</u>
192. Use of smelting ash	Kenjiro Ogawa, Kyushu Imp Univ, BT	In progress
193. Chinese ores used in iron manufacture	Takeichi Imura, Tekko Toseikai, MA	In progress
194. Improvement in smelting of low grade native ni ore	Yoshiki Ogawa, Tokyo Imp Univ, 1st Engr Dept, Alloy Research Lab, BT	In progress
195. Recovery and use of re- cipitated copper.	Tokuichi Mishina, Tokyo Imp Univ, 1st Engr Dept, BT	In progress
196. Processing of useful metal not found in principal area.	Kenjiro Kimura, Tokyo Imp Univ, BT	In progress
197. Processing of radio-active substances from native sources	Akiyasu Jinori, Insti- tute of physical and chemical researches MM	In progress
198. Tools and materials made of extra hard alloys	Naojiro Kumagai, Mitsui Mining Co, Ltd,	Completed
199. Polishing tools and materials substitute for diamonds.	Shinichi Suzuki, Tokyo Institute of Tech, MN	In progress
200. Characteristics and manufacture of fine grained or fused and aluminum oxide	Juro Manabe, Tsueani Antag Plant, BT	Completed
201. Processing of Linonite by the earthen furnace methods.	Sutekichi Ibuka Teiroku Sueno, Gifu Potterywork Directing Lab, Min of Munitions Geological Survey Station, MM	In progress
202. High speed construction and repair methods.	Yukikane Nakanishi, Electrical Test Lab BT	Completed
203. Iron refining by application of electricity and improvement in rolling efficiency	Matsujiro Oyama, Tokyo Imp Univ 1st Engr Dept MM	Completed
204. Manufacture of boracic acid and alumina using electricity.	Nobuyuki Yamamoto, Toho Production Research Lab, MM	Completed
205. Technical policy to be adopted in anticipating vast improvements in production of vacuum tubes	Hidetoshi Yagi, formerly President of Tokyo Inst of Technology. BT	Completed
206. Improvement in rate of produc- tion of light metals by appli- cation of electrical technique	Matsujiro Oyama, Tokyo Imp Univ, 1st Engr Dept MM	Completed
207. Simple manufacture of alumina from alun by use of earthen furnace.	Yahei Asada, Min of Ed, Completed Bureau of Scientific Ed, BT	Completed
208. Production of precision axles bearings for use in gyros.	Eiichi Sasaki, Machin- ery Test Lab, Nagoya Branch, MM	Completed

SUBJECT	RESEARCHER	NOTES
209. Steel casting by pressure die	Uichi Hashimoto, Tokyo Engineering School BT	In progress.
210. Extracation of boracic compounds from non-mineral resources	Minoru Tanaka, Naguchi Research Lab BT	Completed
211. Simple and speedy manufacture of sheet metal patterns for airplane parts.	Shiniji Fukui, Aeronautical Research Lab Institute of Physical & Chemical Research, BT	In progress
212. Manufacture by electrolytic refining of the metal of pure aluminum base.	Motoo Takahashi, Japan Light Metal Company Ltd, Light Metal Research Lab. MM	In progress
213. Developments and Improvements in low boracic acid for use in transmitting vacuum tubes.	Harao Nagaoka, Japan Optical Engr Co Ltd, Glass Plant.	In progress
14. New methods of salt manufacture	Itsuro Tohara, Hokkaido Imp Univ Catalyst Research Lab BT	In progress
215. Improvement in efficiency of existant ammonia synthesis apparatus.	Harionari Inoue, Tokyo Engr Test Lab MM	In progress
216. Intermediate industrial manufacture of chlorine and caustic soda by direct electrolysis of sea water.	Hiroshi Suzuki, East Asia Synthetic Chemical Engr, Magnesium Research Lab MM	In progress

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SUBJECT: Lt Gen Reikichi TADA, President Board of Technology

DATE: 24 September 1945

INTERVIEWED: Lt Gen Reikichi TADA

INTERVIEWERS: Drs Longacre, Moreland, Griggs, Stephenson, Maj Hewlett

Tada is a retired technical lieutenant general who displaced Dr H Yagi as president of the Cabinet Board of Technology, 22 May 1945, in the hope of improving the relationships between that board and the services. These had fallen to a low ebb during Yagi's term and this is the second attempt to improve them. H Kunabe was appointed vice-chairman, 3 March 1945--a position Yagi had been trying to fill along with his chairmanship for several months. A description of this board and its contributions will appear in another report.

Tada's life work had been more or less associated with metallurgy, and before becoming director of the Board of Technology he sought and received grants for researches on sources and processing of uncommon metals. He administered five groups:

- a. Search for rich source of tantalum. This effort proved unsuccessful.
- b. (1) Complete analysis of tantalum and ferrozirconium ores.
(2) Enriching low grade ores of tantalum and zirconium.
- c. Processing and fabrication of wire and sheets with 90% tantalum from columbite. Also work with niobium and columbium and other rare metals.
- d. Refining and use of zirconium as a substitute for tantalum in vacuum tubes. Developed a technique of coating sheet molybdenum with zirconium powder which was suitable for large size tubes. The surface was too rough for holding tolerances when fabricating small parts.
- e. Development of a ferro-zirconium alloy to be used as a constituent in steel melts. It was hoped to make a gas-free high temperature steel. Laboratory samples showed some success. Frequently the zirconium had been consumed and the resultant steel showed no trace of it. The composition of the ferro-zirconium constituent was approximately 40% Zr, 11-15% Si, 2% C, less than .08% Al. and the rest Fe. It was estimated this would be about 10% of the steel mill.

This work came to an end in July, 1945, when the imposed time limit had already been exceeded by three months. The process was never used commercially.

During a questioning period he gave us some leads on synthetic fuels, new process for obtaining aluminum, relationships between Army-Navy and Board of Technology, the "death ray", German scientists, and heat-homing bombs.

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RESEARCH ON USE OF RARE ELEMENTS

Report submitted to Chief of Research Mobilization Dept, Board of Technology. 10 August 1945. Reikichi TADA, in charge of research. Period of research: June, 1944 - July, 1945.

(ABSTRACT)

1. Search for source of Tantalum (Y KOZU). Search was made in Korea but no promising source was found. Total tantalum mineral in Korea approximated at 100 kg. Search for Ta source in Japan proper, especially in Ishikawa, Fukushima prefecture and research on substitutes for Ta are suggested.

2. Extraction of low Ta-bearing ore and Zr ore. (E SETO)

a. Magnetic extraction of Columbite. Possible to obtain 90% pure columbite.

b. Flotation extraction method for Zr ore gave purified ore with Zr purity of 90% and better. Need further research to increase yield. Research on carrying out magnetic extraction of Columbite on industrial scale is suggested.

3. Quantitative determination of niobium, tantalum, titanium in tantalum ore. (M IKAWA) Research is not yet completed. Tannin method, titration method, Mariniyakki* method and others are being used. So far, have found tannin method suitable for the mineral and reduction titration method suitable for determination of niobium and tantalum.

4. Method of quantitative analysis of ferro-zirconium. (T NAKAI). Have completed research on method of analysis for total Zr, metallic Zr, Zr nitride, Zr carbide, Zr silicide in ferro-zirconium. Research on analytic method for pure metallic Zr powder was made.

5. Manufacture of metallic Ta (for use in vacuum tubes) from low Ta-bearing ore (columbite). S HATA, A MAEDA, M WATANABE, T SHIRATSUJI. Research held up due to lack of Ta ore. Results obtained so far:

a. Maeda Lab. If yield can be disregarded to some extent, ore bearing 30% Ta oxide can be considered as source of Ta.

b. Hata Lab. With low grade (10%) ore found in the country, 70% yield of Ta oxide can be obtained. However, consumption of reagent material is high.

* Phonetic

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6. Manufacture of metallic Zr plate and wire for use in vacuum tube. (S HATA, S FUKAGAWA, H NAKAMURA). Results up to now:

a. Have completed researches on methods of preparing metallic Zr powder of high purity.

- (1) By reduction of Zr oxide with metallic Ca, Zr powder of about 100% purity can be obtained on industrial scale.
- (2) It is possible to obtain Zr powder of high purity by reduction of Zr chloride with metallic Na. Process gives small yield and is not suitable for large-scale production.
- (3) Reduction of Zr potassium fluoride with Na can be carried out on small scale but is not suitable for production on industrial scale. There is danger of explosion and caution is required. Impurities are removed by preparation of Zr potassium fluoride from Zr oxide and very pure salt is obtained. However, due to the chemicals required this process is only suitable for production on laboratory scale.

b. Have prepared metallic Zr wire and plate with high "drawing" quality on laboratory scale but have not yet succeeded in devising a process for making these on industrial scale.

- (1) Have prepared in the laboratory metallic Zr of high "drawing" quality by heat dissociation of Zr iodide.
- (2) Research on process of compressing and shaping metallic Zr powder and heat treatment of this in vacuum and the process of fusion in a high frequency vacuum electric furnace not yet completed because of installation difficulties.

c. Preparation of metallic Zr by electrolysis of aqueous solution and fused salt is now under research.

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7. Manufacture of Ferro-Zirconium. (T TAKEI, T KOJIMA, K KISHIMOTO, F INAMI, N WATANABE, S FUKAGAWA).

Object: Preparation of ferro-zirconium of suitable composition and quality for making of Zr steel.

Results: a. It is believed that ferro-zirconium of the following composition can be made on industrial scale.

Zr - approx 40%
Si - 11-15%
C - approx 2%
Al - less than 0.08%
Fe - remainder

Material: Coarse Zr oxide
Red ochre
Coke powder or Koraito* powder
Calcium oxide or fluorite
Electric arc furnace is used.

b. Method of preparing ferro-zirconium directly from the source ore.

(1) The ore is first run through processes by which P and Sn are removed. The Zn ore (-P and Sn) is mixed with iron scrap, silicic acid and a reducing agent (carbon) and is reduced in a Jiro* type electric arc furnace. Production of low Zr Ferro silicon and high Zr ferro silicon on industrial scale is possible. For the future, research is planned on preparation of Zirconium-ferro-silicon of high Zr content and low silicon content.

(2) The process of directly reducing source ore with iron oxide, aluminum powder, metallic silicon in an arc furnace gives variable yield and quality of product and is not suitable for use on industrial scale.

(3) It is possible to produce ferro-silico-zirconium containing 50% Zr by heating source ore with metallic silicon and calcium oxide in an arc furnace. By running this alloy product through a silicon-removing process it is possible to produce ferro-silico-zirconium with 65% Zr content.

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c. A simple industrially possible process is the powder metallurgical method using metallic Zr powder and electrolytic iron powder to pure Ferro-Zirconium (does not contain C, Al, Si, etc) of desired composition.

8. Research on Fr Steel. (T MITSUHASHI, Z TAKAO, S NISHIGORI)

Object: Research on the influence of iron steel and on the method of Zr addition.

Research was delayed because ferro-zr suitable for Zr steel production was not on hand. Used ferro-zirconium prepared as given previously. Research on influence of Zr on heat-resistant steel and special strong steel and method of Zr-addition has been partly completed.

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SECOND CONFERENCE WITH LT GEN REIKICHI TADA,
PRESIDENT, BOARD OF TECHNOLOGY

SUBJECT: Research Supported by Board of Technology and Miscellaneous
Information on Army and Navy Research.

INTERVIEWED: Lt Gen Reikichi TADA.

INTERVIEWERS: Dr H K Stephenson, Dr E L Moreland, Maj W R Hewlett, Lt Yamada.

DATE: 3 October 1945.

1. General Tada submitted information on the following items of research. This information came to him in his capacity as Pres of Bd of Tech and from private sources. The projects were not all supported by the Bd of Tech.

a. Synthetic Fuel from Liquefaction of Coal. This was a process in which cobalt was used as a catalyzer, but since cobalt is scarce in Japan, research was conducted on the use of iron as catalyzer. Tada had heard that this work was successful. The details can probably be learned from exports of the Hokkaido Synthetic Petroleum Co., Ltd.

b. Production of Alcohol and Butanol from Agricultural products. Research was done on this problem at the Fermentation Research Laboratory under the Ministry of Trade and Commerce (Mr K Kurono was connected with the work) at the Navy Fuel Depot at Ofuna (Prof S Komatsu of Kyoto Imp Univ directed the work); and at the Army Fuel Depot at Fuchu (near Tachikawa).

c. Beneficiation of low-grade aluminum ores. Four low-grade sources of aluminum were worked on as follows:

- (1) The Asada Chemical Engineering Co., Ltd. worked on alunite as a source. The plant is located at Himeji (Shikama-Ku) but was probably not in production.
- (2) The Japanese-Manchurian Aluminum Co., Ltd., located at Toyama (north coast of Honshu) had a plant in production at Dujun, Manchuria, using "alumina" shale as an ore.
- (3) The Nitto Chemical Research Laboratory at Oniya (near Tokyo) developed a process, successful on a laboratory scale, using clay as raw material.
- (4) "Kanuma" clay was used as a source by the Sankei Mining Co., Ltd. in Kanuma (Tochigi Prefecture). Research on the process was completed and plans were under way for production when the war ended.

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d. Separation of Magnesium. Two processes for extracting magnesium had been perfected before the war by the Physical-Chemical Research Laboratory, Tokyo, and were in use by the Japanese-Manchurian Magnesium Co., Ltd. at Ube (South tip of Honshu). The preferred process involved Mg separation from the "bittern" produced in extracting salt from sea water. The second process used dolomite as a source. The magnesium in the dolomite was first converted to $MgCl_2$, then extracted.

e. Sources of Uranium. When questioned about sources of uranium ores available to the Japanese, Gen Tada reported that the Japanese government had supported some exploratory work, but that no deposits of note had been discovered. Japan itself has no good, known source of uranium. A low-grade deposit occurs near Kaijo, Manchuria, where uranium occurs in the mineral samarskite. A partial analysis gave the following results:

$(Nb, Ta)_2O_5$	-	32.5%
UO_3	-	2.41%
UO_2	-	3.51%

In Korea, some monazite-bearing sands have been found. Exploration in Mongolia developed no sources of uranium.

f. Information on "Tokkoki" (Baka Bombs). Regarding Baka bombs (called Tokkoki by the Japanese), Gen Tada stated that from informal sources he understood that there were three types, the first two developed by the Navy, the third proposed by the Army.

Type 1: This is the usual type of Baka, carried by a large plane and equipped with rocket motors.

Type 2: A rocket-propelled plane loaded with explosive and using H_2O_2 fuel. This was experimental only.

Type 3: This was to be a rocket-launched, pilotless plane to be guided to its target by radar or other homing means. It was proposed but had not been developed.

g. Information on Heat-Homing Bomb. From private sources Gen Tada understood that work on heat-homing devices had been done by the Army at Heiki Gyosai Hombu (lit. trans., Weapons Administrative Headquarters) at Ushigome, Tokyo. He did not know any details.

2. a. Gen Tada corrected the impression that he had given in his first interview that the Board of Technology directs research work of direct interest to the Army and Navy. The original intent was for the Board of Technology to coordinate the general research program for the Army and Navy, but the latter became so strong that they took over practically all of the direction of the work.

b. The Board of Technology directed some projects concerned with general, long-term research, and from those projects received periodic progress reports. Gen Tada submitted a list of the projects supported by Bd of Tech as well as a list of funds allotted to various research laboratories. In addition, he submitted a list of industrial research projects, a list of Board of Technology prizes awarded to scientists in January 1945, and a list of similar prizes awarded by the Japanese Army in October 1944.

c. Gen Tada went on to explain that as President of the Bd of Tech he was vice president of the Scientific Mobilization Society under which his board operated. The Scientific Mobilization Society consisted of 30 members, 10 Army, 10 Navy and 10 civilians, the latter from various government offices. The Army and Navy submitted proposed researches to this society to "pass," but the right of refusal was never exercised because of the strength of the Army and Navy.

3. Gen Tada had submitted a list of 216 war research projects (attached). He explained that though this list was available to him, his Board of Technology had no part in directing most of the work, and he was not informed about the details of the results. (He, incidentally, revealed that information obtained from captured enemy equipment was not released to other organizations by the Army and Navy.) He was questioned about some of the research items of the list with the following results (numbers refer to corresponding numbers on the list):

- Item 3 - "Maneuverability of Aircraft." Gen Tada did not think that this had anything to do with suicide planes.
- Item 6 - "Rocket Planes." Probably done at Central Aeronautical Research Laboratory (under Cabinet). Researcher may have been Fujio Nakanashi.
- Item 27 - "Rocket Fuel." Army or Navy work.
- Item 71 - "Sound Deadening." (Done by "car specialist")
- Item 78 - "Increase in Low Visibility." Night vision studies. Done by Army or Navy.
- Item 85 - "Nitrogen Fixation." Done by Industrial Examination Laboratory - Ministry of Trade and Commerce.
- Item 106 - "Automatic Searchlight." Done at Electric Testing Laboratory - Board of Communications.
- Item 122 - "Measurement of high G." No information.
- Item 127 - "Airborne short wave and ultra short wave." Done at Electrical Testing Laboratory - Board of Communications.
- Item 130 - "Special Vacuum Tubes" No information.
- Item 134 - "Radio Charts." Work done at International Electric Co.
- Item 135 - "Aircraft Antenna." Elec. Testing Lab., Bd. of Communications.
- Item 136 - "Long Distance Radio." Elec. Testing Lab., Bd. of Communications.
- Item 137 - "Ions in Air." Elec. Testing Lab., Bd. of Communications.

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- Item 138 - "Effectiveness of Doppler." Done at Chemical Research Laboratory and at Osaka Imperial University.
- Item 139 - "Measurement of UHF." No information.
- Item 141 - "Alomite conductors." "Alomite" is an Al_2O_3 material used in coating wires. No further information.
- Item 144 - "Wiring for Type 4 Mk 3 Wireless." No information.
- Items 180 and 182 - "Aerial Photography." The work was done by a researcher at Tokyo Imperial University.
- Item 185 - "Position by Radio." Electric Testing Laboratory, Bd. of Communications.
- Item 197 - "Radioactive Substances." Done at Physical-Chemical Research Lab.

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SUBJECT: Interview with Dr. Tadaaki YAMAMOTO

DATE: 24 September 1945

INTERVIEWED: Dr Tadaaki YAMAMOTO

INTERVIEWERS: Major Hewlett, Moreland, Stephenson, Griggs, Longacre, Yamada.

1. Background. Yamamoto was born in 1881, graduated from Tokyo Imperial University in 1905, and went to work for the Shibaura Engineering Works. He studied in Germany in 1909, and about 1911 he went to the General Electric Company in Schenectady, New York, where he worked under Steinmetz and acted in a technical liaison capacity between the General Electric Company and the Shibaura Engineering Works (now Tokyo Shibaura Denki) which had recently become affiliated with General Electric. After about a year and a half in the United States, he returned to Japan where he gave a series of lectures at the newly-founded and privately-financed Waseda University in Tokyo. He was soon appointed to the faculty where he became professor and then dean of the Science Department. In addition to other duties, he became Director of Athletics. In March 1944 he left Waseda University to become president of the newly-formed and privately-financed (by Iwasaki Communication Apparatus Company) Kugayama Radio Technical College. The college was quite small, about 450 students, and was primarily concerned with the training of men for industry. It had no laboratories and a minimum of equipment for demonstration purposes.

2. Scientific Grants. Two sources of scientific grants were available to Waseda University.

a. Japanese Scientific Technical Committee of the Ministry of Education. This organization, headed by Dr. H. Hayashi, controlled annual grants amounting to approximately two million yen. The average grant being between 10 and 20 thousand yen. (Note: This figure does not check with other sources of information.) It was established shortly before the war. The application for these grants were made by the individuals desiring to carry on the proposed work. If approved, the grants were made to those individuals who were allowed a fairly free hand in their work. Only periodic reports to the committee were required. If ideas appeared to have military application, they were taken over by the Army or Navy, but the individual concerned was not usually taken.

b. Japan Science Promotion Society. This society, headed by Dr. Nagaoka, controlled grants amounting to approximately 200,000 yen per year, the average grant being between one and two thousand yen (see note above). The society had been established for 15 or 20 years and required strict control on all work performed under its grants. Approximately five or six grants from this society were made annually to professors at Waseda University.

c. As Waseda University was privately financed, grants from the Board of Technology or from the Scientific Mobilization Society were not available.

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3. Relation of Faculty with Military. When a faculty member became engaged in work which was of interest to the military, it was very often taken over by them and further work conducted in military laboratories. In such cases, little information was given to the individual on the ultimate use to which the research had been placed, although occasionally they did obtain such information in general terms. A certain amount of consulting service to military laboratories was carried on by professors at the university. In such cases, the professors visited the military laboratory concerned and did not carry on work at the university proper.

4. Technical Work.

a. As early as 1929, Dr. Yamamoto became interested in television and continued actively in this field until 1935. In 1931 he put on a demonstration of television about two weeks ahead of a similar demonstration put on by Alexanderson in Schenectady. Due to the expansion of the television field and the expense incident to extensive research, Dr. Yamamoto said he was unable to continue work in this field. As far as he knew, no military use had been made of television during the war.

b. Under a grant from the Japan Science Promotion Society, H. Iwagata carried on work at the Waseda University on horn antennas for use with 10-cm wave lengths, with a vacuum tube in the throat. Initial research was directed towards a transmitting antenna but was subsequently expanded to include receiving antennas. Dr. Yamamoto thought that this work had been of interest to the military.

c. Under a grant from Japan Science Promotion Society, Kawashimo of Waseda University conducted research on a acoustic noise reduction in vessels. This work was primarily directed towards the development of suitable shock mounts for engines.

5. Outside Activities.

a. Dr. Yamamoto was head of the Wartime Scientific Technical Advisory Center. This was a small organization of approximately ten men who desired to accelerate the introduction of scientific ideas to the military. It was started in February 1945. They maintained an office in Tokyo where "day workers" could submit ideas and inventions, and receive evaluation and advice on their utility. Promising ideas were brought to the attention of the military. The offices of this organization were twice bombed.

b. Dr. Yamamoto was also chairman of the board of directors of Japan-Germany-Italy Friendship Society of Tokyo. At the time of the signing of the anticomintern pact of Japan, a movement was started to promote friendship between the axis partners. This movement appeared to have initially obtained impetus in student circles, and according to Dr. Yamamoto, his close associa-

tion with student activities were responsible for his initial interest in this society. He claimed that his appointment as chairman was a surprise to him, and he knows of no particular reason for it. The society appeared to have primarily been a social organization and principally concerning itself with social functions. Dr. Yamamoto's personal friendship with the German ambassador at that time further stimulated his activities in this field. When the ambassador was changed, the new ambassador was less friendly and his interests divergent from those of Dr. Yamamoto. At this time the character of the organization changed more towards a drinking and eating group, and as Dr. Yamamoto did not believe in drink, for as he said, "he was a Christian," his interests in this society were still further lessened. There were approximately 40 or 50 Germans actively associated with the society. Most of them had been residents of Japan, China, or other parts of East Asia. As far as he knew, the society had had no contact with any German technicians that might have been sent from Germany. When pressed on this point, he suggested that the Japanese-German Co-Cultural Society might have information on any such technicians. This society, the chairman of which was a professor at Tokyo Bunrika University (Arts and Sciences), had more intimate contacts with the German colony and was considerably more exclusive in nature. Dr. Yamamoto had attempted to join this society, but had been turned down, ostensibly because of his Christianity.

c. Dr. Yamamoto's close association and interest in athletics resulted in his attending the Olympic Games at Los Angeles in an athletic-administrative capacity.

6. General Comments. Dr. Yamamoto may have had some scientific interests at one time, but he gradually trended towards administration. He appeared to have had a certain popular appeal, possibly due to his close association with athletics. He definitely does not appear to have been an important person in the scientific field. His former association with the General Electric Company and the fact that he had been Christianized may have resulted in his being denied access to important scientific information. His association with the Japan-Germany-Italy Society should be further investigated by the organization concerned with such activities.

SUBJECT : SUBSTITUTE LUBRICATING OILS
 DATE : 25 September 1945
 INTERVIEWED : Prof Yoshio TANAKA, Professor of Applied Chemistry,
 Tokyo Imperial University; Vice Chairman: Gakujitsu
 Kenkyu Kaigi "Scientific Research Council", under
 the Department of Education.
 INTERVIEWERS: Dr Howard E. SKIPPER, Dr E. L. MORELAND, Dr D. T. GRIGGS,
 Dr H. K. STEPHENSON, Tec 4 YAGI.

Dr Tanaka is Emeritus Professor of Applied Chemistry, Tokyo Imperial University, having retired from active research five years ago. He has served as a consultant on oils to the Army and Navy, but especially the Army since his retirement from the university.

The problem Dr Tanaka has been principally concerned with during the war is one of providing a lubrication oil from some source more plentiful than natural crude oil.

Fish oils and coconut oils were investigated (principle--splitting the fatty acids obtained therefrom into proper hydrocarbons using $AlCl_3$ catalyzer). This method worked well in the laboratory*in some cases but was not very successful on a production scale. The end product was not quite as good as good natural oil for lubrication purposes. They were attempting to get an oil as good as Texaco 120.

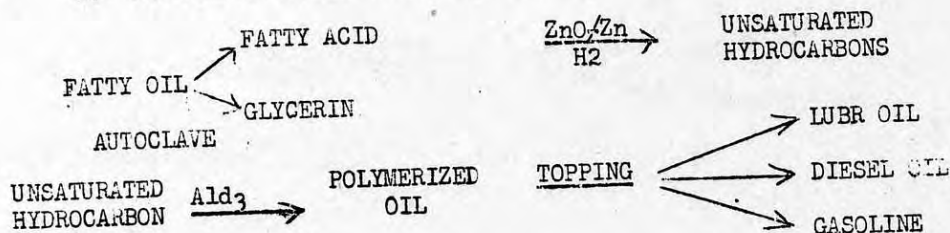
Plants** were:

- Dai Nippon Yushi Kabushiki Kaisha (this plant blew up)
- Nippon Yushi Kabushiki Kaisha, Tokyo, Dr Taiji Ohashi, Chief Investigator.
- Miyoshi Kagaku Kabushiki, Tokyo. (May have burned but new plant being set up in western Japan)

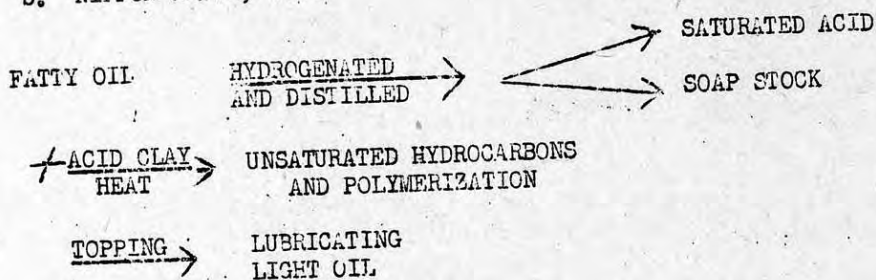
*Experimental work carried out in the Army and Navy labs.
 **For more information - Dr Yasota Kawakano, Dept of Commerce and Industry.

The following are, to the best of Prof Tanaka's knowledge, the procedures being used or to be used in the above listed plants:

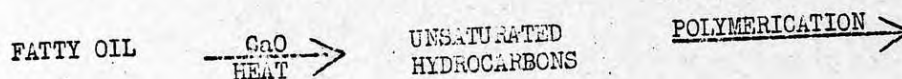
a. DAI-NIPPON YUSHI KABUSHIKI KAISHA



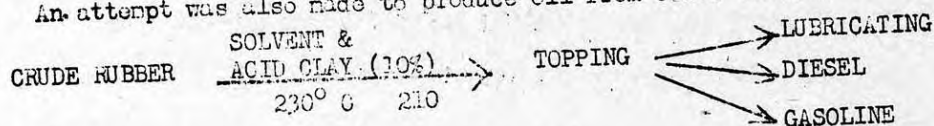
b. NIPPON-YUSHI, K. K.



c. MIYASHI, KAGAKU KABUSHIKI KAISHA



An attempt was also made to produce oil from crude rubber.



Loss extremely low in this method (approx 2%): lubricating oil - 40-50%; diesel oil and gasoline - 50-60%. This method was used on a production scale from June to December, 1944, (until rubber ran out). About 2,000-3,000 tons of crude rubber were used in this time. The oil was of a grade that could be used by automobiles but not by planes. Reclaimed rubber from tires, etc., can be used for this process but the poorer the rubber, the poorer the grade of oil obtained.

The government provided funds for the above projects, but there was apparently no connection with the Board of Technology.

Hydrogen peroxide fuel for rockets was studied in "Special Chemical Dept" under the Navy. This was carried out at the Yamakita Laboratory* (near Fuji). Information on this problem was obtained from the Germans.

Prof Tanaka claims never to have had anything to do with, or made any reports on, explosives,** nor with thickness for fuels such as are used in flame throwers.

A Department of Explosives in the Tokyo Imperial University was mentioned by Tanaka. He also stated that the Department of Applied Science, Kyoto Imperial University, was the center of study on synthetic rubber. Prof Kita was suggested as a source of information on this subject.

*Between Gotenba and Mishima.

**Prof Tanaka was reported to have given a speech at the House of Peers concerning a new explosive.

SUBJECT : Meeting with Prof Isamu YAMAMOTO, Chief Professor, Electrical Engineering Department, Tokyo University of Technology, 27 September 1945.
DATE : 25 September 1945
INTERVIEWED : Prof Isamu YAMAMOTO.
INTERVIEWERS : Dr H. K. STEPHENSON, Dr E. I. MONTLAND, Dr D. T. GREGGS, Dr A. LONGCORE, Maj W. R. HENTLETT, Lt. YAMADA.

1. Prof Yamamoto was called in place of Prof Konosuke Nakamura who, it was found, had resigned as President of the Tokyo Institute of Technology in 1942 and who had died in January 1945. Prof Nakamura had been succeeded by Dr Hidetsugu Yagi from 1942 to 1945. Dr K. Wada is the present head of Tokyo University of Technology.

2. Prof Yamamoto stated that Tokyo University of Technology had maintained its full quota of about 1,000 students throughout the war. He said that this was true generally of engineering, scientific, and medical schools in Japan, and that no interference from the Army or Navy was evident. He claimed that the faculty at U of Tech were not engaged in war research, although certain individuals might be called on consulting jobs for the Army or Navy. As examples in the Electrical Engineering Department he cited Dr I. Koga who did some quartz crystal work for the Army, and Prof K. Morita who worked for the Army on ultra-high frequency studies. Yamamoto was not sure how this work was financed.

3. Yamamoto discussed the organization of the U of Tech and gave the following information:

Electrical Engineering Department:

Chief Professor: Prof Isamu Yamamoto (Fundamental Electronics)

Other members: Dr I. Koga (Quartz Crystals)
Prof K. Morita (UHF Components)
Prof T. Otsuki (Elec Power Transmission)
Prof Y. Onoto (Elec Mach & Illumination)
Prof M. Suzuki (High Tension Elec Eng)

Other departments in the University and the Chief Professors:

Mechanical Engineering

Prof Y. Matsuike (Hydraulics)

Applied Chemistry

Prof So Uchida (Organic Chemistry)

Chemical Engineering

Prof Shunichi Uchida (Oil Distillation Plant)

(Note: Prof Uchida did some consulting work for the Navy)

Electrochemistry

Prof T. Takei (Electric furnaces)

Dye Chemistry

Prof M. Hayashi (Dye Chem)

Architecture

Prof M. Kobayashi (City Planning)

Aeronautical Engineering

Prof M. Kikuchi (Structural Design)

(Note: Prof Kikuchi "May" have consulted for aircraft manufacturers. Since the end of the war it is planned to place this entire department in the Mechanical Engineering Department.)

Fuel Engineering

Prof Y. Tanaka (Synthetic Fuels)

(Note: This department has existed only during the war. It is now planned to place it in the Applied Chemistry Department.)

Ceramic Engineering

Prof S. Yamauchi (Glass Technology)

(Note: During the war this department has done some work on dielectric materials for high frequency by Prof K. Tabata (now dead)).

Metals Engineering

Prof R. Yamada (Heat Treatment of Steel)

Textile Engineering

Prof Uchida (Textile Machinery)

Service Departments (no degrees granted)

PHYSICS
MATHEMATICS

Prof Z. Oishi (Theoretical Physics)
Prof Masaoichi Watanabe (Theory of Functions)

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ORGANIC CHEMISTRY
INORGANIC CHEMISTRY
PHYSICAL CHEMISTRY

Prof Toshio Hoshino (Synthetic Rubber)
Prof Tama Nemura (Spectro-Analysts)
Prof Mikio Tamura

4. Regarding his own work, Prof Yanamoto explained that during the past three years he has been engaged in high frequency measurements, especially the measurement of field strengths at wave lengths between 10 meters and 100 meters. Voltage differences were measured between condenser plates by means of the period of oscillation of a conductor on a tension suspension between the plates. Minimum voltage difference measurable was about 1000V. Current was measured by the brilliance of a lamp in series with one of the condenser plates. This technique was satisfactory for frequencies up to 30 M.C.

The object of the above measurements was to study the "physical and chemical reactions" of ultra high frequency fields, in an attempt to put diathermy on a scientific basis. Yanamoto explained that he had become interested in diathermy about seven years ago when he attended a meeting of "International Radio Science" in the United States. The research in his laboratory was conducted without medical assistance, because he "had no connections in the medical field." The physiological effects of the high frequency fields were tested by one of the laboratory workers placing his hand between the plates of the condenser. The effect was described as "comfortable", "uncomfortable" or "intolerable". This work was supported by University funds, and Yanamoto disclaimed any tie-up with or interest on the part of the Army.

5. Prof Yanamoto was asked what he knew about the development of a "death ray" in Japan. At first, he denied any knowledge of such a development, then admitted that he had heard of it "about two years ago." He had "forgotten" how he heard of it and did not remember the names of any persons with whom he had talked about it. He had heard that experiments had been performed on the effect of high frequency waves on small animals. He believed that work on this development was done at the Army Research Institute at Naborito (A Tokyo suburb). He had heard that this institute was recently shifted to Nagano prefecture.

SUBJECT : Conference with Dr K. HONDA, President of Metallic Materials Research Institute at Sendai, formerly President of Tohoku Imperial University, Sendai.
DATE : 27 September 1945.
INTERVIEWED : Dr K. HONDA.
INTERVIEWERS : Dr E. L. MORELAND, Drs LONGACRE, STEPHENSON, GRIGGS (part time.)

1. The Metallic Materials Research Institute at Sendai was organized by Dr K. Honda (who is probably the world's outstanding authority on magnetic steels and one of the foremost authorities on all types of steel).

The personnel of the laboratory consists of the following full-time employees:

15 Senior Scientists
27 Junior Scientists
80 Assistants and Technicians

Dr Honda is 75 years old and does not look physically strong but his mental vigor is still unimpaired.

2. The financial support of the Institute comes from grants from:

- a. Japanese Scientific Technical Committee of the Ministry of Education. (Dr H Hyashi, Head; Dr Kinoshita, member of Committee)
- b. Japanese Science Promotion Society. (Dr Nagaoka Head)
- c. Direct grants from the Imperial Government (400,000 yen this year).

3. The workshop and the chemical analysis building were destroyed by fire (bombing) but are now being rebuilt. Otherwise the Institute is intact.

4. The major fields of activity of the Institute and the Chief Investigator in charge are as indicated below:

a. Magnet Steels	Dr K. Honda
b. Stainless Steels	Dr H. Endo
c. Armor Plate	Dr. Naoyki Watanabe
d. Light Alloys for Airplane Construction	Dr I. Obinata (Duraluminum type, slightly modified)
e. Powder Metallurgy	Dr Okamura
f. Special Steels	Dr T. Murakami, head resisting steels. (Did not work on Carboloy which is made by Tokyo Shibaura and called Tungaloy.)

- g. Tool Steels and Hard Steels
- h. Heat Treatment of Steels

Dr R. Osawa
Dr S. Takeuchi

5. General Information.

- a. No work was being done on armor-piercing shells.
- b. Work was being done on soft iron for shell cases and on powdered, low-carbon steel for wearing bands on artillery shells, following German methods, but only the experimental stage had been reached.
- c. Dr Honda had no direct contact with the Germans and he does not know of any German scientists coming to Japan during the war. All of his information as to German procedures was gleaned from abstracts of German scientific publications.
- d. Apparently the activity of the Institute during the war years was largely along normal research lines and relatively little effort was related to direct war work.
- e. The volume of work done during the war years was about the same as before the war.
- f. Dr Honda expressed the opinion that the addition of zirconium to steel would not increase its strength by more than one per cent or so and was not worthwhile. (Compare greater enthusiasm of Lt Gen TADA, President of the Board of Technology.)

6. Conclusions. No information was secured of anything strikingly new, but in view of the outstanding ability of Dr Honda and the magnitude of the research organization he has at work at the Institute, it would seem to be worthwhile for the Ordnance Department to send an expert metallurgist, familiar with ordnance equipment, to Sendai to visit the Institute and get first hand information. Dr Honda said he would welcome such a visit.

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SUBJECT: Interview with Sumitomo Tsushin Co. Representatives
DATE: 29 September 1945
INTERVIEWED: From Sumitomo Co.: Dr Kaji, Pres; Dr Niwa,
Chief Engr; Dr Kobayashi, Asst Chief Engr;
Mr Hirata, Legal Dept
INTERVIEWERS: Drs Longacre, Moreland, Griggs, Maj Hewlett

Physical organization of the Company: The main office is at Mita. This was the principal prewar plant. This contains the office of the president, the managing director, the assistant managing director, the departments of administration, finance, sales, and materials. There are five principal plants:

a. Mita Plant. About 5,000 employees. It was practically undamaged by bombs. Here they manufactured radio direction finders, the ground sets, air-ground communication systems, and telephone and telegraph instruments.

b. Tamagawa Plant. This was also a prewar plant. In its peak it employed about 12,000. About one-half of this plant was damaged by American bombs. They constructed vacuum tubes, radar sets, acoustic devices for submarines, large transmitters and corresponding receivers, telephone and telegraphic carrier systems, public address systems and some portable carrier equipment for the services.

c. Osaki Plant. This plant took over from the Tamagawa Plant, radar systems. It also constructed carrier systems of different types from those of Tamagawa as well as taking on some of those of Tamagawa. About 2,500 employees. About 2,500 employees. The dormitory was only partially destroyed by bombs.

d. Otsu Plant. Here they manufactured electrical meters, measuring instruments, super-sonic equipment, and had a small glass manufacturing plant. They had about 2,000 employees and there was no damage to it from American bombs.

e. Okayama Plant. Here they built and manufactured radio direction finders for airplanes and made an attempt to produce manual switchboards. They had 2,000 employees. It was totally destroyed by bombs.

f. Takasaki Plant. This was a subsidiary plant devoted to the production of tungsten filaments, getters for vacuum tubes and fluorescent materials. They employed about 500. It was not damaged by American bombs.

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The total employment of Sumitomo Co. reached about 22,000 at a peak of which between six and seven thousand were nominally paid transient students who worked for short periods at a time. The remaining 15,000 were regular employees.

The research laboratory is known as the Ikuta Laboratory, and is located near Noborita. Dr Niwa is director of this laboratory. It has about 800 employees, of which 400 are engineers, 300 technicians, 100 clerks. It did not suffer any damage from bombs. The work was organized into three parts:

- a. Fundamental researchers
- b. Systems development
- c. Materials

During the war the principal efforts of the fundamental researchers section were directed toward vacuum tubes. In this line they put their primary effort on high frequency triodes. They preferred these to magnetrons because of (1) their lighter weight; (2) the variability of the wave length; (3) the difficulty of making magnetrons to precisely fixed wave lengths. They were about to develop 12 cm triodes giving 1 kw peak output. For shorter wave lengths they found it necessary to go to magnetrons. Furthermore, the Navy insisted on magnetrons for both transmitters and local oscillators. The principal high-power tubes of the shorter wave lengths which they developed are as follows:

- 4 m 50 kw pulse triode.....was in mass production
- 4 m 50 kw CW triode.....experimental
- 4 m 300 kw peak triode.....experimental
- 80 cm 10 kw pulse triode.....was in mass production
- 40 cm 10 watt CW.....was in mass production for Army
- 30 cm 1 kw peak triode.....experimental
- 10 cm 1 kw peak magnetron.....experimental
- 5 cm 1 kw peak magnetron.....experimental

The Sumitomo Co. did not go into production on any of the magnetrons since the services seemed to prefer to buy from Nippon Musen. They took up and worked on magnetrons on their own initiative, starting with a 10 cm 1 kw and changing to a 5 cm 1 kw tube. The latter had 16 equal diameter cavities. With this tube they experimented with both glass and metal envelopes. Sumitomo believed in a velocity modulated tube for short wave length local oscillators and despite the navy's insisting upon magnetrons for this use they were proceeding to develop a manufacturable tube for as short as 3 cm.

The principal elements of this tube were in a glass envelope. In general, glass envelopes were preferred because of the shortage of suitable welders and critical metals for the metal cases. The Navy showed considerable interest in this 3 cm velocity modulated tube, but the war ended before any orders were placed. The remaining work of this section was considered secondary but some effort was put upon crystal detectors, infrared-ray image tubes, photocells, electronic emission and secondary emission amplifiers. It was in this section that Sumitomo developed a short cathode ray tube. The systems development section worked on receivers, indicators, and complete systems.

Sumitomo produced a 40 cm 3-channel communications set of which there was some model shop production and they were about ready to put it into mass production when the war ended. They also had a 12-channel communications set in the works. It depended for operation on a FM modulated RF carrier and amplitude modulated (double side band) subcarriers for the operating channels. It was not possible to place this set directly in carrier telephone circuits as is the case with U.S. equipment, but required that the individual channels be brought down to separate voice channels. A terminal weighed about 180 kg and was packed in three boxes.

Sumitomo developed and produced the following radars for the armed forces: For the Army, a 4 m early warning set, a 1.5 m gun-laying set, and a 4 m gun-laying set which replaced the former. For the Navy, they developed and produced a 3 m early warning set and a 1.5 m gun-laying set and a 1.5 m searchlight laying set. The systems development section was just beginning to work on radar sets of shorter wave lengths. The 1.5 m gun-laying sets developed for the Army and Navy were different sets.

The materials section worked on fluorescent materials, substitutes for nickel and molybdenum, insulators, steatites, and paints, and colloid graphite.

As a rule they had sufficient tantalum and nickel for most of their war-time productions. However, they had developed a chromium-iron alloy which would be a suitable cathode material and possibly superior to nickel.

The total tube business of Sumitomo was about two million yen per month, prewar, and gradually increased during the war to a peak of ten million yen per month. It was interesting to learn that in the early phase of the war there seemed to be no premonition that vacuum tubes were

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going to be in such demand as to strain their manufacturing facilities and hence, while materials and labor were available they did not prepare for the eventual load.

The Company did no work on IFF, Jammers, search sets for detecting our use of radar, or on proximity fuses. It also had done no work on vacuum tubes to withstand high linear or centrifical acceleration, nor had either the Army or Navy ever asked that such developments should be undertaken.

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SUBJECT: Interview with Dr Daitaro ARAKAWA.

DATE: 31 September 1945.

INTERVIEWERS: Drs Longacre, Moreland, Griggs, Maj Hewlett.

1. In November, 1941, Dr Arakawa left the Ministry of Communications and went to the Marine Radio Co. On 15 May 1943, he left the Marine Radio Co to become the managing director of the Japanese Broadcasting Co.

2. During the war the Marine Radio Co worked primarily to standardize the wireless, telegraph, and telephone communications for non-military shipping. They developed five sets, ranging from 10 watts to 500 watts. The 500-watt set was telegraph only and was used for the larger ships. Most of these sets worked on the international 500 kc call frequency; the fishing boats worked on 1350 kc. Another set was built to work between 8 and 6 megacycles having at least 5 frequency channels, of which some were crystal-controlled.

3. During the war Dr Arakawa's association with the Japanese Broadcasting Co was primarily concerned with the construction of broadcasting and relay stations. No production was allowed for this purpose and so they had to set up their own manufacturing organization and build their own equipment. Relay was usually done by telephone line although some was done by radio at 40 megacycles.

4. Recently Dr Arakawa became head of the Technical Laboratory of the Japanese Broadcasting Station. Dr Minohara had been chief of this laboratory during the war but had to retire because of ill health. Dr G Hara acts as Dr Arakawa's aid. This laboratory has four divisions: (1) the first being devoted to television; (2) ultra-short waves; (3) acoustical problems of broadcasting; (4) a model shop.

5. The television section of the technical laboratory worked on the developing system for broadcasting between 70 and 40 megacycles. They tried both amplitude and frequency modulation; for the main part they used amplitude modulation. They were also working on a television relay at about 70 centimeters. The transmitting tube for this was a peaked oscillation triode. Dr K Takayanagi is director of the Television Section.

6. Dr G Hara is director of the Ultra Short Wave Section. The section worked on the application of centimeter waves to television only because high-frequency communications were considered the exclusive right of the International Communications Broadcasting Co. In the work on centimeter waves they developed a velocity modulated tube for between 8 to 10 centimeters. This tube was considered suitable for receiving purposes but did not have enough power for transmission. They developed a CW magnetron. They found that there was an approximate relation between the power available for a CW magnetron and the wave length, the number of centimeters wave length being approximately equal to the number of watts output. This work was all done in one room and at no time did they get to developing a system of modulating the centimeter waves. The location of this part of the laboratory is Kamata Machi, Satagaya-Ku.

7. In the early part of their work on centimeter waves they used Dr Okabe as a consultant. More recently they have used Dr K Morita and Dr Hahaisi as consultants.

8. The acoustics division was under Mr S Takamura who concerned itself principally with the design of broadcasting studios and the pickup apparatus.

9. It is to be noted that during the war the Japanese Broadcasting Co did no military work whatsoever and lost many of their engineers to the services; the few that were left were also used by the services as consultants so that the laboratory got no use from them.

SUBJECT: Dr. Ryoto Mitsuda

DATE: 2 October 1945

INTERVIEWED: Dr. Ryoto Mitsuda

INTERVIEWERS: Dr. E. L. Moreland (others part-time only)

- Dr Mitsuda was shown on our advance records as having served with the
- (1) Electrotechnical Laboratory (Denkisikenjo) of the Ministry of Communications;
 - (2) Prof. of Electrical Power Transmission and Distribution at Waseda University;
 - (3) Director of Waseda University; (4) Imperial Household Dept of Engineering.

The interview brought out the facts that:

a. He is now retired from all activities except that of Honorary Lecturer at Waseda University.

b. His field of activity was exclusively in connection with electric power, generation, distribution, utilization.

c. The Ministry of Communications has supervision of electric power rates and standards.

d. Dr Mitsuda's work for the Ministry of Communications was on standards for electric service, inspecting and testing of meters, etc.

e. He has no qualifications for research work in the Electrotechnical Laboratory.

f. His work as Imperial Household Department Engineer was in 1940 in connection with revamping the electrical wiring and installations in the Imperial establishment.

g. No increase in power developments or in transmission facilities was undertaken during the war. In general, there was sufficient electrical power to meet war demands. Where there was any shortage it was met by curtailing non-essential uses of power.

h. Dr Mitsuda's activities and knowledge had no bearing on war developments.

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SUBJECT: Dr. Koroku WADA

PLACE: Dai Itchi Sogo.

DATE: 4 October 1945.

INTERVIEWED: Dr. Koroku WADA (accompanied by Dr. Ikihara, M.I.T. Graduate).

INTERVIEWERS: Dr. A. Longacre, Dr. E. L. Moreland, Dr. D. T. Griggs,
Major W. R. Hewlett.

1. Dr. Wada was a member of the Faculty of Engineering of Tokyo Imperial University and for sometime a member and later director of the Aeronautical Research Institute of that University. His scientific career was devoted to the theoretical aspects of fluid flow at high velocities. During the war he did no aerodynamics for the military services. In recent years his work turned to administration.

2. Dr. Wada gave the following names as those men with detailed knowledge on aerodynamic problems:

a. Prof. Ichiro TASSI, Tokyo Imperial University. High speed aerodynamics following the boundary theory of Van Karmen.

b. Prof. S. KAWADA, Tokyo Imperial University, has a high speed multi stage axial flow wind tunnel with 30-40 cm throat. Specialized in propeller tip turbulence.

c. Prof. Ryozo FUKATSU, Tokyo Imperial University. General aerodynamics.

d. Prof. Fujio NAKANISHI, Tokyo Imperial University. Thermodynamics, jet propulsion.

3. When asked about the Tokkoki (Iakka bombs), he said some of the above mentioned men may have worked on it but he did not know so.

4. For about 15 years the Ministry of Education had an Aeronautical Council known as Koku Shyogi-Kai with the Minister as chairman. The director of the Aeronautical Research Institute of Tokyo Imperial University was usually an important member of the Koku Shyogi-Kai. Dr. Wada occupied this position. The rest of the membership was made up of University men, and Army and Navy. There were no industrial representatives. The work of this council was principally concerned with standardization of fabricating materials and shapes and experimental measurements. It had no power to enforce the recommended standards. Further, despite the Army and Navy representation it was not informed regarding the services' aeronautical developments. Thus its work was concentrated on commercial and civilian aeronautics.

5. In 1942 the Aeronautical Council was divorced from the Ministry of Education and was amalgamated with the Cabinet Scientific Council and the Inventions Promotion Council to form the Scientific Engineering Council, "Kagaku Gijutsu Shingi-Kai", which in turn became a bureau of the

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Board of Technology "Gijutsuin". As such it was supported by Gijutsuin funds. The Kagaku Gijutsu Shingi-kai served as a standing board of consultants for the ministries but did not support or undertake any researches.

6. Dr. Wada was vice chairman of the Board of Technology "Gijutsuin" from its start on 31 January 1942 until 5 December 1944. This organization is described in a separate report.

7. Dr. Wada was also a member of the National Research Council, "Gakujutsu Kenkyu Kaiji" of the Ministry of Education. This organization is also described in a separate report.

8. As an example of how the services kept all research problems and developments of any tactical application in their own hands, Dr. Wada cited the case of Dr. S. Kikuchi, a nuclear physicist, who joined the Naval research programs and essentially left the university save for a few lectures. He assumed Dr. Kikuchi worked on magnetrons.

ELECTRO TECHNICAL LABORATORY OF THE MINISTRY OF
TRANSPORTATION AND COMMUNICATION

DATE : 5 October 1945.
JAPANESE PRESENT: Dr Yoshida CHASHI (retired as Director, 3 Oct 45),
Dr Saburo KOMAGATA (successor); Engineer Sen NISHIYAMA.
INTERVIEWERS : Maj W. R. HENNING, Drs MORELAND and CRIGGS.

1. For the history, organization, projects and brief description of principal fields of research of this laboratory see report submitted by Dr CHASHI, Incl #1.

2. With reference to the section of this report dealing with research, the following information was obtained:

a. Dr Chashi before the war recognized that the advantages to be gained by the use of teletypewriters was great both from the standpoint of security and from the standpoint of speed transmission. His original work was directed toward the development of a teletypewriter system for use over wire circuits. The system devised contained fifty characters and used a six mark code, plus stop and start marks. Limited security features were incorporated. This system was demonstrated to the army. Dr Chashi then turned his efforts to the application of teletypewriters to radio circuits. For this purpose the same general system was used with the exception that each letter code group was transmitted twice with the time interval between variable in accordance with static conditions. The principal problem anticipated was synchronism between transmitting and receiving terminals although the system itself was only semi-synchronous. His work was confined to the teletypewriter phase of the problem alone and did not include methods for the actual radio transmission or reception. A more detailed report on this project and associated security system was requested and will be furnished in the near future.

b. Prior to the war the laboratory had initiated a project to improve the operation of communication equipment under conditions of high temperature and humidity. As during the war the army and navy had not shown any interest in this project all work had been discontinued. The principal findings, however, had been:

- (1) The elimination of all fiber board.
- (2) Application of suitable moisture proofing compounds to the exposed edges of all laminar bakelites and fibers.
- (3) Improved precautions in soldering.
- (4) More adequate specifications for the testing of components under conditions of high temperature and humidity.

It had been planned to obtain representative samples of fungi from tropical regions to study their effect on communication equipment and to develop suitable fungicides therefor. No work had been done toward protecting transformers and chassis other than specifying a liberal margin of safety.

c. The principal activities of this laboratory in the field of carrier telephone had been on the theoretical side and have not involved the actual construction of equipment. However, in 1944 the army asked that they furnish consulting service on proposed field telephone carrier system. Dr Chashi stated that he would attempt to furnish the names of the principal manufacturers involved in this project.

d. For about 30 years a laboratory had been maintained at Hiraiso in Ibaraki prefecture near the town of Mito for the study of radio propagation. Work at this laboratory had been principally directed towards ionospheric measurements, as far as was known no work had been done on tropospheric propagation or on propagation at wave lengths of less than 1 meter. Dr. E. Yokoyama and Dr. Mayeda now with the Ministry of Education had been previously associated with this laboratory. The present director is Dr T. Kono.

e. The laboratory was also working on means for radio navigation. This work was carried on at Yabuchi Branch of the laboratory near Kofu, approximately two hours from Tokyo. The director of this laboratory and principal investigator was Dr M. Okada. No accurate details of the work of this laboratory were known by Dr Chashi or his associates. The only information that he could furnish was that the system (Dr Okada's) was considered quite effective by the Japanese. Arrangements will be made at a later date to interview Dr Okada.

f. The laboratory was also engaged in a small program for the development of vacuum tubes. This work was carried on at the Jindai branch just outside Tokyo. Mr A. Seimiya is head of this group. This branch had been carrying on development work on magnetrons for wave lengths of 10 cm or less on velocity-modulated tubes on co-planer triodes for operation at centimeter wave lengths. No direct contacts between this branch and the military were maintained except for certain routine testing of tubes.

g. In addition to the above items, several other points of information were obtained.

(1) In the course of an investigation of the corrosion of buried cables, the laboratory had become interested in electro-potential means of geophysical prospecting. Dr Iwasa was the inventor of this system and resigned from the laboratory to exploit his invention. The Denka Tanko Kyokai (Electrical Prospecting Company) of Tokyo was formed with Dr Iwasa as head. Information on the exact backers of this company and its methods of operation were not obtained although it was stated that it had now gone out of business.

(2) S. Matsumura had been engaged in research directed towards the development of highly stable, frequency determining circuits, not depending on crystals. About 1941 this work had been discontinued. Matsumura had also done some work on quartz crystals.

3. The following additional projects not covered in Inclosure #1 were also discovered.

a. The list of projects of the Board of Technology showed Dr Ohashi as principal investigator on a project entitled "The Use of Wireless Over Long Distances." When questioned about this project, Dr Ohashi disclaimed any knowledge of it, but on pressing the subject, he volunteered that this project might have covered his work on telemetering. This work, begun during the war, apparently had been instigated at the request of the army and technical contact with Dr Ohashi's work was maintained by the Fourth Military Service Laboratory for Air. Work on the project had fallen into two basic groups, that of the remote reading of instruments and the transmission of the data by radio, and the remote control of ships or planes. The same general principle was used in each case. This principle involved an amplitude modulated radio frequency carrier with frequency-modulated subcarriers. As many as ten simultaneous controls could be operated by the use of ten subcarrier channels. Or where speed was not a factor and simplicity of operation was, information for the ten controls could be transmitted by the use of a single frequency-modulated subcarrier channel and a time-division scheme. The receiver control for each subcarrier channel for either of the above cases consisted of an automatic following frequency bridge. Owing to the use of the frequency modulation principle, it was possible to transmit continuous control data rather than mere off-on data. Special meters were required for the telemetering application. These meters were so constructed that movement of the needle caused a change in the subcarrier frequency. Dr Ohashi claimed to have received a little support from the Army on this project and had never been able to get a plane assigned to him for test purposes. He had, however, installed an operating system in a small model boat and successfully controlled the boat.

b. The list of projects of the Board of Technology indicated Dr Aoki of the laboratory as principal investigator on a project entitled "Ions on the Air". Dr Aoki had originally become interested in this problem while studying the high voltage breakdown conditions. During the war Dr Aoki had continued his work on ions in the air, particularly for meteorological purposes, i. e., the correlation of weather to the ratio of positive and negative ions. This project had been sponsored directly by the Board of Technology and apparently was not a military backed project.

4. The Electro-Technical Laboratory appeared to have maintained an important electronic research laboratory with many of the projects having military importance. It will be necessary to further investigate their work in the fields of teletypewriter transmission, radio propagation, vacuum tubes, radio aids to navigation, and radio remote control. Some additional information on these projects will be submitted in report form by Dr Ohashi. In accordance with the order from the Supreme Commander for the Allied Powers, the laboratory is preparing a complete list of their research projects. This list should be carefully scrutinized, and if necessary special projects investigated.

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Incl 1

(From Dr K Ohashi,
5 October 1945)

THE ELECTROTECHNICAL LABORATORY

I. History

The Electrotechnical Laboratory was established in 1891, one year after the opening of the telephone service in Japan. Its purpose was to test various equipment for use in electrical communications.

In 1893 the duties of the Laboratory were extended to inspection connected with the issuing of permits for electrical enterprises.

When the World Conference on International Electrical Standards took up the problem of electrical units in 1908, the Electrotechnical Laboratory was appointed to maintain the standards for Japan.

In 1910 the electric power companies began employing the metering system, and the Laboratory started the official certification tests of watt-hour meters.

Upon request of the Welfare Ministry in 1937, the certification of X-ray dosage meters was also added to the Laboratory's duties.

The forementioned duties have given rise to an ever-increasing number of research problems which now occupy a considerable part of the Laboratory's work.

II. Organization

Because electrical communications and power enterprises were placed under the administration of the Ministry of Communications, the Electrotechnical Laboratory, which was a part of this Ministry, grew with these enterprises and came directly under the administration of the Communications Minister. During a number of governmental changes the Laboratory remained intact. Especially in the change of November, 1943, when the Ministry of Communications was dissolved and two new ministries were formed (The Munitions Ministry and the Transportation and Communications Ministry), resulting in the administration of electric power by one ministry (Munitions) and communications by the other, the Laboratory still maintained both fields, and in view of its history and the nature of its test and research organization, it was placed under the administration of the Transportation and Communications Ministry. At present it is connected with the Board of Communications.

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Incl 1

Laboratory organization in 1944: Under the Director there were the following two departments, seven sections, a shop, and seven branches.

Department of General Affairs

Cooperative Department

Shop

First Section	(Electrical standards, measurements)
Second Section	(Wired communications)
Third Section	(Power generation and transmission)
Fourth Section	(Radio communication, r.f. measurements)
Fifth Section	(Electrochemistry, electrical materials)
Sixth Section	(Electric power applications)
Seventh Section	(Electronic tubes)

Of the branches, the one at Hiraiso engaged in observations and research on radio-wave propagation. The other six (at Osaka, Nagoya, Hiroshima, Fukuoka, Fukushima, and Sapporo) and the headquarters in Tokyo were engaged in the certification of meters for electric power.

Organization since May, 1945: The increased severity of air raids on Japan Proper necessitated the evacuation of research equipment from Tokyo. Laboratories were located at four places (Fukui, Iida, Aizu-Wakamatsu and Yamanashi) and the Laboratory was reorganized so that under the Director there were the four evacuated laboratories, the former seven branches (unchanged), and the following one department and six sections (in Tokyo).

General Affairs Department (Personnel and Treasury)

General Duties Section
Basic Electricity Section
Communications Section
Power Applications Section
Materials Section
Electronic Tubes Section

The Laboratory sustained severe damages in the air raids during May, and only a very small part of the equipment in Tokyo remains.

III. Personnel and Expenses.

The expenses of the Laboratory can be roughly divided into the following three groups.

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Incl 1

(1) Expenses for testing communication equipment	¥ 2,306,904
(2) Expenses for testing electricity meters	520,000
(3) Expenses for technological research in communications and power	<u>2,078,634</u>
TOTAL	¥ 4,905,538

The official personnel, including those at the branches and evacuated laboratories, is as follows.

Engineers	83
Assistant engineers	279
Secretary	1
Clerks	<u>44</u>
TOTAL	407

In addition to the above there are a number of assistants and apprentices. When these are included, the entire personnel is about 1,500. This number will increase somewhat when all who have been called into military service return after demobilization.

IV. Routine Duties.

A large portion of the duties of the Laboratory consists in testing various communication equipment purchased by the Communications Board. Because of the wide variety of equipment and materials handled in these tests, it is difficult to give a brief but clear statistical picture of the scope of these duties. A general outline of the number of cases of tests is shown in the following table:

Fiscal Year	Measuring Instruments (Sec 1)	Telephone & Telegraph Equipment (Sec 2)	Radio, Telephone & Telegraph Equipment (Sec 4)	Communication Materials & Batteries (Sec 5)	Power Devices for Communications (Sec 3 & 6)	Total
	Cases	Cases	Cases	Cases	Cases	
1937	2,061	7,957	1,576	3,335	1,810	16,739
1938	1,811	5,494	1,576	3,047	1,709	13,691
1939	2,191	5,112	1,805	2,085	9,017	20,210
1940	2,796	5,222	1,284	2,850	6,039	18,191
1941	1,900	3,144	763	2,353	5,329	13,489

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Watt-hour meters, which are agents for the buying and selling of electric power, must be tested and certified for accuracy every five years by law (every seven years in wartime). Under the responsibility of the Electrotechnical Laboratory, the government and several civilian organizations undertake this task;

Meters handled by the Electrotechnical Lab.	512,624
Meters handled by civilian laboratories	658,660
TOTAL	1,171,284

The applicant pays a fee of 4 yen per meter to the Finance Ministry, except in the case of special tests or meters of exceptionally large capacity. The Electrotechnical Laboratory receives through the Communications Board a sum of about 520,000 yen from the Finance Ministry as expenses for tests that it carries out. This work of certification is undertaken at the Laboratory headquarters and six branches excluding Hiraiso.

Although the foregoing routine was reduced somewhat after the start of the war in the Pacific, approximately the same funds were necessary for continuing the work of the Laboratory.

V. The Maintenance and Use of Standards.

Like the U.S. Bureau of Standards, the Electrotechnical Laboratory has custody of the electrical standards and maintains them for Japan. The absolute measurement and international comparison of these standards have been carried out recently. A world conference for employing absolute electrical units internationally was scheduled for 1941. Japan's delegates were on their way to Europe when war broke out, causing them to abandon the trip.

Research for the development of frequency standards has been conducted for many years, and the work of maintaining the standard was transferred to the Radio Wave Bureau of the Communications Board. Fundamental research in this subject is being continued.

The photometric standard and telephone standard have also been maintained at the Laboratory in connection with the duties and routine work in each field.

VI. Investigations for the Establishment of Standard Specifications.

The work of standardizing specifications was placed under the control of the Technological Board. The preparation of

specifications in the electrical field, however, has been greatly aided by the Electrotechnical Laboratory, and many specialists are engaged in investigations for this work.

VII. Researches.

A glance at the organization of the Laboratory will give a view of the types of research work undertaken. They can be roughly divided into the following four major groups.

- (a) Researches on standards.
- (b) Researches arising from duties in electrical communications.
- (c) Researches connected with power enterprises.
- (d) Researches on the applications of electricity to industries and civilian life.

The contents of these researches therefore extend over the entire field of electrical science. It has always been a difficulty with the Laboratory that the research personnel has been far too small for the great number of projects that must be undertaken.

The Director's opinion on the above four major groups of research is as follows.

(a) Standards for the fundamental units are believed to be maintained at the same high level as those of the United States, England, and Germany. The frequency and telephone standards are far below the highest world level. The radio-metric and photometric standards have also been compared internationally and have proven to be quite high in technical excellency.

(b) Researches in communications have been planned by taking into consideration the various conditions particular to Japan. It has been only during the last fifteen years that researches in this field have made any considerable progress.

1. Both American and German types of technology have been imported, and it is necessary to adjust these two types to suit the conditions in Japan. Automatic exchanges and various measuring instruments for communications are predominant examples.
2. Telegraphy was originally patterned after the G.F.O. system in England. But with the advent

of the teletypewriter and carrier communication systems in the more recent years, the trend has been towards American technology. Problems unique to Japan are those of the teletype system in the Japanese language and a telegraph system combining both Japanese and Western languages. The Japanese teletypewriter has passed the first stage of development but there are many problems still remaining to be solved. The problem of a teletype system combining both Japanese and Western characters is still unsolved. In this connection, research on facsimile transmission has resulted in one system that has been put into partial service.

3. Communication materials in Japan have required special study owing to moisture and other unfavorable weather conditions. Also the traffic load has been so great as to overwork each device, and studies must be conducted to relieve this condition.

4. The inherent skill of the Japanese people has made possible the manufacture of telephone cables of very high quality. This has significance in the development of cable carrier systems.

5. Research has been carried out on telephone technology in the Japanese language.

6. The propagation of radio waves is being studied with special reference to the geological conditions of Japan.

7. Research has been conducted to obtain reliable guiding systems for ships and airplanes navigating near and in Japan, where the complex nature of mountains and coastline cause very unfavorable conditions of air currents, shoals, and sea currents.

8. Research in materials and parts for use in communication equipment, including vacuum tubes, must be given special attention from the standpoint of resources available within Japan.

9. Measures must be taken to compensate for the shortage of such special materials as quartz crystals.

The above projects in communication research were motivated by the various special conditions in Japan and have resulted in a fair degree of progress. However, a frank evaluation of the results show that in general this progress is considerably lower than the standard attained in the United States or Germany.

(c) Research in connection with power enterprises:

1. A research project showing exceptional advancement in Japan is the prevention of induction between heavy- and weak-current circuits. Another is the prevention of buried telephone-cable corrosion due to leakage currents from tram rails. This problem being extremely serious because of ground conditions in Japan, special efforts have been devoted to its solution. It is believed that this field of research has advanced to the highest world level.

2. Lightning arrestors have received a great deal of attention, with the aim of protecting transmission lines, because Japan's territory is exposed to a particularly large number of lightning strikes.

3. Research in long-distance power transmission has also been undertaken.

The power companies of Japan have thus far remained geographically separated with practically no research laboratory of consequence. It has thus rested upon the Electrotechnical Laboratory to devote a part of its facilities to research and tests in this field as the only institution of this kind in the country. The Laboratory has aided in the technical advancement of manufacturers of electrical machinery and has acted as a go-between for the application of technical developments to practical service.

(d) Researches in the application of electricity to industries and civilian life:

1. Japan, with her shortage of natural resources, has paid special attention to the use of electric and magnetic phenomena for prospecting ores. The Electrotechnical Laboratory has continued research in this subject.

2. Electrochemical methods of making food products is a project still in its primary stage.

3. Electrical production of salt is being studied.

4. Another important project is the electrification of farms.

VIII. Wartime Activities.

The Electrotechnical Laboratory is an all-embracing insti-

tution of test and research in electricity. Having studied a wide variety of theoretical and practical problems in both the weak- and heavy-current branches of electrical engineering, it possessed a considerable number of research projects that were of value in military fields of research. The army and navy consulted members of the Laboratory on various problems such as special amplifiers, radio-frequency measuring instruments, high-altitude flying, and high-frequency materials. Data and technical advice were supplied and special experiments and tests carried out, as requested, to produce the required information.

IX. Conclusion.

The termination of the war has left to Japan only one natural resource of comparatively large quantity: The heavy rainfall over an exceptionally mountainous land is an abundant source of electricity.

In order to sustain the subsistence level of the people and enhance their daily lives, it is imperative that every branch of electrical science be thoroughly utilized. While the war saw the Electrotechnical Laboratory pushing its projects with doubled energy in response to the nation's call for science's reinforcements, peace finds the Laboratory faced with tasks of even greater scope and urgency. Communication enterprises, which originally motivated the founding of the Laboratory, will now present problems of technical improvement that are greatly intensified and modified by the need for rapid reconstruction. The generation, transmission, and distribution of electric power will be keyed to the development of agriculture, civilian industries, and home appliances, and new problems must be solved to attain the maximum of efficiency and economy under the changed conditions. Electrochemistry must be applied to the manufacture of fertilizers, the improvement of sanitation, and the development of other essential phases of modern life. Farms will depend on electric power to relieve the shortage of gasoline. The use of electricity in agriculture is vital to obtaining the best and largest yield from an extremely limited land area. Accompanying this situation is also the need for food preservation in which electrical methods show great promise. In order to conduct these tests and researches properly and maintain a uniformly high level of quality in the practical applications, it is necessary to develop and apply suitable measuring instruments and maintain the fundamental electrical standards to which the measurements can be referred. In all of these tasks and in many others that readily suggest themselves, the mission of the Electrotechnical Laboratory will be more important than before.

(JAPANESE PREPARED)
ON THE METHOD TO KEEP SECRET IN TELEPRINTER

INCL 2

BY

TAKEJI ISHIKAWA & MASAOKI KAJI
(Electrotechnical Laboratory of Japan)

Origin of this study. We have formerly made a study of Chinese letter printer and signal translator, in which signal storage and reconstructing devices had to be developed.

In course of this study, we took an interest in a point that these devices may be easily applied to keep secret of printing telegraph code. This is the origin of the study.

Experienced methods

A. Change of order: Each element of six-unit code are first stored using a relay or condenser group in normal order, and then sent out in predetermined special order.

B. Development of A: Those process above described may be taken place among more than two six-unit codes.

C. Change of polarity: Polarity of each element of six-unit code is changed such as +ve $\rightarrow$ -ve, -ve $\rightarrow$ +ve and -ve $\rightarrow$ -ve under some promise.

In each case, the receiving process must be carried out reversely to sending one.

D. Change of polarity of start and stop signal.

E. Masking with some auxiliary sentence.

From the result of experience and its practicability, we actually put in use (C) and (D) methods. The method of (E) was also added in simple form of a letter or two in place of auxiliary sentence.

Principle of our system See Fig. 1. The segment S_1 is connected to +ve or -ve battery contact via transmitter lever T_1 , which is positioned corresponding to the 1st element of six-unit code. The segment S_1' is connected to +ve or -ve windings of sending relay in accordance with the position of wiper W_1 , which is moved one step every time a letter signal is sent out. When the brush is reached on S_1 , S_1' segment, the tongue of the sending relay is positioned to +ve or -ve contact corresponding to the position of T_1 and W_1 . (In this figure, the 1st element of six-unit code is taken up only, and the 2nd - - - 6th element are not.)

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The bank of this rotary switch RS_1 have 25 contacts as an usual telephone switch (each contact is connected to +ve or -ve winding of sending relay SR according to the predetermined promise), so that the effect of W_1 is repeated with 25 steps.

In order to increase this period, an auxiliary rotary switch RS_2 (same type as RS_1) are inserted between segments $S_1 \dots S_6$ and RS_1 . In this case the interconnection between $S_1 \dots S_6$ and $W_1 \dots W_6$ of RS_1 is also periodically changed with 25 steps. Accordingly, setting a stepping difference between RS_1 and RS_2 , we can have the period of $25^2 = 625$ as maximum value. (See fig. 2).

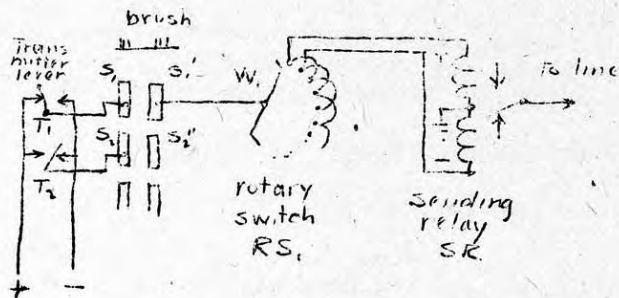


Fig 1

In order to get this stepping difference, we adopted such method as illustrated in fig. 3.

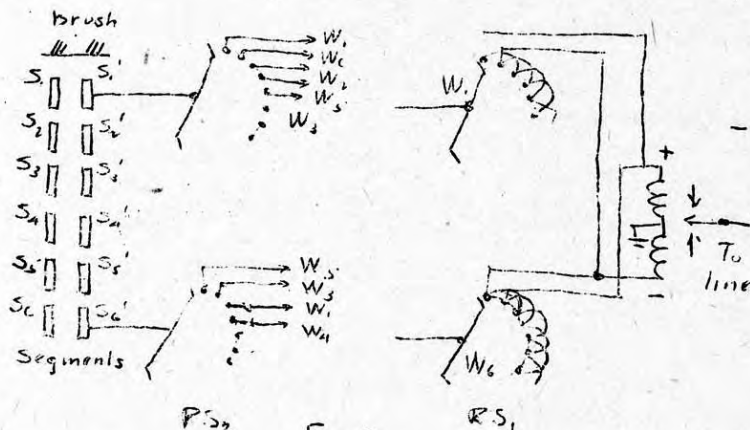


Fig 2

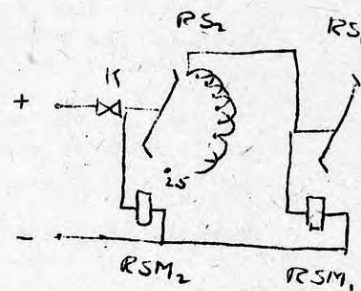
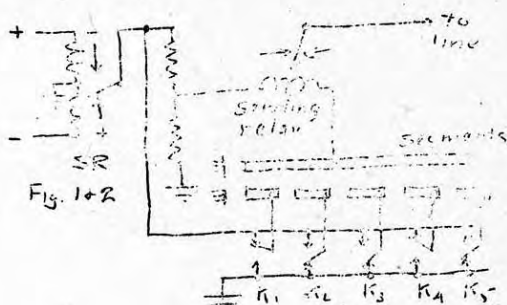


Fig 3

The contact K is closed once per revolution of brush, just when the stop and start impulses are sending out. Hence the switch RS_1 and RS_2 revolves intermittently in steps, one step for each letter, but at the 25th contact RSM_2 only operates and RS_2 takes a lead of one step, and the operating circuit of the magnet RSM_1 is disconnected at this point on RS_2 . Thus, the stepping ratio between RS_2 and RS_1 is 25 to 24.

This method can be applied to any number of rotary switches to enlarge the periodicity previously mentioned. If we exchange the positions of RS_1 and RS_2 in fig. 2, then it gives a new formation of signal changing.

The method (E) above mentioned is carried out as follows (fig. 4):
Set the Key K_1 -- K_6 to one or two position corresponding to predetermined



signal code combination, then the original code set at the relay SR will be successively changed to another different code by rotating brush.

Moreover, the above method is equally applicable to the stop and start signals.

Method to keep secret in radio printer The study above described was taken place for the wired printer, but its principle can be almost invariably applied to radio printer. But in the latter, the telegram is transmitted twice with a time interval to overcome the errors occurred by fading, statics etc., so some parts of the practical arrangements such as distributor have to be little modified.

Owing to the twice-sending in radio printer, we can easily get a new method to keep secret. That is one in which the order of transmission of the letter of sentence sending first and one of same sentence sending secondly are interchanged with some predetermined promise. Such as

(A) a b c d b' f d' e' i

(B) a' e c' g h f'

That is, if a b c d e -- and a' b' c' d' e' -- are the same sentence sending first and secondly (for the purpose of distinction, the latter is affixed with dash), d a' is the normal order but b' e is not. (see the report on "Radio printer" as for the twice sending mechanism.)

Conclusion These privacy in printer is a simple transposition system, in which one letter is changed to another one. but when the start-stop signal is also marked, then the deciphering will be become difficult, we suppose.

In the case when these privacy is applied to the radio printer, it must be provided with special same-starting and synchronizing devices at each end.

We can not discuss the value of these system from the ciphering point by reason of our ignorance for the cipher.

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(JAPANESE PREPARED)

INCL-3

ON THE RADIO PRINTER

BY

TAKEJI ISHIKAWA & MASAAKI KAJI
(Electrotechnical Laboratory of Japan)

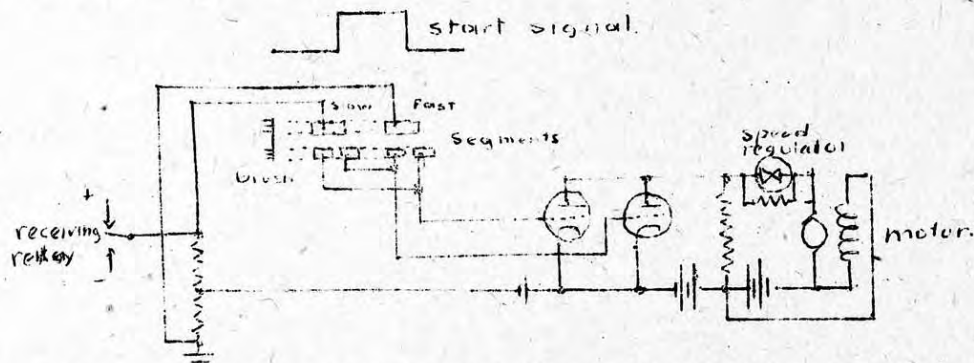
Introduction Teleprinter which is used nowadays in Japan is the start-stop type, tape printer and is used to wired circuits only. We have continued for the last several years to develop the method applying this printer to a radio circuit (either α_1 or α_2 wave).

- A. Static noise and fading of radio circuit,
- B. Asynchronism of receiver with transmitter due to obstruct a start signal by the above-mentioned causes, and
- C. Errata which arise by damage of signal if synchronism is able to maintain.

The following is the out-line of our system. (We will publish the details in the journal of the Institute of the Electrical Communication of Japan.)

Maintenance of synchronism For this purpose, we made use of the start signal. In our start-stop printer, the transmitter has the distributor consisted of ringform segments and brush, but the receiver is the system selecting code by one electromagnet and rotating cams. And then the receiver starts by releasing a clutch with a start signal, but stops automatically. Accordingly, the correction of synchronism by start signal is in other words the orientation of starting position.

In order to realize our method, we prepared a receiving distributor and carried out the speed control of motor through the segment of correction of synchronism on the receiving distributor. This principle is illustrated in the following schematic diagram.



As this is the method which is used often we abridge these details.

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Method of prevention of errata. In radio circuit, the static noise and fading are prevented as possible. And yet we developed the method to prevent the effects of these phenomena in printer itself.

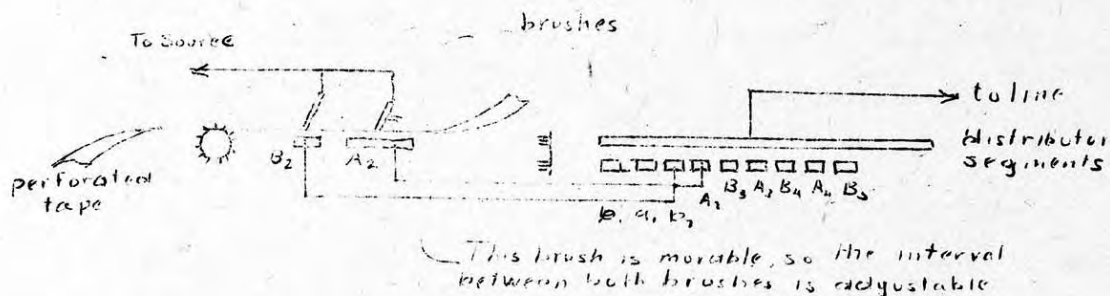
A method of this kind is Baudot-Verdan's system. We thought one series of static noises or fadings have a correlation in a some time interval, and after a longer time the occurrence of these phenomena have same probability. In other words, if, as Baudot-Verdan's system, same letters are transmitted successively, it is very possible to injure both letters at the same time by the same cause, and if same letters are transmitted at wholly different time, the probabilities that both letters suffer from injure are equal. Therefore, we adopted the method that same sentence was transmitted twice with most suitable time interval.

In order to realize this method, it is enough to transmit the same sentence through the time division, two channels system. A right sentence is got by the comparison of two received tapes. These relations are illustrated in following example.

(A) a b c d e X X h i j X l
(B) a b X X e f g X i

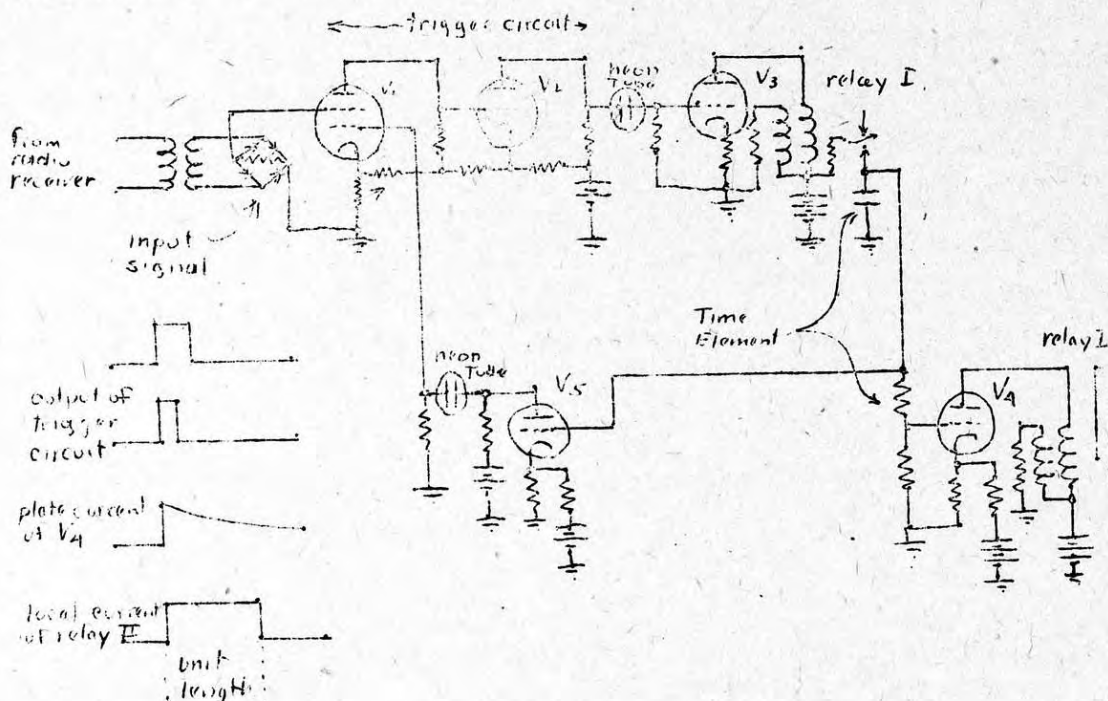
In this example, letters f, g and k are uncertain in (A) printer and letters c, d and h in (B) printer. It is impossible to communicate with (A) or (B) only, but if (A) and (B) get together the sentence is complete.

The arrangement of this system is same to the multiplex printing telegraph system, so the details are abridged, but the schematic diagram of transmitting mechanism is illustrated only in following figure.



(In this figure, the 2nd elements of six-unit code only is shown.)

Correction of length of received signal The wave form correction of received signal at a radio receiver is carried out by the use of AVC and limiter, but especially in short wave the length of signal is in question by echo, scattering, etc. For the purpose of the correction of the signal length we adopted the system in which the length of transmitted signal is shorter than a half of a unit, the receiving relay operates at the wave front only and from its instant the normal length is given automatically without the effect of received signal. This is realized by valves, relays and SR circuit as time element. The schematic diagram of this circuit is illustrated in the next figure.



Conclusion The interest and the special feature of this system is to transmit twice the same sentence with most suitable time interval.

The results of several field tests was satisfactory. But we will continue the experiment in order to make sure our way of thinking.

RADIO-FREQUENCY INSTRUMENTS

Signal Generators	TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
	Precision Long, med, & short waves	#101	Nihon (or Nippon) Musen	50kc to 25mc Output: 1V; 0.1V to 1μV Accuracy: ±1db	Simple operation Direct reading output voltage & freq. Internal & external mod.	General studies & test of receivers for long or short waves	Output can be adjusted to less than 1μV. A.C.
	Same as above	#102	Oki Electric	25kc to 30mc Output: 0.8V to 1μV (Max voltage above 20mc 0.3V) Accuracy: ±1db	Plug in coils. Separate output meter, tuned buffer amplifier. Internal & external mod.	Same as above	Same as above
	Precision u.s.w.	#103	Nihon Musen	15 to 150 mc Output: 0.1V to 1μV Accuracy: 12db	Plug in coils. Tuned Buffer amplifier. Internal & external mod.	Study & test of w.s. receivers	Output can be adjusted to less than 1μV Battery source (6V & 200V)
	Semi-precision, long to short waves. 3 bands	#111 Ko (A) Otsu (B) Hei (C) Tei (D)	" "	A: 3.5. to 30mc B: 275kc to 4mc C: 18 to 300kc D: 3.5 to 22mc 275 to 750kc Output: 1V; 0.1V to 10μV Accuracy: 12db	Small. Easy to produce. Types A to D each contain 3 bands Type D generates both r.f. and i.f.	Production tests (& study) of s.w. (or long & med wave) receivers. Test of i.f. stages of u.s.w. sets. Expected to replace #101 & #102	Output can be adjusted to less than 1μV. a.c. source (100V)
	Semi-precision 2 bands. s.w. & u.s.w.	#112 Io (A) Otsu (B) Hei (C) Tei (D) Io (E)	Ando Electric	A: 140 to 220mc 22mc I 15% B: 90 to 160mc 22mc I 15% C: 55 to 100mc 7mc I 15% D: 35 to 60 mc 7mc I 15%	Small. Easy to produce. Generates r.f. & i.f. Possible to modulate with rectangular waveform. Easily portable	Production tests (or study) of u.s.w. receivers of certain freq. range. Can replace #103	Output can be adjusted to 1μV Battery source 6V & 100V Appendix 17 Incl 4 (1)

			E: 20 to 40mc 4.7mc 15% Output: 10mV to 1uV Accuracy: 2db			
Semi-precision single band	#113 Special Ko (Special A) Ko (A) Otsu (B) Hei (C) Tei (D) Bo (E)	Nitchiken Kogyo	Special A: 220 to 350 mc. A: 140 to 220mc B: 90 to 160 C: 55 to 100mc D: 35 to 60mc E: 20 to 40mc Output: 10mV to 10uV Accuracy: 3db	Small. Easy to produce. Possible to generate up to 700mc by suitable circuit. Balanced output possible. Also modulation by rectangular wave form possible	Same as above. Also suitable for use on receivers having balanced input circuits	Output adjustable down to about 1uV Battery source (6V & 100V)
Semi-precision single band	#114	Nihon Musen	75 to 350mc Output: 10mV to 3uV Accuracy: 3db	Easier to make than #103 Generates 75 to 350mc in one sweep Modulation by rectangular waveform possible	Study & test of u.s.w. receivers Expected to replace #103	Output adjustable down to about 1uV Battery source (5V & 200V)
Semi-precision single band	#115	Fuji Tsushinki	200 to 700mc Output: 10mV to 10uV	First in Japan	Study & test of u.s.w. receivers	A.C. source (100V)
Semi-precision single band	#116	Fuji Tsushinki	Magnetron osc. with attenuator. Antenna with plate reflector. Rectangular wave modulator	First in Japan. A known field is produced, in which test receiver is placed and tested with antenna	Same as above	D.C. source (12V & 300V)

Signal Generators

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Ordinary class. Long med. & short waves	#151	Fuji Sokuteiki	60kc to 25mc Output: 0.1V to 100uV 400cyc (mod.) output: 3V to 0.3mV	Simple signal generator that can be also used as test oscillator. Small, simple operation, low-frequency signal also generated.	Maintenance tests of receivers for long & short waves. Also auxiliary equipment for research & experimentation	Output can be adjusted down to about 10uV A.C. source (100V)
Ordinary class. microwave	#152	Denki Gijutsu Jitsuyoka Kyokai (Ass'n for Applications of Electrotechnology) Also Fuji Tsushinki	2wave-length Type LD 220 tube, 1000 cyc rectangular wave mod.	Signal field produced Half-wave doubler with reflector (plate) Inductance attenuator Balanced output	Test & study of microwave receivers. Expected to replace #116	Battery source (+250V) (+100V) (+4V)
Ordinary class microwave	#153	Fuji Tsushinki	wave-length Type LD 50A tube, 1000 cyc rectangular wave mod.	Signal field produced Doublet with reflector plate. Inductance attenuator. Balanced output	Test & study of microwave receivers. Gives wave band intermediate between #115 & #116	Battery source (200V & 2V)
Ordinary class. microwave	#154	Oki Electric	wave-length Velocity modulation tube, 1000 cyc impulse wave mod.	Signal field produced Doublet with reflector plate. Inductance attenuator. Balanced output.	Test & study of microwave receivers.	Source: separate eliminator using 100Va.c.
Impulse modulated oscillator	#181		Impulse generator tube Impulse freq 1000 cyc/sec. 1 to 20us width 180° phase adjustment Carrier freq 75 to 150 mc. 150 to 300mc. Output: 10uV to 1mV	Short impulses producible. Waveform of impulse approximately rectangular.	Test & study of overall performance of u.s.w. receivers for impulse modulated waves.	Battery source Appendix 17 Incl 4 (3)

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Microwave test oscillator	#182	Denki Gijutsu Jitsuyoka Kyokai (Ass'n for Applications of Electrotechnology)	& 0 wave-lengths Double split-anode magnetron used. Cavity resonator. 1000 cyc. sinusoidal mod.	Large output. Wave-length variable over comparatively wide range. Oscillator tube easily manufactured.	Experiments & research in microwave region auxiliary aid to test of receivers.	Source: separate eliminator using 100Va.c.
Precision u.s.w. (Heterodyne type)	#201	Nihon Musen	30 to 1500mc Accuracy: 1×10^{-3} Readability: 5×10^{-4}	Crystal oscillator included for calibrations	Test & research on u.s.w. & microwave oscillators	Battery source (6V & 200V)
Precision microwave (Heterodyne type)	#202	Nihon Musen	200 to 3500mc Accuracy: 1×10^{-3} Readability: 5×10^{-4}	Same as above	Test & research on microwave oscillator	Same as above
Precision Long, med. & short waves (Heterodyne type)	#203	Tsukamoto Denki	100kc to 30mc Accuracy: 1×10^{-3} Readability: 5×10^{-4}	1mc crystal oscillator included for calibrations (circuit developed by Electro-technical Lab.) 6 plug in type oscillator coils to change range	Test & research on long, medium & short wave oscillators	Same as above
Absorption type	#251	Yokogawa Denki	17 kc to 75 mc (7 plug in type coils to change range) Accuracy: 1.5% Readability: 1%	Direct reading Easily handled	Test of long, med & short wave oscillators	Crystal detector contained in set
Absorption type u.s.w.	#252	Denki Gijutsu Jitsuyoka Kyokai (See, for example, #182)	75 to 350mc Accuracy: 2% Readability: 1.5%	Direct reading. L & C simultaneously varied No change of coils required. Easily handled.	Test & research on u.s.w. oscillators	Crystal detector contained in set Appendix 17 Incl 4 (4)

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Absorption type microwave	#253	Same as above	Ko(A): 1000 to 2000mc Otsu(B): 500 to 1000mc Hei(C): 250 to 500mc Accuracy: 1% Readability: 0.5%	Closed type, capacity variable	Test & research on microwave oscillators	Crystal detector contained in set
Med. to short waves	#301	Okii Electric	500kc to 20mc Med. wave-length intensities: 1V/m to 5uV/m Short-wave intensities: 1V/m to 10uV/m	Stationary type. Wheels attached.	Study of med & short-wave propagation	Sensitivity can be increased by using vertical antenna. Battery source (6V to 200V)
U.s.w.	#302	Nihon Musen	20 to 200mc Intensities: 0.1V/m to 10uV/m Reception possible up to 300mc	Stationary type. Wheels attached for moving short distances Standary field-strength generator provided. Suitable for automatic recording of measurements over range of 30db.	Study of u.s.w. propagation problems	Rough measurements possible down to 1uV/m. Battery source (6V, 200V, also dry cells for other voltages)
U.s.w. field-strength indicator	#351	Nihon Musen	Special: 3 bands 330mc 20% 180mc 20% 85mc 20% K(A): Single band 330mc 20% Otsu(B): single band 180 20% Hei(C): Single band 85mc 20% Intensity: 10 to 0.1/m	Antenna: short doublet with reflector (except type-C). Suitable for simple mobile measurement of intense fields. Vertical or horizontal component of field strength measurable. Little error due to surrounding bodies.	Test & measurements of field radiated near u.s.w. transmitting equipment.	Source, dry cells

Capacity
meter
Resistance
measuring devices

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
U.s.w. vacuum- tube voltmeter	#401	Nihon Sokuteiki	5kc to 100mc Voltage ranges: 0 to 1.5, 5, 15, 50, & 150V Accuracy same as ordinary class meter	portable. Has extra large scales. Probe type h.f. head (diode rectification)	Suited to general voltage measure- ments from 5kc to 100mc. Test & research work	Combination of diode peak- voltage recti- fier & d.c. amp- lifier, A.c. source (100V) Voltage stabili- zation provided
Low-fre vacuum-tube voltmeter ("V" tester)	#402	See circuit testers				
U.s.w. Large h.f. currents	#511	Shimazu Soisakusho	Standard consists of resistance lamp & photo-coll. 10 to 100 10 to 100mc 0.1 to 10A		Test of u.s.w. current meters of fairly high am- perage. Also use- ful in research	A.c. source (100V)
Precision Low capaci- tances	#601	Fuji Sokuteiki	Ranges: 0 to 120 & 1200 uuf Accuracy: 1% 0.5uuf (for 0 to 120uuf) 1% 5uuf (for 0 to 120Guuf)	Direct reading Easy to operate	Test of various low-capacity condensers	Resonance indicator employs 100kc quartz crystal. a.c. source (100V) Measurement freq. =100kc
Precision	#602	Yokogawa Denki	Range: 0.001 to 10 ⁷		Measurement of various d.c. resistances	Movable. D.C. wheatstone. bridge
Megger ("M" tester)	#652	See circuit testers				
Contact resistance tester ("C" tester)	#653	See circuit testers				

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	TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Capacity comparator	Precision differential type	#603	Ando Electric	Capacity to be compared: 30 to 1000μf Measurable ranges of percentage difference (2 steps): Range I : 0 to 2% Range II: 0 to 20% Accuracy: 0.1%	Operation simple. Comparison fast & precise.	Test & adjustment of ganged variable condensers. Can also be used for resistance or inductance comparisons	a.c. source (100V)
Inductance meter	Precision low inductances	#604		Ranges: 0 to 10, 100, 1000, & 10,000μh	Direct reading Simple to operate	Tests of various coils for use in radio equipment	Resonance indicator employs 100kc quartz crystal a.c. source (100V) Measurement freq. changes with range (4 steps, app. 20, 60, 200, & 600kc)
ICR meter	Simple tester ("R" tester)	#651	See circuit testers				
Loss measuring sets		#701	Yokogawa Denki	50kc to 25mc Q: Scale reading 0 to 250 multiplication factor 1 to 2.5 Capacity reading: 30 to 450μf	Direct reading. Easy to operate. Measurements simple	Measurement of Q of coils & condensers, high resistances. Various tests (or research) on high frequency impedance	a.c. source (100V)

loss measuring sets

Impedance measuring sets

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Locher-wire type u.s.w.	#702	Yokogawa Denki	Measurement wave-lengths 1.5, 2.0, & 2.5m. tano: 1×10^{-4} to 100×10^{-4} Accuracy: 1%	Suited to measuring impedances symmetrical to ground	Chiefly for measuring loss angle high freq insulation. Also used in study of u.s.w. impedances of high resistors, small condensers, etc.	Measurement by line-length variation a.c. source (100V)
Short-wave dielectric loss measuring set	#703	Kawanishi Kikai	Freq: 3 to 100mc tano: 1×10^{-4} to 200×10^{-4} Accuracy: 10%	Suited to measuring insulations at high temperatures (max 200°C) Heterodyne detection & amplifying circuit used for measuring voltages (of resonance curve)	Test & research on high-frequency insulating materials	Reactance (capacitive) variation method Battery source (6V & 200V)
P meter (Parallel resonance impedance) Long, med & short waves	#751	Kawanishi Kikai	Freq: 50kc to 20mc Ranges: 5k to 100k in 50kc to 10mc band 5k to 30k in 10 to 20mc band	Direct reading simple to operate, simple construction. Utilizes negative resistance oscillator tube (transition)	Test of LC resonance circuits Inspection of h.f. tuned circuits & i.f. band filters	a.c. source (100V)
Bridge for calibrating P meter	#752	Kawanishi Kikai	Calibration at 100cyc 500 to 300k Multiplier in 3 steps	Direct reading negative-resistance dial	Calibration of #751 Pmeter scale Any number of P meters can be calibrated by providing one of these bridges	Source obtained from #751 P-meter

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	TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
ing sets	Radio frequency bridge	#753	Ando Electric	Frequency: 1 to 30mc Ranges: 20 to 200k & 0 to 300uuf for symmetrical circuits 10 to 100k & 0 to 600uuf for unsymmetrical circuits	Bridge employing differential transformers. Symmetrical & unsymmetrical impedances measurable	Measurement of antenna feeders (impedance) & adjustment of various radio circuits	Modulated oscillator, & detector-amplifier combined in set
tion meter	U.s.w.	#821 Kc(A) Otsu(B) Hei(C)	Oki Electric	A: 140 to 300mc B: 70 to 150mc C: 40 to 80mc Suited to measurement of u.s.w. impulse currents	Gives accurate distribution of current along lines at u.s.w. No effect of voltage Easy to use, light, source self-contained	Adjustments & matching of lines such as antenna feeders	Peak rectifier Battery contained
Oscilloscope	Low freq cathode-ray oscillograph	#901	Matsushita Musen	Cathode ray screen dia. = 75mm. Self-contained amplifier. Freq: 50 to 10,000 cyc/sec.	Small light	Direct observation of frequency characteristics of r.f. & i.f. amplifiers. Observation of impulse signals. Also test & research	d.c. source (100V)
Type checkers	Simple type	#1001	Fuji Sokuteiki	Simple tests of ordinary receiver tubes, acorn tubes, metal tubes, NF2, RE3, & RE4.	Small simple Rapid checking of small tubes	Maintenance tests of various receiver tubes	a.c. source (100 or 200V)

Tube Checkers (Contd.)

Sweep-freq Oscillator.

Low frequency oscillators

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Simple type (Single purpose)	#1002	Fuji Sokuteiki	Check of acorn tubes and 8-pronged receiver tubes	Same as #1001	Chiefly for maintenance of special equipment	D.c. source
Operating tester for acorn tubes	#1051		Simple operation test of acorn-type UN-954 tubes	Gives simple indication of performance of the UN-954 at u.s.w.	Same as above	D.c. source
For direct observation of receiver freq. characteristics	#1101 Kō (A) Otsu (B) Hei (C)	Nitchiku Kogyo	A: 4 to 30mc B: 600 to 6000kc C: 75 to 800kc Sweep frequency: 50 or 60 cycles	Electrical method used for sweeping frequency. Small, simple. Band width of frequency sweep arbitrarily adjustable. Essential for mass production of radio equipment	Adjustment of i.f. stages of u.s.w. receivers (or long & short wave receivers) by direct observation of the frequency characteristics on a cathode ray oscillograph	A.c. source (100V) Used in combination with #901 oscillograph and #151 signal generator
LC step freq	#1151	Kubota Musen	Step change of frequency by switching over L & C values (11 steps) 0.2 to kc. Output: over 50mw at 600 Distortion less than 10%	Small, simple. Oscillations & frequency stable. Output constant regardless of frequency	Test & study of receivers & other low frequency circuits	A.c. source (100V)
CR continuous variation	#1152	Tokyo Shibaura Electric	Step-change of C & continuous variation of R. 50 cye to 20kc Output: over 50m at 600 or 2000 Distortion less than 5%	Oscillator frequency stable. Good frequency vs output characteristic (Output deviation about 5%	Same as above Also suited to acoustical tests & experiments	A.c. source (100V)

	TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
Receivers	Long, med & short waves	#1201	Oki Electric	50kc to 20mc Auxiliary equipment for 50 to 100db calibrations with standard signal generator	Suited to measurement of very small signal voltages. Stationary type. Contains i.f. attenuator	Test & research work requiring a long, med. or short wave receiver, such as the calibration of signal generators	Corresponds to receiver portion of #301 field-strength measuring set. Battery source (6V & 200V)
	Med. to short waves ("all-wave" set)	#1202	Mita Musen	550kc to 22mc Heterodyne reception possible. Output about 1w	Table set, Change over coils. Easy to operate.	Simple measurements of signal strength, amplification, & detection	A.c. or d.c. source
	U.s.w.	#1203	Oki Electric	20 to 300mc	Suited to measurement of very small signal voltages. Stationary type. Contains i.f. attenuator	Test & study with u.s.w. measuring receivers; such as calibration of signal generators	D.c. source (6V & 200V)
Audio-frequency Amplifier		#1301	Kubota Musen	Band: 50 to 20,000cyc Negative feedback. Gain: 50db. Gain deviation: 1.5db or less at 1000 cycles Input & output impedances: 600 & 10k Distortion: 1% or less	Simple to handle. Small. Low noise	Study & test of audio-freq. circuits of receivers	D.c. source (6V, 200V) or a.c. source (100V)
Testers	"A" tester Field use (Dry cell operated)	#1501	Tsukamoto Denki	Voltages (d.c. & low freq.): 0 to 10, 50, 250, & 1000V Current (d.c.): 0 to 1, 10, 100, & 500ma. Output voltage measurements (audio-freq.): 0 to	Universal tester including use as output meter. Other testers also encased in same sized box	Suited to field experiments. Simple tests of voltages currents & resistances in radio equipment. Also usable as	Comes with carrying box. Contains square type 2 dry cell (1.5V). Appendix 17 Incl 17 (11)

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
"B" tester Indoor use (a.c. source)	#1502		10V at 10k Resistance (d.c.): 0 to 10 & 100k Voltages (d.c. & low freq.): 0 to 10, 50, 250, & 1000V Output voltage (audio freq): 0 to 10V at 10k Capacitances: 0 to 0.11 & 10uf. Resistances (d.c.): 0 to 10, 100, & 1000k	Includes output meter Universal type using a.c. source	output meter for radio receivers.	Chiefly for indoor A.c. source experiments. (100V) Simple checking of voltages, capacitance of voltages, measured at capacitances, & 50 or 60 cycles resistances of radio equipment. Also usable as output meter for radio receivers
"E" tester (Universal voltmeter)	#1503	Tsukamoto Denki	D.c. & low freq. voltages 0 to 10, 50, 250, 500 & 1000V. Also 0 to 3000V. Output voltages: 0 to 10V at 600 0 to 10 & 100V at 10k Accuracy same as ordinary class class voltmeter	General voltage measurements. 3000V Also can be measured by employing external multiplier.	Used in general test & research work when accuracy required is not as high as precision instru- ments.	External multiplier & special connector cords provided
"I" meter (Universal milli- ammeter)	#1504	Ts kamote Denki	D.c. & low freq. currents 0 to 1, 5, 25, 100, & 500ma Accuracy somewhat less than ordinary class meter	General current measurements Protection provided for over-current in indicating meter.	Same as above	

Testers (contd) (can be carried inside box #1601)

Auxiliary device
Auxiliary

TYPE & KIND	TYPE NO.	MANUFACTURER	SPECIFICATIONS	FEATURES	USE	COMMENTS
"R" meter (LCR meter)	#651	Shimazu Seisakusho	Resistances (d.c.): 0 to 1, 10, 100, & 1000k Capacities: 0 to 0.01, 0.1, 1, & 10uf Inductances: 0 to 10 & 100k	Suited to general checking of resistance capacitance, and inductance. Operates on a.c. source	Checking parts used in radio equipment	A.c. source (100V) Capacities & inductance measured at 50 or 60 cycles
"M" meter (Megger)	#652	Shimazu Seisakusho	0 to 100M at 500v	Rectifier contained Operates on a.c.	Indoor use. Can replace megger for checking insulation of parts & radio equipment	A.c. source (100V)
"V" meter (Low-freq. vacuum tube voltmeter)	#402	Nihon Sokuteiki	Low & high frequency voltages (up to 20mc) 0 to 5, 15, 50, & 150V Accuracy a little less than ordinary class meter	Rectifier set provided. Operates on a.c. Simple High input resistance. D.c voltages can also be measured	For general measurements in radio. To replace usual "A" type & "D" type vacuum- tube voltmeters	A.c. source (100V)
"D" meter (Contact resistance meter)	#653	Denki Gijutsu Jitsuyoka Kyokai	Middle point indication 100m Max. indication 1	Simple to use. Reliable.	Simple checking of various contact resistances & low resistors in radio equipment & parts	Battery source
Dielectric loss measuring jig.	#1571	Yokogawa Denki	tanS: 2×10^{-3} to 50×10^{-3}	For use on #701 Q meter; tanS can be easily measured with this.	Measurement of loss angle of insulators by Q meter	
Box for testers	#1601			Common to all testers listed.	For use to carry various types of testers	

APPENDIX 18

SUBJECT: Production of Aluminum from Clay.

DATE: 11 October 1945.

INTERVIEWED: SATOYASU IIMORI.

INTERVIEWERS: Major H. Skipper; Drs. Mooreland, Stephenson and Longacre.

Prof Iimori when asked to describe the method of extracting Al from low grade ore reputedly developed by him summarized the process as follows:

Loam consisting of 20% Al_2O_3 , 18% Fe_2O_3 and 34% SiO_2 was treated with 60% H_2SO_4 . The Fe and Al were then precipitated as hydroxides by addition of ammonia. The yield attained in the process was 7-8% (based on dry loam). Large quantities of $(NH_4)_2SO_4$, an important fertilizer, are the by-product of this process.

The Japanese Board of Technology examined this procedure for extraction of Aluminum, but decided it was too expensive (too much H_2SO_4 required). Prof Iimori, though emphasizing that he was only a scientist and didn't know anything about production, stated that he did not believe the process had any practical value.

SUBJECT : Interview with Dr Kinjiro OKABE
DATE : 11 October 1945
INTERVIEWED: Dr OKABE
INTERVIEWER: Dr A. LONGACRE

1. Dr Okabe is Professor of Physics at the Osaka Imperial University. In Japan he is considered to be the inventor of the magnetron as an oscillator and actually had with him copies of a paper published on the proceedings of IRE, 17, 652 (1929), in which he refers to previous publications. Since that time he has written numerous papers and at least one small book on generation of ultra short waves and magnetrons. As a student at Osaka University, he was a pupil of Prof H. YAGI.

2. At Osaka, he has a laboratory where he does his work on magnetrons. His associates there are Prof Sanai MITO who works on high-frequency circuits and Prof S. SONOTO who works on radio frequencies. During the war this laboratory received grants from the Army to continue its researches. The total of these grants was between 500,000 and 600,000 yen.

3. During the war Dr Okabe worked on 15-cm CW, air-cooled, glass envelope magnetrons for 30 to 100 watt outputs. He was primarily interested in the basic design of the magnetrons. However, these were aimed toward detection of moving figures by the Doppler effect. In the system they first used an "Osaka" tube as a detector. Later they used crystals. (The "Osaka" tube is a reflex tube with built-in resonant circuits and magnetic columniation of the electronic beam.) Presentation of the data was to be with a Braun tube and/or audible. Distance was to be determined by modulating the beam with an imposed 3 mc to .3 mc frequency on the high voltage. Frequency of the output of the magnetron was stabilized by a branch RF line consisting of a series of $\frac{1}{4}$ wave length sections and terminated by a $\frac{1}{2}$ wave length section. This group forms a fairly high Q system. It is not quite clear to the author how a magnetron stabilized to $\frac{1}{2}$ mc by such a filter could be modulated by the anode voltage to $\frac{1}{2}$ 3 mc.

4. The system was to have had two antennas for transmitting and one for receiving.

5. No work was done by Dr OKABE on the possible use of CW magnetrons for communications. During the conference Dr OKABE was asked to name the principal Japanese working on magnetrons. The following is his list:

K. MORITA (Tokyo Technical University)
K. OAKI (Kawanishi Company)
T. OKADA (Nippon Musen)
S. UDA (Tohoku University)
S. MIZUMA (Navy)
T. ITO (Navy)
F. BABA (Mitsubishi Denki)

It is to be noted that Dr OKABE appeared very much as a quiet, academic man, interested in fundamental principles, and he has probably emphasized the academic approach to the magnetron rather than the manufacturing approach

in the above list.

6. It is to be noted that in a discussion concerning the Japanese type of magnetron in which alternate cavities are of two different wave lengths, he felt that this would be slightly lower in capacity and slightly higher Q, provided the mutual reaction between the neighboring circuits alone is taken into account, than the American type in which all cavities are for the same wave length. He was unwilling to commit himself as to which type, Japanese or American, is actually the better from a theoretical point of view.

SUBJECT: Interview with Dr. H. Hayashi, Chairman of the National Research Council.

DATE: 12 October 1945

INTERVIEWED: Dr. H. Hayashi

INTERVIEWER: Dr. Longacre.

About 1937, the Ministry of Education decided to give grants for aiding scientific researches in Japan and asked the National Research Council to review the requests and recommend the amount of funds that it would be suitable for the Ministry of Education to grant. The National Research Council had been set up in Japan as a part of the scheme of international research councils fostered by the League of Nations. Until this request came from the Bureau of Education, there had been no real connection between the Ministry of Education and the National Research Council. Even after the establishment of the National Research Council as an agency for handling funds of the Ministry of Education for promoting research, the members of the National Research Council continued to consider themselves independent of the Ministry of Education.

In 1940 they administered a total of about 3,000,000 yen for general scientific purposes. It was never considered that this fund, which grew to 8,700,000 yen by 1943, was to be specifically devoted to wartime researches. In 1943 the government directly gave to the National Research Council an extra 10,000,000 yen specifically for projects related to the war effort. In the six months of 1945, the National Research Council spent only 5,000,000 yen, and, as is obvious, they were spending this at a lower rate than they had in preceding years. Dr. Hayashi pointed out that out of the 8,700,000 yen for advancement of the sciences, 200,000 yen was appropriated to the literary sciences (Law, Economics, and Literature); the remaining 8,500,000 yen was devoted to the natural sciences. In actual operation, the Ministry of Education received requests for aid from the services, especially on general problems, and tried to appropriate their funds to support this aid from the 10,000,000 yen. As with the Board of Technology, they also frequently suggested the appropriate men for researches that the Army or the Navy wished to do in their own laboratories. At no time did the National Research Council provide money for these researches. Also, they had cases similar to that of Prof. Kumagai of the Tokyo Imperial University who did special work for the Army on ultra high frequency in his laboratory at the university. However, he did get funds from the National Research Council for accessory problems.

Actually, the greater part of the 8,500,000 yen, nominally reserved for general science, went for accessory problems to the war effort and especially to those associated with the projects being floated under the extra 10,000,000 yen allotment. Thus, indirectly, a large portion of the 8,500,000 yen fund went to help radar, metallurgy, chemical warfare, medicine, biological warfare, agriculture, and mathematics. Dr. Hayashi was never specifically informed regarding the details of most of the researches but had a fair idea.

One thing is to be noted in particular: that the Ministry of Education frequently made grants to groups of individuals with one man acting as the nominal head; and that these groups, running from three to a dozen, worked on various aspects of a particular problem. Heretofore, most of our information had been that the grants were to individuals who hired their own assistants. In the case of these group grants, the whole group acted as a committee on the problem being investigated.

RESTRICTED

20-3

RESEARCH SUBJECTS
MINISTRY OF EDUCATION
(¥7,415,000)

- PART I. Mathematics, Physics, Astronomy, Geophysics. ¥1,129,000
- PART II. Pure Chemistry, Applied Chemistry, Agricultural Chemistry, Pharmacy. ¥1,600,000
- PART III. Geology, Geography. ¥241,000
- PART IV. Zoology, Botany, Anthropology. ¥230,000
- PART V. Applied Physics, Mechanical Engineering, Ordnance Technology. ¥800,000
- PART VI. Mining, Metallurgy, Metal Engineering. ¥380,000
- PART VII. Aeronautical Engineering, Marine Engineering. ¥770,000
- PART VIII. Electrical Engineering. ¥430,000
- PART IX. Civil Engineering, Construction. ¥490,000
- PART X. Pure Researches. ¥2,080,000
- PART XI. Agriculture, Aquatic Industry. ¥815,000
- PART XII. Forestry. ¥320,000
- PART XIII. Veterinary Science, Zootechy. ¥230,000

RESTRICTED

20-3

I. MATHEMATICS, PHYSICS, ASTRONOMY, GEOGRAPHICS. Total: ¥1,129,000
 (* not member)

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Statistical mathematics. ¥29,000	1.a. Statistical control of production. b. Math. plan of maintenance & supply. c. Calculation for military use. d. Quality test & distribution of men. 2. Principles of statistics. 3. Preparation and construction of statistical tables and tables of special functions.	Prof KYUSHU, Imperial University Kitagawa, Toshio, and 17 others
2.	Special statistics. ¥15,000	Statistical study of special subjects which are required by the Army.	The Institute of Statistical Mathematics Research, Kawada, Tatsuo
3.	Mathematical study of domestic economy. ¥19,000	Study to define a national standard of living by investigation of family budgets and nutrition.	Prof KYOTO, Imperial University, Sono Shozo and 6 others
4.	Special algebraic analysis. ¥6,000	Study on cryptograph chiefly.	Sono, Shozo and 6 others
5.	Conformal Representation. ¥11,000	Study of unusual form of airplane.	Prof Tsuji, Masatsugu, Tokyo Imp U, and 6 others
6.	Special differential equations. ¥16,000	Study of phenomena of vibration and electric wave diffraction.	Shimizu Tatsujiro Prof Osaka, Imp U
7.	Reconsideration of aero-equations. ¥10,000	To reexamine various aeronautical equations.	* Nakano, Hidegoro Asst Prof of Tokyo Imp Univ, and 7 others

RESTRICTED

15. Atomic nucleus. ¥90,000 Study of separation of isotopes using cyclotron, betatron generators, Vandergraaf apparatus, a thorough investigation of the uranium bomb problem. Production of artificial radioactive elements and their application. Nishina, Yoshio and 21 others
16. Fundamental theories. ¥24,000 Study of new effective methods in fundamental theoretical physics and their application in various fields. Tomonaga, Shinichiro Prof Tokyo U, of Science & Literature, and 17 others
17. Vacuum technology. ¥36,000 To improve vacuum technology in order to increase efficiency in manufacture of vacuum tubes. Research on air exhaustion vacuum vaporization methods for special mill equipment. Sagane, Ryokichi Prof Tokyo Imp U and 4 others
18. Special metal. ¥45,000 Study of production and heat treatment of alloys which have properties needed for military use. Hirone, Tokutaro Asst Prof Tohoku Imp Univ and 14 others
19. Properties of metals to be used as material. ¥48,000 Study of elasticity and compressibility of metals to find change in their property when worked upon. Yoshida, Usaburo Prof Kyoto Imp U and 13 others
20. Fundamental research in acoustics. ¥16,000 To study fundamentals of sonic equipment and to improve their efficiency. Sato, Koji, and 10 others. Prof Tokyo Imp U
21. Theory of matter. ¥30,000 Study of structural theory of gases, liquids, and solids in order to make make-up of matter clear. Ochiai, Kiichiro and 18 others Prof Tokyo Imp U
22. Semi-conductors. ¥32,000 Study of properties of semi-conductors and application to heat sensitive material. Muto, Ioshinosuke and 17 others Prof Kyushu Imp U

8. Geometrical study of special machines and tools. ¥9,000
Geometrical study of the gear wheels and others. Kubota, Tadahiko
Prof Tohoku Imp U
9. Sights. ¥11,000
Geometrical study of the aiming apparatus and others. Kubota, Tadahiko
10. Application of the Cathode Rays. ¥25,000
Study of the surface structure of solids and the molecular makeup of gases by applications of cathode ray diffraction. Nishikawa Masaharu,
Prof of Tokyo Imp U, and 7 others
11. Application of invisible rays. ¥56,000
Method of generating and detecting ultra-violet ray, heat ray, infrared ray, and very long heat ray. Study of material which transmits or absorbs certain rays which can be used as basis of mil weapons. Fujioka Yoshio,
Prof Science & Lit Tokyo U, and 22 others
12. Optical material and instruments. ¥24,000
Study of methods for polishing, examining, anti-clouding, anti-corrosion in order to improve capacity. Kiuchi Seizo
Prof Tokyo Imp U and 16 others
13. Examination of materials by X-ray. ¥48,000
Best methods for examination of material by X-ray penetration and of composition by X-ray spectrum analysis. Development of a superior X-ray generating apparatus. Nishikawa, Masaharu
Prof Tokyo Imp U and 26 others
14. The cosmic ray. ¥40,000
Study of cosmic ray has been carried out independently in this country. Purpose of research will be to continue this study and to work out means of applying knowledge gained to study of high altitude meteorology. Nishina, Yoshio
Inst of Physical & Chemical Research and 9 others

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| 23. Study of Fog
¥24,000 | Nature of fog. Study of their formation and dispersion. | Nakatani, Ujichiro
Prof Hokkaido Imp U
Aoki, Toshio (in charge of research) and 4 others |
| 24. Optics of the Telescope. | Math study of optics. Exam methods. Mass production of optical material. | Sekiguchi, Rikichi and 12 others
Tokyo Astron Observ. |
| 25. Sun's radiation lines and their application.
¥50,000 | Math study of radiation, ionosphere, propagation of electromagnetic terrestrial magnetism. | Hagiwara, Yusuke and 21 others
Prof Tokyo Imp U |
| 26. Celestial Navigation
¥17,000 | Navigation by astronomical observation. | Notsuki, Masao and 12 others
Asst Prof Tokyo Imp U |
| 27. Special observations and time report transmission and receiving in war time. | TN - print not clear | Tsuji, Konosuke and 3 others
Tokyo Astron Observ |
| 28. Radiation by earth objects. ¥16,000 | Study of earth's radiation, atmospheric radiation, cloud and others. | Sekiguchi, Rikichi and 12 others
Tokyo Astron Observ |
| 29. Propagation and detection of elastic wave in the earth. | To apply principle of seismograph to study propagation of elastic wave through earth's core and to detect minute vibrations. | Inoue, Uin and 8 others
Central Meteorological Observatory |
| 30. Propagation of pressure wave in water.
¥16,000 | Study of relation between propagation of sound wave in water and the temperature and salt content. | Hidaka, Koji and 4 others
Prof Tokyo Imp U |
| 31. Generation and propagation of impact elastic wave. ¥24,000 | Study of generation mechanism and propagation of impact elastic wave. | Nasu, Nobuji and 3 others
Earthquake Research Institute |

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| 32. Geophysical conditions for ground on which to put up installations. ¥16,000 | Study of geophysical conditions necessary to be considered when putting up vital installations. | Kishigami Fuyuhiko and 5 others
Asst Prof Tokyo Imp U |
| 33. Earth magnetism and electricity. ¥24,000 | Study of distribution, change, and measurement of earth magnetism. | Hasegawa, Mankichi and 34 others
Prof Kyoto Imp U |
| 34. Detection of foreign material by change in earth's magnetism. ¥16,000 | Detection of very small change in earth's magnetism and application of this. | Sasa, Kenzo and 5 others
Prof Kyoto Imp U |
| 35. Geophysical prospecting method. ¥40,000 | Study of underground construction by elastic wave, gravity, and earth magnetism in order to find natural resources. | Matsuzawa, Takeo and 12 others
Tokyo Imp U |
| 36. Special atmospheric phenomena. ¥16,000 | Study of sudden and unusual atmospheric phenomena and measures against these. | Hatakeyama, Hisanobu and 2 others
Central Meteorological Observatory |
| 37. Freezing. ¥40,000 | Experimental study of freezing phenomena at lower temperature. | Nakatani, Ukichiro and 3 others
Prof Hokkaido Imp U |
| 38. High strata meteorology. ¥16,000 | Study of high strata, especially the stratosphere. | Nukiyama, Taizo and 2 others
Strata Meteorological Observatory |
| 39. Transportation by utilization ocean currents. ¥8,000 | Study of transportation of material from southern area by utilizing the ocean current. | Hidaka, Koji
Prof Tokyo Imp U |
| 40. Waves along coast. ¥8,000 | To study wave conditions along coast. Results to be used as reference in landing operations. | Yoshimura, Nobuyoshi and 3 others
Central Meteorological Observatory |

41. Maps and methods of determination of position. ¥8,000 To work out a simple method of map projection and to work out geodetical data which will become basis of method. Matsuyama, Motonori and 3 others
42. Properties of ground water. ¥20,000 Study of distribution and utilization of the ground water, especially that near important installations. Nomitsu, Takaharu and 8 others
43. Precision geophysical measuring apparatus and their application. ¥24,000 To go over various geophysical measuring apparatus and to extend their application. Tsuboi, Chuji and 5 others Prof Tokyo Imp U
44. Prevention of vibration and shock to equipment and measuring apparatus buffering methods. ¥16,000 Study on prevention and elimination of vibration, and buffering method for measuring apparatus. Takahashi, Ryutaro and 6 others Prof Tohoku Imp Univ
45. Properties of material at very low temperatures. ¥20,000 Study on brittleness, super electric-conductivity of metals, and properties of non-metallic materials at very low temperatures. Aoyama, Shinichi Prof Tohoku Imp U

II. PURE CHEMISTRY, APPLIED CHEMISTRY, AGRICULTURAL CHEMISTRY, PHARMACY.
Total: ¥1,600,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Wartime Medicine ¥200,000	Medicine for chemotherapy; medicine from natural resources.	Cgata, Akira and 23 others Prof Tokyo Imp Univer.
2.	Vitamin. ¥100,000	Production of vitamins from natural resources and waste materials.	Yabuta, Teijiro and 43 others Prof Tokyo Imp U
3.	Explosives. ¥100,000	Study of manufacture and properties of explosives, especially those which can be cheaply produced and in quantity.	Yamamoto, Sakenori and 8 others Prof Tokyo Imp U
4.	Chemicals for jet-propelled airplane (Funshinki) ¥150,000	Study of mass production method on jet-propulsion chemical and of new jet-propulsion chemical.	Uchida, Shunichi and 23 others Prof Tokyo Imp U
5.	Materials for radar equipment. ¥150,000	Study of manufacture and properties of non-metallic materials for radar equipment.	Mizushima, Sanichiro and 31 others Prof Tokyo Imp U
6.	Piezo-electric material. ¥50,000	Study of method of preparation and properties of Rochelle salt and other piezo-electric crystals.	Nieda, Isamu and 9 others Prof Osaka Imp U
7.	Rare elements. ¥150,000	Investigation for sources of rare elements; development and method of extracting them.	Kimura, Kenjiro and 21 others Prof Tokyo Imp U
8.	Preparation of standard pure substances. ¥50,000	Study of preparation of pure substances for use in measurements and analysis.	Tominaga Hitoshi and 14 others Prof Tohoku Imp U

9. Phosphorescent and fluorescent. ¥70,000 Study of phosphorescent Magi Takeo and fluorescent sub- and 19 others stances for use in war Prof Tokyo Imp U equipment.
10. Rubber substitute. ¥50,000 Study on materials Kanbara, Shu which are not natural and 5 others rubber, but which can Asst Prof Tokyo Imp U be used for tires & other purposes as substitute for rubber, & the kind of preparation.
11. Adhesives. ¥80,000 Study of adhesives for Oda, Rijokei making reinforced wood, and 11 others for joining wood & metal, Prof Kijoto Imp U & for various other purposes.
12. Aluminum. ¥50,000 Research in obtaining Al Kameyama, Naoto from domestic sources. and 12 others Solution of technical Prof Tokyo Imp U difficulties in making aluminum.
13. Individual research special committee. ¥400,000 Efficiency of machine dry Nagai, Osaburo distillation and fermentation in preparation of Chairman of Committee raw material. Industrial chemical work. Determining capacity of chemical installations & equipment to withstand explosions & their other properties, lubricating oils.

III. GEOLOGY AND GEOGRAPHY. Total: ¥241,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Industrial materials & mineralogical & petrological study of raw materials. ¥50,000	---	Tsuboi, Saitaro and 8 others Prof Tokyo Imp U
2.	Special resources, ores, and rocks. ¥50,000	Study of special raw materials needed for war.	Ito Sadaichi and 5 others Prof Tokyo Imp U
3.	Petroleum geology. ¥71,000	---	Kamitoko, Kunio and 14 others Prof Tokyo Imp U
4.	Coal geology. ¥50,000	---	Yamane, Shinji and 12 others Geological Survey Bureau
5.	Coal Deposits. ¥50,000	---	Kato Uobuo and 10 others
6.	Geography of Resources. ¥20,000	Geographical analysis & conditions of resources.	Tsujimura, Taro and 5 others Prof Tokyo Imp U

IV. ZOOLOGY, BOTANY, ANTHROPOLOGY. Total: ¥230,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Prevention of damage to ships by living creatures. ¥55,000	To prevent action of small hole-boring creatures on wooden ships & to avoid fuel loss in iron ships due to decrease in speed caused by attached creatures.	Okada, Kaname and 11 others Prof Tokyo Imp U
2.	Multiplicity and its application. ¥50,000	To study increase of food production by creating multiple forms of products.	Joto, Yoshito and 14 others Prof Tokyo Imp U
3.	Breeding of small animals for experiments. ¥25,000	Finding best method for quickly increasing no. of small animals for experiments.	Okada Kaname and 9 others ex-Prof Tokyo Imp U
4.	Regulating mechanism in living body and its military application. ¥40,000	Aim to create new type of equipment.	Aida, Tokusuke and 8 others Prof Tokyo Imp U
5.	Insects. ¥35,000	To make clear the cycle of diseases such as malaria and eruptive typhus which are carried by insects & to study prevention of these diseases.	Bokuzawa, Sanji and 13 others Prof Tohoku Imp U
6.	Increasing micro-organism and minute factors which contribute to fermentation. ¥25,000	In the fermentation of ethanol, butanol, etc, the action of minute factors has a tremendous influence. Aim is to make clear the nature & capacity of these minute factors in order to increase the production of liquid fuel.	Shibata, Yoshita and 6 others Resource scientific Research Lab.

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PART V. APPLIED PHYSICS, MECHANICAL ENGINEERING, ORDNANCE TECHNOLOGY.
Total: ¥800,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Study of aviation instruments from standpoint of dynamics. ¥30,000	To study aviation instruments from standpoint of dynamics in order to improve performance of planes	Sasaki, Iwajiro and 6 others Tokyo Imp U Aeronautical Research Lab
2.	Lubrication mechanism. ¥15,000	To improve efficiency of bearings in airplane engines & various other types of bearings by study of lubrication mechanism.	Suga, Yeshio and 7 others Tokyo Imp U, 1st Engr Dept
3.	Heat conductivity of high speed air current. ¥50,000	To assist air fighting power by studying heat conductivity of high speed air current.	Kobayashi, Akira and 7 others Nagoya Imp U, Engr Dept
4.	Fatigue of high speed machine parts and materials. ¥30,000	To lengthen life of machines by studying fatigue phenomena of parts & materials of high speed operating machines.	Nishihara Toshio and 8 others Kijoto Imp U, Engr Dept
5.	Sound buffering in warships. ¥40,000	To give an advantage to warships in surface & underwater engagements by buffering their sound.	Noguchi, Shoichi and 9 others Tokyo Imp U, 1st Engr Dept
6.	Impact destruction. ¥30,000	To study mechanism of impact demolition in order to increase power of weapons.	Takeuchi, Jiro and 8 others Imp U Tokyo, 2nd Engr Dept
7.	Penetration of bombs and bullets. ¥30,000	To improve power of bombs & bullets by studying mechanism of their penetration & further to improve measures against them.	Majima, Masaichi and 8 others Tokyo Imp U, 1st Engr Dept

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8. Bomb sight equipment. ¥30,000
To improve bomb sight and to increase accuracy of bombing. Hishikawa, Mansaburo and 11 others Tokyo Imp U
9. Improvement of design & manufacturing methods of weapons to facilitate mass production. ¥50,000
Complete reconsideration of design and manufacturing methods of machine guns and various other weapons, from the point of view of mass production. Okoshi, Atsushi and 14 others Tokyo Imp U
10. Arm parts making by pounding method. ¥30,000
Study on production of arm parts by studying pounding work in making products such as shells & various other arms. Yuasa, Kameichi and 22 others Tokyo Imp U
11. Mass production of gear wheels. ¥50,000
To study mass production methods for gear wheels in order to increase mass production of planes & various weapons. Naruse, Masao and 6 others Tohoku Imp U
12. Vacuum tube manufacturing method. ¥35,000
To improve radar equipment by studying methods of construction vacuum tubes. Kaneshige, Kankuro and 20 others Kyoto Imp U
13. Surface treatment methods & methods of examination. ¥40,000
To increase accuracy of precision or measuring instruments by studying surface treatments & methods of examination. Okoshi, Atsushi and 13 others Imp U Tokyo
14. Mass production of bolts. ¥30,000
To assist in mass production of planes & ships by studying mass production of bolts. Tbihara, Keikichi Tokyo Inst. of Technology
15. Precision forging & casting. ¥30,000
Studies on mass production of roller bearing races by precision forging method & of various machine parts by precision casting method. Fuji, Shinji and 20 others Tokyo Imp U Aeronautical Aviation Research Lab.

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| 16. Mass production by precision forging. ¥30,000 | Mass production of various machine parts by applying precision forging method. | Yamauchi, Hiroshi and 32 others
Waseda U, Science & Engr Dept |
| 17. Precision manufacturing of air ordnance parts. ¥20,000 | To improve accuracy of air weapons by studying precision method of manufacturing ordnance parts. | Sasaki Shigeo and 8 others
Tokyo Inst. of Tech. |
| 18. Increasing of efficiency of high speed bearing. ¥50,000 | To improve plane efficiency greatly by studying high speed bearing. | Sasaki Takio and 10 others
Kyoto Imp U, Engr Dept |
| 19. Small model high efficiency steam engine and other prime movers. ¥50,000 | To increase fighting power by studying small model high performance steam engine & other prime movers. | Yamanaka, Naojiro and 6 others
Tokyo Imp U, 1st Engr Dept |
| 20. High speed Diesel engine. ¥40,000 | To increase power of ship arms greatly by studying Diesel engines. | Shimizu, Kikuhei and 10 others
Tokyo Imp U |
| 21. Fluid axle coupling. ¥30,000 | To study fluid axle coupling theory & mechanism & its application to weapons & equipment. | Miyagi, Otogoro
Tohoku Imp U, Engr Dept |
| 22. Adjustment of flow supply & distribution in pipe systems in airplane. ¥30,000 | To work out method whereby automatic adjustments of flow supply & distrib. in pipe systems in a plane can be made freely & thereby increase performance of plane. | Oki, Iwao & 8 others
Waseda U, Science & Engr Dept |
| 23. Speed regulating equipment on jet-propelled airplanes. ¥30,000 | To increase air fighting power by studying speed-regulating devices on jet-propelled airplanes. | Sasaki, Shigeo and 3 others
Tokyo Inst. of Tech. |

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VI. MINING, METALLURGY, METAL ENGINEERING. Total: ¥380,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Locating mining & extraction of ores for war use. ¥40,000	Investigation of ore beds of various war-time ores. To increase ore production by studying rock blowing tunnel temperature & ore extraction.	Aoyama, Hidesaburo and 5 others Tokyo Imp U
2.	Refining of non-ferrous metals for war use. ¥30,000	To increase production from domestic resources of copper, lead, & other non-ferrous metals needed for war by studying fundamentals & their application from a new point of view.	Ogawa, Yoshio and 6 others Tokyo Imp U, 1st Engr Dept
3.	Iron ore treatment. ¥30,000	To solve various difficulties involved in furnace operation by studying various ore treatments & thereby increasing iron production from domestic resources.	Fujiye Hiroshi and 10 others Prof Osaka, Imp U
4.	Special method of iron manufacture. ¥30,000	To establish suitable method of refining ferric sand and other domestic raw material other than by use of typical furnace.	Iwase Keizo and 7 others Prof Tohoku Imp U
5.	Special method of making steel. ¥30,000	To increase production & to improve quality of steel by using new ideas in steel manufacturing method & further by utilizing materials containing special elements.	Hamazumi, Matsujiro and 3 others Prof Tohoku Imp U

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6. Magnesium production & its military uses. ¥20,000

To study industrial preparation of anhydrous $MgCl_2$ of high purity by improving the chloride preparation method, which is defective in the usual electrolytic process, & to run factory test. To advance in direct reduction process & to run factory test for this. To study action of Fe & Cu in the metal in order to produce anti-corrosive high strength Mg alloy.

Yoshikawa, Haruju and 4 others
Prof Tokyo Imp U

7. Light alloys. ¥45,000

To solve bottlenecks in production of Al & Mg alloys for planes & also to study quality drop of aluminum & utilization of scrap aluminum in order to increase production of airplanes.

Nishimura Hideo and 11 others
Prof Kyoto Imp U

8. Special steels. ¥55,000

Study of special steel for weapons such as heat resistant steel, cutting steel, & study of high speed steel & other material for tools to meet demands of the time.

Ishihara, Torajiro and 8 others
Prof Tohoku Imp U

9. Castings. ¥35,000

To study thin steel-plated castings & crank shaft materials which can be forged & cast, & materials for cast patterns. Also to investigate causes of casting faults so as to increase production of needed weapons.

Ishikawa Tokiyu and 6 others
Prof Waseda U

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10. Prevention of corrosion.
¥35,000

To study methods of preventing corrosion in steel, alloys, water pipes, corrosion-resistant material for use in chemical industrial apparatus & alloys for high pressure chemical reactions, & thereby remove various defects due to corrosion.

Uchiye, Nagaaki
and 16 others
Imp Invention Society

11. Surface treatment.
¥30,000

To increase cutting, anti-wear, & anti-corrosion properties of dies & other tools by chromium plating, surface hardening, nitriding, carbonizing, & KARORAIJINGU.

Mishima, Tokushichi
and 4 others
Prof Tokyo Imp U

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VII. AERONAUTICAL ENGINEERING, MARINE ENGINEERING. Total: ¥770,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	High speed aerodynamics. ¥50,000	To undertake theoretical & experimental study of aerodynamics to serve as references in design of high speed machines.	Moriya Tomijiro and 13 others Prof Tokyo Imp U
2.	Super high speed airplane. ¥130,000	Various researches on super high speed plane.	Kawada, Sanji and 23 others Aeronautical Research Lab.
3.	Engine for super high speed airplane. ¥100,000	Various researches on high performance, small model, high HP engines necessary for above.	Torakichi, Kinro and 20 others Aeronautical Research Lab
4.	Stratospheric airplane. ¥100,000	To study capabilities, flight performance, construction, equipment of strato-planes. Physiological & psychological consideration.	Ogawa, Taichiro and 16 others Aeronautical Research Lab
5.	Engine for stratoplane. ¥100,000	Various researches on engines of excellent high altitude performance & small fuel consumption necessary for above.	Tanaka, Keichi and 20 others Aeronautical Research Lab
6.	Wooden airplane. ¥100,000	Study on construction, strength, materials, & manufacturing method of wooden airplane.	Yamamoto, Hachio and 16 others Aeronautical Research Lab
7.	Steel plane. ¥50,000	To study construction, strength, materials & manufacturing method of steel planes in order to meet insufficient supply of light metal.	Kuranishi, Masashi and 13 others Prof Tokyo Inst of Tech

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| 8. Prevention of commercial ship sinking. ¥35,000 | To study methods of preventing commercial ships from sinking by bombs & torpedoes. | Yamamoto, Takezo and 5 others
Prof Tokyo Imp U |
| 9. High speed boat. ¥50,000 | Various researches on high speed boat. | Iguchi, Tsuneo and 10 others
Prof Tokyo Imp U |
| 10. Method to calculate safety factor drop & strength. ¥55,000 | To study method of calculating safety factor drop & strength of various construction for purpose of saving material. | Iguchi, Tsuneo and 11 others
Prof Tokyo Imp U |

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VIII. ELECTRICAL ENGINEERING. Total: ¥430,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Electrical equipment for airplanes. ¥75,000	Problems such as those on the power supply on an airplane, electrical motor, ignition system for the plane engine, DC motor brushing, which require early solution in order to increase air power are assigned to specialists for research.	Yamashita Hideo and 12 others Prof Tokyo Imp U
2.	Heat-resistant insulators. ¥45,000	With demand for increase in output for a fixed weight of electrical equipment, or in other words, the decrease in weight of equipment for a given output, the need for improving heat resistance of insulators became more urgent. Yet the supply of insulators used up to now, such as Mica, white cotton, heat resistant paints became more limited. This study is to solve the problem from aspects of electrical engring & applied chemistry.	Oyama, Matsujiro and 6 others Tokyo Imp U, 1st Engr Dept
3.	Brushes for electrical machines. ¥60,000	The quality of brush of Honno, Riyo electrical machinery is very important in determining efficiency of DC machines. The brushes of domestic production are not yet satisfactory & require improvements in many respects. This study endeavors to solve problems of brushes from pt of view of elect engring & applied chemistry.	and 18 others Emeritus-Prof Kyoto Imp U

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4. Electronic microscope.
¥30,000

To study to improve electronic microscope itself & to give basic assistance in solving various problems which require early solution.

Seto, Shozo
and 8 others
Tokyo Imp U, 2nd Engr
Dept

5. Automatic control & automatic adjustment. ¥55,000

Application of automatic control & automatic adjustment to various machinery & especially their application to weapons.

Fukuda Setsuo
and 11 others
Tokyo Imp U, 2nd Engr
Dept

6. Phenomena of electronic discharge at high altitude.
¥45,000

Various electrical equipment, especially high voltage, high frequency equipment on plane at very high altitude present quite difficult problems, different from those encountered on ground or at usual altitudes. This study is to endeavor to solve those problems.

Honda, Takushi
and 10 others
Tokyo Imp U Science
Dept

7. Electrical welding.
¥70,000

The widening use of electric welding industrially is continually bringing out new problems which require early solution. The purpose of this research is to attack the problems from a theoretical standpoint so as to gain basic reference which can be applied to making electric welding more effective.

Okamoto, Takeshi
and 17 others
Kyoto Imp U, Engr Dept

8. Relays. ¥50,000

Because of its importance in manufacture of highly efficient weapons, improvements in relays are sought. Study is made from point of view of electric & magnetic circuit, mechanics & material engring.

Ohashi, Mikiichi
and 9 others
Chief, Electrical
Test Lab

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IX. CIVIL ENGINEERING. CONSTRUCTION. Total: ¥490,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Underground constructions for military use. No. I. ¥30,000	To study method of building underground structure for military purposes and to work out some practical plan.	Yamasaki, Kunisuke and 12 others Tokyo Imp U, 1st Engr Dept
2.	Underground constructions for military use. No. II. ¥30,000	To study structures for air force bases.	Fukuda, Takeo and 10 others Tokyo Imp U, 2d Engr Dept
3.	Bridges for military forces. ¥40,000	To study bridge structure for military purposes to meet present war situation & to work out some definite	Tanaka, Utaka and 12 others Tokyo Imp U
4.	Civil engineering materials for military use. ¥20,000	To meet present war situation, civil engineering materials are re-examined, particular attention being given to substitute material & to use of local material.	Aoki, Kusuo, Chief, Civil Engr Test Lab, and 12 others
5.	Concrete structures for military purposes. ¥50,000	To study use of concrete & construction methods for military purposes.	Yoshida, Tokujiro Tokyo Imp U, 1st Engr Dept, and 6 others
6.	Military water supply & sewage ducts. ¥20,000	To study military water supply & sewage system to meet present situation of war & to obtain some actual plan.	Hirose, Korokuro and 7 others Tokyo Imp U, 1st Engr Dept
7.	Strengthening of electric power generation. ¥30,000	To study hydraulic problem to obtain larger hydro-electric power to meet present situation of the war.	Homma, Jin and 9 others Tokyo Imp U, 1st Engr Dept

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| 8. Strength of structure.
¥30,000 | To study strength of structures. | Mise, Kosaburo
and 11 others
Kyushu Imp U |
| 9. War time buildings (I)
(material) ¥30,000 | To study various materials for bldgs in wartime. To find substitute materials & to use local material. | Kobayashi, Masaichi
and 13 others
Tokyo Inst of Tech |
| 10. War time buildings (II)
(construction) ¥30,000 | Study of bldg structure in wartime & to work out some actual plan. | Naito, Tanaka
and 12 others
Waseda Univ. |
| 11. Wartime buildings (III)
(installations, sanitation)
¥30,000 | To study installation & sanitary problems in wartime. | Watanabe, Kaname
and 4 others
Tokyo Imp U |
| 12. Wartime buildings (IV)
¥30,000 | Study of installation of air bases & to work out suitable plan for it. | Ban, Shizuo
and 11 others
Kyoto Imp U |
| 13. Defense of production plants. ¥30,000 | To study various problems of war defense of production plants & work out actual future plan. | Hamada, Minoru
and 6 others
Tokyo Imp U. |
| 14. Defense of cities.
¥30,000 | To consider the defense of cities & dwellings & to work on a practical national plan. | Kishida, Hideao
and 11 others
Tokyo Imp U |
| 15. Defense of buildings and constructions. No. I.
(against bullets & bombs)
¥30,000 | To study constructions method to stand bombs & bullets attacks & to work out a practical plan. | Muto, Kiyoshi
and 5 others
Tokyo Imp U |
| 16. Defense of buildings and constructions. No. II.
(against fire and gases)
¥30,000 | To carry out a hurried study of structures to withstand fire & gases & work out some practical plan. | Hirayama, Ko
and 3 others
Tokyo Imp U |

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X. PURE RESEARCHES. Total: ¥2,080,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Flight medicine. ¥260,000	Study of high altitude flying & diving for purpose of trying to increase ability to withstand these & to prevent dangers.	Kato, Toyojiro and 70 others Tohoku Imp U
2.	Underwater medicine. ¥100,000	Study to improve living conditions in submarine & to increase operating efficiency.	Hisano, Nei and 15 others Nagoya Imp U
3.	Ability to stand heat & acclimatization. ¥110,000	Study to promote working efficiency & to direct way of living by examining individual differences in ability to stand heat & suitability for life in tropics.	Hisano, Nei and 17 others
4.	Acclimatization to low temperature. ¥120,000	Study on method of protection against cold, precautions against frostbite and further to find a method of increasing ability to stand cold.	Toda, Masazo and 8 others Kyoto Imp U
5.	Nutrition in the tropics & in cold regions. ¥45,000	Study on selection of food stuff suitable for climate & on method of increasing production & of storage.	Toda Masazo and 15 others Kyoto Imp U
6.	Physical power. ¥30,000	Study on maintenance & promotion of physical power of people & on individual's suitability to various manual work.	Uramoto, Masazaburo and 30 others Gichukai Med Sch
7.	Sight strengthening. ¥54,000	Prevention of nearsightedness & strengthening of sight in daylight & night.	Shioji Yoshiji and 15 others Tokyo Imp U

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| 8. The health of infants.
¥50,000 | Study on nutrition of infants in war-time, prevention of sickness, motherly care, method of keeping health of working women. | Kuriyama, Shigenobu
Tokyo Imp U
and 24 others |
| 9. Blood transfusion substitute. ¥180,000 | Study of blood transfusion substitute medicine, method of storing of blood, method of blood transfusion. | Miyakawa, Yoneji
and 14 others
Tokyo Imp U |
| 10. Emission Ray.
¥120,000 | Study on method of indirect X-ray photography, on its application to group examination for tuberculosis & on effects of various emission rays on living matters. | Nakazumi, Masatoku
and 12 others
Tokyo Imp U |
| 11. Tuberculosis.
¥140,000 | Study on inoculation against tuberculosis, improvement in method of treatment, & on problem of work for tuberculosis patients. | Imamura, Arao
and 63 others
Osaka Imp U |
| 12. Filterable viruses.
¥20,000 | Study of influenza, small pox, trachoma | Takeuchi, Matsujiro
and 21 others
Osaka Imp U |
| 13. Immunity.
¥50,000 | Study on inoculations against various infectious diseases, mass production of inoculation serums, methods of storage & use. | Tamiya, Takeo
and 28 others
Tokyo Imp U |
| 14. Fatigue.
¥94,000 | Study of nature, diagnostic method, prevention of & recovery from fatigue. | Katsunuma, Seizo
and 36 others
Nagoya Imp U |

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15. Nutrition efficiency.
¥78,000

Study on nutritional value of wartime food in Japan, Korea, Manchuria, & determination of minimum amt required for different professions.

Toda, Masazo
and 13 others
Kyoto Imp U

16. Eruptive typhus.
¥96,000

Study on inoculation against diagnosis extermination of eruptive typhus & also on problems concerning mass living sanitation.

Miyakawa, Yoneji
and 20 others
Tokyo Imp U

17. Brain waves.
¥38,000

Study on picturization of brain wave & its application.

Katsumura, Seizo
and 11 others
Tokyo Imp U

18. Enzymes.
¥40,000

Chemical research on various enzymes & quantity production of those which can be used to increase physical power & heat-standing ability.

Kobu, Yashiro
and 16 others
Osaka Imp U

19. Physical Standards for Japanese. ¥40,000

Determination of physical standards by measuring young & adult male Japanese.

Nishi, Naruko
and 24 others
Tokyo Imp U

20. Physical constitutions.
¥20,000

To study ability & change in ability to resist various diseases from standpt of constitution & type of body.

Koike, Kyiji
and 23 others
Chiba Med College

21. Hot springs.
¥38,000

To study effect of natural hot spring & to apply this in recovery from fatigue.

Misowa, Keigi
and 11 others
Tokyo Imp U

22. Hormone Vitamins.
¥60,000

Study of mechanism of action & method of use of (vitamin hormone).

Shimizu, Tayei
and 17 others
Okayama Med College

23. Infectious cerebro-spinal meningitis. ¥50,000
Various chemotherapeutic methods parallel use of inoculation serum, measures against carriers, & improvement of vaccine.
Miyakawa, Yoneji and 5 others
Tokyo Imp U
24. Digitalis. ¥27,000
Hayashi, Haruo and 15 others
Tokyo Imp U

Special tropical diseases.

- (a) Prevention of malaria & treatment. ¥60,000
Prevention of malaria, malarial mosquitoes, sanitary installations, treatment test of efficacy of new medicines.
Hayashi, Haruo
- (b) Preparation of anti-malarials. ¥60,000
Synthesis of new anti-malarial compounds.
Asahina, Haruhiko
- (c) Prevention of dengue fever & treatment. ¥50,000
Culture of dengue parasite, animal inoculation method of diagnosis, experiment with human being.
Koizumi, Tan
- (d) Leprosy. ¥50,000
Animal inoculation, culture of bacteria, new chemotherapy.
Ota, Masao

XI. AGRICULTURE, AQUATIC INDUSTRY. Total: ¥815,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Animal & plant sources for lubrication oil. ¥79,000	Examination of sources, discovering new sources, cultivation of superior species, treatment of plant oil.	Moritaka, Jiro and 7 others Prof Tokyo Imp U
2.	Communication interferences in sea. ¥25,000	To study method of preventing communication interferences in sea caused by aquatic creatures, fish, & small seaweeds. (Research in coop. with Navy)	Ito Koichi and 4 others Prof Tokyo Imp U
3.	Construction of airfield on agricultural land & its drainage system. ¥36,000	Study & investigation on airfield construction, advantages of agricultural ground, its surface & underground drainage, nature of soil, planting, & on machinery for working the ground.	Tanaka, Teiji and 13 others Prof Tokyo Imp U
4.	Cultivation of special aquatic products. ¥48,000	Study of luminous creatures for night military use & as sources of nutrients products for the military. (Research in cooperation with Army)	Amemiya, Ikusaku and 12 others Prof Tokyo Imp U
5.	Fibers from agricultural products. ¥48,000	Selection of suitable species, method of cultivation for increased yield, speeding up lengthening of hemp with chemicals.	Sasaki, Ko and 27 others Prof Tokyo Imp U
6.	Soil maintenance. ¥45,000	To improve soil & growth factors & also to increase the effect of fertilizer.	Kasugai, Shimichiro and 13 others Prof Tokyo Imp U

7. Uses of water areas on land. To increase production of aquatic products by utilization of water areas on land such as rivers & lakes. Amemiya, Ikusaku and 14 others
¥23,000 Prof Tokyo Imp U
8. Agricultural insects. Studies on extermination of chief insects harmful to rice, barley, sweet potatoes, etc.; on insects harmful to stored foods; their nature & method of extermination; on extermination of insects harmful to pine trees; on mass production of insects that can be utilized for above extermination purpose & nature of these insects. Tekiki, Takio and 16 others
¥50,000 Prof Tokyo Imp U
9. Wartime food for health. Treating of food stuff; rationalization of combination & cooking; preparing food from things not used as food but which are edible, making inedible substances edible; grains powdered food; country food stuffs; search & use of natural vitamin sources; effects of vitamin & others in a limited food supply. Yabuta, Teijiro and 28 others
¥89,000 Prof Tokyo Imp U
10. Phenomenon of "fall" in autumn & its elimination. Research on eliminating the phenomenon of "fall" during autumn. Attack of problem from standpoint of soil technology, fertilizer, meteorology, drainage, irrigation, & cultivation. Osugi, Shigeru and 10 others
¥31,000 Prof Kyoto Imp U

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| 11. Diseases of farm products & their prevention.
¥53,000 | To investigate & establish methods for extermination of nine diseases among rice plants, barley, sweet potatoes, & potatoes; rust on plants that are very important for military purposes, & disease on standing trees. | Ito, Seiya
and 22 others
Prof Hokkaido Imp U |
| 12. Sea weeds resources.
¥45,000 | To study seaweeds resources for potassium, sodium, food, medical material. | Kokugi, Hiroshi
Asst Prof Tokyo Imp U
and 20 others |
| 13. Sweet potatoes.
¥43,000 | Early planting, "wet cultivation", storage method, prevention of spoilage. | Inomoto, Chuei
and 17 others
Prof Kyoto Imp U |
| 14. Potatoes.
¥34,000 | Study to economize on seed potatoes, method of cultivation to obtain increase in yield by hormone treatment, storage, & prevention of spoilage. | Tegima, Torao
and 15 others
Prof Hokkaido Imp U |
| 15. Chemicals for agricultural purposes. ¥20,000 | To study efficacy of substitute chemicals & new agricultural chemicals, to discover effective, suitable new agricultural chemicals. | Takei, Sankichi
and 12 others
Prof Kyoto Imp U |
| 16. Chrysanthemum potatoes.
¥15,000 | There are many things not known about chrysanthemum potatoes, a newly-risen product important as food, animal fodder, & as industrial raw material. | Sasaki, Ko
Prof Tokyo Imp U |

20-32

RESTRICTED

17. Various grains.
¥25,000

Selection of types & cultivation method to take advantage of the productive capacity, even under unfavorable conditions, of grains such as soy beans, corn, "SOBA", and barley, and take advantage of various grains.

Terao, Hiroshi
and 5 others
Prof Tohoku Imp U

18. Vegetables.
¥25,000

Selection of highly productive species, utilization of first generation hybrids, study on winter storage, improving vitamin production in vegetables.

Asami Yoshichi
Prof Kyoto Imp U
and 8 others

19. Second crops on rice field.
¥44,000

To promote second crops on rice field in Tohoku region where this is not practiced in large scale.

Terao Hiroshi
and 9 others
Prof Tohoku Imp U

20. Increased production & utilization of coast aquatic food stuff. ¥37,000

Study to increase production & utilization of coast aquatic food stuffs for supplementary food supply to assist present difficult situation in ocean fishing.

Imai Fumio
and 14 others
Prof Tohoku Imp U

XII. FORESTRY. Total: ¥320,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Materials for airplanes & for wooden ships. ¥130,000	Physical & chemical study of wood, their species, quality, place of growth.	Miura, Ihachiro and 21 others Prof Tokyo Imp U
2.	Wood fibers. ¥24,000	Consideration of methods & utilization of various kinds of trees as sources for wood pulp & development of use of various wood fibers.	Nishida, Kozo and 7 others Prof Kyushu Imp U
3.	Carbonization of wood & manufacture of pine root oil. ¥50,000	To improve method of carbonization of wood to meet great demand for charcoal in industries & to improve the hurriedly-developed method of preparing pine root oil.	Miura Ihachiro and 13 others Prof Tokyo Imp U
4.	Use of resins & tannin. ¥38,000	Study on methods of collecting natural resin from forests, their properties, methods of preparing them. Study of tannin content, properties, & on extraction method.	Fujioka, Mitsunaga and 8 others Dept of Agric & Commerce
5.	Production of special forest products. ¥26,000	Study to increase production of forest products which are vital war material such as resins, oil, essential oils, dye stuff, & alkaloids.	Nakamura Kentaro and 6 others Prof Tokyo Imp U
6.	Uses of various mushrooms. ¥30,000	Study on profitable uses of forest mushrooms & action of mushrooms on forest products.	Hosogawa, Kozo and 6 others Tokyo Forestry Bureau

7. Plants for camouflage & for Study in camouflage & Nakamura Kentaro
prevention of fire. prevention of fire by and 9 others
¥22,000 use of plants, espe- Prof Tokyo Imp U
cially on method of
preventing forest fires.

2. Investigation of shooting

4. Use of leather & rubber

3. Construction of wood &

5. Wood types

1. Methods for various &

NO. SUBSIDIARY

XII. BOMBING 10441: 2250000

RESTRICTED

20-35

RESTRICTED

50-34

XIII. VETERINARY SCIENCE. ZOOTECHNY. Total: ¥230,000

NO.	SUBJECTS	RESEARCH AIM	NAME OF CHIEF RESEARCHER
1.	Military horses & animals. ¥80,000	Study on increasing production of military horses & other animals for military use & on their sanitation, so that source of military horses in wartime can be maintained.	Emoto, Osamu and 14 others Prof Tokyo Imp U
2.	Domestic animals & domestic fowls. ¥44,000	To plan to increase number of best domestic animals & fowls by applying principles of heredity in present situation of insufficient feed.	Masui, Kiyoshi and 11 others Prof Tokyo Imp U
3.	Increased production of feed. ¥35,000	Study of utilization of all possible sources of feed & to plan immediate increase in production.	Egushi, Kenzo and 10 others Prof Hokkaido Imp U
4.	Leather & furs. ¥27,000	To increase production of leather & furs for military purposes.	Sato, Masayoshi and 10 others Prof Hokkaido Imp U
5.	Animal fiber. ¥17,000	Mainly study of sheep & rabbit hair & to increase production of good quality hair.	Sasaki, Seiko and 8 others Prof Hokkaido Imp U
6.	Utilization of animal products. ¥12,000	To study utilization of animal products aiming to produce feed of high nutritional value such as Casein & others which cannot be neglected for military purpose.	Nakai, Toshiro and 8 others Chief, Livestock Exp Station
7.	Parasites of domestic animals. ¥15,000	To exterminate harmful parasites of domestic animals, to promote efficiency of military horses & general domestic animals.	Yoshimura, Ichiro and 5 others Pres, Veterinary Coll.

SUBJECT: Quartz Crystals.

DATE: 12 October 1945.

INTERVIEWED: Dr I KOGA, Tokyo Technical University.

INTERVIEWER: Maj W R Hewlett.

1. Dr Koga, for the past 15 years, has been actively interested in the Piezzo-Electric properties of quartz crystals. In August, 1933, he published an article in the PHILOSOPHICAL magazine on the theory of vibration of quartz crystals. He classified nodes of vibration into two groups: thickness and contour. Those in the thickness group depended only on that dimension to determine the natural frequency of vibration. In the second class the frequency is independent of thickness and dependent only on the external contours of the plate. The bulk of Dr Koga's work had been on the first class and through his work in this field he claimed to be able to predict all modes of vibration of the thickness type, and to derive such special cuts as the AT and ST. He admitted, however, that with the reduction in size of quartz plates there was a merging between the thickness and contour classes. Dr Koga, in an earlier paper, had proved that a principle of similitude could be extended to quartz crystals. He had also been interested in the measurements of the elastic constants of quartz by dynamic rather than static means.

2. During the war, Dr Koga had carried on no research specifically for the Army or Navy. In a few instances he had acted as consultant in a personal capacity on minor problems. His principal wartime research projects are listed below:

a. An effort to develop a 250-watt crystal controlled transmitter requiring only two tubes, but this work had not been particularly satisfactory.

b. Methods to reduce the frequency of crystals when they had been ground too thin. In an effort to solve this problem, Dr Koga investigated the possibilities of baking a hard enamel on the crystal surface and then regrind to the desired frequency. However, the stability of the crystal so treated was only fair. The shortage of silver and the feeling that a silver plating process was not commercially feasible, prevented any extensive work on the use of silver to reduce the natural frequency.

c. During a visit to the US, Dr Koga had seen the apparatus for measuring the "Q" of crystals as developed by K Van Dyke at Wesleyan University. Dr Koga had felt that this method was too cumbersome and had devised one of his own in which a vacuum tube quartz crystal-controlled oscillator was abruptly switched on and off in the plate circuit. By means of a cathode ray oscillograph it was possible to study both the building up of the oscillation when the voltage was applied and the tailing-off when the circuit was broken. From the former observation an estimate could be made on the efficiency of a given tube as an oscillator, and from the latter, "Q" could be easily computed.

d. He had also investigated possible substitutes for quartz

crystals by undevelopment of highly stable components. His best results had been obtained with a fused quartz coil form on which was plated a conducting layer of silver and a spiral groove then ground on the surface of the cylinder to form an inductance. The stability of this coil form had been such that when used with suitable condensers it would have a temperature coefficient of 2 cycles per megacycle per Co.

c. Dr Koga had heard of no serious difficulties encountered with the aging of quartz crystals although there had been some informal indications that a few Army radio sets in tropical areas had been bothered by this effect.

3. The principal manufacturers of quartz crystals in Japan were:

Meielsenha Co, Osaka-Fu, Tokyo
Toyo Tsushinki Co, Tokyo

a. It may be concluded from the interview with Dr Koga that the quartz crystal industry in Japan never assumed the importance that it did in the US. Although many of the Japanese military communication sets were crystal-controlled, neither the quantity in production nor the quality of performance placed any degree of strain on the industry. As the foremost quartz crystal expert in Japan, Dr Koga was never consulted by the military for technical advice of crystal problem.

Japanese Magnetrons

As far back as 1927, Professor Kinjiro OKABE of Osaka Imperial University published papers in the Proceedings of the Imperial Academy on magnetrons as oscillators. In Japan he is regarded as the inventor of the magnetron as an oscillator and has frequently served as a consultant to both services and to the industries. He has continued to work on C.W. Magnetrons.

Work on magnetrons was wide spread in Japan. Besides the service laboratories, several research institutions and several universities carried on design and theoretical studies which lead to its use as a transmitter and local oscillator for C.W. waves. During the war several nuclear physicists were induced to join the service laboratories for this work. However Professor Morita of Tokyo Institute of Technology, chief influence on Army designed, remained at the institute and served as a consultant.

Despite this widespread interest no attempt was made to coordinate the efforts. This lead to two schools of design as far as the services were concerned, that of the Navy under Y. ITO, now a Naval Captain, Technical, and that of the Army under the influence of Professor Morita.

The Navy program dates back to June 1933 when Captain ITO started studying the magnetron. Since that time there has been a fairly steady naval development. Captain Ito seems to have been largely under the influence of Professor Okabe who is strictly academic and interested much more in the magnetron perse than in its uses as a weapon. Literally, scores of designs were tried most of them novel to the members of this mission and most of them of low power. A few gave as much as 5 KW. In time these varieties were grouped into 7 types. Typical diagrams are shown on pages 22-6 and 22-7.

1. "Mandarin Orange" characterized by having alternating cavities or resonating circuits tuned to two different frequencies. This had an appropriate theory that indicated it would have a lower Q and slightly higher Q than the type having all the circuits tuned to the same frequency (Plum). In this they felt they obtained greater frequency stability.

The 10 cm magnetrons for the Navy built by Nippon Musen were of this type. The transmitter was broached from a copper block about 1 cm thick. For ground stations this was surrounded by a copper tube for water cooling. The local oscillators were fabricated from wire about 1 mm in diameter. The anode took the form of a ring rim with four symmetrical short spokes. Each of these supported a U piece at the apex thus providing 8 spokes coming into a slotted hub surrounding a single stretched filament electrode. The electrodes or poles making the hub were 3 mm pieces of sheet welded to the ends of the spokes normal to the plane of the anode rim. The diameter of the hub was about 2 mm.

2. "Sunrise" - characterized by having all cavities tuned to the same frequency and being fabricated from sheet metal or wire. The cavities were usually spot welded to the inside of a sheet metal cylinder and were usually wedge shape with the apex cut off.

3. "Plum" is a modification of the sunrise broached from a solid block with cylindrical cavities all tuned to the same frequency. It closely resembles American unstrapped design. Work was done on this type by Nippon Musen for the Army. Mr. Nakajima showed a slotted anode from which he claimed to have gotten 7 mm waves.

4. "Rilly" - This anode usually took the form of a number of electrodes surrounding the anode and all spot welded to a circular ring at one end. Occasionally it took the form of having alternate electrodes soldered to a ring at one end and the other set soldered to the second ring at the other end. Also examples were seen where the open ends of the first form were strapped in 3 phase, every third electrode being connected.

5. "Cage" - Essentially the Rilly with both ends of all electrodes soldered to rings.

6. "Lap Widging" - possibly "lap winding". Essentially this is not a new type but strapping, called equalizers by the Japanese, could be applied to most of the above types. The Navy preferred 3 phase strappings while the Army preferred 2 phase strappings.

7. "Crysothermum" - Unquestionably the most elaborate of the very low power magnetrons. Typically it had wire U's with electrodes at the tips normal to the plane of the U's. Then these were supported by small stubs to a surrounding ring much as for the Navy local oscillator. However, the U's were more open and each leg overlapped the leg of the adjacent U. Thus there were two electrodes between those appropriate for the connected pair. The electrodes were evenly spaced surrounding a filament cathode.

Power was usually taken from the anode by capacity coupling. Sometimes this took the form of a ring plate coplanar with and near the resonant circuits. Occasionally it was a single disc near one of the resonant circuits. Again there were probes penetrating the cavities. Occasionally they had two capacity pick ups, on opposite sides of the resonant circuits or in adjacent loops, and fed both of these out for a two wire system. This was the arrangement for the navy 10 cm, local oscillator. The navy airborne transmitter had the plane of the resonant circuits normal to the stub supported coax line it was feeding. The connections to the inner conductor were four symmetrical straps coming from the rim of the anode block to the lead to the inner conductor. The 200 KW "Death ray" magnetron (appendix 24) was to have been a "Plum" type with such a feed to a cone supported by the lead. The lengths and number of straps affects the output impedance.

Until very recently all magnetrons had a glass envelope. This made for rather large air gaps and operation at low magnetic fields. Most

magnetrons had the power take off and filament leads coplanar with the anode structure and thus permitted iron core magnets. The Navy airborne magnetron, described above with the take off and filament leads normal to the anode, fits inside of an air core solenoid.

Recently the Sumitomo laboratory at Ikuta made a magnetron for 3 cm very similar in design to the American 3 cm magnetrons. It was an all metal tube with input and output leads coplanar with the anode block. The output terminated in a vacuum sealed probe to excite waves in a guide. The block had 12 cavities. On each end a circular slot had been milled 1.5 mm back from the poles 1.5 mm wide and about 1 mm deep. A ring had prongs soldered into the slot of every other pole. A similar ring was on the other side of the block. These rings were called equalizers. The take off was a loop just outside of one of the cavities. It was reported to give 50 w.

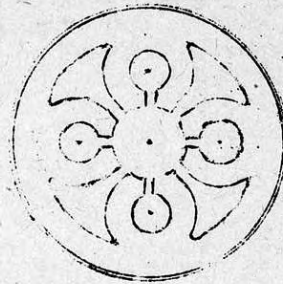
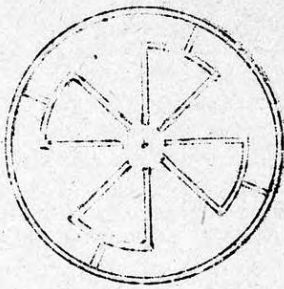
The Army had developed a very similar device. The members of this mission are very suspicious that these developments were started after some B-29's had been downed over Japan despite the Japanese protests that they had been started before that.

On attempting to get the necessary cooling for high powers there were several novel designs. In one a copper tube was wound in the form of a spiral on a doughnut mandril. This did not prove to be very efficient. In another, the anode was constructed by having 8 copper tubes bent in the form of U's as spokes to a hollow rim with the planes of the U's coaxial to the cathode at the axis. It seems incredible that tolerances were kept sufficiently to produce any predominate frequency. Suffice it to say they did not go into production on either of these.

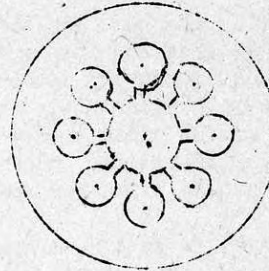
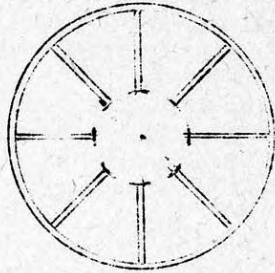
A novel 2.8 cm tube, presumably designed for 3 cm had its block normal to the axis of a piece of circular guide. There were eight cavities. Each cavity had a U shaped loop or wicket connecting one side of the cavity to the other with the plane of the U tangential to the cylinder of symmetry about the axis and extending out from the block about 5 mm. Each of these loops acted as a radiator for the cavity it bridged. Since all cavities had loops circularly polarized waves were set up in the guide. This magnetron gave 130 KW peaks.

Several magnetrons were constructed with built in di-poles.

Besides the application to radar various investigators were developing magnetrons for other uses such as communications, television, diathermy, fixation of nitrogen, irradiation of seeds to hasten growth of the plant, and the use of electromagnetic waves as a chemical catalyzer. The diathermy lead to the magnetron in the reported death ray described in report 1-E. The preliminary results on the fixation of nitrogen showed that no particular advantage would be gained by going to high frequencies. Preliminary results with wheat showed a possible shortening of the growing period by two weeks. Several Japanese are anxious to pursue this aspect further due to the tight agricultural situation. The work on the use of UHF waves as a chemical catalyzer had not started.



Mandarin Orange

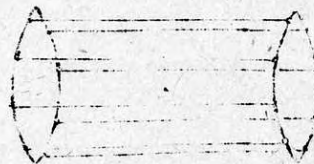


Sunrise

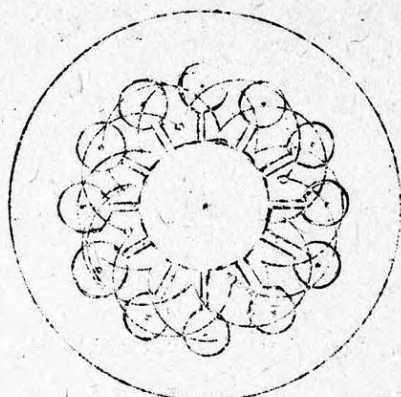
Plum



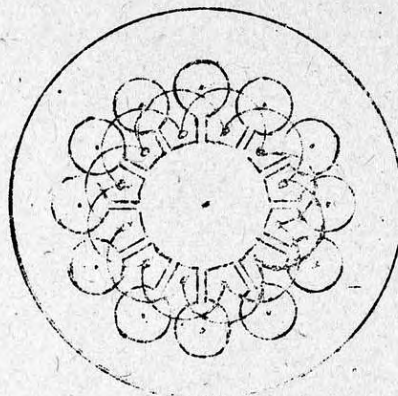
Lily



Cage

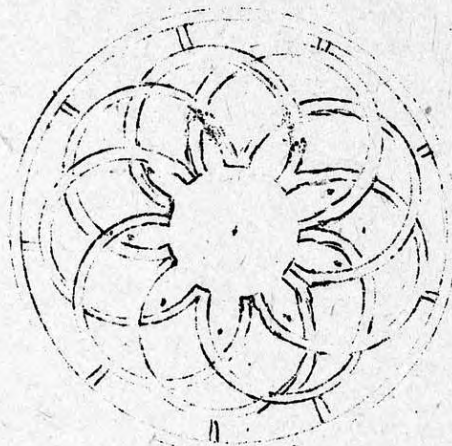
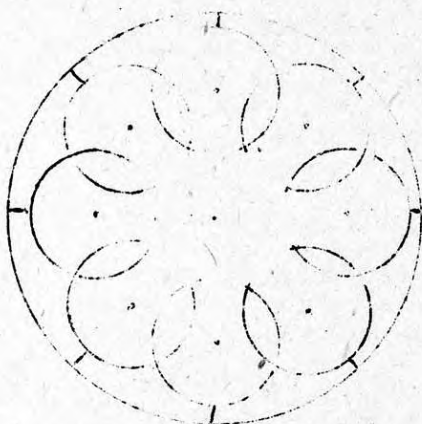


3 phase



2 phase

Lap Widging



Crysanthemum

List of Japanese Magnetrons Researches
Prepared by M. Mizuma of Shimada Branch of
2nd Naval Technical Institute

	<u>Year</u> - <u>Month</u> - <u>Day</u>
1. Start study of Magnetron Y. Ito Naval report	33 6 10
2. Ultra short wave from 2 split magnetrons 50 cm. 0.1 w. Y. Ito, T. Ito Naval reports 1-4	34 5 10
3. Application of back coupling theory to Magnetron Experimental study at low frequency Y. Ito Naval report 5	34 12 10 36 4 10
4. 3 phase oscillation with 3 split magnetron Experimental low frequency Katurai Naval Report 6	36 10 5
5. 4 phase oscillation with 4 split magnetron Experimental low frequency M. Mizuma Naval report 7	36 4 23
6. 5, 6, and 7 phase oscillations with 5, 6, and 7 split magnetrons Experimental low frequency M. Mizuma No report	37 10
7. 3 phase ultra short waves from 3 split magnetrons 2 m, 200 w. M. Mizuma Kenseiroku	38 5 11
8. Ultra high frequencies with 4 split magnetron 15 cm, 0.1 w. Nippon Wireless Co No report	39 4
9. Communication with No. 8 valve Distance 20 km. M. Mizuma No report	
10. Invention of "Mandarin Orange" 10 cm, 15 w. M. Mizuma, T. Ito, K. Takahashi Kenseiroku	39 6 11
11. To discover G - type oscillation M. Mizuma, T. Ito, K. Takahashi Kenseiroku	39 6 11
12. Internal Electric field distribution in 3 split magnetron Low frequency M. Mizuma Naval report	40 11 30

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22-6

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22-7

	Year	Month	Day
13. Static fields in multi-split magnetron theoretical study I. Takao Naval report	40	6	1
14. Rotating electric field and indirect currents due to gap capacity and spacing. Theoretical M. Mizuma, I. Takao Naval report 0127	40	10	1
	40	12	2
15. General theory of poly-phase oscillations M. Mizuma Naval report 2295	39		
16. Invention of "Chrysanthemum" type 10 cm, 10 w, 3 cm, 1 w, 5 cm, 1 w, 0.7 cm, 0.1 w. M. Mizuma, Y. Inagaki Naval report 2273 etc	39		
17. Invention of "Chrysanthemum" type Y. Ito, M. Mizuma Patent No. 17907	39		
18. Invention of "Lily" type 8 cm, 20 w. M. Mizuma, S. Nakajima, S. Makino Kansenroku 3 & 11	40		
19. Invention of "Lily of the Valley" type 8 cm, 20 w. S. Nakajima, S. Yamajaki, S. Makino Kansenroku 21 & 48	40		
20. 3 phase oscillations with 3 split magnetron 20 cm, 10 w. M. Mizuma No report	40	20	10
21. Multiphase centimeter waves 4 phase, 8 cm, 6 phase, 5.6 cm. M. Mizuma, S. Nakajima Kansenroku	40		
22. Invention of "Cage" type 3 phase, 10 cm, 11.8; 2 phase, 5.7 cm, 12.5 w M. Mizuma, S. Nakajima Kansenroku	40		
23. Centimeter waves from "Chrysanthemum" type 10 cm, 10 w; 15 cm, 25 w; 10 cm, 100 w; 6.1 cm, 32 w. M. Mizuma, Y. Inagaki Kansenroku	39	10	10
	40	1	10
24. Communications Experiments 11.21 cm, 5.8 w for 20 Km. B.K. rec- ording tube T. Ito, M. Mizuma, S. Yamajaki Naval report	39	11	10
	41	4	10

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22-7

RESTRICTED

22-8 33-1

Year -- Month -- Day

25. Application to Radio Locator	41	5	1
10.2 - 10.6 cm, 2 KW Peak			
M. Mizuma, S. Yamasaki, S. Nakajima	No report		
26. High Power Magnetrons	40	4	10
10 cm, 150 w			
M. Mizuma, S. Yamasaki	No report		
27. Magnetrons for Radio Locators	42	5	17
10 cm, 10 KW; 5.1 cm, 11 KW;	44	10	5
3.2 cm, 9.5 KW; 4.2 cm, 10 KW (peak);			
5.0 cm, 10 KW.			
M. Mizuma, I. Takao, H. Ito, M. Matumoto,			
S. Nakajima.			
28. High Power C. W. Magnetrons.	43	6	8
21 cm, 4.1 KW; 15 cm, 5 KW; 23 cm, 9 KW.	45	7	10
M. Mizuma, S. Yamasaki, Watase	No report		
29. Theoretical study of ultra short wave magnetrons	38	10	4
Y. Ito, S. Nakajima, M. Mizuma,	43	11	30
S. Tomonaga, M. Kotani, I. Takao.			
Shimada report			

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22-8

RESTRICTED

SUBJECT: Japanese Meteorological Work.

DATE: 13 October 1945

INTERVIEWED: Dr H. Arakawa, Central Meteorological Observatory
Lt Col Mizuma, Japanese Army

Mr S. Aoki, Interpreter

INTERVIEWERS: Maj Hewlett, Dr Griggs, Tec 4 Yagi

1. The Central Meteorological Observatory (Chuo Kisho Dai) under the Ministry of Transportation is divided into five main departments.

- a. Research Department. Located at Kamesuwa. Superintendent, K. Hidaka.
- b. Investigation Department. Located at Okaya. Superintendent, H. Arakawa.
- c. Instrumental Department. Located at Iwamura. Superintendent, R. Kuraishi.
- d. Weather Forecasting Department. Located at Tokyo. Superintendent, K. Wadachi.
- e. General Affairs Department. Located at Tokyo. Superintendent, K. Wadachi.

The present director of the observatory is Dr F Fujiwara. Before 1943, the observatory was under the Ministry of Education.

2. Prior to 1939 Dr Arakawa was only engaged in weather forecasting, but in 1940 he became a research member of the observatory and superintendent of the Department of Investigation. His principal fields of investigation had been:

a. Statistical study of weather elements in Japan and of the world at large. This work was divided into three groups:

- (1) Upper air observations (elevations greater than two meters).
- (2) Ground observations (elevations below two meters).
- (3) Climate.

b. Theoretical meteorology of air masses in the Far East. The results of this investigation were published in Japan in 1940.

c. Cosmic Ray Measurements. The results of this investigation were published in the Physical Review in 1940.

The records of these investigations are at present intact in Dr Arakawa's personal files.

3. Dr Arakawa had not been engaged in any equipment development work. Information pertaining to this field was supplied by Lt Col Niizuma. The only major item of meteorological equipment that Col Niizuma could remember as having been under development during the war was an automatic weather station. This station was intended to record surface conditions in remote and inaccessible areas such as those that exist in Manchukuo. Original experiments had indicated that data could be transmitted for a distance of 4 or 5 km for a period of a week or more, but it was hoped that both range of transmission and time of operation could be substantially increased. Col Niizuma stated that this set was being developed by the Hiraio Donki Shikonjo in Ibaragi Prefecture. Col Niizuma had no detailed information on any radio sonde work that the Army had been carrying on. He stated that Mr K Yuasa of the Meteorological Section of the War Ministry had been actively engaged in this field and might have further information. So far as Col Niizuma knew, no effort had ever been made to track meteorological balloons carrying suitable reflectors by ground radar stations. Neither Dr Arakawa nor Col Niizuma knew of any detailed tropospheric propagation work in the ultra short-wave region that was under way in Japan.

4. Dr Arakawa had been reported to be one of the three meteorologists who studied the theoretical capabilities of the Japanese balloon attack against the United States. Although questioned in considerable detail, he was unable to furnish any exact information on his studies in this field. Further, due to the lack of interchange of information between military and civilian agencies, he was unable to learn the extent to which his predictions had been realized. Col Niizuma stated that the balloons were tracked in the first part of their course by a radio direction-finder net consisting of two stations, one in Hokkaido and one in Chiba Prefecture, Honshu. It is interesting to note that with a base line of slightly more than 250 miles and with an admitted direction-finding error of $\pm 20^\circ$, the Japanese were attempting to pin-point the location of balloons over two thousand miles away.

SUBJECT: Interviews with Professor K. Morita.

INTERVIEWERS: Doctors Longacre and Griggs.

DATED: 15 and 31 October 1945.

Professor Morita is on the faculty of the Tokyo Institute of Technology. There he has a laboratory for ultra high frequency research. In it he has two co-workers, Mr. Nismaki and Mr. Y. Watanabe, besides 18 assistants in 1944. All salaries were paid by the institute and appropriations for research were:

	1940	1945
From Japanese Society for Promotion of Scientific Research:	¥3,000	¥20,000
From Army Tama Technical Research Laboratory:	0	¥10,000

During the war Professor Morita and his staff served as consultants to the Army and their manufacturers. He continued his teaching throughout the war and he published a much sought second edition of his book on ultra-high frequencies in 1945. He did no work for the Navy. His transcription of the projects of his laboratory is appended to this report. It is to be noted that the high power magnetron of part 3-C was being designed for the Death Ray experiments of Appendix 1-E.

Professor Morita reported that the Japanese Army started radar work with C.W. and the doppler effect as early as 1938. They later went to a pulsed technique with a 3-4M back coupled oscillator to obtain the distance of the target. This led to trials with pulsing a C.W., 20 cm, magnetron in 1941. The first army pulsed magnetron system was developed in 1943.

Professor Morita has been interested in other uses of high frequency waves.

a. Working with Professor Momitau Suzuki of Tokyo Higher School, they tried the fixation of Nitrogen with an 80 cm C.W. Magnetron giving an arc discharge. This was found to be no more efficient than lower frequencies.

b. Professor Hashai used a spark discharge giving 3 mm radiation for diathermy which could be focused on internal organisms. This led to the study of biological action of ultra high frequencies. General Saseda at Nobirito, found that 80 cm waves caused lung and brain hemorrhages which led to the "Death Ray."

TOKYO KOGYO DAIGAKU
(The Tokyo University of Engineering)
Ookayama, Meguro-Ku:Tokyo, Japan

Notes on our activities during the war. 15th Oct. 1945.

Dr. Professor Kiyoshi Morita.
Tokyo University of Engineering.
Electrical Department.

1. Classification according to the kind of service.
for Tama Military Laboratory.

- a. Parabollic Reflector.
- b. Special receiving tube (reflex Barkhausen Type)
- c. Sending tube of wave length less than 10 cm.

for Noborito Military Laboratory.

- a. Parabollic Reflector.
- b. Magnetron tube of high power.

for Nippon Gakujitsu Schinko-Kai.

- a. Impedance Measuring Device at dm-wave range.
- b. Measurement of Dielectric Loss Factor at wave length less than 15 cm.

for Education purpose.

Writing a text book "Cho tanpa."
Meaning "Ultra Short Waves,"
published by Shukyo-Sha.

2. Classification according to the Scientific items.

- A. Parabollic Reflector.
- B. Receiving Tube of B. K. Type as a detector.
- C. Magnetron tube of high power.
- D. Magnetron tube of wave length less than 10 cm.
- E. Impedance measurement.
- F. Measurement of dielectric loss factor.

3. Abbreviated Records for each item.

A. Parabollic Reflector,
Co-operator; Dr. Professor Kaneshige.
(for Mechanical Design)

Manufacturer: Miwa Kogyo Kabushiki-Kaisha
Chief engineer: Wake.

General characteristics.

Two novel design for paraboloid of revolution are as follows:

- a) One for Tama
Installed at Sunosaki, Chiba Prefecture.
- b) One for Noborito
To be erected at Goodo, Nagano Prefecture.

Diameter at opening 10 m, focal

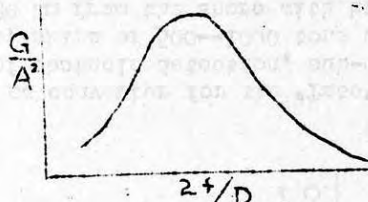
distance $f = \frac{D}{4\sqrt{3}} = 1.47 \text{ m}$. Special features:

Minimum side radiation for given gain of mirror, attained side lobe 2 % in field strength for one way; i.e. -38 db.

Diameter at the opening, $D = 10 \text{ m}$

Focal distance: $f = 0.3D$

Special features: Most economical design; i.e. Necessary amount of metal plates for the mirror construction is smallest for given gain of mirror.



A.....total area of mirror envelope.
G.....power gain.

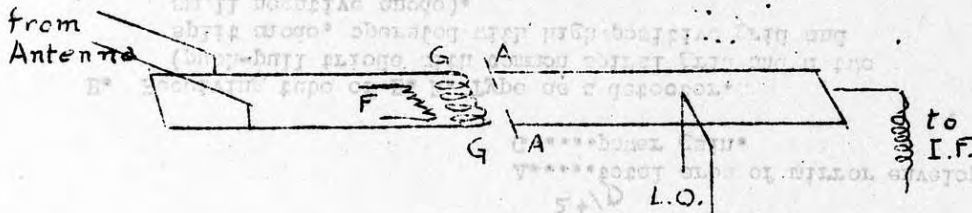
- B. Receiving tube of B. K. Type as a detector.
(push-pull triode with common spiral grid and a two split anode, operated with high positive grid and small negative anode).

Co-operator.....Assistant, Y. Watanabe.

Manufacturer...Nippon Musen Kabushiki Kaisha
chief engineer: T. Ueno.

a) General characteristics.

Plate dia. 2.4 mm
 Dia of spiral grid 1 mm
 for use as detector or converter at the wave
 length 15--20 cm.
 Minimum operating input voltage (H.F.), 20 --50 μ V.
 More stable as compared with crystal.
 More sensitive as compared with acorn triode.



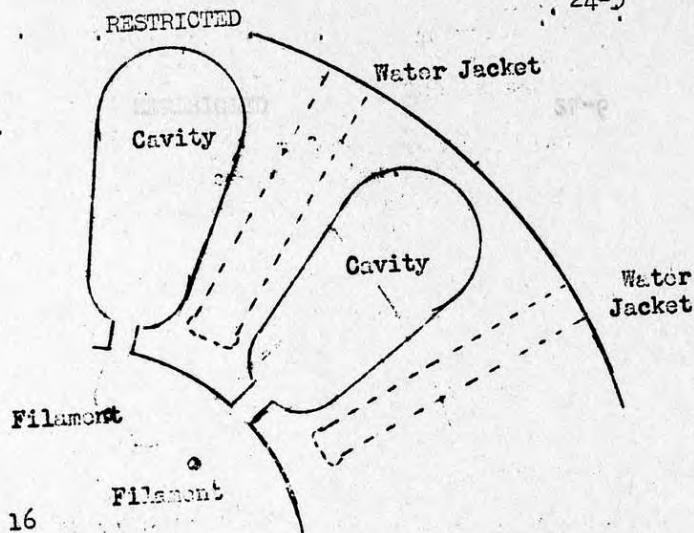
The tube is used as converter for the "Tase" No-1,2
 with the object of obstacle detection, sub-marine
 detection. Result; ships of 500--1000 tons were detected
 at the distance 30 km from the shore with height 15 m
 above the sea level.
 Model periscopes of diameter 10 cm & 5 cm were detected
 at the distance 5 & 2.5 km respectively under the same
 conditions.

b) Modified form of the twin triode.

With neutralizing electrodes attached very near to
 the anode segment, we can obtain amplifier tubes with
 a gain of 20 db at a wave length 20 cm under the best
 conditions.

c) Magnetron tube of high power.

Co-operator.....Assistant Professor M. Nishimaki.
 to be manufactured by
 Nippon Koshuha Kabushiki Kaisha.
 Chief engineer, Dr. J. Ikebe.



Anode:

O.D. = 38 cm
 I.D. = 15 cm
 No. of cavities = 16
 Thickness = 10 cm
 Equipped with strips on both sides.

Filaments:

No. of filaments = 16
 in front of each cavity.
 O.D. of cage of filaments = 8 cm

To be operated at	
plate voltage	10,000 volts
plate current	20 amperes
filament voltage	40 volts
filament current	600 amperes
magnetic field	200 gauss
wave length	
(model observation70 cm)	
total input	200 kilowatts
supposed output	100 kilowatts
(Water cooled)	

Any harmful effect may be expected when the field strength becomes 50 volt/cm, and under the following conditions:

Mirror Dia.	100 meters
power output	10,000 kilowatts

The effective distance is calculated as follows:

$$E = \frac{60}{r} \sqrt{\frac{P}{f}} \cdot 2\pi f / \lambda$$

where: E..... field strength $V/cm = 50$
 r distance in $cm =$
 P power in $watt = 10,000$
 f focal length of mirror in $cm = 2500$
 λ wave length in $cm. = 80$

r becomes 850 m.

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D. Magnetron tube of wave length less than 10 cm

Chief designer.....Assistant Professor

M. Nishimaki.

Machinest.....Assistant T. Asaba.

Object; Generation of impulsive oscillation

One example: $\lambda = 3.5$ cm.

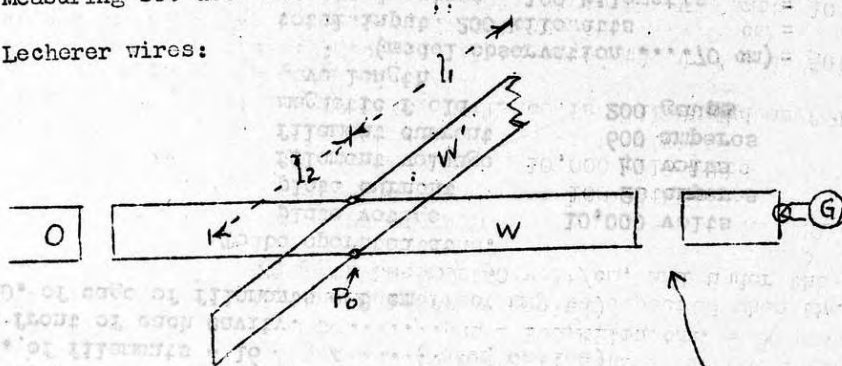
peak power $P = 1$ KW

12--16 splitted anode made of molbdenum plate.

E. Impedance measurement.

a) Measuring set used for $\lambda \geq 20$ cm. Crossed

Lecherer wires:



P_0 = Potential
antinode.

Magnetic coupled
thermo-junction.

O.....Oscillator
 W.....Surge impedance of main lecher wire
 W'.....Ditto but for sub-lecher wire.
 Z.....Impedance to be measured.

i) When Z is large, choose $\lambda_1 = \lambda/2$, then we have

$$Y = \frac{1}{Z} = \frac{1}{W} \left(\tan \frac{2\pi\delta}{\lambda} - \tan \frac{2\pi\delta_0}{\lambda} \right) + \frac{j}{W'} \left(\cot \frac{2\pi l}{\lambda} - \cot \frac{2\pi l_0}{\lambda} \right)$$

ii) When Z is small choose $\lambda_1 = \lambda$, then we have

$$Y = \frac{W'^2}{W} \left(\tan \frac{2\pi\delta}{\lambda} - \tan \frac{2\pi\delta_0}{\lambda} \right) + j W' \left(\cot \frac{2\pi l}{\lambda} - \cot \frac{2\pi l_0}{\lambda} \right)$$

where δ = half breadth of tuning
 (take tuning by adjusting S)

δ_0 = Ditto but without load Z

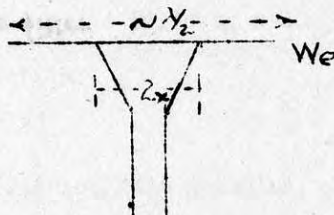
l = Length of λ_2 under the condition of tuning.

l_0 = Ditto but without load Z

Measured object:

matching antenna

$$Z = \frac{4W_e^2}{R} \sin^2 \left(\frac{2\pi x}{\lambda} \right)$$

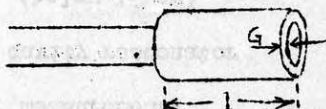


RRadiation Resistance

Renny gives the above.

Dr. Morita finds the factor to be 1 instead of 4.

b) Sperr Topf (Choke coupling)



It was found that the length of mantle l is very critical to get optimum condition of tuning when the gap is small.

D. Dielectric loss factor measurement.

a) With cylindrical cavity resonator

(below 15 cm)

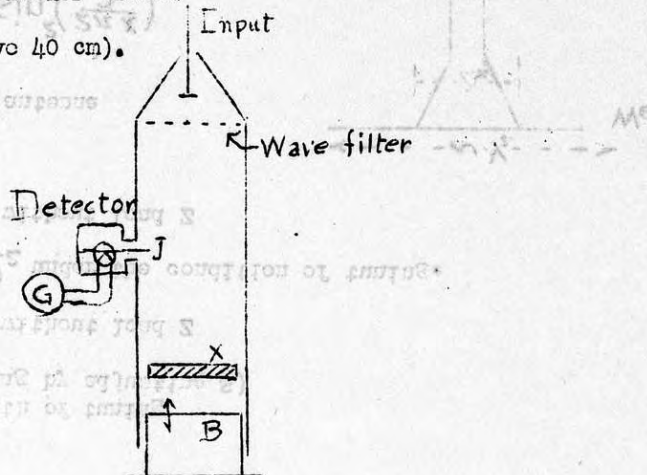
 H_{11} wave

X.....dielectrics under test

determine the loss factor from the
tuning breadth, adjusting the bottom
plate B. (sample X), simultaneously.

b) Ditto but with locher wires.

(above 40 cm).



$$\lambda = \frac{M}{M_{10}} \left(\tan \frac{\gamma}{5\sqrt{2}} - \tan \frac{\gamma}{5\sqrt{2}p} \right) + \frac{M}{M_{10}} \left(\cot \frac{\gamma}{5\sqrt{2}} - \cot \frac{\gamma}{5\sqrt{2}p} \right)$$

$$\lambda = \frac{M}{M_{10}} \left(\tan \frac{\gamma}{5\sqrt{2}} - \tan \frac{\gamma}{5\sqrt{2}p} \right) + \frac{M}{M_{10}} \left(\cot \frac{\gamma}{5\sqrt{2}} - \cot \frac{\gamma}{5\sqrt{2}p} \right)$$

$$\lambda = \frac{M}{M_{10}} \left(\tan \frac{\gamma}{5\sqrt{2}} - \tan \frac{\gamma}{5\sqrt{2}p} \right) + \frac{M}{M_{10}} \left(\cot \frac{\gamma}{5\sqrt{2}} - \cot \frac{\gamma}{5\sqrt{2}p} \right)$$

$$\lambda = \frac{M}{M_{10}} \left(\tan \frac{\gamma}{5\sqrt{2}} - \tan \frac{\gamma}{5\sqrt{2}p} \right) + \frac{M}{M_{10}} \left(\cot \frac{\gamma}{5\sqrt{2}} - \cot \frac{\gamma}{5\sqrt{2}p} \right)$$

.....

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SUBJECT: Japanese Society for the Promotion of Scientific Research
(Nippon Gakujutsu Shinko-kai)
INTERVIEWED: Dr Hontaro NAGAOKA, Chairman of the Advisory Council
(Hyogin-kai)
INTERVIEWERS: Drs Moreland, Longacre.
DATE: 16 October 1945.

ORGANIZATION AND SUPPORT

The Japanese Society for the Promotion of Scientific Research was organized about 1934 for the encouragement and support of research.

Funds for support of research and for administrative purposes are supplied (1) by the Government, through the Ministry of Education (supplying approximately 3/4 of the funds); (2) Donations from Industry or other private sources; and (3) a small amount of fixed income from endowment. The total available for support of research amounts to nearly ¥ 5,000,000

Grants are made for support of specific research projects by an advisory Council (Hyogin-kai) of which Dr Nagaoka is chairman.

The council consists of 25 members, five of whom are ex-officio representatives of the Ministries of War, Navy, Finance, Agriculture and Commerce. The other twenty are elected by vote of the members of the Society and usually include ten or more representatives from industry with one or two bankers and business men. The universities usually have only relatively small representation. During the war some of the elected members were also Army or Navy men. The Council elects its own chairman.

The Council is organized into twelve sections as follows, each section under the supervision of a Section Committee consisting of 5 to 15 experts in the field of interest of the section:

Jurisprudence	Biology
Literature	Medicine
Economics	Machinery, Metallurgy, Mining, Ship Building,
Physics	Aeronautics
Chemistry	Electricity
Geology	Architecture, Civil Engineering
	Agriculture

Members of the Council and of the twelve Section Committees are given "very trifling" compensation.

ORIGIN OF PROJECTS

Projects may be originated in three ways:

- By the Council, on its own initiative.
- By the Council at the request of the Army or Navy or other Government agency.
- By an individual, or group of individuals, desiring a grant-in-aid.

PROCEDURE

The request for support of a project is referred to the appropriate Section which looks into the proposal and makes recommendation to the Council as to whether or not the project should be undertaken and, if so, the extent of the grant which should be given. The recommendations of the Sections are considered by the Council at meetings held approximately once a month. Dr Nagaoka reports that the Council meetings are frequently long and lively with sharp differences of opinion, and that the recommendations of the Sections are frequently modified by the Council.

During war times requests from the Army and Navy were invariably accepted but in peace times such requests are frequently declined (diplomatically!). During 1944, grants for service projects amounted to nearly ¥ 800,000.

All of the major projects are carried out by working committees under the leadership of chairmen. These committees are carefully selected. The chairman of the working committee, and the agency initiating the request, may propose the membership of the committee but it is subject to the approval of the Council. Dr Nagaoka insists that there should always be industrial representation on the working committees "because college professors are not always very practical". The working committees vary in size up to a maximum on one military project of 120 (total staff), with 20 to 30 being a more usual size.

In addition to the major projects carried out by the working committees, grants are also made in aid of a large number of small projects, carried out by individual research workers, usually, but not necessarily, college professors. Applications for grants are filed by the individuals and are subject to review by the appropriate sections as outlined above.

The Section Committees have overall responsibility for the projects undertaken on their recommendation. The committees visit some of the projects to check up on progress but, in general, rely largely on the integrity of the scientists in charge of the projects.

On the fiscal side the expenditures are apparently very carefully watched.

PROJECTS SUPPORTED BY GRANTS

During the fiscal year, 1944, grants totaling a little over ¥4,000,000 were made to approximately 425 projects; 87 of these projects, with grants ranging from ¥4,300 to ¥200,000 and totaling nearly ¥3,400,000, were handled by working committees, while the remainder, with grants ranging from ¥300 to ¥6,250 were handled by individual research workers. Appended is a list of the projects to which grants were made from 1944 funds, showing in the first section the projects handled by working committees, and in the second section the grants to individual research workers.

In each case the subject of the research, the chairman of the committee or the individual in charge of the research, and the amount of the grant are indicated. The funds shown are the maxima made available for the respective projects--the actual expenditures average approximately 15% less than grants. Research projects usually run about three years (grants renewed). Projects leading to industrial applications are carried to the point where industry can take over. Ordinarily industry also takes onto its staff, at least temporarily, one or more of the research workers to aid in the industrial development.

COMMENTS BY DR NAGAOKA

He thinks his Board (Advisory Council) was less subject to restrictions than either the Board of Technology or the National Research Council, and was consequently more effective. "Success of research depends upon freedom."

When asked whether he thought it would have been more efficient if the research activities of the Board of Technology (approximately ¥20,000,000 per year for research), the National Research Council (approximately ¥19,000,000 for research), and the Advisory Council (¥5,000,000 per year) had been combined under a single administration, he said no, that that would be too large for any group to manage effectively. In fact, he thought that ¥5,000,000 was about the most efficient size of organization.

During the war, research and development were more objective than during normal times, but due to lack of facilities and of suitable men, were not as successful as had been hoped for.

Scientists were not used effectively by Army and Navy. They were badly handicapped in such work as they were asked to do for A or N because they were not taken into confidence and told what the aim was. As a result of this policy, the scientists were given only narrowly-specified detail problems which were usually unsuitable for university scientists.

The military did not make effective use of the results of scientific research, especially if the results differed from the preconceived ideas of the military.

When asked about the principal men in Japan who have worked on nuclear physics he mentioned Dr Hishina, at the Institute for Physical and Chemical Research, Tokyo, to whom Dr Nagaoka's organization has given substantial grants-in-aid; Dr Kikuchi of Osaka Imperial University, who, however, was working for the Navy on electron tubes during the war; and Dr Arakatsu at Kyoto Imperial University. He does not know what Dr Arakatsu was doing during the war but does not think he was using his cyclotron for lack of power.

Dr Nagaoka had heard something of the work done by the Army at their Noborito Laboratory, on the Death Ray, and had seen one of the early experiments where a rat was killed in a few seconds at a distance of something like 30 centimeters, but he knew nothing of the details of the recent work. He expressed the opinion that it would be ineffective because it would be so easy to shield against it.

Projects supported by grants from the Advisory Council which Dr Nagaoka mentioned as examples having produced outstanding results were:

1. Secrecy techniques in radio communication by Prof H. Nukiyama of Tohoku Imperial University at Sendai under a committee headed by Prof Shimuzawa. (NOTE: Prof Nukiyama was formerly a pupil of the late Dr A E Kennelly of Harvard University).

2. Development (in three months) of dye for dyeing fabrics for uniforms, by Prof H Maki, Tokyo Imperial University.

3. Development of techniques for geophysical prospecting for coal, oil, and copper, by Prof H Aoyama, at Tokyo Imperial University; and

4. Dye stuffs for infrared sensitized film, at the Institute for Physical and Chemical Research, Tokyo.

There is no page 25-5 in this appendix.

Research Grants
Japanese Society for Promotion of Scientific Research
(Nippon Gakujutsy Shinko Kai)

A) Scientific researches submitted to committees during 1944

Subject	Chairman of committee	Annual expense (yen)
Explosives for industrial use	Hidesaburo Aoyama	15,700
Basic research on heredity	Ken Aguma	13,700
Indirect photographing by X-ray	Masaji Nishikawa	7,500
Non-linear problems	Tekin Tomochika	11,500
Fertililiyers from national resources	Keiijiro Aso	9,570
Prevention of lightning damages	Sahihei Fujiwara	70,850
u Special steels for particular use	Kuniichi Tawara	200,600
Race improvement	Tamo Hayashi	37,120
Auditory sense	Iate Kunihiko Harhida	18,910
Oil floatation	Yoskiro Yamaguchi	19,240
Exploitation of the seas	Takematou Akaca	30,000
High pressure chemistry	Nobukichi Horiba	23,100
Materials scarce in war time	Yoshio Tanaka	33,180
u Air craft	Ketaro Honda	120,000
u Utilization of superabundant vegetable materials in southern regions	Hiroteraro Ando	180,000
BD, Economical problems in great Asiatic co-prosperity sphere	Kakichi Takenchi	200,000
Prevention of insect damages in wooden ships	Taku Romai	21,000
u Scientific research on fire	Masaichi Majima	34,000
Apparatus for wireless telephony	Heiichi Nukiyama	131,080
System of government employ	Masamichi Royama	7,920
Chinese characters and Calligraphy	Kumaji Royuma	8,000
Picture scrolls in ancient Japan	Yoshinari Yoshizawa	12,000
u Corrosion proof materials and prevention of corrosion	Naguaki Ujiie	50,880
Mechanism of defacement	Kiichi Asakura	5,300
Condensers of highly clear field of vision	Rikichi Sekiguchi	4,300
Prevention of tuberculosis	Taizo Kumagai	27,000
Intellectual development in North-eastern district of Japan	Ryoichi Furuta	8,000
Synthesis of organic compounds	Taizo Kurota	53,600
Catalyzer	Toshizo Chidani	10,760
Labour control for industry and agriculture in war time	Takeo Ono	30,000
Examination of archeological remains in the Far-east	Foru Hanada	8,420
Standards of nutrition	Saburo Kakiuchi	25,740

Subject	Chairman of committee	Annual expense (yen)
Translation of Japanese classics	Sanaki Ichikawa	5,000
Materials for electrical industry	Shoji Seto	43,420
Manufacture of special steels	Kuniichi Tawara	34,260
Faunal species in Japan	Nachide Yatsu	6,000
Medical and sanitary problems of Southern regions	Yoneji Miyakawa	20,000
Economic control policy	Torajiro Takagaki	24,020
Mathematizing technology	Takaji Ishikawa	39,630
Palaeogeography	Akinasa Ono	43,120
Eugenic heredity	Koichi Miyake	17,380
Clothing and housing problems	Saeko Toda	36,000
Medicine and sanitation	Iate Chikahiko Roiyumi	17,330
Precision machinery	Tamotsu Aoki	19,800
Metallic packing	Iwao Oki	30,000
Glass and refractory materials	Taiyo Kurota	106,440
Improvement of Duralumin	Benyo Katsura	27,720
Electron microscope	Shoji Seto	33,660
Oriental architecture	Tachu Naito	21,980
Myopia	Shinobu Naito	9,110
D. Preventions of hemorrhage of the brain	Chujiro Nishino	33,000
Synthetic fibre	Katsumoto Aoki	31,500
Metal bearings	Iwao Oki	15,180
Metal working machinery	Tkushichi Mishima	46,980
Machine shop practice	Tamotru Aoki	15,510
Protection of railways against air raid	Yoshio Miuro	15,710
Feed for domestic animals	Kyoji Iwamoto	14,030
Psychological study of human character	Iate T Koizumi	13,960
Increasing production of coal	Hidenosuke Sano	10,000
Medicines scarce in war time	Yasukiko Asakina	30,000
u Examination of coals for adequate uses	Taizo Kurota	200,000
Seaweeds for industry	Keita Shibata	11,500
Epidemic enteritis	Ryoei Miki	10,000
Improvement of smelting method of pig iron	Kuniichi Tawara	30,000
Improvement of construction process in civil engineering and architecture	Saburo Taniguchi	10,000
Improvement of farming machines and tools	Shuroku Taniguchi	15,000
Reorganization of the system of finance and money fit for war time	Seibi Higikata	9,900

Subject	Chairman of committee	Annual expense (yen)
Special minerals and their deposits	Skukusuke Royu	57,000
Multiplication of rats for cultivation of disease germs	Kaname Okada	10,000
D Refrigeration	Takeyo Yaramoto	30,000
D Cohesive materials for wood	Rinjirō Sasaki	30,000
Crimes in war time and its counter-measure	Kameji Kimura	11,000
Legislative measure at the national crisis	Toshiyoski Miyazawa	21,000
Custom laws in the Southern countries	Zernnosuke Nakagawa	11,000
Family system and land system characteristic of Japanese nation	Shinzo Takayanagi	11,000
Range of vision	Takeo Shimizu	30,000
Economic enterprises in war time	Yojiro Masuji	20,000
Iron resources in Japan	Shinji Yamane	20,000
Oil resources in oriental regions	Iate Kanji Uchida	30,000
D Malignant influenza	Ryukichi Indo	30,000
Increasing production of non ferrous metals	Benzo Katsura	30,000
D Factory protection against air raid	Yoshikazu Uchida	30,000
Application of new methods of agriculture	Hirotsuro Ando	20,000
Physiology of microbes	Keita Shibata	5,000
Microscopic examination of vegetable foods	Kenjiro Fujii	5,000
Utilization of wild vegetables	Masaji Honda	5,000
War time construction materials from local resources	Kusuo Aoki	20,000
TOTAL		3,398,000
Group A		

B) Scientific researches by individuals who received grants during 1944

Subject	Researcher	Annual expense (yen)
Jurisprudence		
Politics in war time	Toyosaku Igarashi	800
History of nationalistic movement in French	Hanji Kinoshita	3,000

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Literature

Confucianism in Kamakura and Muromachi periods of Japan	Ryotaro Sakamoto	1,000
Collection of materials relating to history of economics of modern China	Shigera Kato	2,000
Compilation of index of old Japanese literature	Hisataka Omogato	2,320
Development of the doctrine of Buddhism in the period of Song	Yasumori Izumi	900
Study of the history of educations in the Imperial Household	Hiroyasu Ogata	1,730
Historical study of formation of the system of total warfare in modern Germany	Juien Hara	650
Materials relating to the history of Japanese music	Minoru Shibata	1,800
Relation of the characteristics of Indian art and those of Southern art	Teruo Ueno	1,200
Bhagavadgita	Gikai Matsuo	600
Ship transportation of the Ming and Ching periods	Binpu Hoshi	810
Popularized Zen analects in Japan and the literature thereto	Daisetsu Suzuki	1,200
Lives of the poets with Imperial Anthology	Yashisada Ishida	770
Village system of medieval China	Zenkai Matsumoto	900
History of Dutch dialects in Japan	Tetsuro Iheda	800
Study of Japanese intonations	Terno Hirayama	1,200
Compilation of names of sites and remains in the Kinki provinces	Fujio Imai	1,000
Study of cross-current of thought between old Greece and India		
Study of sources of civilization in Asia	Shoichi Sumita	1,000
Researches of materials relating to ancient and medieval history in the shrines of the Kinki provinces	Naojiro Nishida	1,500
Educational significance of students labour	Sozu Irizawa	1,000
Religions, social life in India	Geu Nakamura	1,500
Overcoming of the difficulties by European powers in Napoleonic wars	akoto Kanazawa	1,200
Problem of the preservations of objects of art in war time	Kikuo Kojima	1,500
Study of national characteristics as seen in fine art	Nasao Yamamoto	1,200
Study of Altaic languages	Shiro Hattori	1,500
Attitude of English and American youth toward the first world war	Isamu Saito	1,200
Psychological study of the leaders of social organization	Toshire Suenaga	1,500

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Economy

Examination of condition of middle and small scale industries in Chosen	Takeji Oyama	2,500
Farming management in modern Northeastern districts of Japan	Kahei Mori	1,400
Positive research on control of enterprise	Akira Yamashiro	850
Economical study on poverty	Susumu Kuwabara	1,200
Study of currency in French East Indies	Koji Matsuoka	500
Cost estimation under the condition of industrial reform in Japan	Otojiro Kubota	2,700
Theoretical and demonstrative study of industrial location in the district around Nagoya	Masao Terazawa	1,000
Historical and Geographical study of Japanese irrigation undertakings	Toshio Kitamura	2,000
Fundamental and political study of industry plantation in Hokkaido	Jiro Takahashi	2,000

Physics

Physical research on the regular lattice construction of certain magnets	Shuichi Rinchi	3,000
Measurement of the absolute value of electrode potentials on the surface of metallic crystals	Michira Sato	1,700
Damage causing cool weather in Hokkaido	Risuke Yakura	1,300
Absorption of light by smoke	Hiroshi Ito	1,690
Measurement of quantity of coal dust in a mine	Kanji Suda	1,800
Weather condition in cold districts for preserving health	Kiyoyasu Akai	3,000
Influence upon the elastic wave caused by disorder of minute construction of the earth crust	Keinzo Sassa	6,500
B-rays examined by a spiral analytic apparatus	Goro Miyamoto	3,000
Ballistics	Toshizo Matsumoto	1,500
1 Granular structure of snow and its relation to the dynamical character	Renichi Saito	1,500
2 Change of granular structure of snow with time		
3 Crystal form of falling snow and the weather of the upper atmosphere		
Relation between the time change of the elasticity of the earth crust and the occurrence of earthquake	Fiichi Nishimura	2,500
Calamities due to abnormal weather condition in Japan	Magokichi Nakahara	1,160
X-ray study of ores of rare elements	Hideo Tazaki	3,200

Examination of weak lines of Aso volcano
by electrical method
Elasticity of ice

Munetoshi Nanba 1,000
Hisao Fukushima
Shoichi Sayeki 3,000

Design and construction of microscope
objective with large working distance

Jan Oana 2,000

Chemistry

Test in half-way industrial scale of new
electrolytic refining process of lead
Geochemical study of Thorium

Mitsugi Shimada 3,500
Kozo Shimokata 1,000

Molecular construction and its relation
activation of organic compounds

Tomoro Shinomiya 1,000
Masakichi Takano 1,000

"Umesterung" of oils and fats

Molecular construction in relation to the
efficiency of dipole

Masaji Kobo 1,000

Highly unsaturated acids contained in
fish oils

Shushi Toyama 2,880

Desiccation of alcohols and on closed
ring action

Tamon Matsuura 300

Conditions under which vitamin C is
grown up when seeds sprout

Yuzuru Okuda 1,200

Synthesis of guanidin compounds

Kiichiro Sugino 2,300

Sulphur bearing piridin derivatives

Torizo Takahashi 2,000

Alkaloids extracted from tropical flora

Shinju Tomita 2,000

Utilization of the waste liquids from sulphite
pulp by products

Tatsuji Fukame 1,300

Properties of surface gas liquid and of
solid liquid systems

Husazo Iemura 1,000

Influences of amorphous substances con-
tained in fibre upon its mechanical
properties

Yoshiaki Matsunaga 900

Manganese dioxide used for dry cells

Kamazo Sasaki 2,000

Synthesis of diisochynolin series compounds

Sigehiko Sugawara 2,000

Chemical construction of cericin and fibroin

Susumu Okamoto 1,000

Directness of dye

Sasumu Ando 800

Decomposition mechanism of carbohydrates by
strong mineral acids and utilization of
decomposed products

Teizo Takahashi 1,500

Relation between tuberculosis germs and
lipoid

Michizo Asano 2,000

Stabilization of vitamins

Yusuke Sumiki 3,000

Mechanism of catalytic action of metals

Fusanojo Nakahara 1,300

Basic study of fibre dichroism

Saburo Okajima 1,000

Quantification of sulphur contained in iron
and steel by the volumetric analysis with-
out using Iodine or its compounds

Saburo Ishimaru 2,000

Agitation mechanism of the heterogeneous
system reaction

Saburo Kamei 2,000

Quantum chemical study on organic compounds	Ri Taikoi	2,500
Chemical study of albumins, carbohydrates, oils and fats of copra	Hanemon Ito	1,500
Manufacture of pulp from the woods in Southern regions, especially from broad leaves trees	Kazutsuhi One	2,000
Physico chemical study of surface phenomena in solid liquid phases	Susumu Ando	2,000
Utilization of rare earths for special porcelain	Shinichi Suzuki	1,000
Physico chemical study of Talc	Raisaku Mima	1,500
Sterilization for aquatic products by corona discharge	Eiichi Tanikawa	1,200
Synthetic study of hydrocarbons derivatives	H Suginome	1,000
Investigation of lactose by the utilization of heavy oxygen and heavy hydrogen	T Chitani	1,500
Study of electrolytes containing heavy molecules	B Kagawa	1,000
Fermentation treatment of special raw fibres	S Honda	3,500
Study of polyethyleneglycol and its derivatives	T Ishiguro	3,500
Chemistry of polyvinyl alcohol	I Sakurada	2,000
Chemical study of normal constituents of shells and their deteriorated products	S Takagi	1,500
Separation of high molecular weight con- pounds according to its molecular weight	K Kanamaru	1,500
Decomposition mechanism of elastic substances	S Akiy	2,500
Synthesis of vitamin C	Y Hamamura	2,000
Bio-chemical study of virus of agricultural products	K Yamafuji	2,000
Constituents of bark of Ilex Sieboldi	T Mitsu	1,500
Bio-chemical study of Abelmoshus esculentus Moench	M Kitahara	1,500
Observation of fibers with electron microscope	M Horio	5,000
Fusing flux material	R Kiyoura	2,000
Action of polishing and rapping material	R Kiyoura	1,000
Heteropolar high molecular weight compounds	T Hata	2,000
Study of synthetic high molecular weight material with inorganic elements	K Kubo	2,000
Utilization of brown seaweed of Japanese origin as a raw material of chemical industry	T Takahashi	1,500
Geo-chemical study of the distribution of rare elements in Korea and Manchuria	N Saito	5,000
Utilization of rapas	Y Obato	3,000
Manufacture of high grade lubricant from wax and rich heavy oil in petroleum from Southern islands	M Hiroki	2,500
Chemical composition of Scordin extracted from the rocambole	Y Hamamura	1,500

Effect of organic free base on the heat reaction of hydrocarbons	K Onda	2,000
Oxydation mechanism of methanol vapour	T Morita	2,000
Synthesis of asbestos	I Noda	4,000
Absorption of water vapor in dyed fibers	S Ando	1,500
Surface electrical conductivity of high molecular weight substances	T Hata	

Geology

Palaeozoic stratum of chichibu system chiefly consisting of fusuline lime stone in Chugoku and Shikoku districts of Japan	Ryuzo Toriyama	1,000
Minerals of later occurrence which are attendant on deposits	Toshio Sudo	1,500
Special construction of Ishikari coal field in Hokkaido	Kenichiro Otahime	900
Palaeogeographic study of the artary zone in oil fields of Tohoku and Hokuriku district	Kazao Fujioka	800
Lithological study of super-basic rocks in Japan	Atsus Harumoto	1,000
The deposits bearing limonite in Japan	Fumio Sato	500
Engineering study of exploitation of copper deposits in Hokkaido	Takaihi Takuno	2,160
Geological construction in Saseen and Yokusenin Korea in comparison way of study	Taiich Kobayashi	5,500

Biology

Ciliata of oriental origin	Yoshimasa Ozaki	1,000
Utilization of the sorts of sea-cucumber	Toshihiko Yamanouhi	700
Animals found in statolactite grotto in Kochi prefecture	Iujiro Ishikawa	300
Distribution of shells of Japanese origin	Tokuyone Kurota	800
Specification and distribution of the parasitic crustacea living on fishes	Hideo Sugino	600
The resuscitation power of the intestinal organs by using newt	Seiichi Kobayashi	800
Hereditis study of the construction of gen	Masaru Kato	2,800
Biological study of animals living at the bottom of the inner bays and their productive power	Denzaburo Miyachi	2,000
Relation between organisms synthesis and respiration	Hiroshi Tamiya	650
Multiplicity and geological distribution of plants belonging to Trillium Kamtschaticum	Bin Haga	800
Foll		

Cell hereditism of plants growing on the swampy weight	Ichitaro Harata	800
Embryological study of gymnosperm	Yashinori Sugihara	2,000
Reproduction of fresh water duckweeds	Masanuki Kusumoki	7,000
In orient changes of filerafter the utertiary period	Shigeru Miki	500
Theory of organism dyeing	Chihoi Yamaha	600
Construction of a map of Formosan ... plants	Genkei Masamuen	1,500
Influence of centrifugal force upon chromosome	Toranosube Sugiura	500
Physiological properties of red sulphur germs which grow in Japan	Shozo Tokuda	500
Activity of protoplasm	Senro Kamiya	1,700
Plant-cological study of wandering sand dunes in Asia	Motoe Takahashi	1,900
The mechanism of meiosis	- - -	1,200
Multiplication of an useful red algae graciluria converoides greville	Hikoe Omi	1,000
Physiological study of potassium having a serious action for plant growth and yield	Tomoji Gamashita	600
Abnormal type of animal sperms	Shigemori Irihi	400
Deepsea animals along Kii Coast	Soichiro Sakaguchi	400
Influence of seasonal temperatures Blepharisma undelans	Yasushi Ihara	400
Sense organ of fishes	Mitruo Sato	300
Occological experiment on period action of animals	Oichi Mori	800
Specification and distribution of diplopoda and chilopoda in greater Asiatic coprosperity sphere	Yoshioki Takahuwa	450
Sense physiology of mites especially of the sense of smell	Ko Fujita	400
Disease carrying mites found in Japan and Manchuria	Yasushi Asanuma	1,200
Wild stocks found in plains of Asia	Tadao Umeza	2,000
Sense phyiology of bees	Toru Uchida	800
Studies on the intergeneric hybridization of genes toraxacuum	K. Ono	600
Karyogenetic studies in Ronunculaceae	T. Mizuno	800
Studies on the acquired physiological conditions of plant	Ryehen Taguchi	800
The systematical and comparative investigation of Diatomal of Japan with fossils	H. Okuno	900
Heteroploidy in genes carex)	N. Suita	1,000
The fertilization and fruit-bearing)		
Morphological and experimental studies on the structure and behaviour of the chromosome	T. Soeta	600
Cytological studies on the artic flora and fundamental studies on the sterility treated by low temperature	T. Okuno	800

The growth substance in the growing point and in the special organ of plant	T. Kosumizu	2,000
The double fertilization of agricultural plants	A. Yuasa	600
Influence of tropical environment upon the plant-karyotype	S. Sato	1,400
Botanical studies on the treatment and increasing method of receipts of plants which produce tartaric acid	M. Takahashi	1,400
Growth and mitosis of Spirogyra-cells	M. Uruguchi	600
Botanical studies on the increase of yield of potato with plant growth hormone	M. Arimoto	800
The distribution of Laurinariales in Hokkaido coast	C. Kanda	700
Medicine		
Pathological Anatomy of acute infectiouses	Tokushiro Mitamura	2,500
Anatomical and hereditary studies of pneumatic cellulal of the temporal bone of Formosans	Kenji Yamashita	1,500
Rat leprosy	Kaoru Tomabe	2,000
Tropical acclimatization, especially in skin and dermal temperature	Kiyoshi Sakai	1,500
Pathology of aviation	Iwao Take	6,250
Physiological and chemico-pathological studies of fatty substances	Morio Yasuda	1,500
Extermination of round worm by albumen enzyme	Tsunehiro Kazama	2,500
Significance of prevention and attention of disease in reliculo-endothelial system	Koken Shimamoto	500
Respiration function of human body in the air of low oxygen content	Sho Inoue	1,000
Deposition of red blood corpuscle	Shokichi Ueno	2,000
Vector and heart sound analysis of Helictroca diograph	Kyozo Komizo	1,500
Cause of infections jaundice	Masami Kitaoka	1,500
Epidemics and vitamins and hormone	Hidetake Yaeo	3,000
Damages (war wounds, injury in industrial working) and promotion of working efficiency	Kenji Takagi	1,500
Emperical study of high frequency characteristics to organisms	Takashi Minoshima	2,500
Anthropological study of Mongols	Yasuo Yokoo	1,300
Leptospira istercheamirhagica	Masami Kituoka	1,500
Kala azar	Shintaro Ishii	1,500
Conception toxicosis	Michio Kaku	1,200
Group testing method for the disease caused by lack of vitamins	Kinturo Kawasaki	1,500
Frost-bite	Fumito Honna	1,000
Salivary glands hormone	Akira Ogata	2,500
The cause of abortion, premature delivery and fatal death; and its prevention	Masahiro Shiraki	()

Anthropological study of the natives of Manchuria	Kyozo Kudo	1,500
Gaining of resisting power for the bite by blood sucking	Michio Kubo	1,500
Distribution of poisonous snakes and manufacture of polyscrum for medical treatment	Shoga Hosoya	1,800
Quantitative examination of vitamins contained in our foods	Akiji Fujita	1,500
Health condition of labouring women in war time	Masakiro Shiraki	3,470
Improvement of vaccine	Keizo Nakamura	2,500
Diagnosis and prevention of eruptive typhus	Yutaka Nakamura	5,000

Machinery, Metallurgy, Mining, Shipbuilding,
Aeronautics

Cementation by electric discharge	Yokio Saito	2,400
Manufacture of ignition alloys	Takesaburo Izawa	2,000
Influence of Nitrogen on steel	Shozo Akamoto	2,500
Prevention of scattering of metal dust		
Zinc electrolytic refinery	Isao Kujima	2,000
Improvement of Japanese sword	Masao Homma	2,500
Removal of transformation point of alloys by rapid heating	Seita Sakui	2,500
"Mickbildung" phenomenon of light alloys	Ryozo Takigachi	1,500
Diffusion of light alloys in solid state	Keizo Niimi	1,500
Desulphur and refining of nickel	Fuyoyasu Nishihara	2,000
Optical investigation of a finished surface	(Masuo Kawakami)	1,800
Metallurgy of magnesium		5,000
Hydrodynamics of centrifugal super charger layer in an aircraft	Hido Yamada	1,800
Machine tools and cams used in precision measuring apparatus	Zentaro Kizaura	3,000
Sintering phenomenon of pure iron powder	Kazuhiko Ogawa	3,000
Powder sintering of high melting point metals together with additional elements	Tsunevuki Otsube	3,000
Heat capacity of dust metals at high temperature	Hiroshi Sawamura	2,500
Thermodynamic properties of freezing medium	Sageo Sagai	2,200
Recovery of iron from alumina residue	Hachiei Sawamoto	2,000
Flowing near the vanes of hydrodynamic machines	Keizo Tabuse	2,400
Rapid manufacture of malleable cast iron	Tokuhiro Mochida	5,500
Nickel refining	Masanobu Izawa	2,500
AN modification in carbon and special steels	Ko Hayashi	2,500
"Mickbildung" phenomenon in alloys as super duralumin	Nariyasu Kota	3,500
Testing machine for rock drills	Eiichi Yamamoto	2,500
Stress measurement with magnetostriction method	Tameo Tsubouchi	2,530
Pulsation flow, especially the fluid dynamical loss at suction inlets	Hidetoshi Kusama	2,100

Metallography of permanent magnet alloys	Shuichi Kiuchi	3,000
Structure of rolled magnesium alloys	Hayo Hisatomie	3,000
Oil pumping by water injection method	Sornohura Ohashi	3,000
Ignition of internal combustion engines with igniting oil injection	Fujie Nagas	2,000
Conditions for the lightest and the strongest structure	Masatsugu Kuranishi	1,750
Control character of tailless aeroplane	T. Okumoto	2,000
Flow at the guide vanes of centrifugal super charger	H. Yamada	2,000
Refining of sulphide ores by the direct fusion electrolysis	K. Okamoto	4,000
Oiling free bearing and bearing with substitute materials	S. Ito	3,000
Leakage through contact airtight construction	S. Yoshida	3,000
Method of fine finishing of cams	J. Kimura	2,000
Turbulence and transformation of boundary layer	T. Okamoto	2,500
Elastic theory of orthotropic body and its application to the construction of air crafts	M. Kuranishi	1,100

Electricity

Construction of vacuum tubes for ultra short wave	Shintaro Nakamura	3,000
Basic research on solid insulator	Shigeo Mochitsuki	3,500
Generation of strong sound waves in water	Kiyoshi Awaya	3,180
Application of high frequency discharge to chemical munitions	Ukichi Shinohara	3,000
Characteristics of impact current and to application	Nikio Hamura	3,000
Electron tubes used for measurements	Kiyoshi Ogawa	3,130
Prevention of moisture for electric insulator	Matsuo Suzuki	2,900
Fundamental study of high frequency discharge through gases	Kiyoshi Awaya	3,600
Structure of mechanical acoustic network	Hisuo Hayasaka	2,000
Secondary electron emission from metals and its application	Shigetomo Yoshida	3,200
Resistance materials for ultra high frequency use	Yukio Saito	4,500
Acoustic direction finding	Hisao Hayasaka	1,000
Fundamental study of measurements of impulsive electric waves	Kiyoshi Awaya	3,820
Sealing of vacuum tubes with reference to mass production	Shinichi Suzuki	3,000
Practical test of anti moist quality of high frequency porcelain insulators	Shinichi Suzuki	5,000

Architecture, Civil Engineering

Shrine building technology in Formosa	Suketaro Chiuiwa	700
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Dynamical mechanism and properties of sand	Takeo Mogami	800
Bearable power of architecture materials against the impact load	()	2,000
Workability of concrete and its measurements	Suzuo Ban	1,000
Sand amount drifted up in the river	Soshichiro Nagai	2,320
Application of concrete crust to the underground structures	Yoshikatsu Tsuboi	800
Osmosis and vitrification of concrete in liquid	Haruichi Kano	1,000
Protection against hot and cold for removable housing	Ichiro Nishifuji	1,000
Connections of the members of timber, structures and their strength and deformation	Kyo Tanahashi	1,500
Study of construction according to the theory of elasticity and of plasticity	Saburo Soshiroda	1,000
Water flow at the mouth of a river	Jin Hanna	1,500
Properties of concrete using piano wire for that of usual steel	Yasuo Ichiki	1,500
Tiling and thatching of roof	Kiyoo Matsushita	1,500
Ventilation of structures	Etsusaburo Ichimasu	2,400
History of fire fighting in yedo period	Hirotao Ota	2,000
Magnesia concrete	Takakazu Maruyasu	1,500
Making window area of structures minimum	Kaname Watanabe	2,000
Increasing of the strength of long wooden bridges for saving steel	Eiichi Murakami	2,000
Sound absorption rate of constructing materials by several measuring methods	Takeo Sato	1,500
Test of concrete impact strength	Takeo Hori	1,000
Drifted sand	Seiichi Sato	4,000
Improvement of crane-box, especially its inner weather condition	Hirotao Suzuki	1,500
Influence of the deposition time by chemicals upon rapid sand filtration	Karokuro Hirose	1,000
Relation between the strength of concrete and its liquid content	Tokujiro Yoshida	2,000
Stress on special rigid frame construction	Tadaaki Sakai	1,000
Shaft shaped hydraulic press tube	Bennosuke Tanimoto	1,000
Stadia method of quick measurement of long distance	Yoshiro Tanaka	1,500
Quick hardening of concrete construction	Mutsuni Kato	3,140
Consideration of hardening contraction and creepage of concrete in actual design and construction	Yoshiro Yoshida	1,000
Method of avoiding snow accumulation around the building in windy district	Kuichiro Kimura	1,000
Colloidal character of soil	Hachiro Shimada	1,000
Weathering proof quality of hardened wood	Juro Soshiroda	1,200
Construction of shelter in air raided city	Kyoji Yoshida	2,500
Test of strength of buildings by the propagation velocity of sound	Kiyoshi Awaya	6,000

Theoretical study of initial displacement and
initial stress of skeleton construction due to
explosion pressure wave

Tatsuo Tajime

1,000

Agriculture

Chemico-physiological study of trees and their seedling	Tomoichiro Nakatsuka	1,500
Water temperature of irrigation reservoir	Sugao Torii	1,500
Pathological bacteria of sooty mould	Kayutaro Yamamoto	1,300
Ailmental bacteria of haemolysis septicaemia	Morihide Yamada	900
Cause of certain disease to which both raised and wild silkworms are liable	Suzuo Watanabe	1,100
Silviculture of <i>Cryptomeria Japonica</i> Don	Seikei Sakurai	1,100
<i>Leptospira</i> on animals	Shutaro Yamamoto	1,800
Embryology and oecology of girard	Shinichi Sato	420
Production of bees wax	Yoshinobu Tokuta	800
Pathology and diagnosis of <i>Trypanosoma</i> of domestic animals	Hideo Ishiguro	1,800
Growth and development of domestic fowl	Tamio Yamada	1,800
Physical and chemical study of etching of nails for fire proof woods	Tamio Yamada	1,300
Mechanism of seed gathering of staple vegetables	Nagaharu U	1,200
Covered drain for the collection of irrigation water	No Tshiguro	1,500
Vegetable seeds transported from southern regions	Sadao Yasuda	1,400
Empirical and theoretical study of physically heterogeneous properties of woods	Kamekichi Yazawa	700
Affinity of wood trees' grafting	Nobuo Kayama	1,200
Organic acid fermentation of plant ailment germs	Makoto Hiura	1,500
Promotion of motor ability of domestic animals for war use	Masamiki Okamoto	1,500
Starchy crops necessary to mix or supplement the main food	Keitaro Asai	800
Relation between effect of nitrogen containing fertilizer and under ground drainage	Azuma Okada	2,000
Increased production of provisions and farming with the aid of domestic animals	Hidetoshi Isobe	4,000
Extermination of wild rats	Tetsuo Inukai	1,200
Fresh water duckweed in Hokkaido	Hiroyuki Hirose	800
Morphological properties of cultivated forests	Tokutaro Nakamura	2,200
Peculiar growth of horticultural crops in volcanic ash-soil	Katsuo Nagasawa	1,800
Cell hereditism of oats	Ichizo Nishiyama	1,500
Rice disease in tropical regions	Yoshio Hashime	2,800
Disease of farming products caused by scarcity of small quantity of indispensable nutriment	Shoichi Tanaka	1,000
Change of amounts of vitamins contained in fruits and vegetables during their growth, storage and transportation	Kumaichi Matsumoto	750

Artificial fertilization of domestic animals	Hajime Mimura	1,200
Horse abortion caused by bacteria	Shiro Miura	1,500
Improvement of black soil	Katsumi Hosoda	2,000
Bringing up of thread by raised silk worm	Masatake Ono	1,500
Distribution and ecology of scale insects found in North Japan	Shigeo Kanda	2,000
Parasites living inner parts of domestic animals	Tadashi Nishimura	2,000
Cultivation of <i>Gloiopeltis furcata</i>	Hiroshi Kunieda	1,000
Sterilizers for agricultural use, containing no or minute quantity of copper	Goro Maya	2,000
Sterilization and storage of aquatic products hot districts with heavy moisture	Yuzo Toyama	2,500
Disease damage prevailing on seedling fields in Hokkaido	Sanki Imai	1,600
Red blood type of the horse	Hisayoshi Matumoto	1,300
Pathology of horse disease	Moriichi Kure	3,000
Conditions of preservation and extraction of tannin	Kyoji Minami	3,000
Distribution of trees adaptable for aircrafts and ships in Japan	Nagao Yamazaki	3,000
Physiology and pathology relating to storage of sweet potatoes	Moriya Abe	2,500
Utilization of water cultivation of vegetables	Hideo Mori	1,830
Cultivation of <i>Samper-Secula</i>	Kusakabe	2,680
Operation ability of military dogs	Shinji	
Castration and disease apt to happen immediately after	Denkichi Yokozawa	2,000
Noxious influences of agricultural medicines upon the vines	Akira Kobayashi	1,200
Influence of temperature and surroundings on rice leaf hoppers	Chuhichi Harukawa	3,300
Agricultural controls during wartime	Michiyi Kobayashi	3,000
Endurability of farm products against cold	Rei Aoki	3,000
Species of <i>cryptomeria japonica</i> Den for silviculture	Michiro Kukamura	1,500

Total Group B - 341 Projects, Y 618,510

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SUBJECT: Interviews of German Scientists and Technicians (Including a Listing of Other Known German Technicians).

I. DATE: 12 October 1945.

INTERVIEWED: Heinrich FODERS, Electronics Engineer for Telefunken Company, Germany.

INTERVIEWERS: Drs A Longacre, D T Griggs, H K Stephenson.

1. Mr Foders came to Japan in September, 1943, in the same submarine with Col Sasaki, of the Tama Radar Research Laboratory, who was returning from a visit to Germany. He came to help with the Army radar program but since most German assistants were being brought in by the Navy and supported by the Navy, his salary was paid by the Japanese Navy. His primary interest was to assist Japan in duplicating the "Wurtzburg-D". The first models of this were just about finished in August, 1945, when the war ended. As a matter of fact, the Japanese had not as yet succeeded in producing good C.R. tubes. To duplicate the Wurtzburg-D required the production of new tubes. Mr Foders felt that the Japanese tube art was quite low. They had no high-powered tubes and despite every effort were unable to get tubes that would operate beyond 6,000 volts. It took four months to get the first models of tubes suitable for the Wurtzburg-D.

2. He was not kept very closely in touch with advances in the German art after leaving Germany. All communications from Germany were delivered to the Japanese Embassy in Berlin, and then came through regular channels when they did arrive. However, he had received sufficient information so that the Japanese were modifying the Wurtzburg-D so that it might work through jamming. There were three of these modifications:

a. To change the wave length through $\pm$ 6 mc by changing the operating voltage on the triode oscillator.

b. To have a quickly replaceable transmitting unit 30 mc away from the primary 560 mc operation.

c. They were developing a doppler effect apparatus, using an auxiliary oscillator to keep the transmitter in phase. Observation was made on A-scope presentation by looking for the "louse" (butterfly) characteristic of a moving target.

3. Mr Foders also worked on the auxiliary apparatus for tuning and range calibration. While in Germany, Mr Foders had worked on RF and 20, 10, and 5 cm magnetrons; essentially he was a systems man. Despite this experience he was kept quite thoroughly out of Japanese developments and seldom called for consultation. He felt that the Japanese lacked not only the art of good tube manufacturing but also had an appalling lack of insulating materials, RF cables, and of the tubes that they could manufacture.

II. DATE: 16 October 1945.

INTERVIEWED: Kurt SCHMIDT, Aeronautical Engineer for Heinkel Aircraft Factory.

INTERVIEWERS: Drs H K Stephenson, D T Griggs.

Mr Schmidt came to Japan on a German Merchant ship, the SS Osorno, leaving Bordeaux in March, 1943, and arriving in Japan in June, 1943. He is an aeronautical engineer concerned with aircraft plant construction, and was ordered to Japan by his employer, the Heinkel Aircraft Company. His mission was to construct and operate a plant in connection with the Hitachi Aircraft Company in Japan to build the "Ginka", or V-20, a twin-engine bomber for the Japanese Navy. The plane was Jap-designed, but was to be built with German machine tools. The supply of machine tools from Germany was nil, as was manufacture of the plane. Mr Schmidt said that no means of communication with Germany was available to him, and the aura of secrecy surrounding all Japanese war developments was such that it prevented any useful purpose he might have served outside the scope of his mission. He considers his mission a failure.

III. DATE: 16 October 1945.

INTERVIEWED: Franz POHL, Aeronautical Engineer for Henschel Aircraft Factory.

INTERVIEWERS: Dr H K Stephenson, DR D T Griggs, Sgt Curtis (interpreter).

Mr Pohl arrived in Japan on 13 June 1943. On 18 October 1943, he went to Singapore by air, intending to return to Germany by submarine, but he became ill, and on 15 May 1944, returned to Japan. He is an aeronautical production engineer and was head of construction for the Henschel Aircraft Company in Germany. His purpose in coming to Japan was as consultant on a press for airplane wing manufacture which the Japanese had purchased in Germany. This was for a transport plane for the Japanese Navy, which was manufactured at Yokosuka. The Japanese hoped to speed up production with the German equipment. However, Mr Pohl does not feel that the Japanese properly understand mass production problems, and he believes his mission served little useful purpose.

IV. DATE: 17 October 1945.

INTERVIEWED: Kurt SCHIFFNER, Engineer for Atlas Works, Bremen, Germany.

INTERVIEWER: Dr H K Stephenson.

Mr Schiffner arrived in Japan on 11 December 1943 by Japanese submarine. He is an engineer for Atlas Works, Bremen, Germany, manufacturers of underwater sound equipment, and was sent to Japan by his company to aid the Japanese in the manufacture of equipment using Rochelle salt hydrophones. He brought from Germany plans for echo-ranging and underwater listening equipment. Production was by Tokyo Shikaura Co in Kawasaki, and Schiffner served as consultant on construction. He expressed a low opinion of Japanese ability at manufacturing and feels that his mission was not profitable. He was not permitted communication with Germany.

V. Listing of other German scientists and technicians known to be in Japan:

<u>Name</u>	<u>Location</u>	<u>Specialty</u>
EMIL BRINKER	Sengokuhara, Hillmann Eosso	Manufacture of radar.
ERNST HEEBERLEIN	Moto Hakone 19	Auxiliary machines of German submarine.
HERMANN LANGE	Sengokuhara-kogen 1246	Design & manufacture of MAN submarine Diesel engine.
JOHANN MUELLER	Moto Hakone 19	Shipbuilding design of German submarine.
DR HANS SCHMIDT	Moto Hakone 19	Welding of ships, particularly submarines.
PETER SCHMIDT	Hakone Machi 197	Manufacture of Al pistons for the MAN submarine Diesel.
WILLI STECKERT	Gora, Kataoka Eosso	Installation of underwater sound equipment.

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SUBJECT: Electro-Technical Laboratory under the Board of Communications.

DATE: 18 October 1945

INTERVIEWED: Dr Minoru Okada; S. Komagata, Chief of the Laboratory; S. Nishiyama, Engineer and Interpreter.

INTERVIEWER: Major Hewlett

1. Dr Okada has been primarily concerned with radio navigational means for aircraft. Principal research projects are listed below.

a. Omnidirectional Beacon. This system is described in detail in Incl 1. In principle, it depended on an electrically-rotated, figure-8 antenna pattern and an omnidirectional antenna transmitting a reference phase signal. The receiving set (in airplane) included a direct reading phase measuring device, calibrated in degrees bearing to the beacon. The overall accuracy of this system ranged from $\pm 1^\circ$ to $\pm 10^\circ$, depending upon the station site error. The system operated at a frequency in the neighborhood of 300 kc.

b. Rotating Marine Beacon. A brief description of this system, which is merely an improvement on an existing and well-known system, is contained in Incl 2.

c. Site Errors. Dr Okada did some work on determining the errors resulting from topographic irregularities, buildings, power lines, etc., and came to the conclusion that a good site should be at least 2 km away from a coastline or hills over 100 meters high and more than 500 meters away from buildings, power lines, railroads, and the like. Ground mats of at least 20 to 30 meter radius were advocated. A well-chosen site should have an error of less than $\pm 1^\circ$.

d. VHF Airborne Direction Finders. A Board of Technology project was started to develop an airborne direction finder with a frequency range of 9 to 2 meters. The conclusions reached were that for a plane with a wing spread of 8 meters and a length of 9 meters, that:

- (1) in the band 9 to 7 meters, fairly good results could be obtained with a loop antenna.
- (2) in the band 6 to 5 meters, very large errors would be produced (loop antenna).

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Appendix 27-1

- (3) in the band 3 to 2 meters, very large and irregular errors existed with either a loop or an Adcock-type antenna.

Towards the end of the project, there was some indication that the direction finder should be able to receive pulse signals, i.e., radar intercept.

2. Dr Okada felt that the most promising direction finder was the elevated crossed-H type Adcock, using a manual goniometer to determine bearing on a null basis. Only recently had work been started on a switched-lobe type set for ground use, although such a direction finder was already in common use in airborne direction finders where the ambient radio frequency noise was exceedingly high. T. Sakada, formerly with the Electro-Technical Laboratory but now with the International Telecommunications Laboratory, had done some work on an instantaneous type direction finder. His system depended on two sets of antennas, balanced amplifiers with a local oscillator to control phase shift, and a cathode ray tube to indicate bearing. The work on this set was sponsored by the Air Force Technical Society.

3. The state of the radio navigational aid art in Japan, judging from the discussions with Dr Okada, is in a very elementary stage, with principal reliance placed on manually-operated ground direction finder stations. The airborne direction finder equipment was mainly based on U.S. and German design. There was some indication of more advanced thinking in the radio navigation line, but apparently no concerted effort had been initiated to develop these ideas.

A ROTATING RADIO BEACON FOR
MARINE NAVIGATION

The principle and the operational characteristic of another rotating radio-beacon for marine navigation which was invented in 1933 and the experiments about it were continued to 1941 when an experimental station for actual use was accomplished at Danto light house near Tsintao, are as follows.

The rotating radio-beacons widely known work on the principle of measuring the time between the instant of hearing the so-called "North-Signal" and the instant of disappearance at the receiving station of the signal, transmitted from a beacon station by a loop antenna rotating uniformly in one direction. This type of rotating radio-beacon was developed in England, where it is most in operation.

The chief disadvantages of this type of rotating radio-beacon seem to be the following:

(1) It is usual, when the minimum signal zone becomes broad, that is, when the signal disappears for a while, to find the time when the direction of oc is towards the receiving station by averaging the time of disappearance of the signal (point a) and the time of its reappearance (point b). But since obviously $ob \neq oa$, the bearing thus obtained is not correct (Fig. 1).

(2) Irregularities in the revolving speed of the loop antenna introduce errors into the bearing thus obtained.

(3) A special timing instrument, such as a stop-watch, is indispensable at the receiving side.

In order, therefore, to eliminate these objections, the so-called figure-of-eight field pattern in our system, is made to rotate cyclically, turning back after each half revolution, with the result that the bearing can be determined by observing the time of disappearance of the signal (point a and point a') twice in one cycle if necessary (Fig. 1). And instead of the signal wave being transmitted continuously, a definite number of dots are sent during the time that the direction of the minimum field intensity (oc) revolves 180° .

Since in our experiments 90 dots were sent, i.e., 1 dot for every 2° , instead of measuring the time, the correct bearing could be found at once by counting the number of dots from the "North-" or the "South-Signal" to the instant of disappearance of the signal. In this case, the bearing of a re-

ceiving point relative to a beacon station is given by equations

$$\theta^{\circ} = 90^{\circ} + (N_1 - N_2),$$

or $\theta^{\circ} = 270^{\circ} + (N_1 - N_2),$

where θ° is the bearing in degrees from north to east,

N_1 is the number of dots counted from the "North-Signal",

and N_2 is the number of dots counted from the "South-Signal"

(Fig. 2)

When, in this system of radio-beacon, the minimum signal zone becomes broad, correct bearings are obtained by measuring the times of the two disappearances of the signal in one cycle of the field pattern revolution, as already stated, so that in the worst case, it would require about 12 minutes for one observation of bearing when the revolving speed of the field pattern is about one revolution per minute, as it was in our case. There is then introduced an error in the observed bearing, and yet, for instance, when the receiving object is moving at a distance of more than 17 km from the beacon station at the rate of 20 km per hour, the error, at the worst, is only 1°. Our experiments showed that even at a distance of about 40 km, the minimum signal zone is observed very sharply, only one measurement being necessary for a vessel in motion to get correct bearings.

Although a loop antenna was used to get the so-called figure-of-eight pattern in our case, should it be found necessary to get correct bearings at a distance of more than 50 km, at night as well as in daytime, an adcock antenna system becomes necessary.

M. Okada

A New Omnidirectional Radio Beacon for Air Navigation.

(An abstract copy of R. P. No. 442, published by "Denki-Shikenjo, (The Electrotechnical Laboratory, Board of Communications)," in 1941.)

1. The Principle of the New Beacon

For example if we send the radio waves in so-called figure-of-eight field pattern from an antenna system, it is possible to show by the following expression:-

$$E \sin \theta \sin \omega_0 t \quad (1)$$

namely, this θ indicates the bearing angle of receiving points, while ω_0 ($\omega_0 = 2\pi f_0$) does the angular velocity of the carrier wave.

Thus in case we rotate the field pattern at the rate of angular velocity ω_3 in the air, at a receiving point where the bearings of it, measured from the sender, is θ , such a radio wave as follows must be felt:-

$$-E \sin (\omega_3 t - \theta) \sin \omega_0 t, \quad (2)$$

And also, from another non-directional antenna, we radiate such a radio wave as expressed in the following equation.

$$E' \sin \omega_3 t \sin \omega_0 t \quad (3)$$

When (2) and (3) wave is received simultaneously, and detected by a linear detector, we get a pulsic current expressed generally by the following equation, neglecting higher terms.

$$\frac{2A}{\pi} (1 - \frac{2}{3} \cos 2\omega_3 t) \quad (4)$$

or in case the waves are detected by a square-law detector, the following expression may be possible.

$$\frac{A}{2} (1 - \cos 2\omega_3 t) \quad (5)$$

Accordingly in either case the fundamental frequency of the low frequency currents which can be obtained from the result of receiving the radio waves (2) and (3), is $2f_3$ ($\omega_3 = 2\pi f_3$),

$$K \cos 2 (\omega_3 t - \theta) \quad (6)$$

$$K' \cos 2 \omega_3 t \quad (7)$$

by these two expressions we can also express and know, between these two, there exists the phase difference 2θ . In other words, the phase difference between these two currents changes directly proportional to the direction-angles (or the bearings) θ of receiving points.

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(1) Thus if adjust the receiving equipment so as to point true north just as pointing the phase difference zero, we all at once able to distinguish the direction-angle θ by means of a phase-meter indicating the phase difference 2θ . And this is the fundamental principle of our new beacon system.

(2) Though the principle is as plain as a pike-staff, we must take into consideration many circumstances for practical application. Firstly we should necessarily make equal the two sending waves w_0 and w'_0 , because of the desirable reasons from the stand point of frequency allocation and that of being able to use the same or one receiver to receive those two waves; secondary, to eliminate so-called night error, Adcock type antennas must be used, to make out figure-of-eight field patterns; thirdly, the operations of receiving equipments must, by all means, be small-sized and light, and moreover they should show the phase difference as continually and exactly as possible. If allowed it is desirable for them to indicate phase difference with the exactness of 1° .

In consideration of these points how the writer is making experiments by trying to contrive the apparatus or will improve these reads as follows:

2. Sending Waves

To solve the first and the second problems, we use crossed two pair Adcock antennas and one vertical antenna placed at the center, and the wave coming from either of these two is expressed:-

$$\begin{aligned} \text{Waves from North-South Adcock type antenna} \\ E_a \sin w_3 t \sin w_2 t \sin w_0 t \end{aligned} \quad (3)$$

$$\begin{aligned} \text{Waves from West-East Adcock type antenna} \\ -E_a \cos w_3 t \sin w_2 t \sin w_0 t \end{aligned} \quad (9)$$

Amalgamation resulted from these two waves of Adcock type antennas

$$\begin{aligned} E_a (\sin w_3 t \cos \theta - \cos w_3 t \sin \theta) \times \sin w_2 t \sin w_0 t \\ E_a \sin (w_3 t - \theta) \sin w_2 t \sin w_0 t \end{aligned} \quad (10)$$

Waves from vertical antenna

$$E_v (1 + a \sin w_3 t \sin w_1 t) \sin w_0 t \quad (11)$$

Namely in order that we distinguish between the wave from the Adcock type antenna with figure-of-eight field pattern and the wave of the vertical antenna with non-directional character, sub-carriers f_2 ($w_2 = 2\pi f_2$) and f_1 ($w_1 = 2\pi f_1$) are used to modulate the waves respectively, and in addition carrier is completely suppressed from the wave emitted by these both Adcock type antennas to prevent the interference of carrier waves. The experiment this time is made by using $f_0 = 235 \text{ Kc}$; $f_1 = 135 \sim$, $f_2 = 235 \sim$, $f_3 = 10 \sim$, but modulation frequency should be expected to be changed in the near future.

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In the first preliminary experiment, as a way to rotate in the air the figure-of-eight field pattern, we took up a manner to rotate the rotor of a radio-goniometer, but as we realized how difficult it was by this method to set up the goniometer so as to rotate even and at high speed the figure-of-eight field pattern, in the experiment, this time an improvement was planned to do it electrically, as shown above to give some proper modulation to the waves, and some devices such as "rotating transformer" were made in low frequency part, and fortunately have succeeded in handling the sending system with much safety and almost perfect.

3. Antennas, Feeders and Earth

Four antennas forming two sets of Adcock type antenna system and the center vertical antenna are, severally, cage type vertical antennas and the former are composed of 4 strands of hard copper wire (dia. 4mm) and the latter is also composed of 4 strands of stranded silicon-copper wire (14 mm^2) and its length is about 55 m. The opposite angles of the Adcock antennas are severally 200 m in distance. From a sending apparatus near the center of the antenna system, radio frequency energy is fed to those antennas by feeders of paper insulated power cables for 6,600 V placed under the ground at a depth of 40 m measuring 130 m in length, and is so equipped as to excite the antennas through matching devices at the end of them.

Earth is a net-work placed 60 cm deep under ground focussed by 48 hard copper wire of 4 mm measuring 40 m in diameter.

The practical test of the constants of antennas, earths and feeders, which is done at 235 kc sending-wave is approximately illustrated by table 1 and table 2.

The reason for the general high resistance of the aerials is considered to be ascribed to the sandy area in which this wireless station is placed; and between the start of this test and the end of it there was a considerable difference in underground water-level according to the situations of the station. As we noticed, the high resistance of the north antenna being attributed principally to the difference of soil, the addition of earth wires and the change of their grounding points and other several steps were often tried to pull down it; but we expected in vain from the contrivances. From the results we are obliged to think it would be better to use counter-poise next time.

4. Sending Apparatus

Different points of the sending apparatus used for our "Omni-directional Radio Beacon" from those of equi-signal beacon are said to lie in the change of modulators or power plant for modulation. And accordingly the experiment this time was attached much importance to using as the sender the equi-signal radio beacon transmitter purposely made together with the apparatus of modulation power plant which was planned as a test. Figure 1 is the gross outline of it; the upper part is

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the sender and the lower part is the modulation power plant. In working our "Omnidirectional radio beacon", modulator of the transmitter and radio-goniometer are not used. The carrier input power of the centre is 1 kw and during our test the maximum percentage modulation being about 30%. The input power of two sets Adcock type antennas is, as said above, that of carrier suppressed and so if not modulated there will not come out any output at all. And although practically it receives double modulation, from convenience sake, we set the apparatus at the degree of about 470 W when modulated by a single frequency; that is the percentage modulation is about 50%.

5. Receiving Apparatus

The receiving apparatus as shown by figure 2 is composed of antenna, receiver, and filter separator, two currents of frequency f_1 , f_2 , second detector and direct reading phase-meter or direct reading bearing-indicator which indicates the phase difference of the two current of frequency f_3 .

Any kind of antennas can be used for this device, and no claims made for this sort of receivers; high gain and good character one is the better. For this test as illustrated by Fig. 3, 6 valves super-heterodyne receiver was used and its characteristics is shown by Fig. 4. For filters, there is no special demands, but you may understand by Fig. 5 the characteristic used for it. One of our phasemeters, as is shown by Fig. 6, is a dynamometer type and its operation needs, I may say, no explanation. Another is an impulse type, also illustrated in Fig. 7, and as you see by Fig. 8, we so planned the device as to set up impulses when both currents of frequency f_3 falls down to zero, to make flow continuous and constant valued current from another source between these two sets of impulses, and to read the phase difference of the two currents of frequency f_3 by the mean value of the pulsic current thus obtained. As you notice in Fig. 7 the circuit of No. 36 vacuum type is the point where emits the impulses, and by these impulses the function to switch in and out the another source the vacuum tube 38 and S-712-B is destined to perform.

As to the dynamometer type phasemeter the inconvenience, however, results from the inability to indicate phase difference directly, and moreover, as the new-made device has more remarkable drawback in indicating exact values than the impulse-type one, it was not used in our actual tests on an aeroplane. But which is superior of the two awaits further experiments.

The impulse-type, as well as dynamometer type, if attached with course indicator for homing as illustrated in Fig. 7, an aeroplane can shift its straight way by its own choice, and can be utilized as a radio beacon for wind-free homing-device or all destined radio-beacon.

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6. The Results of Practical Test Made by On An Aeroplane.

The examination of the synthetic operational characteristics of the beacon system on a plane which was the principal object of our test, was made between Aug. 10th and 24th in 1940 at Yonago airport. Followings are the outline of them.

(1) Test for the Operational Characteristics of The Beacon As Bearings-Indicator.

In order to examine the move of the beacon as a bearings-indicator, we had recorded the indication of the bearings-indicator at a pre-selected place, by a plane to make circle flying around the station keeping within 40 km in radius, except over the sea where the flying distance is taken down by time from the point of the land the plane left flying at even speed in straight line, and this also leaves room of errors, that is, not so exact as measured on land. The courses of test flights are shown in Fig. 9.

Fig. 10 shows the results taken on a plane at height of 1,000 m, 2,500 m, 3,500 m circling twice within three days.

Though we can see at a glance from this results some very irregular errors and impressed by the impossibility to obtain exact bearings, in fact, on the contrary, they prove that the operation of the beacon is quite exact and delicate.

Namely as the flying path on the land was mountainous district and there were many mountains higher than 1,000 m above the sea-level, the electromagnetic field of the beacon waves suffered complicated disturbances, and thus even when the plane flew over very short distances, there were lots of cases when in the indication of the bearings-indicator on the plane, a considerable change arose, but the remarkable similarity at the same height and place, as is shown in Fig.10 indicates how the movements of the beacon are stable and superior.

That the degree of disturbances in the electromagnetic field are changeable according to the height of mountains which is a main disturbance as we know, and the bulk of them, the height at which an aeroplane makes a flight and the distance from those mountains is rationally right and Fig 10 is introduced for this purpose, too.

From the results of these tests on a plane, we can derive some final conclusion.

That is to say:- there comes some errors of $\pm 10^\circ$ in those mountainous districts shown in Fig. 9, but generally it is within $\pm 5^\circ$ and in such places we can at once notice that there will arise in the indications of the bearing-indicator a sudden change they are fickle and delicate in reading.

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(2) Even in these mountainous districts, places where indicate large errors are limited and in most places, in relation to the removing position of an aeroplane, indicator will give stable bearings. And in places in question, errors are small and delicately estimated at worst within $\pm 20^\circ$.

(3) In case of flying over the sea there are some spots about the coast and islands where disturbances occur, but those are but small and slight, giving no change to the indications.

(4) Interference of telephone or of telegraph does not change the indications.

(5) Accordingly in such places, quite free from disturbances as on the plain of sea and in the flat stretches of land, continual and direct reading of bearings can be obtained within the limits of errors $\pm 10^\circ$ and almost in all other such like places errors are within about $\pm 20^\circ$.

At the same time during this circling flight shown in ① to ⑥ of Fig. 9, we tried in vain to measure the bearings by Telefunken type direction finder, because of the abrupt and instantenous changes amounting from $\pm 100^\circ$ to $\pm 200^\circ$.

(2) The Experimental Results Handling As An Ordinary Course Beacon.

For the test to examine the handling as an ordinary course beacon together with the limit distance, as illustrated in Fig. 11, we tried fly straight to three places (N) (O) (J) from the beacon station.

The reason for choosing on purpose these three places lies in the fact we wanted to test severally by (N) the direction seaward, by (O) mountainous districts and by (J) flight on the sea.

The flight in the direction of (N) was accomplished at the height of 2,500 m and the results were as nearly same as those made by the aforesaid circling flight tested at comparatively near places shown in Fig. 10, as the readings of the indicator were shifted by -5° from the true bearings of 700° , in this time, at the place near (N) about 250 km from (T).

The returning via (H), (O) through which we got at (T), and all on the way it could hardly possible for us to read the records of the indicator on account of dullness of electric field intensity, of high atmospheric noise and the instability of the indications. (O)-return flight was also made at the height of 2,500 m.

The distance between (T) and (O) being 200 km. and this route lay across a mountain as high as 1791 m above the sea-level and the movement of the beacon system being as bad as the test we had before made, in addition there was some disturbances which made the needle of the indicator to turn at the middle to left and right as the case might be; but it was clearly proved by the test that we can make a straight flight along

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the expected route taking no notice of sudden change of leading needle.

Though some mountainous districts exist which give disturbances on the electric waves and also made clear this may be used effectively as a course-beacon.

The return trip in the direction (J) was made 2,000 m high and the distance between (T) and (J) was about 630 m and 250 m of the distance being the flight over the sea, so stable and calm was the route, that we could reach the (J) spot with the difference of 1°.

There were some slight disturbances occurred at such places as above the sea line and some above the mountains of Korea, but these were out of the question.

From this experimental test, however, both of the bearings-indicator and the course-indicator can be determined to move exactly and freely in case the beacon signal has an intensity of more than 50 μ V/m.

(3) The Experiment of Influence of Topography.

As to the influence of topography over the beacon signal, we have already spoken of under 2 preceding paragraphs, but especially the influence over the coast-lines was experimented and made clear in other columns that the errors of the indication coming from a place 20~30 km distant from the sea shore is generally 2°~3°.

7.3 Conclusion.

About leading public air-flight, especially the liners, we put up here a table of merits and faults, from our results of researches, of several existing ways and our omnidirectional radio beacon (O.R.B.).

(1) Comparison with direction-finder on ground.

O.R.B.	Direction-finder on the ground.
I. The situation of the plane can be known direct and continually, and so the exactness is remarkable.	I. Much time must be spent in knowing the direction of the plane and intermittent.
II. The aviator must be able to discern at once where the topography giving disturbances to the signal and they can avoid any unexpected accident by marking these places before hand.	II. There are fears to fall into inability to measure, when the electric field is disturbed, or, not knowing this fact, to go on the measuring of direction when, the measurer has no full knowledge, his defect will often bring about some accidents.

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O.R.B.	Direction-Finder on the ground.
III. Innumerable aircrafts can avail themselves of this at the same time.	III. One apparatus can by no means be used for more than one plane.
IV. No need to be skillful in knowing the position of the plane.	IV. Must be skilled in the art of measuring.
V. No need of taking on the plane any correspondent.	V. Need a correspondent on the plane.
VI. No need to establish any receiver or sender of correspondence on the plane.	VI. Need be furnished with receiver and sending apparatus of correspondence.
VII. Comparative large sum to set up any facilities on the ground.	VII. The expenses are comparatively small for the equipments on the ground.
VIII. Expenses are small for the apparatus on the plane.	VIII. In case there is an apparatus on the plane, no need of expenses is specially felt for apparatus on the plane.

Excluding the expenses above mentioned the O.R.B. is far superior, and about the respects of expenses, too, we can not necessarily decide this O.R.B. wants larger sum of expenses, taking into consideration how much is spent on corresponding apparatus as the equipment on the ground and on the communication lines, relating among the stations on land.

(2) Comparison With Direction-finders on the plane.

O. R. B.	D. F. on the plane
I. With no relation with the direction of the planes we can know the position of the plane direct and continually.	I. Few device are there which indicate continually and directly the bearings of the plane irrespective of the direction of the flight, and its exactness remains much to be desired.
II. Can detect all at once the disturbance caused by the topography and can mark the places on the map where accidents are apt to occur before-hand.	II. Fall into inability to measure at places where disturbances of waves often occur, and is difficult to mark distinctly pre-supposition.

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O. R. B.	On the plane
III. Less effected by nights.	III. Ranges of usage are limited because of so-called night effect.
IV. No need of skill to know their own directions.	IV. Need comparative skill to know their own directions.
V. Suitable to use for small-sized planes.	V. Not proper to make use of for small-sized planes.
VI. Large in expenses for land apparatus.	VI. Can utilize existing wireless stations.
VII. Small in expenses for plane-equipments.	VII. Larger in expenses for plane equipments in comparison.
VIII. Limited in the number of stations to use.	VIII. Can utilize any sort of stations.

As shown above setting aside the fact that the limitations to utilization of wireless stations, and the need of large sum for land apparatus, we can find O.R.B. far superior to others and that to have direction-finder on the plane utilized any time as the principal apparatus, we have specially to build a considerable number of wireless stations for that purpose or develop the equipments of existing wireless stations. The expenses for that are by no means small. And the bulk of expenses for plane apparatus rests with the increase of the number of aeroplanes which we have to take into serious consideration.

(3) Comparison with "Homing Device".

O.R.B.	"Homing Device".
I. Without the special need of measuring side current: can trace straight along the fixed route.	I. In order to travel straight on the fixed route need must be felt to effect the measurement of side-current of air.
II. Movements become unstable at a place where signal waves are disturbed.	II. Ditto with the left, except being extreme in instability.
III. Small is the range to be effected by nights.	III. Limited to the ranges of usage because of the night effect.

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O. R. B.	"Homing Device"
IV. Suitable to make use of for small-sized planes.	IV. Considerable difficulty to utilize for small-sized planes.
V. Large in expenses for land apparatus.	V. Can make use of existing wireless stations.
VI. A little small in expenses for plane-equipments.	VI. A little larger in expenses for plane-equipments.
VII. Limited to utilize wireless stations.	VII. Can utilize at large any sorts of wireless stations.

Apart from the limits to the utilization of the wireless station and to the big expenses to set up the apparatus on the ground, there are some superior points in O. R. B., and about these points related in the preceeding pages we have still room for investigation to make "homing device" the principal device used.

Hence the writer, can claim the privilege to conclude the results of leading air-crafts as stated in the followings.

The measures taken for leading air-crafts in Japan are regarded ideal to do as follows:-

(1) The main parts should be composed of O. R. B. and marker beacons to complete the steps of, leading air-crafts, and existing equi-signal beacon must soon give place to O. R. B.

(2) With the help of short-wave direction-finder along with O. R. B. or steps to lead far-distant national air-crafts must be established, and for this purpose the aviation area must be set up as soon as possible, and Direction-finder Bureau should also be systematically established with the completeness of relationship with each other.

(3) On large-sized planes direction-finder and also homing device which they use in urgency must by all means be landed. If this be perfected all air-crafts, I am sure, may safely be guided to their destination. But to make this device or measurements as useful as up to the full mark, we have needs, in the first place, to make the handling of them and organization perfect, and we should give special knowledge about air-craft radio to the aviators as well as that of handling the apparatus themselves, they must be taught the usage of these public measures with no mistake, and after that they can make any trip in the air by so-called Wireless Flight; The writer especially attaches much importance to this point.

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Table 1

	Antenna Resistance without loading coil (Ω)	Apparent capacity (μF)	Natural wavelength (m)
Centre antenna	28.6	1003	288
East "	13.6	931	252
West "	24.3	931	252
South "	18.7	926	252
North "	41.9	940	250

(These values changed somewhat day by day.)

Table 2

feeder constants	surge impedance	phase angle	power loss
	70 Ω	70°	0.41 db.

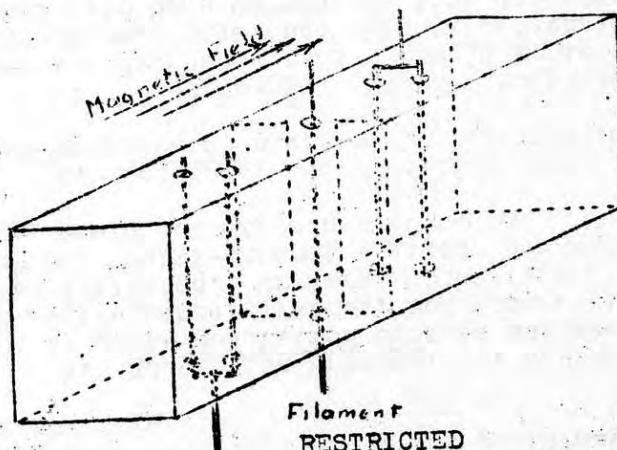
SUBJECT: Research Section, Japanese Broadcasting Company
DATE: 18 October 1945
INTERVIEWED: Dr G Hara
INTERVIEWERS: Maj Hewlett, Tec 4 Yagi

1. From 1926 to 1943 Dr Hara was with the Ryojun Institute of Technology, Port Arthur, Manchuria, where his work was primarily on special vacuum tubes and on antennas. In 1943 he came to the Second Department of the Japanese Broadcasting Company to work on microwaves and special vacuum tubes therefor. Until 1941, this laboratory had worked primarily towards the development of television, but during the war this work was stopped and research concentrated on more basic forms of research in the microwave field.

2. Dr Hara's group was primarily concerned during the war with basic research on vacuum tubes for microwaves, wave guides, resonators, microwave measurements, and general basic theory. The group consisted of 17 engineers, 8 assistant engineers, and 26 assistants. For a list of the engineers and their fields of work, see Incl 1.

3. The following is a brief description of the main fields of research.

a. Vacuum Tubes. Work in this field was almost entirely for tubes operating in the microwave range, primarily those for detection purposes and not for power generation. The tubes worked on were the magnetron, the Barkhausen oscillator, the klystron, and the Osaka tube. A special balanced push pull form of this tube was developed by Dr Hara's group. (See sketch below.)



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No work was done on co-planer triodes. At the request of the Air Force Technical Society (Koku Jyutsu Kyokai), some work had been done to improve the performance and reliability of thyatrons.

b. Modulation Schemes. S. Sonobe had given some thought to pulse modulation schemes and even to the possibility of multi-channel systems, but apparently no actual work had been initiated. Dr Hara, himself, mentioned "time modulation" and "multi-channel systems" but when questioned more closely, could not explain what he was referring to.

c. Antennas. Work in this field had been confined to 40-mc broad-band antennas for television.

d. Measurements. Signal generators had been built to cover the frequency range from 30 mc to 100 mc and from 50 cm to 10 cm. Impedance measuring techniques for use at 10 cm had also been worked out that depended on the use of latcher wires. For current measurement, a thermocouple was used, even down to 10 cm. For power measurement, current was passed through a thin resistance wire and its color compared to a separately-heated nickel plate directly behind the measuring wire. The device was calibrated on DC. Powers in the order of 2 to 3 wt and above could conveniently be measured. For measurement of frequency, a heterodyne wave meter was used up to one meter but at 10 cm a resonant cavity was relied on.

e. Electron Optics. The main work in this field was on a two-stage electron microscope and on single-stage and multi-stage secondary emission amplifier tubes. No work was done on infrared image-forming tubes.

f. Atmospheric Noise (Spherics). Under a project from the Japanese Society for the Promotion of Scientific Research, work was carried on to locate atmospheric disturbances by use of radio direction finders. This work had been under way for about three or four years but was only worked on during the summer. Principal interest appeared to have been in the study of relatively local conditions.

3. The work of Dr Hara's group, as previously indicated, was principally basic research. Present plans are that this group will now turn its efforts towards television problems, particularly in the frequency range of 40 cm. It is believed that the work on spherics should be more carefully investigated by specialists in that field.

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Incl 1

LIST OF THE RESEARCHERS

Official or Professional Rank	Name	Research Subjects
Councillor	Hara, Gennosuke	Receiving tubes
Engineer	Aoyama, Yoshihiko	Resonators, modulators
"	Nomura, Tatsuji	Antenna
"	Fujita, Tokuya	Resonator wave guide
"	Waki, Shichiro	Velocity modulated tubes
"	Nakamura, Gyujiro	Wave guide
"	Nakamura, Kiyoshi	Discharge tube with slit
"	Kurota, Haruo	Wave guide connections
"	Yasuda, Ichiji	Vel. modulated tubes
"	Fukunaga, Iateo	Measuring apparatus
"	Suzuki, Keiji	Receiving tubes (e.g.
"	Kurokawa, Sainichi	Osaka tube, magnetron)
"	Iakeya, Kenichi	Electro-multiplier (1-stage)
"	Miyaji, Isichi	Power measuring tubes
"	Yamamoto, Kiyoshi	Electro-multiplier (multi-stage)
"	Fukushima, Ryutaro	Electron optics
"	Miyahara, Tsubutaro	Conversion tube, microphonic
"	Amano, Tsutaye	Atmospherics
Assistant		
Engineer	Sonobe, Shigeru	
"	Shimizu, Akira	
"	Shimoda, Masujiro	
"	Saito, Masuji	
"	Sato, Toshiiji	

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