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U. S. NAVAL TECHNICAL MISSION TO JAPAN
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SAN FRANCISCO, CALIFORNIA

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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.

Subject: Target Report - Japanese Ordnance Research, Testing, and Training.

Reference: (a)"Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, dealing with Target O-38 of Fascicle O-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Lt.(jg) D.H. Jackson, USNR, assisted by Lt. Comdr. S. Delmar-Morgan, RNVR.

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30656

JAPANESE ORDNANCE RESEARCH TESTING, AND TRAINING

"INTELLIGENCE TARGETS JAPAN" (DNI) OF 4 SEPT. 1945

FASCICLE O-1, TARGET O-38

JANUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

ORDNANCE TARGETS

JAPANESE ORDNANCE RESEARCH,
TESTING, AND TRAINING

Research and developments in ordnance were directed by the Technical Department of the Japanese Navy Ministry. This report outlines the methods of this department and its relationship to other contributing units.

It was noted that most of the highly trained technical personnel received their training at the TOKYO Imperial University.

Testing was inadequate and tolerances were broad. Dynamic tests of directors and computers could not be conducted until after installation aboard ship. However, complete fire control transmission tests were conducted after investigation and the results published. A sample of such a test may be examined in NavTechJap Documents, Nos. ND21-3429 and ND21-3430, which have been forwarded to the Washington Document Center (Enclosure C).

A good gunnery school existed at YOKOSUKA and is fully described in this report.

TABLE OF CONTENTS

Summary ..... Page 1

References ..... Page 3

List of Enclosures ..... Page 4

List of Illustrations ..... Page 4

Introduction ..... Page 6

The Report

Part I - Navy Technical Department ..... Page 7

A. General Discussion ..... Page 7

B. Technical Personnel ..... Page 8

Part II - Arsenals and Civilian Companies ..... Page 9

A. Kure Naval Arsenal ..... Page 9

B. Hikari Naval Arsenal ..... Page 9

C. Toyokawa Naval Arsenal ..... Page 9

D. Aichi Clock Company ..... Page 10

E. Fuji Electrical Works ..... Page 10

F. Nippon Optical Works ..... Page 10

Part III - Naval Gunnery School ..... Page 16

Enclosure (A) ..... Page 22

Enclosure (B) ..... Page 24

Enclosure (C) ..... Page 24

REFERENCES

Location of Target:

Navy Technical Department, TOKYO.

Kure Naval Arsenal, KURE.

Hikari Naval Arsenal, MUROZUMI.

Toyokawa Naval Arsenal, TOYAHASHI.

Aichi Clock Company, NAGOYA.

Fuji Electrical Works, KAWASAKI.

Nippon Optical Works, MIZUNOKUCHI.

Gunnery School, Navy Yard, YOKOSUKA.

Japanese Personnel Interviewed:

Captain S. SUZUKI, IJN, Officer in charge of Ordnance Supply for Yokosuka Naval District.

Commander K. MUTO, IJN, Officer in charge of Fire Control Factory - Yokosuka Naval Arsenal.

Commander J. ICHINOI, IJN, Officer in charge of Ordnance Experimental Laboratory - Kure Naval Arsenal.

Mr. FUKAEDA, Design Engineer, Nippon Optical Works.

LIST OF ENCLOSURES

(A) List of Japanese Naval Technical Personnel

(B) List of Japanese Terms used in Text

(C) List of Documents forwarded to Washington Document Center

LIST OF ILLUSTRATIONS

Figure 1. Partial Organization Diagram of Navy Ministry ..... Page 7

Figure 2. Unit Assembly ..... Page 11

Figure 3. Unit Assembly ..... Page 11

Figure 4. Unit Assembly ..... Page 12

Figure 5. Type 94 Computer Under Assembly ..... Page 12

Figure 6. Type 94 Computer Under Assembly ..... Page 13

Figure 7. Type 94 Computer Under Assembly ..... Page 14

Figure 8. Type 94 Computer Under Assembly ..... Page 14

Figure 9. Type 94 AA Director Under Assembly ..... Page 15

Figure 10. Test Stand for Type 94 AA Equipment ..... Page 16

Figure 11. Model, Type 94 L.A. Computer ..... Page 17

Figure 12. Type 94 L.A. Director (Hoiban) ..... Page 18

Figure 13. Tilting Platform for Type 94 L.A. Director ..... Page 18

Figure 14. Bulkhead Instruments for Commanding Room ..... Page 19

Figure 15. Type 92 L.A. Computer ..... Page 20

Figure 16. Fire Control Switchboard ..... Page 21

Figure 17. Type 94 L.A. Computer ..... Page 21

INTRODUCTION

This report offers a brief account of the methods by which ordnance research (especially fire control ordnance), design development, and testing were carried out by the Japanese. In addition, a section has been included describing the principal Japanese gunnery school.

Since the plants of most of the manufacturing organizations were in ruins, this description of Japanese methods of construction and testing of ordnance equipment is based largely upon investigation of the Nippon Optical Company, whose physical properties were undamaged.

Extensive research and development was done by civilian companies, and an attempt was made to trace the problems of the Ordnance Department through the Navy Section to the civilian company and thence to the final product. An investigation of the important civilian companies was made to examine their equipment and methods.

The gunnery school was visited and inspected in detail, and personnel familiar with it were interrogated.

THE REPORT

Part I - NAVY TECHNICAL DEPARTMENT

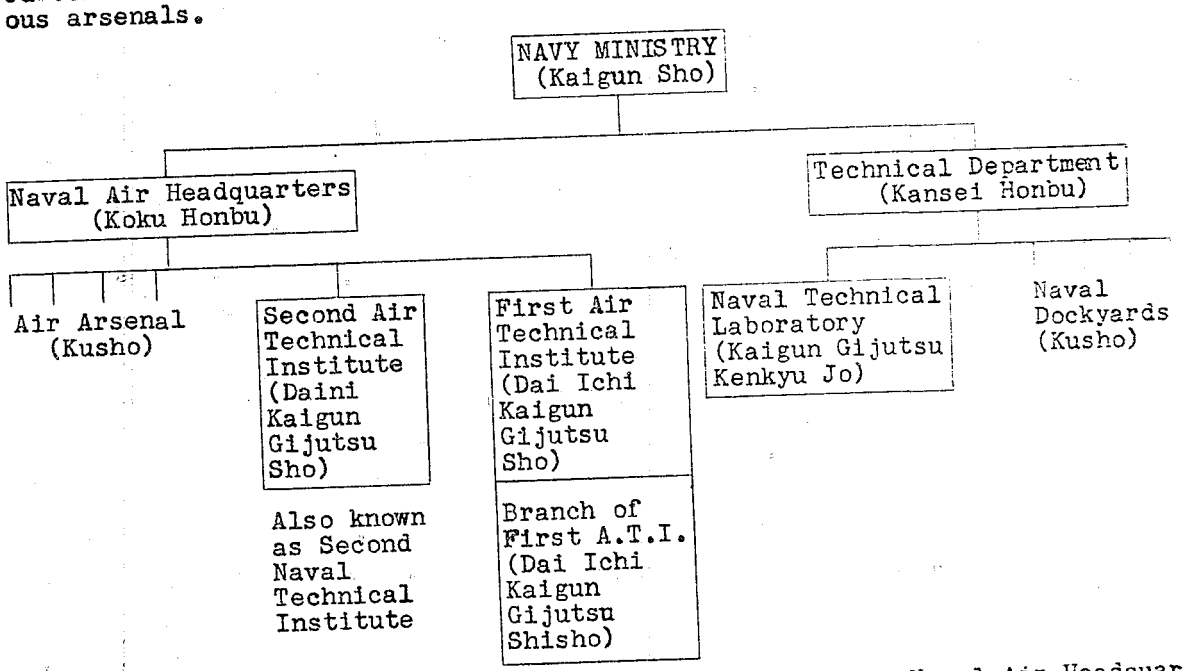
A. General

The following is a brief description of the arrangement of the Ordnance Section of the Navy Technical Department, showing the interrelation of the departments with the various arsenals and their control of research and design problems. A discussion of the training of personnel for the various types of technical ordnance duties is also included.

The Navy Technical Department (Kansei Honbu), under the Navy Ministry (see Figure 1), was divided into six sections as follows:

Gunnery
Electrical
Ship Construction
Marine Engineering
Optical Instruments
Navigational Instruments

Each of these sections was headed by two officers. One officer was a technical expert who dealt directly with the various research and design problems. The other officer was a combination supply and liaison officer whose duties included contact with civilian companies (see Figure 1), Headquarters, and the various arsenals.



Note: The Second Air Technical Institute was under Naval Air Headquarters for purposes of administration only; the physical plant and personnel were actually part of Naval Technical Laboratory.

Figure 1

PARTIAL ORGANIZATION DIAGRAM OF NAVY MINISTRY

The Chief of the Navy Technical Department was in charge of all these sections and had the final word on decisions. The gunnery section was the "strong" section. In a problem on directors, for instance, in which the gunnery, electrical, optical, and navigational instrument sections were involved, any difference of opinion was decided by the gunnery section.

The typical procedure, which culminated in new equipment, started with a design request from the Fleet Commander, sent to the Chief of the Department. The Chief designated the proper section to look into the matter. If the request was found to be of merit, the problem, accompanied by various suggestions and directives, was then turned over to one of the various arsenals where the actual research and designing were done. (There were three main arsenals: KURE, YOKOSUKA, and SASEBO. Of these three, KURE was the most important). The request came then to the Chief of the arsenal. Under his cognizance there were found the same six sections as at the Navy Technical Department. Here, in addition to the gunnery section, for instance, was found the Gunnery Experimental Laboratory.

The problem assigned to a particular section was studied and soon began to take shape. Notes were frequently exchanged between the Department, the Fleet, and the Arsenal as the problem progressed. One of the main difficulties of the set-up was the fact that at the Experimental Laboratory there was little provision for manufacturing; test models and trial equipment were difficult to obtain. Extensive red tape for proper jobbing and personnel negotations between sections further complicated the procedure.

The final result was submitted to the cognizant section of the Technical Department to be approved by both the Section Chief and the Chief of the Navy Technical Department. If accepted, the Supply and Liaison Officer took over and made arrangements for the construction of the equipment by a civilian company.

During the period of research and designing, the technical experts from the civilian companies were often called in to assist with certain details. However, most of the coordination between civilian companies and naval research establishments occurred after designs were completed and ready to be put into production.

The above system was the approved method for handling research problems. However, there was short circuiting of proper channels. Quite often the Fleet Commander would place a request directly with the arsenal when his ship docked there, or the arsenal would work on a problem they realized needed attention. The proper section would look into the matter and, if it seemed promising, would work on it until they had a design that appeared to be of benefit to the Navy. Then they would send it in to the Technical Department pointing out its worth, with the notation that such apparatus would be of great value to the Navy.

Each arsenal issued its own reports on all experiments. These were published by the Imperial Navy and sent to all arsenals. At the close of the war, libraries of these reports were ordered burned, if they had not already been destroyed by bombing. However, the library at YOKOSUKA was found intact and from it were obtained the majority of the Ordnance documents which the Naval Technical Mission to Japan has sent to Washington Document Center. Among the ruins of the KURE arsenal a few valuable documents were found.

B. Technical Personnel

Technical personnel obtained their training in two ways:

1. Those of the regular Navy, after graduation from the Naval Academy, went to sea for approximately two years. During this period each officer

was able to determine his specialty. If it was to be ordnance, he was then sent to the Gunnery School at YOKOSUKA, which is described in Part I of this report.

2. The civilian technical experts and most of the shore base naval personnel working on technical problems obtained their education at the TOKYO Imperial University. The University was attended by civilians and on occasion by military personnel who entered under special arrangements. Each civilian entered the ordnance section for a three-year course after completing high school. Here he studied engineering for electrical and mechanical theory and also studied gunnery and fire-control problems. Most of the material for the course was obtained from patents and technical magazines of various countries.

It is interesting to note that almost all of the Japanese who designed and built fire-control equipment were trained in this school and were all students of Chinichi YAMANOUCHI, who headed the ordnance section of the University. YAMANOUCHI is often referred to as the "Father of Japanese Fire Control" and is no doubt responsible for the psychology of their approach. He died in 1941.

Many of the men who later entered the Navy to perform technical ordnance work were given a short course at the YOKOSUKA Gunnery School to learn about shipborne procedure and problems in connection with gunnery.

Enclosure (A) of this report is a list of key Japanese personnel of technical ability, followed by notes on their training and duties.

Part II - ARSENALS AND CIVILIAN COMPANIES

The principal establishments which carried on the development and manufacture of fire control equipment were: Kure Naval Arsenal, Hikari Naval Arsenal, Toyokawa Naval Arsenal, Aichi Clock Company, Nippon Optical Company, and the Fuji Electric Company. A brief description of each follows (see Enclosure B).

A. Kure Naval Arsenal, KURE

The Kure Fire-Control Factory manufactured several types of equipment in use by the Navy. The main output, however, was the Type 2 Destroyer Director (Hoiban) which could be produced at the rate of three per month. Another important product was the selsyns manufactured here. The principal fire-control building was virtually destroyed by bombing and no equipment of value remained. The normal number of employees was approximately 500.

The Ordnance Experimental Laboratory, discussed in Part I of this report, utilized about 600 employees.

B. Hikari Naval Arsenal, MUROZUMI

A Fire-control factory at Hikari Arsenal was built in 1942 and was a well laid out plant. It was badly damaged, and roofs, bulkheads, and equipment under construction were largely destroyed.

This plant produced the Standard Type H. A. Computer (Kosha Shagekiban, Type 94), the Standard H. A. System (Kosha Sochi, Type 94), certain bomb components, torpedo afterbodies, and miscellaneous machined parts. The production of the Standard Type Computer was approximately 15 per month and of the Standard H. A. System, one system a month. The average number of employees was about 600.

C. Toyokawa Naval Arsenal, TOYOHASHI

The Toyokawa Arsenal was heavily bombed and with very few exceptions the

buildings were completely demolished. This plant was established in 1939 as an arsenal for the production of machine guns (40mm AA, 25mm AA, and 30mm and 13mm airplane guns), optical instruments (20 meter and 4.5 meter high-angle rangefinders and periscopes), gyro compasses, machine-gun ammunition, and fire-control apparatus (principally Type 3 and Type 4).

Before the bombing raid this arsenal produced 28 Type 4 units a month. Production ceased after the raid.

D. Aichi, Clock Company, NAGOYA

The Aichi Clock and Electrical Instrument Manufacturing Company, Ltd. (Aichi Tokei Denki Kabushiki Kaisha) was founded in 1899. The fire-control plant of this company was reduced to rubble by bombing and nothing of technical value remained. During the war it manufactured the L. A. Table and the Standard Type H. A. Computer (Type 92 and 94 Shagekiban). They claimed they could make this equipment at a rate of two per month, but in actuality each unit required from six to eight weeks. This company also manufactured the H.A./L.A. Data Computer (Byodoban, Type 2). Selsyns were also produced there. Employees averaged about 600.

E. Fuji Electric Company, KAWASAKI

This factory was also heavily bombed, leaving little of technical value. Its principal product was a machine-gun director, (Type 95 Shageki Sochi). This was difficult to build in quantity, each unit requiring a month for construction. This company also manufactured some small motors and other general electrical gear for fire-control apparatus.

F. The Nippon Optical Works, MIZUNOKUCHI

The Nippon Optical Works was originally established at OI, a suburb of TOKYO, but shortly before the war a large additional plant was established at MIZUNOKUCHI, just outside TOKYO. Here was manufactured such equipment as the Type 94 Director and Computer (Kosha Sochi). For a description of this equipment see NavTechJap Report, "Japanese Anti-Aircraft Fire Control," Index No. O-30. This plant, although somewhat damaged, was in much better condition than any other Japanese fire-control manufacturing concern. Photographs taken at the plant show some of the methods employed.

This factory may be considered typical of the average advanced Japanese manufacturing plant. It is similar to the plants of companies previously discussed, before they were destroyed.

As a general rule, Japanese naval fire-control equipment was exceptionally well constructed, especially in comparison with other types of gear. Some examples of small units are shown in Figures 2, 3, and 4. Much study of production details had been done and several standards of procedure set up. An example of this study is the fact that they had determined that for the best manufacturing results (without jeopardizing the instrument's performance) the ratio of the total number of parts in a given instrument to the number of different parts in that instrument should be about ten to one.

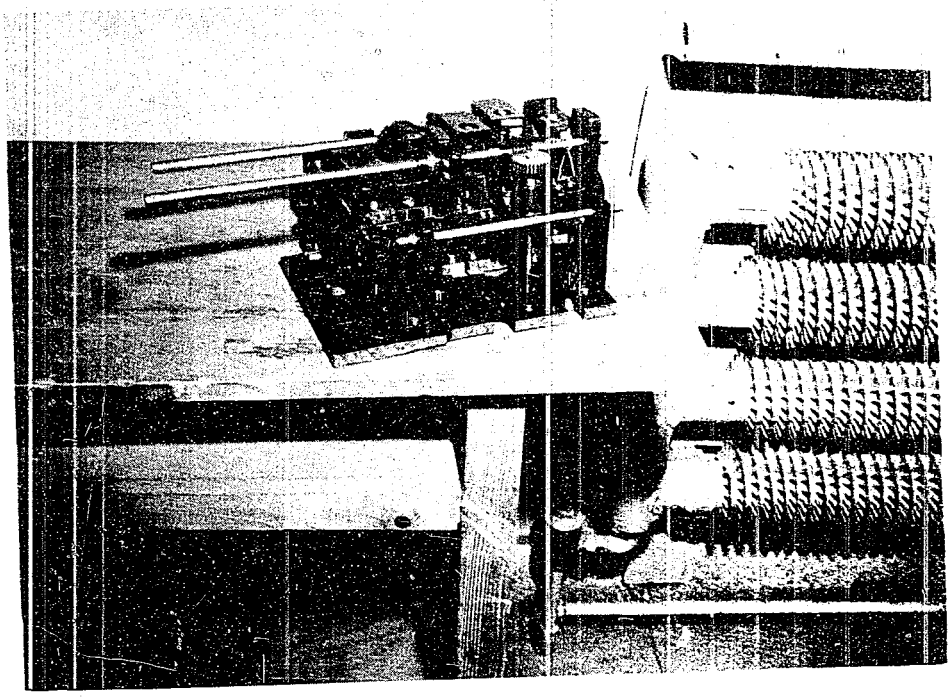


Figure 2
FIRE CONTROL UNIT ASSEMBLY

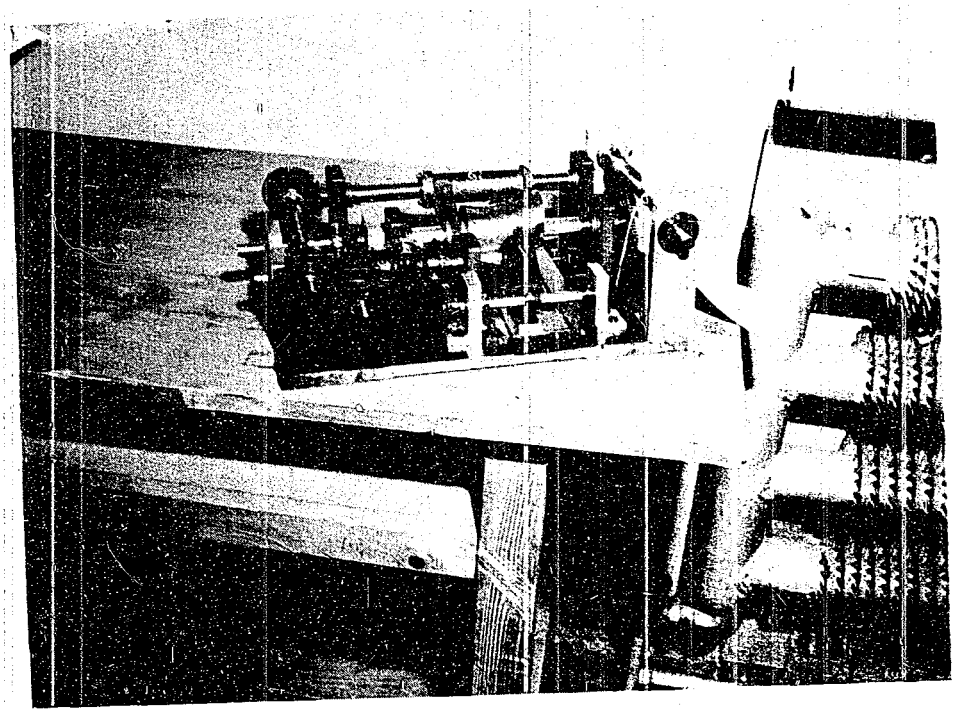


Figure 3
FIRE CONTROL UNIT ASSEMBLY

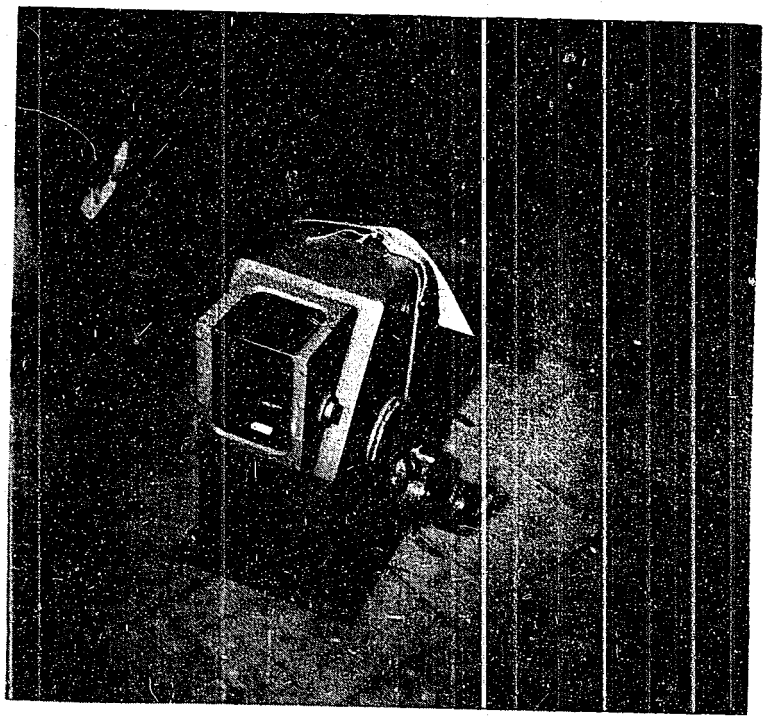


Figure 4
FIRE CONTROL UNIT ASSEMBLY

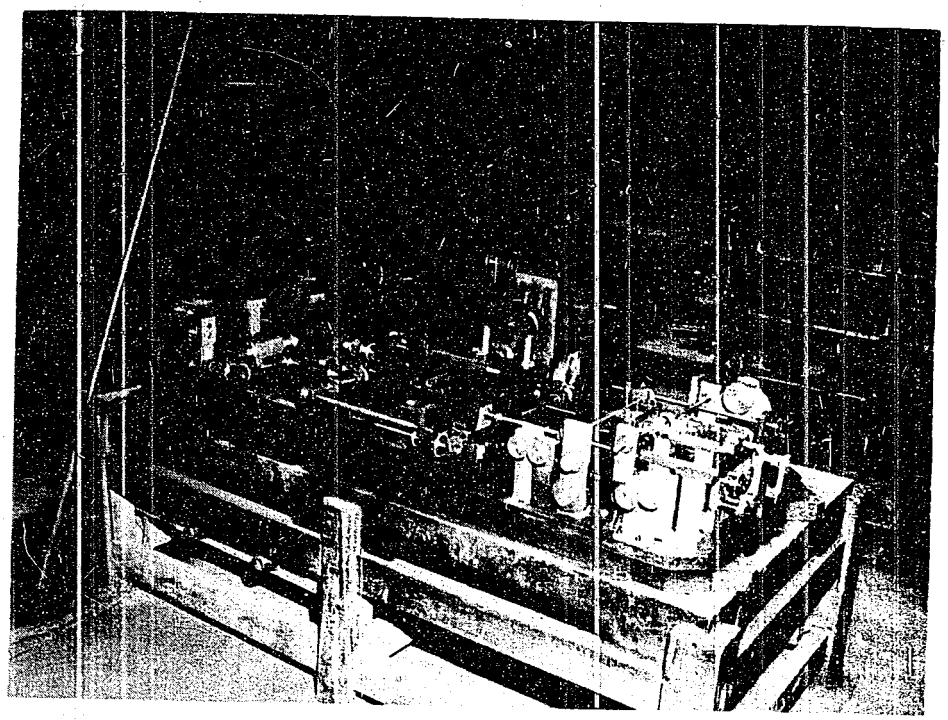


Figure 5
TYPE 94 COMPUTER UNDER ASSEMBLY

An example of the attempt to standardize individual pieces was a supporting bracket used in the Type 94 Computer. The same part was used extensively throughout the apparatus, in many different individual units. This bracket is shown in Figure 5.

All factories relied upon a tremendous amount of hand work. Bench work was much more common than in a United States factory of comparable size. Most of the machine tools were purchased from various countries or were easily recognized copies of well known equipment. One striking example seen at the Nippon Optical Works was a gear cutting machine identical to one manufactured by the Gleason Company of Rochester, New York. In most Japanese factories may be seen machinery with nameplates from England, United States, and Germany.

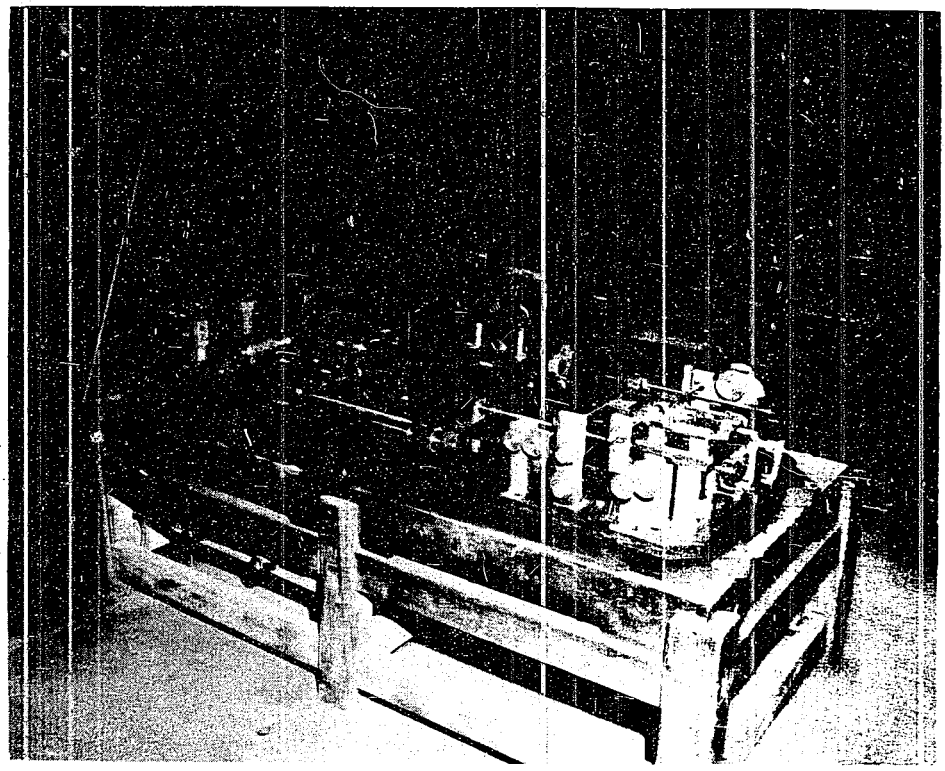


Figure 6

TYPE 94 COMPUTER UNDER ASSEMBLY

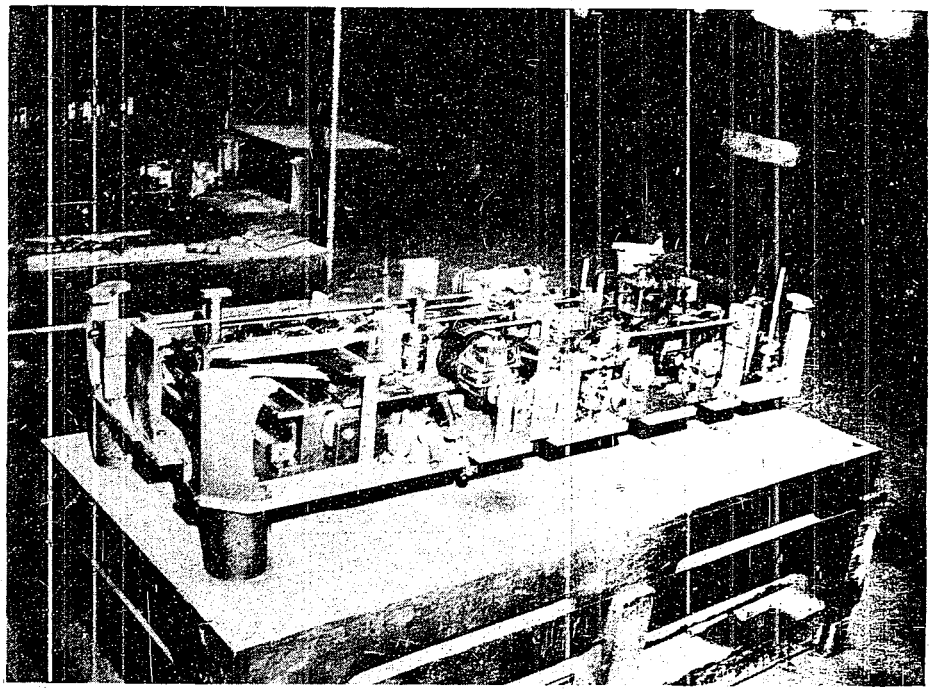


Figure 7
TYPE 94 COMPUTER UNDER ASSEMBLY

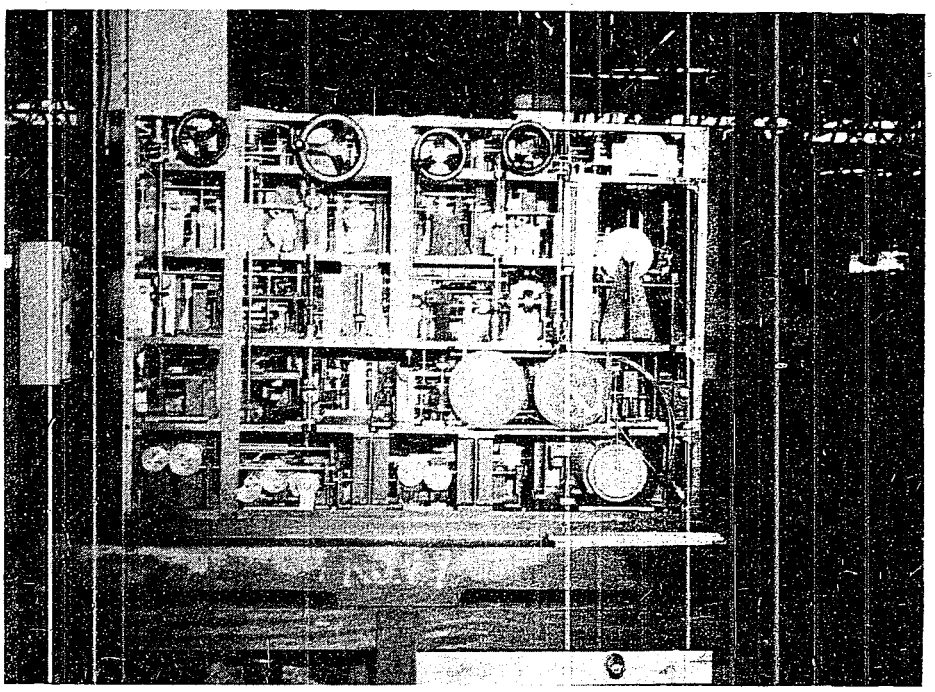


Figure 8
TYPE 94 COMPUTER UNDER ASSEMBLY

Figures 6, 7, and 8 show the Type 94 computer, under assembly. This assembly is on the open factory floor and subject to dust and exposure of all kinds. There was something of a planned flow through bays, each assembling the various levels to be combined into its one complete unit. Occasionally a particular level would get ahead and be traded to another bay; this was continued until everything was terribly confused, and they would stop and start over as completely as possible.

A Type 94 AA Director under assembly is shown in Figure 9.

Each plant had a resident Naval Inspector who operated in a similar capacity to those in the United States. He kept close scrutiny on the quality of the individual parts as well as the finished product.

Testing was relatively poor and incomplete. Figure 10 shows the test stand for the Type 94 AA Director and Computer. This is obviously a quite simple "homemade" outfit which has overrun the original table. Complete dynamic tests in the factory were not possible and testing was limited mostly to continuity and other static tests. Some check was made on transmission accuracy, but tolerances in actual practice were greatly in excess of those allowed by the United States.

Vibration tests were conducted on the Type 94 AA Director in a shallow pit outside the fire-control building. After severe jolting of the apparatus, examination was made to determine defects in the director. This test was performed on the first few directors and later discontinued.

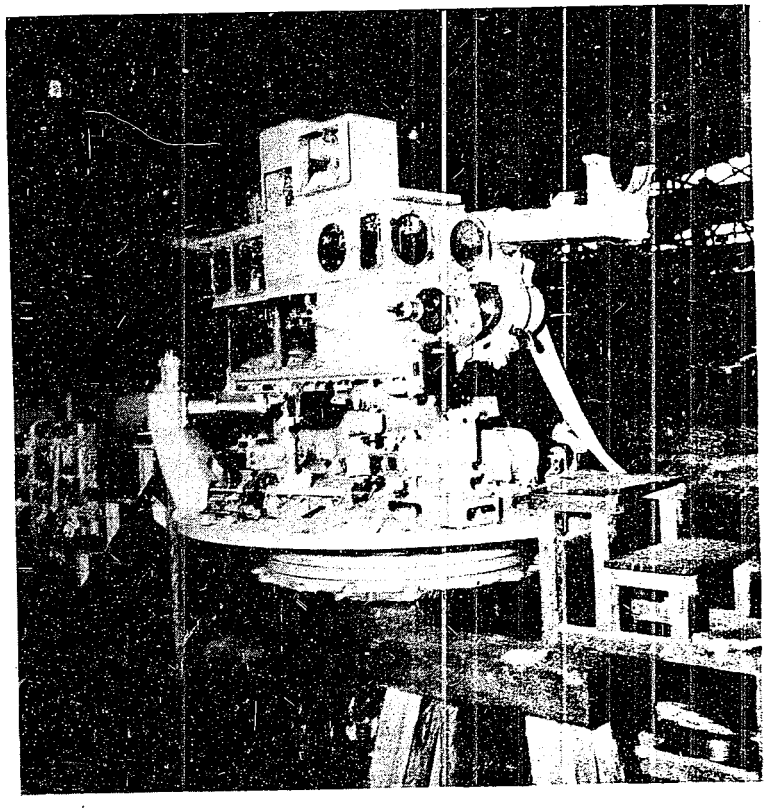


Figure 9

TYPE 94 AA DIRECTOR UNDER ASSEMBLY

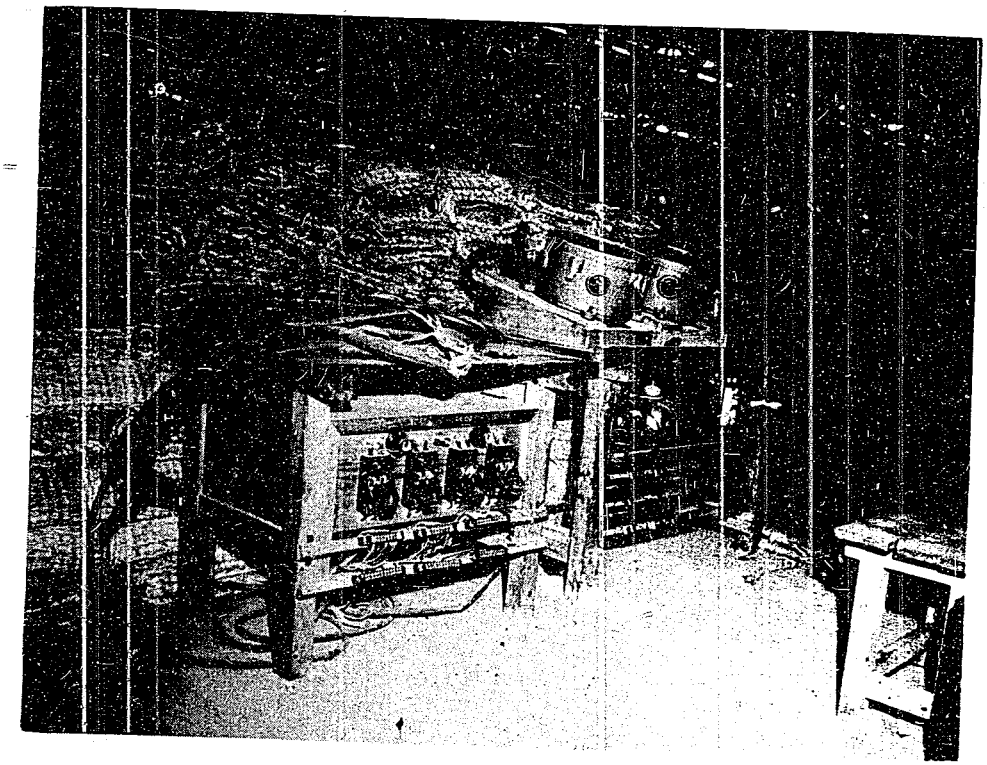


Figure 10
TEST STAND FOR TYPE 94 AA EQUIPMENT

Part III - THE NAVAL GUNNERY SCHOOL

The main Japanese Naval Gunnery School was located in the Yokosuka Navy Yard at YOKOSUKA. The only other ordnance school, located at TATEYAMA, taught ground warfare to the Marines. Information concerning the school was largely supplied by Capt. S. SUZUKI, IJN (Ret.), and Comdr. K. MUTO, IJN (Ret.).

Four large buildings housed the school and provided both classrooms and living quarters for the students. These buildings were numbered 45, 46, 47, and 48 by the Japanese, and these numbers will be used in this report to provide a suitable reference.

In the wide passageway of the first deck of building 45 were mounted several extremely obsolete and battered pieces of fire-control equipment. In the compartments opening off both sides of this passageway had been mounted various types of directors and gun mounts without barrels. On inspection of the building all these items were missing and only the base rings remained. Investigation and interrogation failed to reveal exactly what types of equipment had been installed, but it did show that practice on repair and maintenance had been performed.

The second deck of building 45 was devoted entirely to living quarters for the students.

Buildings 46 and 47 were connected, forming a continous building. In one end of building 46 were a physics laboratory and an instrument. The laboratory was devoted mostly to experimental selsyn transmission set-ups, used for training purposes.

The other section of the main deck had been torn up and a cutaway, full sized, two-man submarine had been installed for training of suicide submarine personnel. This installation was made in 1944, using the gunnery school for convenience.

The second deck of building 46 was devoted to small classrooms on one side and living quarters on the other. Tactics and use of fire control equipment were taught here.

The first deck of building 47 contained a mock-up "commanding room" and spotter stations. These will be described later.

The second deck of building 47 consisted of a large lecture room which contained a wooden model of a L.A. Computer (Shagekiban, Type 94), constructed in great detail. This is shown in Figure 11. As can be seen, the model suffered much damage from souvenir hunters.

There were also wooden models of three different rangefinders.

The far end of this building contained a room with a high ceiling, extending into the second deck. A network of overhead curved girders, covered on the underside with cloth, gave the room the shape of an eighth of a sphere. Fine wires were stretched across the room in various directions and at different heights. Tiny model planes were pulled along these wires and tracked by 25mm machine guns below, in order to familiarize personnel with the maneuvering of these guns.

On each roof of these two buildings was a Type 94 (L.A.) Director (Hoiban) shown in Figure 12. These were mounted on tilting platforms similar to a "Scorsby" machine so that artificial roll and pitch could be introduced by means of cables which controlled the platform (see Figure 13).

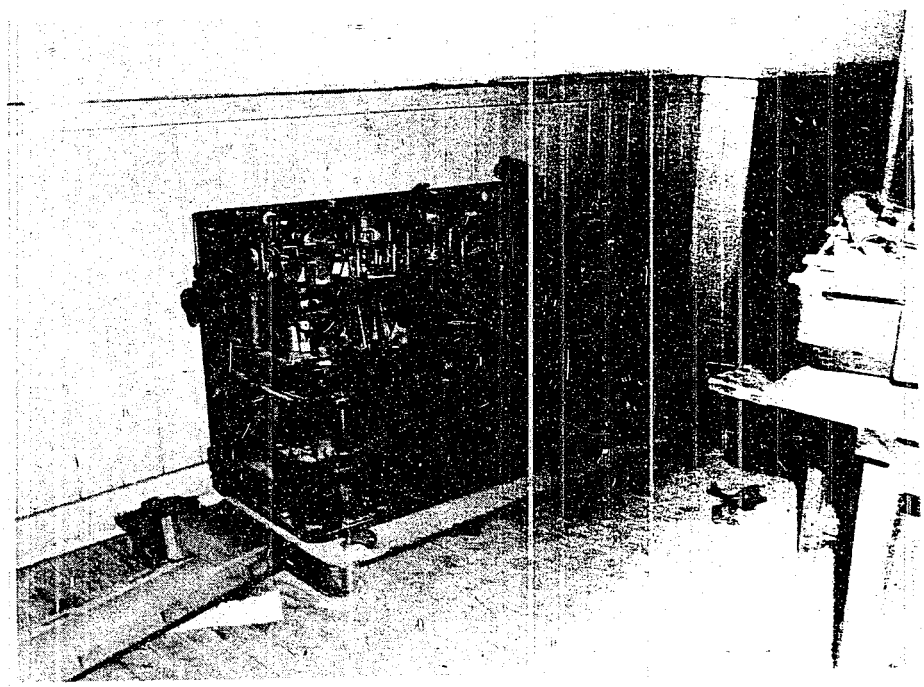


Figure 11

MODEL, TYPE 94 L.A. COMPUTER

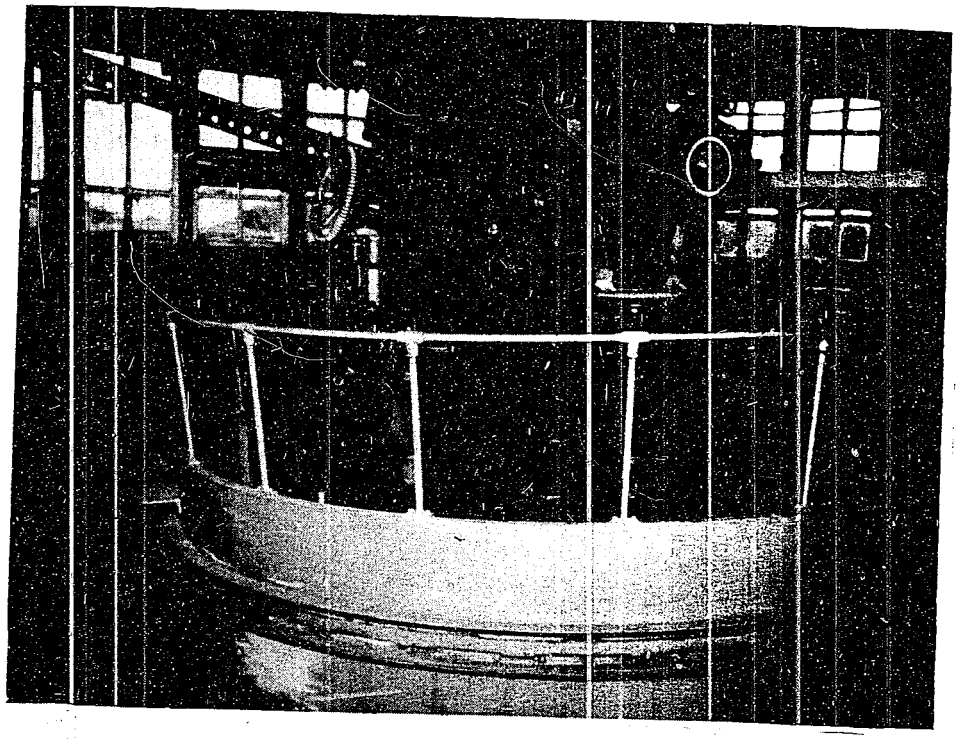


Figure 12
TYPE 94 L.A. DIRECTOR (HOIBAN)

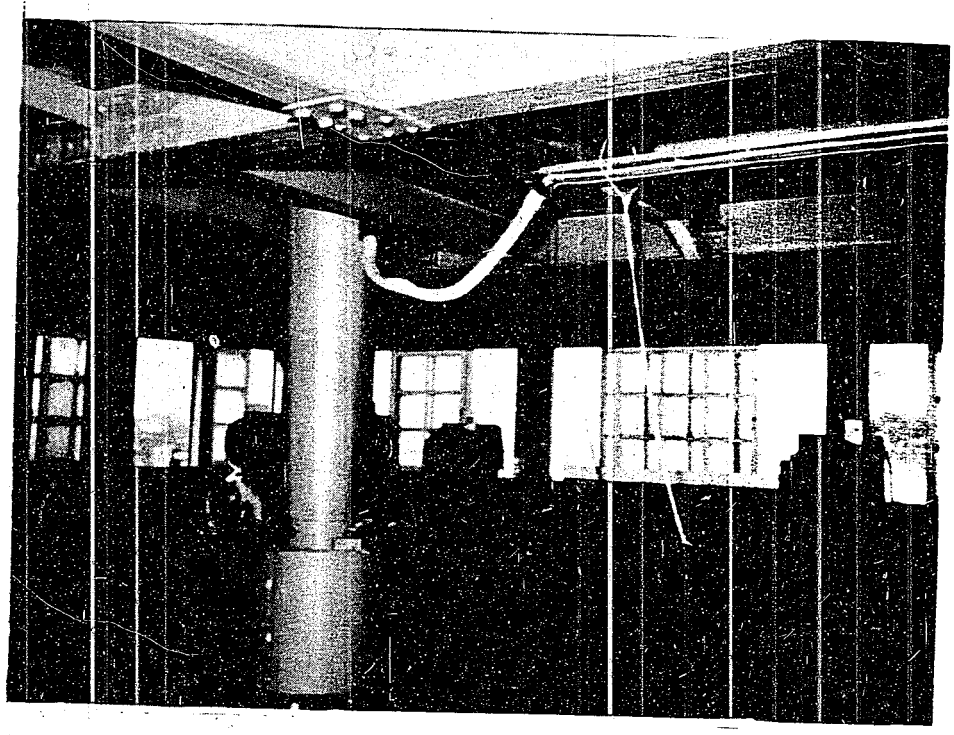


Figure 13
TILTING PLATFORM FOR TYPE 94 L.A. DIRECTOR

Building 48 contained living quarters and classrooms on the main deck. A physics lecture room with a rather extensive collection of demonstrating apparatus was on the second deck. In connection with this was a small but select reference library of technical books, a majority of which were in English, French, or German.

Most of the second deck was devoted to a very large room having an artificial sea horizon at one end, where practice spotting was conducted.

In peacetime the number of students was approximately 100 officers and 500 enlisted men. During the war there were about 200 officers and 800 enlisted men. The peacetime course was two years in length but during the war it was shortened to less than a year.

Officers entered the school for training, after serving from one and one half to two years afloat. During this time it was possible to determine the specialty of each, and if it was ordnance, he entered this Gunnery School. Enlisted men were assigned to the school according to talent.

Instructors were gunnery officers, assigned from the fleet, who taught for two or three years before returning to the fleet.

The curriculum included general courses on electrical and mechanical theory, fire control, directions on how to operate and adjust fire control equipment, and a general discussion on guns.

The basic fire-control problem with standard nomenclature was taught to the students. While at the school they were able to apply, in part, the problem on a simulated fire control set-up.

This fire control set-up started with the directors on the roof of the building (see Figures 12 and 13). Inside the director housing, an artificial horizon, painted around the bulkhead, was used as a reference plane. For practice problems, targets were either model ships pinned to the artificial horizon or real ships passing off shore.

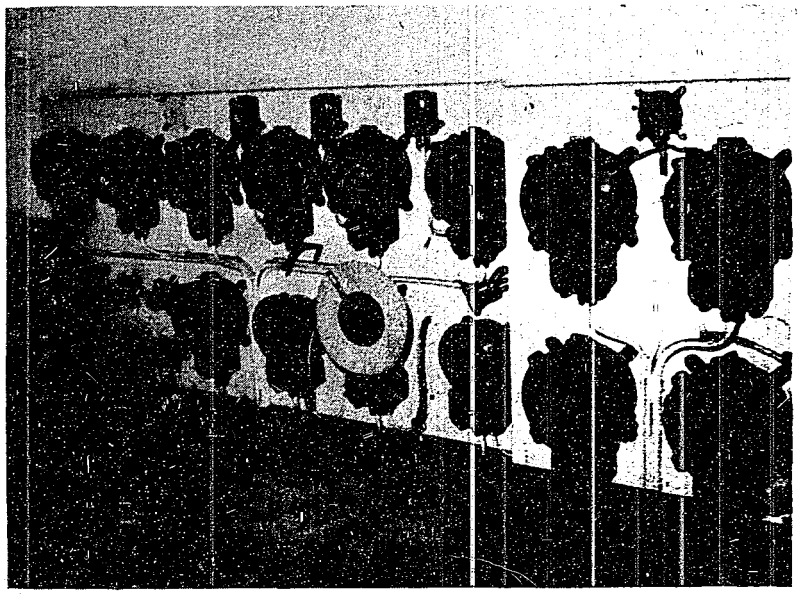


Figure 14

BULKHEAD INSTRUMENTS FOR COMMANDING ROOM

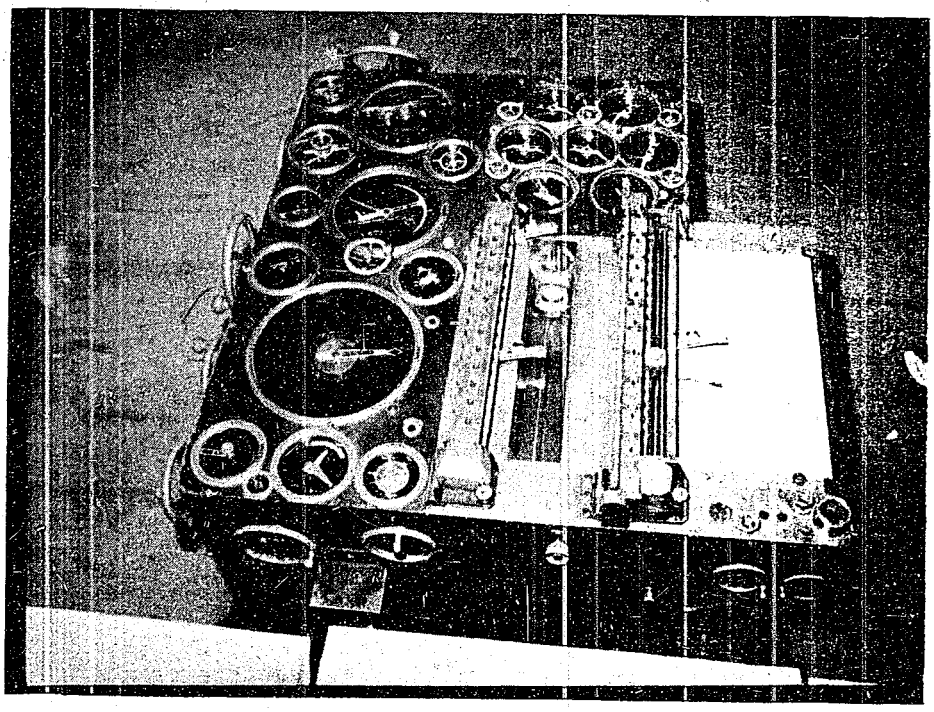


Figure 15
TYPE 92 L.A. COMPUTER

Ranges were obtained from two rangefinders installed outside on the seaward side of building 47. Range values were transmitted to bulkhead indicators in the mock-up "commanding room" on the main deck of building 47 (see Figure 14). In this commanding room, a Type 92 L.A. computer (Figure 15), adjusted for 36cm ballistics, was installed. It received data from Type 94 L.A. directors (Hoiban).

Across the passageway was a checking station consisting merely of a makeshift sight (wood and wire) overlooking the sea and a transmitter so that bearing corrections similar to those obtained from the "Commanders Platform" aboard ship could be imitated. Data from the computer was transmitted to a twin 36cm gun installation on shore behind the school. This gun was never actually fired. However, the physical practice of using the equipment familiarized the student with the apparatus; actual practice was obtained later aboard ship.

A switchboard (see Figure 16) used in this installation was merely a fuzed supply and "on and off" panel which had previously been a telephone trunking board. This was used since it was similar to the fire control boards installed on ships. (See NavTechJap Report, "Japanese Fire Control," Index No. O-29, for further information on fire control switchboards).

Further equipment found at the school is shown in Figure 17. This is a Type 94 low angle computer similar to those used aboard the battleship NAGATO for her secondary battery. This computer was used as demonstrative equipment only and was not run electrically.

Although the school was visited immediately upon the arrival of Field Team 21 at YOKOSUKA in September 1945, the entire place had been thoroughly looted and damaged. Accordingly, information obtained was restricted largely to that given by Captain S. SUKUKI, IJN, (Ret.) and Commander K. MUTO, IJN (Ret.).

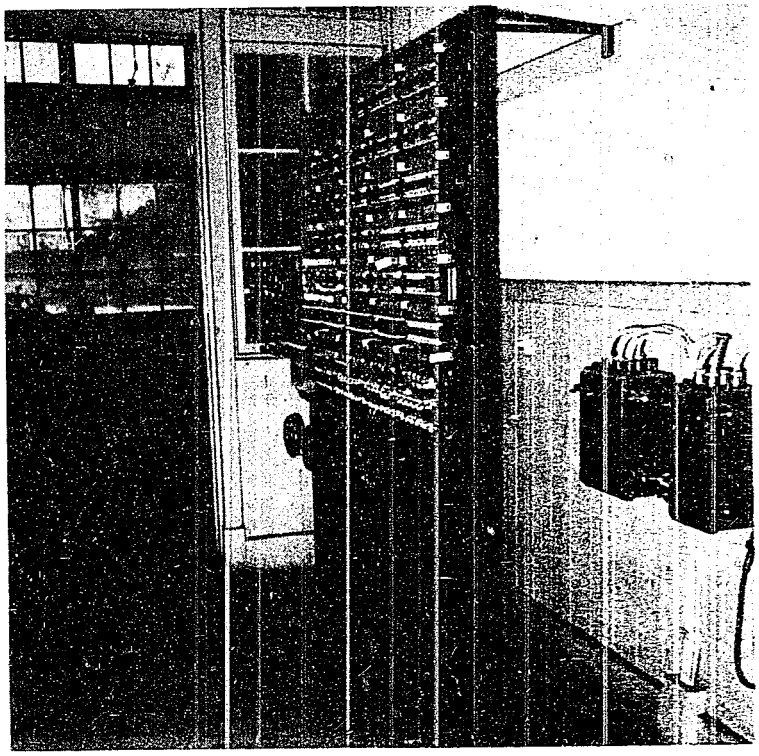


Figure 16
FIRE CONTROL SWITCHBOARD

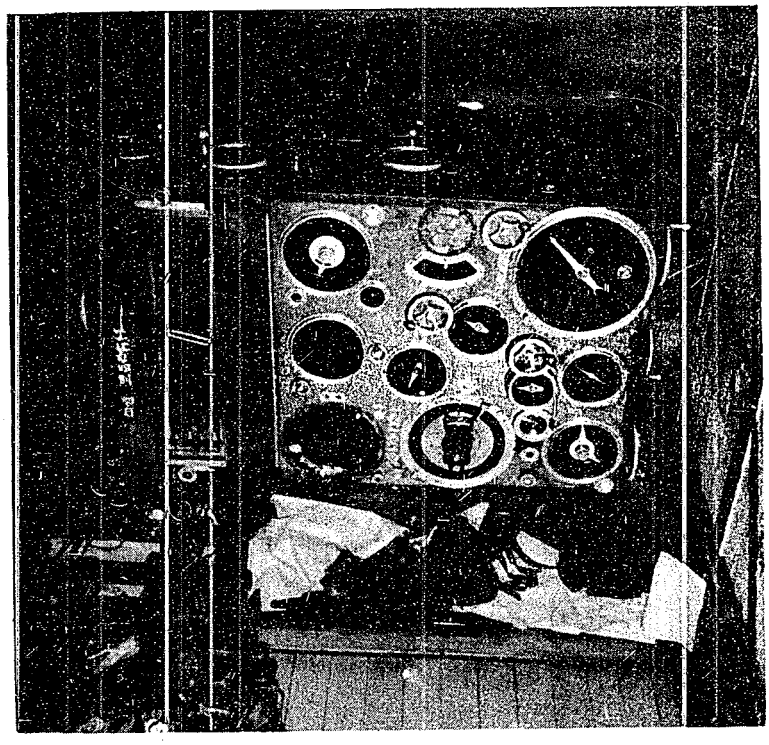


Figure 17
TYPE 94 L.A. COMPUTER

ENCLOSURE (A)

JAPANESE TECHNICAL PERSONNEL

Commander Jiro ICHINOI, IJN (Ret.)

From April 1945 until the termination of the war, at First Naval Technical Arsenal. Officer-in-charge, Ordnance Experimental Laboratory, KURE, and Headmaster of Fire Control factory at KURE, until April 1945. Graduate of TOKYO Imperial University, Mechanical Engineering (Ordnance Technology), 1934.

Commander Yoshikata SUGANUMA, IJN (Ret.)

Officer-in-charge, Fire Control Design, First Division Navy Technical Department (Kansei Hombu), 1940 until the end of the war. Graduate of Tokyo Imperial University, Mechanical Engineering (Ordnance Technology), 1931. (His job corresponds to Re4 in the Bureau of Ordnance, U.S. Navy).

Mr. Ichiro MIZUNO

Chief Design Engineer, Fire Control, Nippon Optical Company, 1937 until 1943. Graduate of Tokyo Imperial University, Mechanical Engineering (Ordnance Technology), 1937. Mr. MIZUNO was lost with a Japanese submarine enroute to Germany to exchange technical information.

Mr. FUKAEDA

Chief Design Engineer, Fire Control, Nippon Optical Company, 1943 to date. Graduate of Tokyo Imperial University, Mechanical Engineering (Ordnance Technology), 1937.

Mr. Chinichi YAMANOUCHI

Professor of Ordnance Technology. Tokyo Imperial University for approximately 39 years until his death in 1941. YAMANOUCHI may be regarded as having been the dean of theoretical fire control in Japan. He had no successor of comparable stature. His courses were unclassified. He did not have access to classified fire control information of the Army and Navy.

Mr. Takashi TSUDA

Headmaster, Section of Gunnery Ordnance, Aichi Clock Company. TSUDA is the foremost fire-control designer in Japan. He was also the first to produce fire-control equipment for the Japanese Navy. Graduate, Higher Technical School, TOKYO, about 1915.

Lt. Comdr. Shiio NATSUMURA

Toyokawa Arsenal

Mr. ISHIKAWA

Engineer, Hikari Naval Arsenal.

Mr. Ichiro MITSUMAKI

Predecessor of MIZUNO as Chief Design Engineer of Fire Control at Nippon Optical Company, now Headmaster of the KAWASAKI factory, MITSUMAKI was also a student of YAMANOUCHI.

ENCLOSURE (A), continued

Mr. Torasaburo OSHIMA

Chief Design Engineer, Aichi Clock Company, graduate of Tokyo Imperial University (Electrical Engineering), 1931.

Commander Kojin KAWAMURA

Line officer in charge of procurement, distribution and policy in fire control. (His job corresponds to a combination of P1b, Pn7, and Mn4 in the Bureau of Ordnance, U.S. Navy).

Commander Koji MUTO

Officer-in-charge, Ordnance factory, Yokosuka Naval Base.

Mr. Kumeo HAMABE

Mechanical Designer, Fuji Electric Company.

Mr. Masaru ISOBE

Electrical Designer, Fuji Electric Company.

ENCLOSURE (B)

LIST OF JAPANESE TERMS USED IN TEXT

Type 2 Hoiban	Destroyer Director H.A./L.A.
Type 94 Kosha Shagekiban	Standard Type H.A. Computer.
Type 94 Kosha Sochi	Standard H.A. System.
Type 92 Shagekiban	L.A. Table.
Type 2 Byodoban	H.A./L.A. Data Computer (DD).
Type 95 Shagekiban	Machine Gun Director (Ward Leonard System).
Type 94 Shagekiban	L.A. Computer (For secondary Battery of Capital Ships).
Type 94 Hoiban	L.A. Director (Capital Ships).

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ENCLOSURE (C)

LIST OF DOCUMENTS FORWARDED TO WASHINGTON DOCUMENT CENTER THROUGH ATIS

NavTechJap No.	ATIS No.	Title
ND25-0001	3033	Tests and Examination Regulations, Shipbuilding, ordnance and engine materials.
ND25-0009	3030	Report of important experimental research, 1943.
ND25-0010	3029	Report of important experimental research, 1944.
ND25-0013	3024	Army Basic Specifications (metallurgical).
ND25-0014	3025	Army Provisional Specifications for Metals.
ND50-3009	3910	General history of director development.
ND50-3010	3911	Early development of directors.