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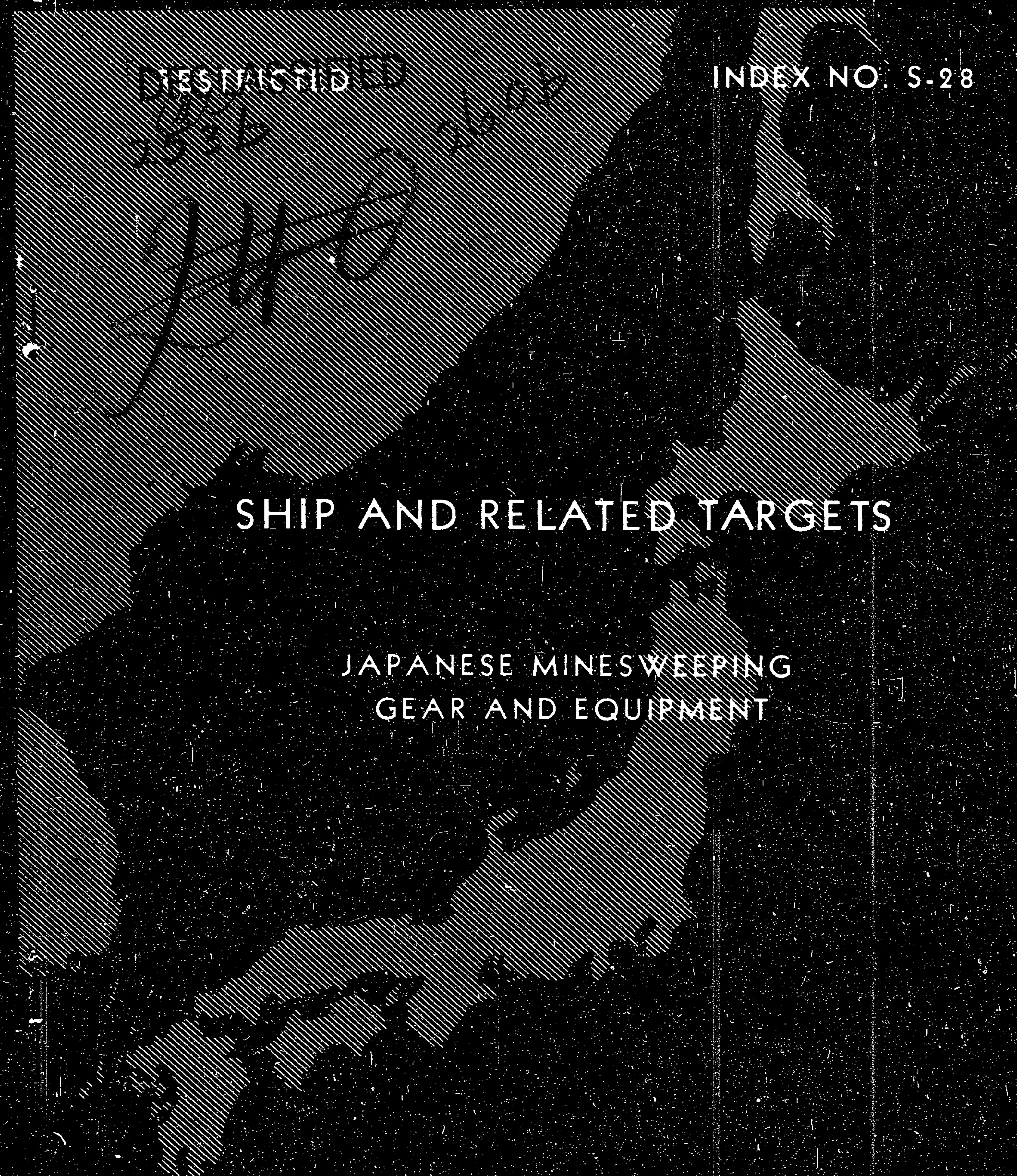

SHIP AND RELATED TARGETS

JAPANESE MINESWEEPING GEAR AND EQUIPMENT

U.S. NAVAL TECHNICAL MISSION TO JAPAN

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

Subject: Target Report - Japanese Minesweeping Gear and Equipment.

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

1. Subject report, covering Targets S-28 to S-36, inclusive, of Fascicle S-1 of reference (a), is submitted herewith.

2. The investigation of the targets and the report were accomplished by Comdr. C. G. McIlwraith, USNR; Lt. Comdr. W. R. Cole, USNR; Lieut. W. Oncken Jr., USNR; Lt.(jg) D. C. Hughes, USNR; Ensign E. A. Bemis, USNR; and Lt.(jg) O. L. George, USNR., interpreter and translator.

C. G. Grimes

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Captain, USN

RESTRICTED S-28

JAPANESE MINESWEEPING GEAR AND EQUIPMENT

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

FASCICLE S-1, TARGETS S-28 TO S-36, INCLUSIVE

JANUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

SHIP AND RELATED TARGETS

JAPANESE MINESWEEPING GEAR AND EQUIPMENT

All Japanese questioned were satisfied that their moored mine sweeping gear left nothing to be desired. They were quite well satisfied with their magnetic gear, although this complacency can only be understood if it is assumed that they were not fully aware of the implications of gross desensitization of the M-9 mechanism, and the long interlook dead period modifications of the M-11 mechanism. There was general agreement that the sweeping of the A-3 mechanism was not much better than 50% effective, and that scarcely any of the A-5 mechanisms were swept. They considered the net sweep fairly effective for A-6 mechanisms, although very slow. In some areas it was unusable because of bottom conditions.

The Japanese considered that there was very little to criticize about the U.S. mine campaigns. It is apparent that they were overwhelmed by the magnitude of the problem rather than by technical difficulties. They estimated that at least 1000 mines fell on land, and that about 1500 prematured after laying. They stated that upon sweeping a mine, they frequently got chain countermining of two or three others, sometimes at distances as great as 15 Km. On one occasion, a mine chain countermined at a distance of 2 to 3 km. with a point of land intervening. These were all believed to be A-3 mechanisms.

Judged by U.S. standards, Japanese moored minesweeping was slow, ineffective, and dangerous. There is nothing in their gear or procedure that can be followed to advantage, although some of their equipment is very good, particularly ball bearing swivels.

Japanese magnetic minesweeping was slow, clumsy, and dangerous. It would have been fairly effective if unmodified mines only had been used. It is an indication of the poverty of their resources that they were forced to use such gear. There is nothing superior in their gear or procedures in general, although in one instance (the hanger for the Type 5 or Type 2 cable) they had an article superior to the U.S. counterpart.

Japanese acoustic minesweeping was quite ineffective. In their use of mechanical or electro-mechanical acoustic gear, there is nothing we can learn to advantage. Their use of explosive acoustic sweeps, however, is in a different class. There they proceeded to do, through ignorance, what U.S. mine designers said could not be done. They had what was probably a better sweep for A-3 mechanisms then any available to U.S. sweepers. It is probable also that they could in time have extended the method to A-5 mechanisms. Their success with gear of this type should be of the greatest interest to U.S. mine and sweep designers.

In their reaction to the A-6 mechanism, the Japanese showed a quick grasp of the situation and rapidly developed a rough and ready sweep method. Their other proposed sweeps showed ingenuity and imagination. The apparent success of the pressure plate is a matter of the greatest importance and one which merits the most careful study, since similar sweeps had been proposed and discarded by the U.S.

Reviewing the campaign from the U.S. viewpoint, several points are outstanding:

1. An unexpectedly large number of mines fell on land. In most cases this provided the Japanese with samples of new types within a week or two after their introduction. It would have been advantageous to have briefed aircraft carrying new types of mines to drop them at points where the chances of their falling on land were remote. The bad effects were, however, partly nullified by the inefficiency of the Japanese mine recovery service.

2. Apparently a large number of mines exploded spontaneously, particularly after storms. This must have materially reduced the effectiveness of mine fields.

3. It appears that the mine modifications program, insofar as it was intended to defeat Japanese sweeping, was not very successful. Japanese magnetic sweeps were effective against all except the grossly desensitized M-9 mechanisms (C2, D2, C4 and D4 in 20th Air Force code), and the long interlook dead period M-11 mechanisms (N4). An attempt was made to improve the Type 5 sweep to make it more effective against desensitized M-9 mechanisms, but the improvement does not seem to have come into general use. Apparently by chance, the Japanese adopted a spacing of their double catenary Type 3 sweep, and a pulse cycle time on their Types 2 and 5 sweeps almost exactly right for the widely used N3 modification of the M-11 mechanism. The N4 modification was used in only a few areas. It is also evident that all Japanese did not know that modifications were being used against them, nor did they understand the reasons.

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LIST OF ENCLOSURES

LIST OF ILLUSTRATIONS

REFERENCES

Location of Targets:

Mine Research Laboratory, KURIHAMA.
Navy Acoustic Laboratory, NUMOZU.
Army Acoustic Laboratory, ITO.
Navy Yards: YOKOSUKA, MAIZURU, KURE.
Mine Sweeping Bases: OTAKE, and KARATSU.
Minor Naval Station, OSAKA.

B. Japanese Personnel Interrogated:

Capt. Kyuzo TAMURA - Naval Academy graduate, A.B. in Physics, Tokyo University, 1930. OinC Development and Supply of Mines and Mine Countermeasures, Mine Section, Navy Ministry, TOKYO.

Capt. Junichiro OSHIMA - Naval Academy graduate, D. Sc. in E.E., Tokyo University, 1922. Kure Naval Arsenal. (Electrical engineering research).

Comdr. Saburo TADENUMA - Naval Academy graduate, Mine and Anit-Submarine School, Kure Area Minesweeping Force. (Connected with mines and minesweeping since 1928).

Comdr. K. SUKIGARA - Naval Academy graduate, D. Sc. in physics and mathematics, Tohoki Imperial University 1936. Mine Research Laboratory, YOKOSUKA.

Comdr. G. MATSUEDA - Naval Academy graduate, D. Sc. in E.E., Service Schools in Signals, Gunnery and Aviation. Mines Research Laboratory, YOKOSUKA 1942 to 1945.

Lt. Col Junzo ISHIKAWA, OinC Seventh Military District Test Laboratory, ITO.

Lt. Comdr. Giichi YOKOYAMA - Reserve officer, A.B. in E.E., Kyoto Imperial University, 1939. Civilian and Technical Officer, Mines Research Laboratory 1939 to 1945.

Lt. Comdr. Kiyoshi NERII - Reserve officer, A.B. in E.E., Waseda University, 1938 (acoustics and communications engineering). Worked in underwater acoustics at Naval Technical Institute, Meguro, TOKYO.

Lt. Yoshihisa IKIDA - Reserve officer, B.S. in E.E., Nagaoka Technical College. Worked on mines and minesweeping and tests of U.S. mines at Mine Research Laboratory, YOKOSUKA.

Lt. JOJI MIZUTA - Reserve officer, B.S. in physics and chemistry, Kyoto Imperial University, 1938. Worked in Mines Research Laboratory, YOKOSUKA on sweeping and tests of U.S. Mines.

Mr. KEIZO SHIBATA - D. Sc. in physics, Kyoto Imperial University, 1930. Mines Research Laboratory, YOKOSUKA, since 1937.

C. Related Reports:

CincPac - CincPoa Special Translation No. 91 "Manual of Magnetic and Acoustic Mines and Sweeps for the Same." Bulletin No. 218-45 of 10 December 1945.

Japanese document, "Reference Book of Minesweeping", dated 1942, now in the possession of ComMinPac.

NavTechJap Target Report O-03 "Japanese Countermeasures and Defensive Organization Against U.S. Mines." Enclosure B "Principal Items of Japanese Naval Sweeps" (translation of NavTechJap Document No. ND 21-4570).

INTRODUCTION

With respect to mine countermeasures, the Imperial Japanese Navy exhibited tendencies common to all navies; i.e., a strong tendency to be satisfied, during periods of peace or relaxation, with the routine development of time honored methods, followed by rapid and frantic expansion of research and development facilities after the need for them had become urgent. It appears that some few Japanese naval officers were aware of their unpreparedness for intensive anti-mine warfare as early as 1942 and 1943, but were unable to arouse sufficient interest in the higher echelons for effective action to be taken.

Upon the beginning of the intensive mine attack upon the Home Islands early in 1945, a rapid expansion of facilities for the development of mine countermeasures was begun, and technical experts from the Army, the Navy, and the universities were called in. This action was partially successful, but the weight of the U.S. attack was too great for Japanese resources, both technical and material, and by the end of the war most Japanese shipping was sunk, damaged or bottled up.

In the solution of the various problems presented by the U.S. mine attack, Japanese technicians were in some instances very intelligent and effective; in other instances they were ineffective and missed obvious points. It appears that at no time were the Japanese able to assign competent personnel to the task of considering possible new influence mine principles and to planning countermeasures. Their efforts were entirely on a "hand to mouth" basis. It is also apparent that at no time were Japanese technicians able to recommend the best possible countermeasures. Their efforts were hampered at every turn by shortages of both material and personnel.

All Japanese questioned stated that official documents were burned early in August 1945 in anticipation of invasion. So far as can be ascertained, this is largely true. Pertinent documents which could be obtained are attached as enclosures or were forwarded to the Washington Document Center as noted in Enclosure (A). It will be noted that these are largely of two types, either official instructions for the use of gear, or else general discussions of the mine warfare situation. Technical reports containing original data are noteworthy by their absence. The failure to find technical reports is disappointing, but does not detract materially from the value of this study, since the general state of their knowledte is quite clear. The information presented herein was obtained largely by questioning Japanese naval officers and technicians. They had nearly all had college or graduate work in physics or electrical engineering, and all appeared to be competent. The information obtained was quite clear, with few uncertainties or ambiguities, despite the language barrier. There was no evidence of reticence on the part of the Japanese. Technical knowledge does not, however, seem to have been very great among personnel actually engaged in sweeping.

THE REPORT

Part I
UNDERSTANDING OF U.S. INFLUENCE MINES

The effectiveness of countermeasures for a mine attack are largely dependent upon prompt, accurate, and detailed knowledge and understanding of all the characteristics of the mines used by the enemy. If this knowledge is sufficiently complete, it will frequently be found that some oversight or failure on the part of the mine designer may be discovered which will make the task of sweeping much easier. Even if no such weakness can be found, the fullest knowledge of mine characteristics is of the greatest importance.

It appears that the Japanese were only partially successful in obtaining this knowledge. Enclosure (C) states that some 80 U.S. mines in all were recovered on land and studied. This figure is in fair agreement with estimates given by the Japanese interrogated. So far as can be learned, they made no attempt to recover mines which fell in shallow water. It appears that the supply available on dry land was sufficient for their needs.

Enclosure (C) gives dates of the first recovery of U.S. mine mechanisms as follows: (Dates of first lay were ascertained from CincPac-CincPoa Mine Charts)

Mechanism	Date Recovered	Place	First Laid in Area
M-3	Feburary 1943	SHORTLAND IS.	
M-4	Feburary 1944	KAKAO	
M-5	April 1944	PALAU	
*M-11	November 1944	CHICHI JIMA	
M-9-1	Early April 1945	KURE	March 1945
A-3	Early April 1945	KURE	30 March 1945
A-6	Early May 1945	KUSHIMOTO	3 May 1945
M-11	Early May 1945	KAMMON STR.	27 March 1945
A-5	Mid May 1945	KAMMON STR.	20 May 1945

The first magnetic mechanism having a reverse look characteristic, with fairly long interlook dead period, was not recovered until April 1945. This type of mechanism required a considerable change in magnetic sweep procedures, to which the Japanese reacted with speed and good effect, by the introduction of the double catenary Type 3 sweep. They stated that they were led to anticipate this type of mechanism from their studies of magnetic torpedo exploders.

So far as can be ascertained, however, the Japanese did not keep up with the modifications made in the M-11 mechanisms, and never knew that interlook dead periods longer than 10.5 seconds had been used. The data on sensitivity and timing of U.S. magnetic mine mechanisms, contained in Reference (C), correspond quite closely to the U.S. data for unmodified mechanisms, although all the modifications of the M-9 were known.

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*This M-11 was so badly damaged that it could not be studied in detail.

It appears that the Japanese made quite detailed studies of the A-3 and A-5 mechanisms. They recognized the frequency characteristics promptly and were quite disconcerted by the A-5, since they seem to have expected that the next U.S. acoustic mine would be super-sonic. They made a good analysis of the A-3 mechanism, although too late to be of much use. Enclosure (D), which refers to the A-3 mechanisms, shows the order of understanding achieved. The function of the anti-countermining circuit of both A-3 and A-5 mechanisms must have been understood, since Enclosure (C) contains a proposal to use the "rendering passive" method for passing over A-5 mechanism mines. This was also borne out in interrogations.

The aging effect in A-3 and A-5 mechanisms does not seem to have been studied at all. The opinion was expressed that both the A-3 and A-5 mechanisms should have had long life, because the batteries were of high quality and much better than Japanese batteries. No estimate could be obtained of their expected life. However, other Japanese displayed a realization that the sensitivity of the A-3 and A-5 mechanisms must diminish with age, although no quantitative information was available.

The A-6 mechanism appears to have been a total surprise to many Japanese mine sweepers. Not only did they fail to obtain any advance knowledge of the principles of the mechanism from German sources, but the use of the physical fact that there is reduction in pressure beneath a moving ship appears to have been entirely overlooked. It must be assumed that this is a result of the paucity of competent scientists in the minesweeping establishment, but when the principle was brought to their attention, their reaction was prompt and effective.

The Japanese mine recovery procedure was as follows: The detonator was extracted, the tail plate removed, and the mechanism taken out and examined. If the markings on the mechanism-can corresponded with mechanisms already known, and if superficial examination showed no unusual features, it was assumed that the mine was not of a new type or a modification, and the material was dumped in deep water. When a new type of mine or mechanism was discovered, only a few examples were studied in detail. This procedure probably accounts for their failure to discover all the modifications made to U.S. mines. The local area commands (Bobotai) were directed to examine all M-9 mechanisms to ascertain the interlook dead period setting. They found about 25% with periods of 3 seconds, the rest with periods of 8 to 10 seconds. They also looked for shunts on the sensitrol of M-9's.

Mine mechanisms were analysed at the Mine Research Laboratory, first at YOKOSUKA (later moved to KURIHAMA), and then at the Acoustic Laboratory at NUMAZU, and finally at the Electrical Laboratory at the Kure Navy Yard. The latter laboratory was subsequently moved to HIROSHIMA. Magnetic mines were tested for sensitivity and timing in a solenoid large enough to contain the entire mine, using various pulse and cycle times to determine the interlook dead period. In the case of M-4, M-9, and A-6 mechanisms, current measurements were made on the sensitrols. A few balance tests were also made, which showed an average of about 2 to 1 between the sensitivities for right-hand and left-hand contacts. Some tests were made with the mine case in the solenoid, others with the bare search coil. Tests were also made of inert loaded mines in the water by running sweeps over them, and also with only the search coil enclosed in an iron pipe in the water. In some instances the mine mechanisms was left on the test barge and connected to the search coil by long leads; in other cases the mechanism was installed in the mine case and instrumentation leads brought out. They generally were able to record looks as well as fires.

Not very much was known about the methods of analysing acoustic mechanisms, but Enclosure (D) shows a good understanding of the principles of the A-3 mechanism, although some points, such as the case resonance, were overlooked. The rate of change feature did not seem to be too clearly understood, although naval technical personnel and KURE were fully aware of its importance and recommended sweeping procedures accordingly.

It appears that the A-6 mechanism was clearly understood. It was tested by applying hydrostatic pressure to the outside of the diaphragm by a liquid stand pipe, and varying the pressure rapidly by a three-way stop cock arrangement. Tests were made at pressures corresponding to 1, 11, 21, and 30 meters depth, and the increase of sensitivity with depth discovered. The "time out" period was understood and was measured as 10 seconds. The shunting of the magnetic element was observed; however, they thought that all mechanisms studied had shunts of 100 ohms. Tests made at KURE gave the following results in 22 to 24 meters depth.

Ship	Speed (knots)	Actuation	
		Pressure	Magnetic
BB 9500 ton	4.4	Yes	Yes
DD 1200 ton	8	Yes	Yes
SS (Surfaced)	6	No	Yes
SS (Surfaced)	12	Yes	Yes
Special SC	10	No	No
AK 900 ton	5.0	Yes	Yes
AK 3000 tons	4.3	Yes	Yes
Tug	8.3	Yes	Yes

The Japanese appear to consider that U.S. mine mechanisms were well designed and constructed, although tending toward over elaborateness. They noted only one instance of faulty assembly: A Mark 25, Mod. 0, recovered at CHICHI JIMA, had the SD 4 incorrectly wired so that it would not have caused sterilization.

Part II
PHYSICAL PRINCIPLES

The Japanese understanding of the physical principles involved in influence sweeps seems to have been quite uneven. For example, the shift from the single catenary to the double catenary in Type 3 magnetic sweeps was a good piece of work technically, and the fact that the change had been anticipated, on the basis of work with magnetic exploders for torpedos, makes it even more creditable. On the other side of the picture, questioning of a number of Japanese technical men brought no evidence that they were aware of the possibility of inducing magnetic looks in induction mines by countermining. When asked about tests of minesweeping by countermining, the answer was that it was tried, and that the radius of lethal damage to the mine was too small to be practicable. When asked to speculate as to reasons for changing from random look firing in the M-4 mechanism to reverse look firing in the M-9 and M-11 mechanism, they pointed to ship signatures and stated that better position of fires would result with a probable higher percentage of lethal fires. However, Reference C containes a passage suggesting some understanding of this point.

The most generally used magnetic sweep, the Type 3 (permanent magnet), was admittedly inspired by British permanent magnet gear captured at SINGAPORE. They appeared to have no knowledge of M Mark 5 type gear, although it is believed that British sweepers so equipped were captured intact in SINGAPORE, and it is known that a BYMS was captured undamaged by the Germans in the Aegean

Sea. In fact, one Japanese commander who had served in the Mine Research Laboratory said that if M Mark 5 type gear had ever been captured, its use had not been understood or appreciated. This same officer stated that American buoyant cable had been captured at MANILA, and although much admired, was not copied by the Japanese. They assumed that it was used for magnetic minesweeping, but the details were not understood. Several reels of A-5 and A-6 magnetic cable were observed at the Mine Research Laboratory at KURIHAMA. One was marked for USS HUMMING BIRD.

German contributions to Japanese minesweeping appear to have been important in some instances, although the Germans never provided detailed plans and specifications or examples of gear. They did, however, advise the Japanese by dispatch of some of their developments. For example, the Japanese Type 5 magnetic sweep (closed loop) was directly inspired by descriptions of the German "diamond sweep" (KFRG).

The Japanese were acquainted with the German use of "Sperrebrechers", and in 1942 made tests using UKI SHIMA, a 750 ton steel AM about 80 meters long, and HA SHIMA, a 1000 ton cable layer about 70 meters long. These ships were coiled to give about 10,000 ampere turns. A vertical component field of 30 milligauss was obtained 35 meters ahead of the ship and on the axis. Since these ships would then have been used against U.S. Mark 12 mines, these characteristics were considered unsatisfactory and the project was abandoned. All gear was removed. UKI SHIMA was subsequently lost. No data or photographs of these vessels could be found.

The Japanese were also aware of the German use of aircraft in magnetic sweeping and were anxious to try it. However, the Navy had no aircraft of a suitable size and was unable to persuade the Army to make suitable aircraft available, so nothing was done. After the recovery of the M-9 and M-11 mechanisms, it was concluded that aircraft sweeping was impracticable and the idea was dropped.

The derivation of the Japanese sound bomb (Hatsuondan), the only widely used acoustic sweep, seems to be a series of accidents and misunderstandings. The first sound bombs were devised for use as practice depth charges in anti-submarine drills. Early in the war the Japanese were informed that the Germans had developed a successful explosive acoustic sweep. This is believed to have been the KKG, which was an entirely different sort of device. The Japanese, however, believed that the sound bombs would be a successful sweep for German acoustic mines, and used them with confidence and considerable success against A-3 mechanisms. Whether they would have been successful against either British or German acoustic mines is at least doubtful.

German influence on Japanese moored gear appears to be nil. The Japanese were aware of the German development of explosive cutters "Sprengreiffer", and had conducted a few tests with indifferent success. Their design must have been faulty since they reported that a charge of 1000 grams was required to produce results that German cutters got with 300 grams. The development was not completed, and no explosive cutters were even used except a large "explosive hook", which is described in Reference C. Two devices showing "Sprengreiffer" influence were found at KURIHAWA.

Part III
SWEEP OPERATIONS

The conduct of sweeping operations was controlled by the area commanders (Bobotai). Technical instructions for the use of sweep gear were promulgated by the Navy Ministry upon recommendations of the Mine Research Laboratory and other cognizant activities. But the operational use of sweep gear and many of the details of arrangements were left to the discretion of the area commanders. Japanese authorities admit, and direct observation confirms, that many local variations of procedure resulted. It appears that technical instructions in the use of gear were not promulgated. Instead, instructors were sent to the various minesweeping bases to explain the use of new gear. This may account for the variations observed in practice.

The location and extent of channels to be maintained was determined by the area commander. So far as practicable, alternate channels were laid out and kept open. Widths varied from 300 to 1000 meters, although few were more than 500 to 600 meters wide. The sides of channels were marked with buoys at intervals of about 2000 meters, and in many instances these buoys were lighted. The lights were extinguished upon receipt of an air alert, usually by crews of flack batteries or mine watchers in the vicinity, although a few were controlled from the beach. Buoys fitted with clock-controlled lights were available. No remote control system was used. The Japanese reported that they had had very little difficulity in keeping both naval and merchant vessels in swept waters.

The Japanese had an extensive system of mine watches stationed both on the beach and in boats moored alongside the channels. Accounts of methods used by these watches are confused and conflicting, but two general principles seem to have been applied. One was to track the plane visually, with or without searchlights, and attempt to spot the time of mine release. The other was to attempt to spot the splash. It does not appear that the Japanese were well satisfied with the reliability or accuracy of either method. It is said that radar was used to track mine laying planes at SHIMONOSEKI, but their is no evidence that they were able to get a return from the mine while falling. It is also stated that attempts were made to locate mine splashes by underwater sound ranging in a manner similar to the "sploc" system, tested by the Massachusetts Institute of Technology. The method was unsuccessful the reason given being the unavailability of suitable apparatus.

When sweeping, the course of the sweeps was plotted at five minute intervals by simultaneous right and left sextant angles. That was the performance aimed at although it was admitted that some sweepers could not do so well. One sweep group, interrogated at KARATSU, Kyushu, took angles at 10 minute intervals. Station keeping within the formation was sometimes done by rangefinder, sometimes by a device akin to a stadimeter, and sometimes by "seaman's eye".

It is difficult to ascertain whether the Japanese had a definite policy on overlap in sweeping. The impression formed as a result of many discussions is that they made little or no allowance for overlap, but relied on a large number of passes to avoid "holidays".

The Japanese believed that their sweeping was very near 100% for all except A-5 and A-6 mechanism mines, and that the expectation of losses in fully swept channels was very low. However, they say that in some instances they routed ships through imperfectly swept channels, and took corresponding losses. An account of Japanese minesweeping activities in the Shanghai area is set forth in Enclosure (H).

Part IV
OPERATIONAL SWEEP GEAR

Japanese moored minesweeping gear is described in detail in Reference C. It is inferior to U.S. moored gear in the following particulars:

1. Being mostly of two-ship type, it exposes the sweepers to considerable risk.

2. No cutters of any kind are said to be used, except mechanical cutters on the paravanes of the high speed single-ship sweep. Several examples of another type of static cutter were found, but no information could be obtained as to their use.

3. Serrated wire is used to some extent, but apparently only on bow paravanes.

4. The gear contains such a multiplicity of short lengths of wire, float pendants, floats, shackles, swivels, etc., that streaming and recovery must of necessity be very slow and difficult.

5. The control of depth is quite uncertain. With some types the variation of depth with speed is excessive.

6. Most types of gear are handled manually. This makes recovery very difficult, expecially in view of the fact that some types of gear, although equipped with floats, lack positive buoyancy. If allowed to sink during recovery, the floats will crush.

7. Due to the fact that no cutters are used, and that much sweeping is done by low-powered vessels, mines are dragged to a dump area rather than being cut. This entails loss of time and the possibility that mines may be lost and re-moored in embarrassing places.

The paravane cutters are simple serrated jaw cutters quite similar to the U.S. Mark 2. The only other item in common use which functions as a cutter is the "explosive hook" illustrated in References C. This device is maneuvered to engage a mine mooring that cannot be cut or dragged, and is then fired statically. It appears to be a very crude and clumsy device. The Japanese made some use of spring and hydraulic dynamometers with ranges up to about 10 metric tons. In some of their sweeps they used both right and left lay wire, frequently designated "A" and "B" wire.

The Japanese expressed themselves as perfectly satisfied with their moored gear. By U.S. standards it can only be described as crude, clumsy, inefficient, and slow.

Japanese magnetic gear most recently used includes Type 3, Type 5, and Type 2, Models 1 and 2. These types are described and illustrated in Reference C. The Type 3 appears to be most widely used in the double catenary form, which is shown in Enclosure (I). These sketches were drawn from data given by the OinC of the Karatsu Sweep Group. It will be noted that with the separation shown between the catenaries, and at the usual sweeping speeds, the time interval between the passage of the two catenaries is about 12 to 15 seconds. This tends to support the impression that they did not know of the long interlook dead period modifications of the M-11 mechanism. Enclosure (J) shows the single catenary arrangement and was drawn from a sketch made by the OinC of the Otake sweep group.

Examples of the various types of magnets used were forwarded to Solomons, Md. These magnets are intended to have a total flux of about 60,000 lines, and their spacing is calculated to give a minimum field of 30 milligauss. The magnetization is checked in the field by a portable magnetometer. The method of remagnetizing is shown in Reference C. Enclosure (K) consists of sketches showing the principle on which the magnetometer operates and a calibration of one particular instrument. A reading of 730 was considered satisfactory.

There seems to be no uniformity in regard to the details of Type 3 sweeps. The doctrine states that the magnets should be floated a short distance above the bottom, whereas it is known that in some instances they are rigged to drag on the bottom. The Japanese did not appear to think that this was an important point.

The Japanese were aware in principle that the orientation of the mine case in relation to the sweep is important, and that for best results cross-sweeping is necessary. They admited, however, that it had frequently been neglected.

Type 5 gear is shown in detail in Enclosure (L), which was drawn from a sketch made by the OinC of the Otake Sweep Group. It appears to have been quite widely used. Several types of cable are used, having seven to twelve cores. The cable makes but one loop; the required number of turns is obtained by connecting cores in series. Three or four turns are usually used. Some types of cable have a steel tension member, either as a core or a sheath, to withstand the strain of towing. In other cases a steel wire rope of about 3/8 inch diameter is married to the electric cable to take the towing strain. Normally 220 ampere turns is specified, with 55 amperes at about 100 volts for a four-turn coil. A generator of 6 to 15 kw is used. The coil must be supported not more than 10 meters above the bottom. The current is reversed manually at 15 second intervals. No automatic controllers were provided. The width of swept path is considered to be 80 meters. The Type 5 sweep was clumsy to handle because of the three vessels required. It is said they attempted to obtain dynamic diversion of the corners of the diamond and failed. In other respects the Type 5 appears to be a fairly satisfactory sweep for all but the grossly de-sensitized M-9 mechanisms. Upon the discovery of these mechanisms, it was recommended that the ampere turns be increased from 220 to 370. This in some cases required larger generators, and it is doubtful that it was accomplished. Nor did the instructions appear to have been widely disseminated.

The Type 2, Model 1 and Type 2 Model 2 magnetic sweeps appear to have been less widely used than those discussed above. The electrodes are noteworthy in that they are steel and are said to have a life of only about 8 hours. The generator is of 40 kw and a current of 380 amperes is used. The voltage is about 70 with new electrodes, and rises to about 100 at the end of the electrodes' life. The current is reversed manually at 15 second intervals. The width of swept path is assumed to be the distance between the electrodes. The cable must be supported at a height of not more than 10 meters above the bottom. When so used, the Type 2 sweeps were fairly effective against all but the grossly de-sensitized M-9 mechanism mines.

The Japanese were equipped to repair damage to Type 2 or Type 5 cables by making vulcanized splices, but details of the method are lacking. So far as can be ascertained they made use of no waterproof connectors in any of their sweep gear. The Japanese considered, when streaming Types 2,3 or 5 gear, wooden fishing boats (Daihatsu) were safe from magnetic mines at a minimum depth of 7 meters.

The Japanese expressed themselves as satisfied that their magnetic gear was quite good, and as effective as they could produce. They made a very strong point of having been unable to devote any large amount of material or personnel to minesweeping.

The only acoustic gear in common use at the end of the war was the sound bomb (Hatsuondan), described in Reference C. There are six types known, of which Types 1, 2, and 3 are obsolescent, Type 4 was in operational use, and Type 5 probably would not have been widely used because of manufacturing difficulties. The sixth type is a simplified design using a friction ignitor and was not yet in production at the end of the war. The doctrine for their use varies somewhat, but it was recommended that groups of 3 to 5 be dropped with 2 second intervals between the bombs in the group, the groups being spaced about 200 meters apart and the sweeper proceeding at about 4 knots. The Japanese considered that one pass down the center was all that was required to cover the width of a channel. They admitted that the sound bombs would sweep only about 50% of A-3 mines and no A-5 mines.

The only sweep which was effective against the A-6 mechanism is the trawl net shown in Reference C and in more detail in Enclosure (M), which was drawn from a sketch made by the commander of a sweep unit at KARATSU. The net appears to be effective only by shifting the mine from its position on the bottom; it is too shallow to be effective in dragging mines to a dump. In KCBE, Japanese sweepers were issued U.S. nets N Mark 1, Model 1, but professed themselves unable to use them because they were too heavy to recover. The Japanese believed that their nets might drag mines for some distance without dropping, and so they occasionally dumped the nets by countermarching.

The Japanese recognized that the risk from pressure mines could be reduced by reduction in speed. It appears that they did not issue tables for speed restrictions; instead they instructed individual ships by dispatch when and where speed restrictions were to be applied. No examples of such dispatches could be discovered. However, the data given in the table at the end of Part I is probably the basis on which speeds were determined.

Part V
EXPERIMENTAL AND IMPROVISED SWEEP GEAR

The Japanese made use of improvised magnetic sweep gear at SURABAYA in the form of a skid coil with a horizontal axis. The details are rather hazy but it is said to have been perhaps 20 meters long, 8 meters in diameter, and to have had 10,000 ampere turns. It was mounted on a wooden barge and powered by a generator of 25 to 40 kw mounted on the towing vessel. The current was not pulsed or reversed. Two such coils were made, and swept some 10 mines before the barges were seriously damaged. It is believed they were used against U.S. Mark 12 mines. It is said that they also used vertical core coils, but no details are available.

The Japanese at one time seriously considered using Type 4 magnetic sweep gear, which is described as a permanently installed static loop covering a large area. The idea was abandoned because of the large amount of material and labor required. In view of Japanese claims of material poverty, it is quite surprising that such a project was even considered.

The Japanese were keenly aware of their unfavorable position in regard to acoustic sweeps, and as the war ended, they were making frantic efforts to make up lost time. Among the items under development were:

1. Fessenden oscillators
2. An explosive sound source differing from the noise bomb.
3. A steam jet sound source.
4. A hammer box.
5. An electro-magnetic oscillator.

The standard 500 cycle Fessenden oscillator was used as a sweep for A-3 mines with some success, some 30 mines being swept. The oscillator was suspended at a depth of 3 to 5 meters from a float, and towed 30 meters astern of the sweepers. At first continuous operation was employed, later it was decided, as a result of tests on mine units, that pulsed operation with 10 second BUILD-UP, 15 to 20 seconds OFF, gave better results. This cycle was used at 6 knots. Mines were fired at distances of from 100 to 300 meters and at least one sweeper was damaged by a near miss. The oscillator was suspended from a spherical float weighing 100 to 200 kg. (200 to 400 lb). The oscillator weighed 500 kg. (1100 lb) or more in air. When sweeping, the lateral distance between successive tracks was determined by the firing distance of mines swept on the first track. If no mines were swept, the tracks were spaced 800 meters apart, a figure that was arrived at on theoretical grounds. Enclosure (N) shows the arrangement used at OTAKE and is based on a sketch by the OinC of that sweep group. The meters of the power supply panel for the Fessenden oscillator were observed to have marks indicating a maximum current of 17.6 amperes and a maximum voltage of 170 volts at 500 cps.

Attempts were made to lower the frequency of the Fessenden oscillator by decreasing the thickness of the diaphragm. It was desired to operate at 50 cycles. They actually got as low as 70 cycles, but the output was too low to be useful and the diaphragm life was unsatisfactory. Attempts were also made to design a twin diaphragm oscillator fed by 25 cycle current. By using it

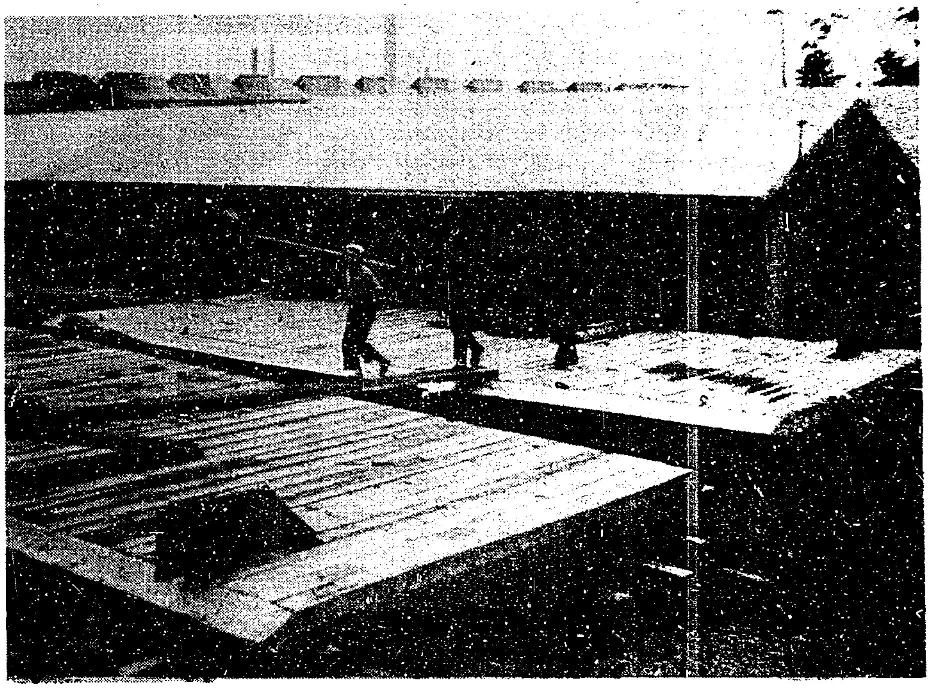

Figure 1

PRESSURE PLATES

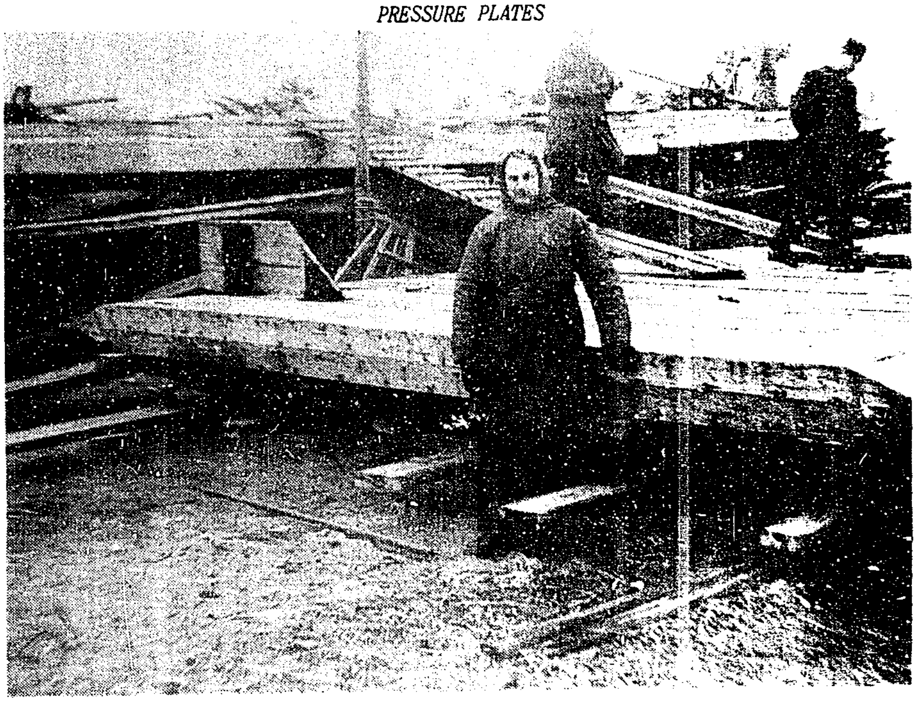

Figure 2

PRESSURE PLATES

polarized or unpolarized, output of sound was 25 cycles or 50 cycles. The output of sound was 25 cycles or 50 cycles. The output was found to be very low and the project was abandoned. The arrangement is shown in Enclosure (O). They admitted that they were not near a satisfactory sweep for the A-5 mechanisms.

The Japanese were starting work on an explosive sound source which was to give 15 explosions in about 0.3 seconds. No real progress had been made on this problem.

The Japanese had succumbed to the universal lure of the steam jet and tested models shown in Reference C. They abandoned the project because of the usual difficulty of supplying the necessary amount of steam. They thought that the sound level was high enough to have been useful if the steam supply could have been solved. They had no figures to support this belief.

The Japanese had made a few experimental models of a hammer box, somewhat similar in appearance to the United States A Mark 6(b) gear. It is shown in Reference C, and had two diaphragms which were struck alternately by a hammer driven by a 1 hp motor. The diaphragms were supposed to resonate at about 100 cycles. These hammer boxes were made in 1942 or 1943 and were considered to be inferior to the sound bomb, so no further work was done. No examples could be found.

In the Seventh Military District Laboratory at ITO (west shore of SAGAMI NADA) was discovered a mechanical noise source which had been used to simulate ship noises for the testing of listening gear. No details of its construction are known.

For sweeping pressure mines, the Japanese were working on two ideas. One was the "pressure plate" referred to in Enclosures (E) and (F), the other the rotator described in Enclosure (E). The "pressure plate" was actually built full scale and tested with the very surprising result that it was successful. The rotator was never tested except as a model. The stated conditions of the pressure plate test are as follows:

1. The pressure plate was 12 meters athwartship and 6 meters fore and aft.

2. It was suspended 7 meters above the bottom from a tug of 400 tons and 600 hps by four steel cables of 14 to 16mm diameter.

3. It had an angle of attack of 14°, leading edge down.

4. Four Mark 25, Model 2 mines were laid in a line 15 meters apart and were connected to instruments.

5. Runs were made normal to the mine line at 4 knots, causing the float switch to open and remain open 12 to 13 seconds. If the height of the pressure plate above the bottom was reduced, the float switch remained open longer.

6. No pressure measuring device was available, so the actual shape and magnitude of the pressure signature is not known. The Japanese recognized that the negative pressure signature must have lasted much less than the 10 seconds required for a pressure look. They did not have a clear understanding of how this surprising result was obtained. In Enclosure (G) is an exact copy of sketches drawn to illustrate the methods of testing the A-6 mechanism and show qualitatively the results obtained. The Japanese found the width of swept path to be 20 meters. Figures 1 and 2 show pressure plates which were found at KAIZUKA, south of OSAKA, in the yard where they were built. The frames were of pine, the planking of cryptomeria. They were ballasted with gravel.

The Japanese were also preparing to use "disposal ships" as shown in Enclosure (F). They had the holds filled with timbers and barrels. They expected that the width of path swept at 6 to 8 knots would be 30 meters in a depth of 20 meters. They also expected that these ships would survive several mines. Two of these ships were prepared but never used.

The art of absolute underwater acoustic measurement was not highly developed. Most of the equipment and reports were destroyed prior to the surrender. They used a decibel scale with a zero level of one microbar. Little could be learned about their measuring equipment. Available information suggests that they were unable to take measurements below 200 cycles. It is know that they went as high as 15 to 20 kilocycles. It seems probable that their measurements were only relative. Nothing could be learned about the method of calibrating hydrophones. The acoustic measuring equipment at KURE was destroyed by bomb damage and the man who did most of the work was killed. (See NavTechJap Report "Japanese Sonar and Asdic", Index No. E-10).

Part VI
MINE LOCATION

Enclosure (C) contains a review of Japanese effort in the field of mine location gear. The principles involved are all well known, having been exploited in U.S. mine location gear and magnetic torpedo exploders. It does not appear that any of these developments progressed far enough to demonstrate their usefulness. U.S. experience indicates that mine disposal by location methods is completely impracticable except under very special circumstances.

The Japanese Army attempted to develop acoustic mine location gear for use by landing craft. It was developed into a gear known as tanraiki. It appears to be a conventional pinging sonar using magnetostriction projectors and receivers which follow very closely the laminated nickel toroid form used in the British "Hughes Echo Sounding Gear". It uses seven projectors and reflectors mounted on a trainable head, and works on about 15 kilocycles. The gear did not prove useful for mine location, or perhaps its intended use did not materialize. It was used as a light weight submarine detection sonar.

Part VII
DOCUMENTS AND EQUIPMENT

It was impossible, within the allotted time, to translate and evaluate all documents which were obtained, hence they were forwarded as untranslated documents, and are listed in Enclosure (A). NavTechJap Documents No. ND50-1361-1, -2, -3, and -4 were written by a Japanese medical man, and should be judged accordingly. Document No. ND50-1362 appears to be a study of the trajectories of aerial mines. Document No. ND50-1363 is a microfilm of the notebooks of a minesweeping officer with years of experience and may well prove to be of great value. Document No. ND50-1364 is forwarded for use as a compendium of Japanese mines in service use. Enclosure (B) may prove of assistance in interpreting Reference (C item 3). Reference (C item 2) is a document not now available, but known to be in U.S. hands and eventually to be translated. It appears to refer only to moored minesweeping gear.

Since Japanese sweeps are in the main inferior to their U.S. counterparts, no attempt was made to collect complete outfits of any particular sweep gear. Instead, items of gear of particular interest were collected with enough information to show how they were used. It is considered that no important items of gear were overlooked. Experimental gear was hard to find, and much of it appears to have been destroyed. For example, the experimental acoustic sweeps were tried and abandoned before the end of the war and the material was probably scrapped. Three pressure plates were discovered in the Hamada Shipyard at KAIZUKA, south of OSAKA, where they were built. It was decided that these were too bulky to warrant shipping, inasmuch as the construction plans were available.

ENCLOSURE (A)

LIST OF JAPANESE DOCUMENTS FORWARDED THROUGH ATIS
TO WASHINGTON DOCUMENT CENTER

NavTechJap No.	ATIS No.	Description
ND50-1361-1	4397	"Training Notes on the Use of Sound Waves in Warfare" Dr. K. SHINOHARA, 30 Nov. 1945.
-1361-2	4397	"Japanese Defeat in Mine Warfare - Remedial Measures for Clearing Mines", Dr. K. SHINOHARA, 25 Oct. 1945.
-1361-4	4397	"Japanese Defeat in Mine Warfare - Remedial Measures for Clearing Mines", Dr. K. SHINOHARA, 10 Nov. 1945.
-1361-4	4397	"Opinions on Minesweeping", Dr. K. SHINOHARA, Nov. 1945.
-1362	4398	"Method for Determing the Impact Point of Mines" Optical Research Laboratory, Yokosuka Naval Depot, 24 June 1945.
-1363	4399	Microfilm of personal notebooks of Cdr. TADENUMA.
-1364	4400	"Summary of Mines" Yokosuka Naval Arsenal. No date.
-1365	4401	"Essential Details of Minesweeping Gear" Yokosuka Naval Arsenal. No date.

ENCLOSURE (B)

LIST OF JAPANESE EQUIPMENT SHIPPED TO
NAVAL MINE WARFARE TEST STATION, Solomons, Md.

NavTechJap No.	Description	Source
JE50-1232	10 Hydrophones of 5 Types	ITO
-1233	Simulated sound source 1/2 hp 100 volts	ITO
-1234-1, -2	Small paravane	YOKOSUKA
-1235-1	Spring dynamometer	YOKOSUKA
-1235-2	Hydraulic dynamometer	YOKOSUKA
-1235-3	Recording dynamometer	YOKOSUKA
-1236	Hydrophone	YOKOSUKA
-1237-1	Submarine cable cutter	KURIHAMA
-1237-2	Submarine cable cutter	YOKOSUKA
1237-3	Submarine cable cutter parts	YOKOSUKA
-1238-1, -2	Cable grips	YOKOSUKA
-1239-1, thru -5	Depth recorder	YOKOSUKA
-1239-6, -7	Depth recorder parts	YOKOSUKA
-1240	Serrated paravane wire	YOKOSUKA
-1241-1, thru -6	Moored sweep fitting	YOKOSUKA
-1242-1, thru -3	Depressor snatch block	YOKOSUKA
-1243-1, -2	Paravane swivel	YOKOSUKA
-1244-1	Swivels small	YOKOSUKA
-1244-2	Swivels large	YOKOSUKA
-1245-1, -2	Explosive cutter model	KURIHAMA
-1246-1, -2	Composite magnet, large	KURIHAMA
-1247	Sea cell batteries	KURIHAMA
-1248	Pelican hooks	YOKOSUKA
-1249	Explosive hook (unloaded)	YOKOSUKA
-1250	Brand "mine testing laboratory"	KURIHAMA

ENCLOSURE (B), continued

JE50-1251	Type 3 hydrophones	OSAKA CASTLE
-1252	Type 3 two ship sweep wire. L. H. Lay	MAIZURU
-1253-1, -2	Type 3 two ship floats 23 kg.	MAIZURU
-1254-1, -2	Swivels, type 3 two ship sweep	MAIZURU
-1255-1, -2	Floats, type 3 two ship sweep	MAIZURU
-1256	Recording depth gage parts	MAIZURU
-1257-1, thru -18	Magnet Type 3, 4cm. x 80cm.	MAIZURU
-1258	Drag net, one panel	MAIZURU
-1259	Depressor, single ship large sweep	MAIZURU
-1260-1, thru -9	Lighted dan buoy parts	MAIZURU
-1261-1, -2	Recording depth gage and parts	MAIZURU
-1262-1, thru -6	Mine sweeping hardware	MAIZURU
-1263-1	Bow paravane stopper	MAIZURU
-1264-1, -2	Wire rope stopper	MAIZURU
-1265	Serrated wire rope, bow paravane	MAIZURU
-1266	Submarine noise decoy	MAIZURU
-1267-1, -2	Float, type 2, two ship sweep	MAIZURU
-1268-1 thru -4	Sound bomb, types 1, 2, 3, and 4.	SHIRAHAMA, MAIZURU
-1269-1, -2	Simplified sound bomb	KATSURA, MAIZURU
-1270-1, -2	Float	MAIZURU
-1271-1	Paravane, spare parts box	MAIZURU
-1271-2	Paravane, tool kit	MAIZURU
-1271-3	Paravane	MAIZURU
-1272	Recording dynamometer, 8 ton	MAIZURU
-1273	Type 3, two ship sweep wire R. H. Lay.	MAIZURU
-1274-1, thru -11	Float	MAIZURU
-1275	Paravane, single ship H.S. sweep	KAWARAISHI MINE DEPOT KURE
-1276-1	Obstructor	

ENCLOSURE (B), continued

JE50-1276-2	Anchor	KAWARAISHI MINE DEPOT KURE
-1277-1, thru -6	Composite magnet, short	OTAKE
-1278	Fessenden Oscillator 500 cycles	OTAKE
-1279-1 thru -3	Static cutter	KURE
-1280-1	Type 5 magnetic cable	OTAKE
-1280-2	Type 5 magnetic cable	KURE
-1280-3	Type 5 magnetic cable hanger	OTAKE
-1328-1, -2	Clamp for Type 5 magnetic sweep cable	KOBE
-1329	Type 5 magnetic sweep cable	KOBE
-1330	Type 5 cable repair material and chafing gear	KOBE
-1331	Type 5 magnetic cable	YOKOHAMA
-1332	Cable, short leg of Type 2, Mod 1 magnetic sweep	YOKOHAMA
-1333	Catenary cable, Type 2, mod 1 magnetic sweep	YOKOHAMA
-1334-1, -2	Type 2 magnetic sweep electrode	YOKOHAMA
-1335	Dynamic hydrophone	MEGURO, TOKYO
-1336	Hydrophone	MEGURO, TOKYO
-1337-1, -2	Hydrophone assembly	MEGURO, TOKYO
-1338	Carbon button hydrophone	MEGURO, TOKYO
-1339	Paravane launching crane	YOKOSUKA
-1340	German P.D.M.	MEGURO, TOKYO
-1341-1, -2	Delay mechanism	MEGURO, TOKYO
-1342	Paravane	NAGA-SHIMA

ENCLOSURE (C)

RESULTS OF MINE COUNTERMEASURES

Minesweeping Department, Naval Affairs Bureau
15 September 1945

(Translation of Document Obtained by ComMinPac)

Chapter I: A SUMMARY OF RESULTS

A. The Development of Special Mines and Minesweeping Gear by the Japanese Navy.

Prior to the Greater East Asia War, research on magnetic mines had not reached a point where they could be put to practical use. However, after the German vessel DOGGABANK put in at YOKOHAMA in September 1942, it was possible to obtain first-hand knowledge of German magnetic and acoustic mines. The Type 3, Mod 1 (submarine-laid) magnetic mine and Type 3, Mod 2 (submarine-laid) acoustic mine were constructed; and after considerable research, the point was reached in March 1944 where they could be put to practical use.

About the same time as the innovation of the aforementioned magnetic mine, the Type 3 Sweep (magnetic) was devised, utilizing British sweep gear seized at SINGAPORE and HONG KONG. This gear went into fairly large scale production in October 1942.

After considerable study of German mines, the effectiveness of noise bombs, that were formerly used in submarine attack training was recognized, and large scale production of these bombs was begun.

B. Results of New Mines Countermeasures.

Although various types of the Allied Powers' magnetic mines laid in the southern areas after February 1943 were acquired and efforts made to develop counter measures, the Japanese Navy gave little recognition to mine ordnance in these areas. The research of officials directly concerned with this work was played down, and a thorough study could not be conducted.

Although lately we have put to practical use the electro-magnetic type sweep gear, most magnetic mine sweeping has been conducted using the magnet type gear due to limitations in available ships and the extreme scarcity of useable mines. However, as a result of exhaustive study of the electro-magnetic type sweep gear, gear towed by three wooden ships was developed and utilized. However, both magnetic mines and acoustic mines were dropped into HIROSHIMA Bay and SHIMONOSEKI Straits in March 1945. To cope with this, the old type sweeping was continued, but at the same time, mine countermeasures received the Navy's recognition, and a program of exhaustive study and practical experimentation was launched in May 1945. This program represented the united efforts of the Army and Navy and a commission of professors of the Imperial University in TOKYO.

Although research and experimentation progressed and considerable precious data was acquired, it could not cope with the new ordnance. Materials necessary to put the plans to practical use were lacking, and there was a scarcity of available trained personnel. The matters of mine countermeasures became especially complicated after the appearance of the magnetic-pressure mine and the frequency acoustic mine. While the mined area was gradually being extended from the KAMMON district and the Inland Sea to the coastal waters of the Japanese Sea, the mined areas all over Japan were greatly enlarged. It has been estimated that there are about 7000 mines in the Japan Sea areas, and about 400 in the Pacific Areas. This gave rise to grave danger to Japanese

ENCLOSURE (C), continued

shipping and seriously hampered military preparations.

There was a shake-up of naval officals charged with the mines countermeasure policy directed toward improving minesweeping personnel. Moreover, each Naval Station and Guard District set to work endeavoring to eliminate the special type mines.

C. Conditions at the Close of the War.

Prior to the end of the war, 88 examples of Allied mines had been acquired. These may be broadly classified as magnetic, acoustic, and magnetic-pressure mines.

Unfortunately, up until the end of the war, no perfect sweep plan had been devised for magnetic-pressure mines or low frequency acoustic mines. However, at the end of July 1945, we were confident that we had a sound method for sweeping magnetic-pressure mines by using net type underwater sweep gear (if the sea bottom should permit its use). However, just at the time we had perfected disposal vessels and pressure boards and were ready to put them to actual use in the middle of August, the war ended.

Despite much research and experimentation, no practical gear was ever devised for sweeping low frequency acoustic mines.

Chapter II: RESULTS OF RESEARCH AND EXPERIMENTATION.

A. Inspection of Aircraft-Laid Mines.

Some of the mines laid by aircraft during the mine-laying operations in various harbors and bays since the end of March have landed on beaches. On such occasions investigations were quickly conducted. Allied mine laying was at first confined to the Inland Sea and the KAMMON district. Later it was gradually extended to coastal areas of the Japan Sea.

New types of allied mines were acquired principally in the Inland Sea, so Kure Naval Arsenal handled the investigations.

A description of new types of Allied mines follows:

CLASSIFICATION	TYPE	DATE TAKEN	PLACE TAKEN
Magnetic	M-9	early April 1945	KURE
Acoustic	A-3	early April 1945	KURE
Magnetic (ground mine with magnetic needle)	Unknown	Feburary 1943	SHORTLAND IS.
Magnetic (ground mine of induction type)	M-4B	Feburary 1944	TAKAO
Magnetic (moored type with magnetic needle)	Unknown	April 1944	PALAU
Magnetic (ground mine of induction type)*	M-11	November 1944	CHICHI-JIMA

*Impossible to investigate capabilities in detail on account of damaged parts.

It was comparatively easy to investigate capabilities and countermeasures in

ENCLOSURE (C), continued

Notes

1. Type 3 Mod 2 Sweep Gear and the Revision in Its construction: The bar magnets in the first and second half are oriented in opposite directions.

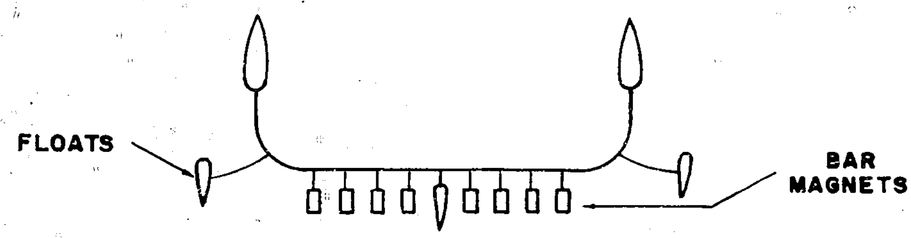

Figure 1(C)
TYPE 3 MODEL 2 SWEEP GEAR

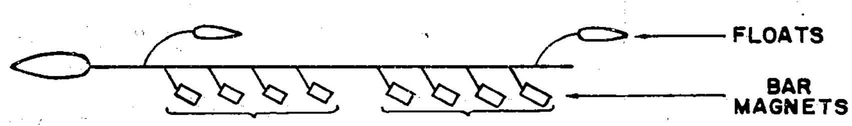

Figure 2(C)
TYPE 3 MODEL 2 REVISED

2. Mark 4 Noise Bomb: A charge consisting of 300 grams of Type 88 explosive (Karitto powder) which explodes about 10 seconds after being dropped into water.

3. Type 5 Sweep Gear: As indicated in drawing, this sweep utilizes 3 tug type boats.
Required power .... 13 KW
Ampere turns 370

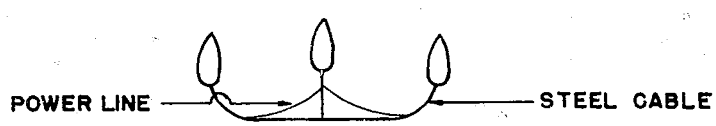

Figure 3(C)
TYPE 5 SWEEP GEAR

ENCLOSURE (C), continued

the cases of M-9, M-3, and M-11 mines; however, data concerning the characteristics of low frequency sound waves and amount of change in water pressure generated by ships passing through the water was almost non-existent. Therefore, some time was needed to conduct a detailed investigation of the A-6 and A-5 mines. After a brief testing of their operation ashore, further investigations were conducted using ships.

B. Research on Countermeasures.

Results of investigation of mines seized by us indicated the impossibility of completely and speedily sweeping with the old type sweep gear. At the time that the M-9 and A-3 mines were acquired in April, Type 3 Mod 2 sweep gear had been revised considerablly for sweeping magnetic mines, and Mark 4 noise bombs were generally used for sweeping acoustic mines; however, immediately thereafter the Kure Naval Aresenal devised the far more effective Type 5 sweep gear for sweeping magnetic mines and constructed the Fessenden-type underwater signal generator. These were quickly adapted to minesweeping techniques and were used with good results inside and outside the military port of KURE. (See Figures 1(C), 2(C), and 3(C).)

The first part of April, Allied minelaying covered all the Inland Sea, beginning with KAMMON and KURE; by May this had spread to the coastal waters of the Japan Sea. A-6, M-11, A-5 and other new type mines were used. The Navy decided to have the research and experimental units of the Navy Ministry carry out study on countermeasures from the technical aspects.

Principal items of study and results achieved by the middle of August are as follows:

1. Classification: Mine Search Gear.

a. Compensating coil type mine detector.

(1) Fundamentals: The subject item is two serially wound non-waterproof counteracting coils in a metal core and can be pulled by a single ship or a pair of ships, as in the following diagram. If the device makes contact with a metal mine case, the flow of current in the coils is shown by a meter on the ship.

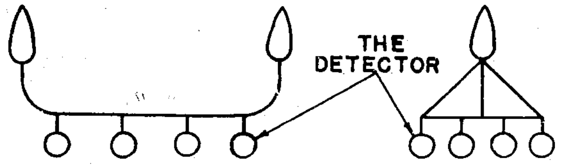

Figure 4(C)

(2) Results: From contact tests ashore on a recently recovered American mine, we were able to compute practical results. Although at first when we experimented with pulling it through the water, it was a failure as far as the waterproofing feature was concerned. As a result of improvements, we have been more or less able to achieve the desired effect.

(3) Notes: Conducted by the Magnetic Ordnance Department of the Navy Technical Depot No. 2.

ENCLOSURE (C), continued

b. Permanent magnet type mine search gear.

(1) Fundamentals: A permanent magnet replaces the iron core of the compensating coil type. Otherwise as in the preceding.

(2) Notes: Conducted by the Mine Experiment Department, YOKOSUKA Naval Arsenal.

c. Search gear utilizing changes in inductance.

(1) Fundamentals: A special magnetic search gear installed on a towed boat for experimental aircraft use is towed about 3 meters from the sea bottom. The mine is detected by changes in induction due to its metal construction.

(2) Results: Although favorable results were obtained in experiments conducted ashore against U.S. mines, this gear was found to be imperfect in experiments conducted at sea. We are continuing to modify without success.

(3) Notes: Conducted by the Magnetic Ordnance Department of Navy Technical Depot No. 2.

d. Air-core coil type mine search gear.

(1) Fundamentals: Two wire coils wound on wooden reels are placed horizontally, about two meters apart and drawn along near the sea bottom. A 23,000 cycle current is passed through one of the coils so that the mutual change in inductance due to the presence of a metal mine case is detected by the other coil.

(2) Results: Still in preparation for experimentation.

(3) Notes: Conducted by the Magnetic Mine Ordnance Department of Navy Technical Depot No. 2.

2. Classification: Mine Sweeping Gear.

FOR USE AGAINST M-9 AND M-11 MAGNETIC MINES

a. Magnetic cable.

(1) Fundamentals: Since production requirements for bar magnets (used in Type 3, Mod 2 Sweep Gear) cannot be met, to investigate possibility of substituting magnetic cable.

(2) Results: Magnetic cable found to be superior to bar magnets.

(3) Notes: Conducted by the Mine Experiment Department, Yokosuka Naval Arsenal. Preparations to use this gear being made by the assigned operating force.

b. Type 5 sweep gear.

(1) Fundamentals: That the new Type 5 gear would be effective against M-9 and M-11 mines.

(2) Results: Best results obtained when current flow changed to 320 AT.

ENCLOSURE (C), continued

(3) Notes: Conducted by the Electrical Experiment Department of Kure Naval Arsenal. Has gone into production and is widely used.

c. Moored type magnetic sweep gear.

(1) Fundamentals: Place for a minesweeping gear fixed to the bottom in important harbors and bays so that mines may be disposed by passing an electric current.

(2) Results: Still in research.

(3) Notes: Conducted by the Magnetic Mine Experiment Department, Kure Naval Arsenal.

FOR USE AGAINST A-3 ACOUSTIC MINES

a. Running fire noise bombs.

(1) Fundamentals: A plan to sweep A-3 mines by bombs that will produce a continuous series of sounds rather than the brief type of Mk 4 noise bomb.

(2) Results: Model completed. Still under experimentation.

(3) Notes: Conducted by the Research Department of Navy Powder Depot No. 2.

b. Type 5 acoustic sweep gear.

(1) Fundamentals: Use of Fessender type underwater signal generator as sweep for use against Type A-3 mines.

(2) Results: Such gear hurriedly improvised at Kure Arsenal in April was effective in disposing Type A-3 mines.

(3) Notes: Conducted by the Electrical Department of Kure Naval Arsenal. Signal generators in stock have been supplied to all active task units.

c. Type 5, Mk 1 acoustic sweep gear, Model 1.

(1) Fundamentals: Gear for sweeping A-3 mines by means of a 500 cycle signal generator based upon the multiple type signal generator principle.

(2) Results: On a basis of experiments with a model, it is believed that A-3 mines can be swept at more than 200 meters.

(3) Notes: Conducted by the Electrical Department of Kure Naval Arsenal.

d. Type 5, Mk 2 acoustic sweep gear, Model 11.

(1) Fundamentals: To sweep A-3 mines by means of a mechanically continuous beat type generator (a simple revision of Type 5, Mk 1).

(2) Results: Although this device was found to be effective in experiment with models at more than 100 feet, much greater

ENCLOSURE (C), continued

sound output is being planned.

FOR USE AGAINST A-5 ACOUSTIC MINES

a. The "render passive" noise bomb.

(1) Fundamentals: By utilizing the anti-countering circuit of the A-5 mine, the mine is rendered inactive when ships pass.

(2) Results: Distances at which 5, 10, and 20 gram explosions of Type 88 powder activated the anti-countering circuit of A-5 mines are as follows:
5 gram - 500 meters
10 gram - 1000 meters
20 gram - 2000 meters

(3) Notes: Conducted by the Research Department of Navy Powder Depot No. 2. Are now planning revisions of the 5 gram charge.

b. Noise type low frequency M/S gear.

(1) Fundamentals: A plan for sweeping A-5 mines by means of low frequency noises.

(2) Results: Since noise output was insufficient, only limited success was achieved using 50, 100, and 500 cycle noise generation plates (diaphragm) or generator propellors against A-5 mines. Improvement of the 50 cycle type is planned.

(3) Notes: Conducted by the Engine Mfg. Department of Kure Navy Yard.

FOR USE AGAINST A-6 PRESSURE MINES

a. Pressure board.

(1) Fundamentals: A pressure generating device effective in sweeping A-6 pressure mines.

(2) Results: It has been found that a 6 x 12 meter board dragged by an SC at a speed of 5 knots and 5 meters from the bottom will generate sufficient change in pressure to actuate the pressure component of the A-6 mine from the point of magnetic influence.

(3) Notes: Conducted by the Ship Building Department of Yokosuka Navy Yard. Now in general construction.

b. Water turbine type pressure tube.

(1) Fundamentals: Although it is dangerous for a special SC to tow the pressure board in water depths of less than 20 meters, this device for generating pressure might be used at depths less than 20 meters by using a landing barge.

(2) Results: A rotating type pressure generating equipment is now under construction.

(3) Notes: Conducted by the Ship Building Department of Yokosuka Navy Yard.

ENCLOSURE (C), continued

c. Disposal boats.

(1) Fundamentals: A plan for 100% clearance sweeping of A-6 mines by towing a special vessel loaded with lumber and with the chance of sinking made as small as possible. This sweep would be as effective against the mine as warships passing over them.

(2) Results: Planning and basic experimentation completed. Seven ships undergoing conversion; two have been completed. Further preparations being made for examination of uses and capabilities.

(3) Notes: Conducted by the Kure Navy Yard.

FOR GENERAL USE

a. Sea bottom sweep gear, Model 1.

(1) Fundamentals: In lieu of special sweep gear for each type of mine, to use nets dragged along the bottom for sweeping A-5 and A-6 mines.

(2) Results: Two mines, picked up in a simply constructed net used experimentally against A-6 by the shock (jostling).

(3) Notes: Conducted by the Kure Navy Yard. Since construction, some success has been achieved in disposing of A-6 mines by task forces.

Chapter III: PRODUCTION AND SUPPLY OF ORDNANCE.

A. Ordnance Production.

1. Magnetic Sweep Gear.

a. Bar magnet type sweep gear.

Since February 1943 production of bar magnet type sweep gear has gradually been stepped up as magnetic mines have been laid in southern areas. The peak was reached during the period January - June 1944 when monthly production figures hit 300 sets (with 54 bar magnets per set). Thereafter war conditions and lack of materials held production goals to 100 sets per month.

When mines were laid in Japan proper beginning in March 1945, production goals were immediately stepped up again to 300 sets per month. Since May 1945 Navy Yards and private firms have gone all-out to meet their production quotas. However, due to intensification of enemy air raids and transportation difficulties, the war ended before we could succeed in this.

2. Flowed Current Type Minesweeping Gear.

Need for such gear has been recognized since early in 1944. However, shortages of materials such as generators and wire became more and more acute. That, coupled with concern over the danger to the minesweeper itself, kept the value of using them low, and production barely reached a level of 10 per month. While studying gear that might be installed on small wooden boats and other boats on hand, a gear towed by three ships

ENCLOSURE (C), continued

was devised. This gear was perfected in December 1944 and was put into production in utilizing available stocks of wire, and a production goal of 175 sets per month after May 1945 was planned. However, air raids and other factors kept us from realizing more than 40% of this goal. Although some success was achieved in study and utilization of a sweep gear consisting of an electric cable moored in important harbors, bays, and sea lanes, it was found to be impractical from the standpoint of the mines' capabilities. Ultimately the chance of putting such gear to use was lost.

Acoustic Sweep Gear.

1. Noise Bomb.

Noise bombs have been employed with great success against acoustic mines since March 1945. Although monthly production goals had been stepped up from 30,000 to 80,000, intensified air attacks and pressing shipping conditions made realization of this goal impossible. Actually only about 40% of this figure was attained. Just as a concrete plan was devised providing simplified construction and substitution of materials, the war ended.

However, those bombs could not be used successfully against low frequency acoustic mines.

2. Sound Gear.

Although the type 5 underwater signal generator, which had been used as a submarine underwater signal device, was extremely effective, there were too few of them. Shortages of materials and difficulties of construction made their production completely impossible. Therefore, research was carried out on other types of sound gear; and as a result of this study, a goal of 50 sets per month was set for the period after July 1945. Just as a point was being reached where they could be put to use, the war ended.

Although much research and experimentation was being conducted in regard to low frequency acoustic mines, no satisfactory equipment was ever devised.

C. Sea Bottom Sweep Gear (Net Type).

Since recovery of the first magnetic pressure mines in May 1945, much effort has gone into the devising of a countermeasure. Sea bottom sweep gear was studied experimentally and found to be effective. It was immediately put into production and supplied to various areas.

D. Disposal Boats and Pressure Boards.

While carrying on research to develop the best disposal gear for use against mag-pressure mines, disposal boats and pressure boards were found to be effective. They immediately went into construction.

When the war ended in the middle of August, three out of seven scheduled disposal boats were finished and 21 out of a projected 72 pressure boards were completed. There has been no opportunity to put them to use.

After February 1943, southern areas were provided with bar magnet type sweep gear and flowed current type gear. However, while we were disposing of these mines with more and more success, shifts in war conditions brought about a transfer of supply from the southern areas to areas of China and Formosa and

ENCLOSURE (C), continued

to the OGASAWARA Islands. Since March 1945 we have had to concentrate on supplying the homeland. Response to changes in war conditions, hurried estimation of supplies beforehand, and beating the preceding year made supply extremely troublesome. Moreover, just when we were guiding and encouraging production replenishment despite frequent air attacks, the war came to an end.

ENCLOSURE (D)

NAVAL SECRET 2nd Dl
KAMPON-ON-GUNGOKUHI [illegible] No. 156-2

COUNTERMEASURES AGAINST THE U. S. ACOUSTIC MINE

3RD SECTION, NAVAL TECHNICAL DEPT.

8 May 1945

(Second Immediate Report)

Translation of a Japanese Document

(Five figures in original not included.)

ENCLOSURE (D), continued

FOREWORD

The following, prepared by the Seventh Research Institute of the Army and distributed from that body as an urgent report on 25 April, 1945, concerns the American acoustic mine seized in the Kure area during early April 1945, and now being held in custody at the Mine Experimental Section of the Yokosuka Navy Yard.

The Navy Technical Department has now seen fit to issue the above as its second urgent report, but which also includes the urgent report on investigation by related naval activities (Kure Navy Yard) as well as experimental results and battle experiences acquired later; and all listed in a separate section attached to the lower portions of selected pages.

8 May 1945
Third Section ,
Navy Technical Department

ENCLOSURE (D), continued

REPORT OF INVESTIGATION ON AMERICAN ACOUSTIC MINES
BY THE SEVENTH ARMY TECHNICAL RESEARCH INSTITUTE

25 April 1945

Lt. Col. Junzo ISHIKAWA
Tech. Lt. Jinichi IGARASHI
Surgeon Capt. Tsuneo TOMITA

I. AIMS

It is our aim to make an investigation on the acoustic mines laid by the B-29 enemy aircraft and find immediate measures to combat it.

II. FINDINGS

The mine acquired seems to show that it functions on a principle similar to the existing hydrophones, so that ways and means of sweeping it are certainly not non-existent. However, as regards such problems as the selection of sweeping equipment or the organization of a sweeping force, these require not only further study but must be decided with due consideration paid toward the position of the Navy.

III. PARTICULARS OF INVESTIGATION

The shortcomings in this investigation must be viewed with due regard, for (1) this investigation was carried out with apparatus borrowed from the Seismological Research Institute of the Tokyo Imperial University; (2) we were prohibited from tearing the firing mechanism apart; and (3) time allowed us to do the work was extremely limited.

As the investigation regarding this mine has already been the activity of the Navy and an urgent report issued as Confidential No. 134 of 20 (1945) of the Navy Technical Department and titled "Investigation on Countermeasures for American Acoustic Mines", it would be most appropriate to study this naval investigation together with this present report. The investigation at this Institute was been carried out as a sort of **additional** experiment to hasten the acquiring of ways and means to solve the problem.

A. Construction and Characteristics of Microphone

Impedance of Input .... Approximately 500 KΩ
Insulation Resistance .... 30 MΩ

B. Functional Characteristics of Electric Circuit

1. Electric Circuit. According to naval investigation*, it is as shown in Figure 3(D). This circuit, from the standpoint of **functional** mechanism, can be divided into the firing circuit and the sympathetic explosion preventing circuit. Both use IS5 (V and V2) as their **input** amplifying tube**. However, the anode circuit in both are led by V4 and V3 grids in cold-cathode syratron tubes*** respectively. V5 also is of the same syratron with detonator fixed between the cathode and the earth terminals.

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*Urgent Report issued by the Navy Technical Dept. on April 11
**That seized at SASEBO during mid-April was pentode JS17
***Word "Govt." printed

ENCLOSURE (D), continued

2. Functional Principle. By measuring the electro-statical characteristics of IS5 pentode, we were able to obtain Figure 4(D). As the anode resistance was 0.4 MΩ in all cases, the functional characteristic in the vicinity of a grid bias pressure of 0 Voltage (due to the saturation of the anode current) is believed to have been in the condition as shown by the dotted line. Thus, as long as the input power is weak, the change of the anode circuit too is meager, and as the rectifying function of the diode shows practically no changes, the grid bias remains stationary in the vicinity of 0 voltage. However, should the input pass a certain limit, the diode begins to show a rectifying function. Because of this, the grid inclines toward the negative side and the amplifying degree of the pentode increases, too. Under the circumstances, the rectifying function of the diode becomes increasingly active and the grid bias passes the unstable A point (Figure 4(D) and moves at once to the vicinity of point B, where it settles down. Under such conditions the mean voltage of the anode makes an enormous rise with the diminishing of the anode current. The increase of the anode voltage in this process operates on the thyratron V4 grid through the connected condenser and causes the discharge. However, in the V3 and V4, through their parallel connection, should one of them operate ahead, the 2μ F is charge through a 2 MΩ and the next function is checked to the extent of the time required to raise the voltage possible for functioning. The functioning of V4 naturally induces the functioning of V5 so that the quantity of electricity stored in 80μ F immediately flows through the fuse and explodes it. However, through the difference of resistance and capacity used in the explosion circuit and sympathetic explosion prevention circuit, the explosion circuit reacts to comparatively low frequency sounds. Moreover, it can be easily surmised that the sympathetic explosion prevention circuit acts most readily to such as comparatively high frequency sounds and non-continuous shocks.

3. Detailed Characteristics of Electrical Circuit

a. Functional input limit in explosion circuit. The result of testing the minimum input necessary to discharge V4 for all frequencies is shown in Figure 5(D). The continuous input for functioning is sufficient at 5 seconds.

b. The change of grid voltage in V4 when the functional input is added. By testing the change of grid voltage in V4 when the discharge in V4 is stopped, and 500 cycle 0.06 volt loaded as input, we arrived at Figure 6(D). In the thyraton, when the grid reaches approximately + 90 V against the cathode, a discharge occurs between the grid and cathode. Moreover, this induces a discharge between the anode and cathode and although there is also a discharge when the grid voltage in V4 reaches approximately ∓ 90 volts, another discharge occurs between the grid and cathode if the condenser charged voltage (inserted between that grid and earth) reach the discharge voltage through 5 MΩ resistance. However, should the anode voltage in this second discharge fail to charge itself to a sufficient voltage due to the preceding discharge, the discharge between the grid and the cathode would be futile in the functioning of V5. This has been ascertained through the test that when the deflection electrode of the Braun tube is fastened directly to the grid of V4 and functional voltage loaded to the input, the point of light of the Braun tube shows repeated rise as well as an abrupt fall.

ENCLOSURE (D), continued

c. The functional input limit in the sympathetic explosion prevention circuit. As shown in B of Figure 3(D), it makes a junction with the sensitive curve of the explosion circuit at approximately 2000 cycles, making it clear that when the input is gradually raised from below 1000 cycles, the function of the explosion circuit constantly precedes it and causes the appearance of an explosion current. As a result of our experiment, the above has now been proved beyond doubt.

d. Conditions necessary for the appearance of the explosion current.

(1) When input below 1000 cycles, but above the functioning limit of the explosion circuit and below the functioning limit of the sympathetic explosion prevention circuit, is loaded, it constantly results in the appearance of the explosion current. Although related in (c), Figure 7(D) has been obtained by testing the conditions necessary to cause the appearance of the explosion current, when loading input is beyond the functional limit of both circuits. To explain: although in general an enormous input (over 1 volt) is needed to cause explosion when it is added continuously for 5 seconds, by lengthening the continuous period of input the required volume of input gradually declines, and when continuously loaded for 15 seconds, irrespective of whether the sympathetic explosion prevention circuit functions or not, it has become clear that the explosion current is sure to appear. Were we to show these various inter-relations in a diagram form, they would appear as shown in Figures 8(D), 9(D), and 10(D). (not listed in this report)

(2) As is clearly shown in Figure 4(D), about 60 seconds after the input has been discontinued, there is a period when the grid voltage in V4 makes a notable downward trend. Even if the next input is loaded at this period, it would be difficult to reach the point of discharge. This point should be carefully considered when adopting any mine-sweeping measure.

(3) Even when the constant amplitude is below that functional limit, if shocking sound is added it is possible to cause functioning. To explain: with the addition of a shocking sound, the rectifying current of the diode starts to function in an instant. This in turn adds grid bias to the pentode, thus increasing its degree of amplification so that it makes possible the movement of the constant input, which had been until then below the functional limit.

C. Overall Experiment

The functional condition was tested with an imitation sound by connecting the microphone to the electric circuit. The source of imitation sound was an electric input amounting to roughly 20 watts which drove a 1/32 hp electric motor and succesively striking a disc whose average sound pressure was approximately $50\mu\beta$ at a distance of 50 centimeters. The functional limit whith this source of sound was generally 50 centemeters, and the time required for functioning 5 seconds. In this case, the sympathetic explosion prevention circuit does not function. The average inducing voltage of the microphone at the functional limit was 0.004 V.

ENCLOSURE (D), continued

However, as there are 10 intermittent sounds per second at the source of imitation sound, the induced voltage at the extreme point is estimated at many times this amount@.

In order to certify this, a test microphone was placed in a sound field of approximately 250μβ through a magneto-striction type vibrator of 800 cycles@@ wherein both circuits failed to function. (Inducing voltage of microphone 0.017 V.). When a shocking sound was added to this they immediately began to function. Thus we believe the functional input of this mechanism, as shown in the preliminary test, to be over 0.04 V.# When we next navigated a fishing boat with a 3 hp hot valve engine, it completely failed to function as the sound pressure at 5 meters amounted to roughly only 1/20 of the functional limit while "Mark Ra"##, also at 100 meters, was merely able to register a sound pressure amounting to 1/odd scores of the functional limit.

From the above, it has become clear that it explodes only when approached by ships or vessels possessing enormous horsepower.

IV. COUNTER MEASURES AND PLANS FOR THE FUTURE

From the above experiment we arrived at the conclusion that such sources of sound as the continuous sound emanating from a naval vessel or the intermittent one which characterized the imitation sound would be most effective when applied to sweeping these mines.

A. Method of Continuously Striking Bottom of a Steel Ship by Means of Electric Motors of Several Horsepower. As a result of the overall test, to explode it at a distance of several hundred meters, electric motors of over 10 horsepower would be needed###.

B. Sweeping Method Using Torpedo (Without Bursting Charge). As torpedoes generally possess over 400 hp and the sound produced is extremely great, we believe that sweeping of dangerous surfaces by launching torpedoes would be effective. The effective width of such sweeping would require further study but is estimated to be beyond 100 meters.

C. Although preliminary tests have shown that it is possible to sweep with "Mark Su"%, this require further study%%.

As shown in Figure 5(D), when the inducing voltage of the microphone goes

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@According to the investigation carried out at the Kure Navy Yard, it functioned at more or less 200μβ on a frequency below 500 cycles.
@@In the vicinity of 800 cycles, it functioned at 320μβ.
#400μβ (sound pressure)
##Army type radar possessing same power as Naval Light Radar.
###Concerning the method of applying successive beatings, further studies are necessary. Merely succesively beating the outer covering, we believe, would have no effect.
%"Mark Su" or Army type underwater detector (like Type 93, Model 5 detector but with larger sound producer).
%%Judging from the frequency characteristics of the firing mechanism, we believe it would be difficult to sweep effectively with "Mark Su" (13.5 D.C.) As the electric input in "Mark Su" is 3 kw, the production of sound is fairly great being roughly 600W, on the basis of 7 degrees for both right and left, but for 13.5 K.C. it would require a sound pressure of roughly 1500μβ.

ENCLOSURE (D), continued

beyond the minimum sensitive curve, the explosion circuit starts functioning. However, as a voltage of roughly 0.5 volts is required in such cases, the distribution of sound pressure obtained through "Mark Su" should be measured. Moreover, as "Mark Su" has a sharp angle of distribution in propagation of sound, we believe that, depending on the position of the microphone, it is liable to be influenced by the inducing voltage.

D. The above is the result of tests carried out on the mechanism a considerable number of days after its moisture prevention case has been removed. In view of the fact that much high resistance is being used in the electric circuit, there is a possibility of the sensitivity to drop due to moisture. Further study regarding this point would be necessary in the future.

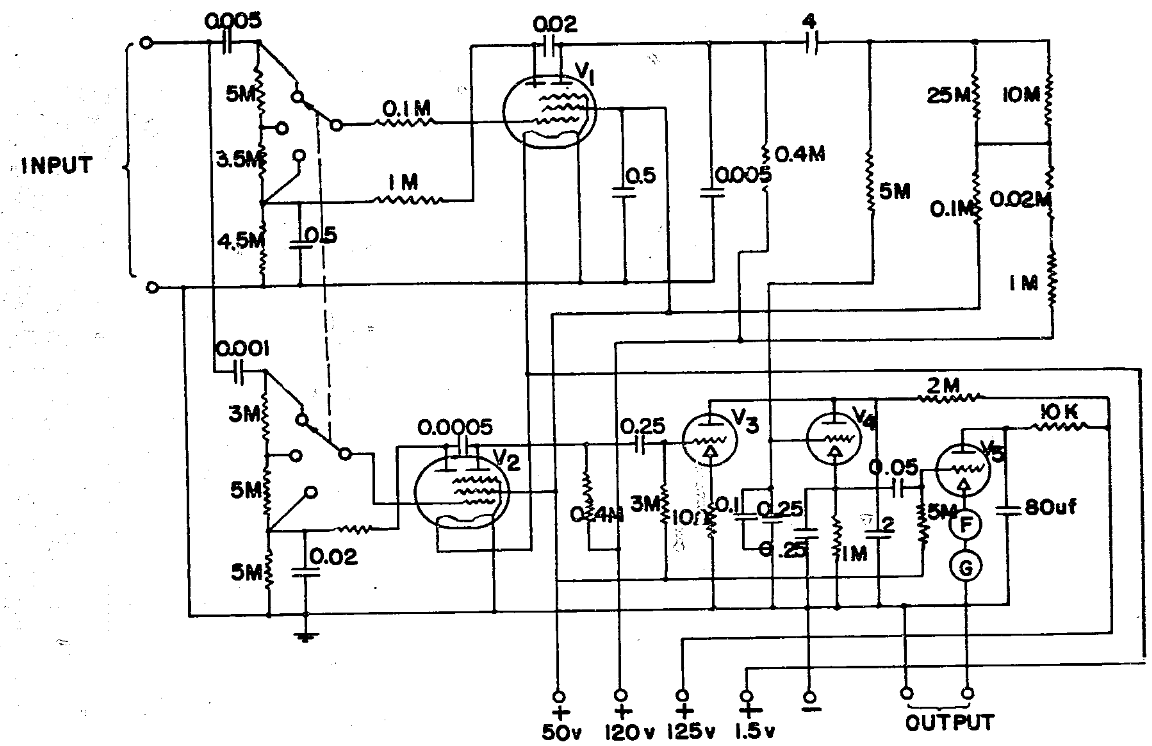

Figure 1(D)

CIRCUIT DIAGRAM OF AMPLIFIERS AND RELAYS

ENCLOSURE (D), continued

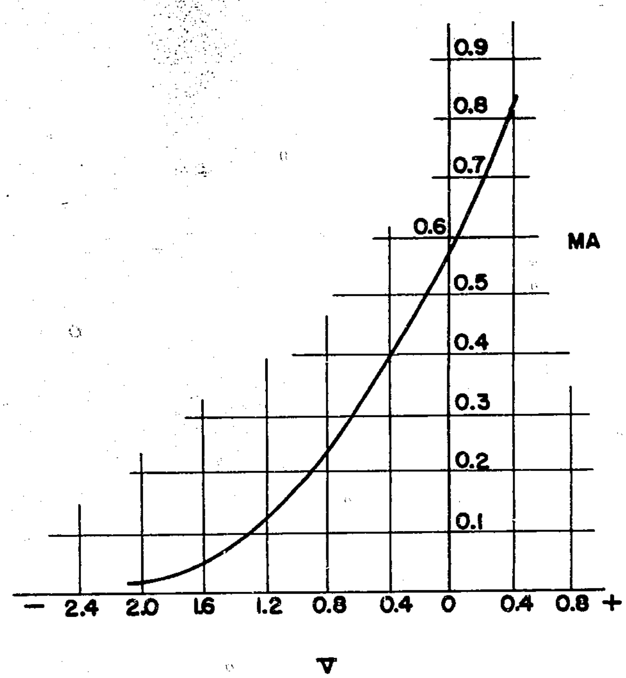

Figure 2(D)

ELECTRO-STATICAL CHARACTERISTIC DIAGRAM OF PENTODE IS5 (DETONATING CIRCUIT)

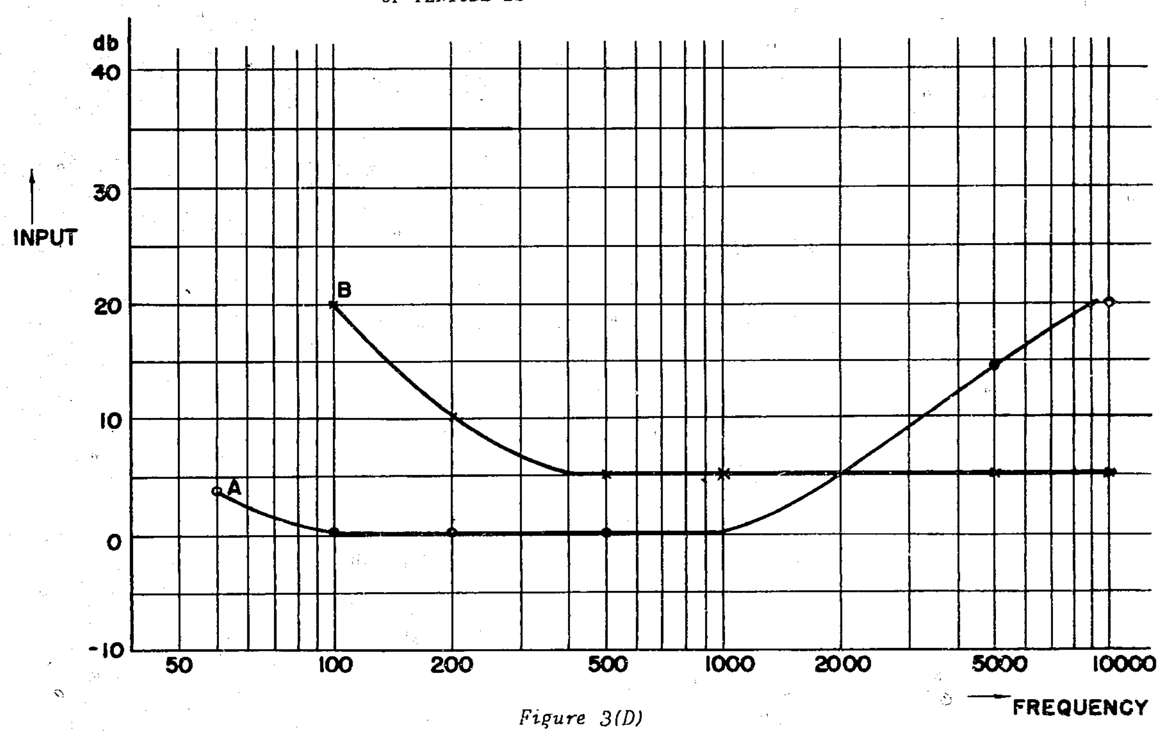

Figure 3(D)

LIMIT DIAGRAM OF INPUT AND FREQUENCY FOR ACTUATION (CONTINUING SOUND)

ENCLOSURE (D), continued

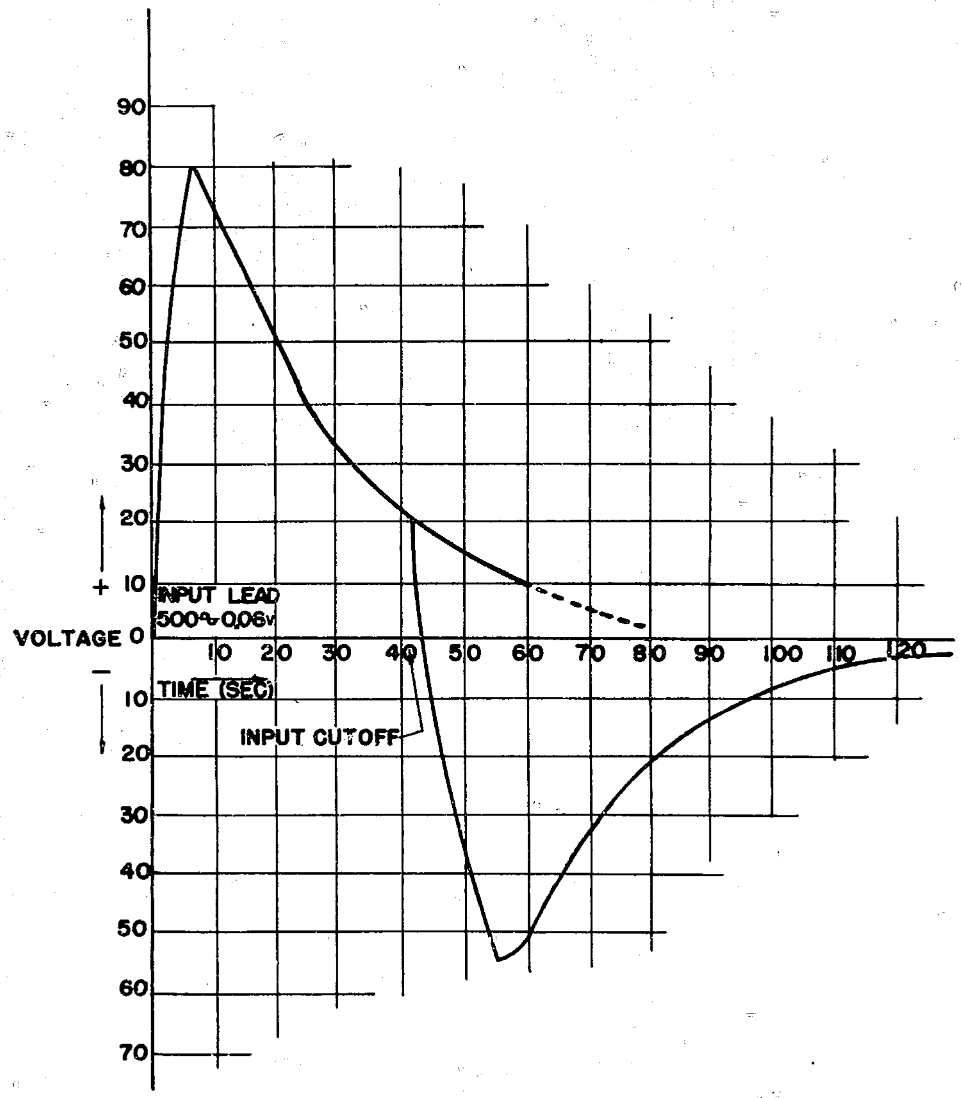

Figure 4(D)

VOLTAGE DIAGRAM OF V_4 GRID TERMINAL

ENCLOSURE (D), continued

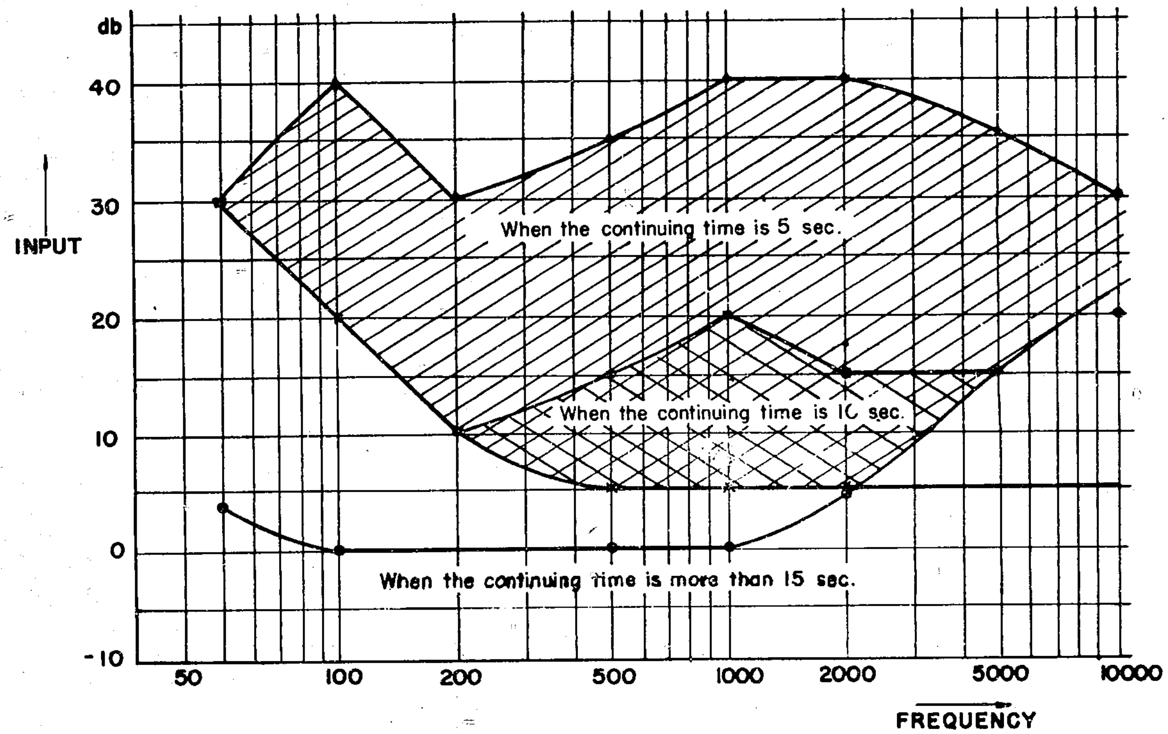

Figure 5(D)
LIMIT DIAGRAM OF INPUT AND FREQUENCY FOR WHOLE ACE UATION

ENCLOSURE (E)

AN EXPLANATION OF SWEEPING APPARATUS FOR THE HYDRO-MAGNETIC MINE

by Yutaka MURANAKA

Theoretical calculations and model experiments were carried out, but we are sorry that all the numerical data obtained were burned and cannot be represented.

I. THEORETICAL CALCULATIONS

With the assumptions that a ship's body could be replaced by a prolate spheroid and that the surface waves produced by a ship could be neglected, the pressure changes on the sea bottom produced by a ship were calculated under several conditions. The length of the spheroid was fixed at 100 meters and the maximum diameter was varied at 8, 10, 12.5, and 16 meters to see the effect of the fullness of the form upon the pressure changes. The distributions of the pressure changes along the longitudinal and tranverse directions were calculated, and the effect of the distance between the spheroid and the sea bottom was also evaluated.

Secondly, the pressure changes produced by a rectangular flat plate, considered as a wing, towed under water were calculated using the wing theory.

The results of the former calculations showed that the numerical values of the pressure changes produced by a ship when passing by were of the same order of magnitude with the data obtained from the examination of the captured hydro-magnetic mine.

The latter results showed that the pressure changes produced by a flat plate towed under water were also of the same order of magnitude with the above mentioned data. Therefore, sweeping of the mines by towing a flat plate under water was contemplated.

II. MODEL EXPERIMENTS

A. Measuring apparatus of the changes of pressure was composed of a small iron box containing a pick-up amplifier, a recorder, and an A.C. generator. The pick-up was of a **magneto-striction principle (inverse-Wiederman effect)** and excited with 3000 cycle A.C. current from the generator. The pressure sensitive area of the pick-up was a small circle of only 2cm diameter, so that it could be considered as a **point** practically. The amplifier was a very simple ordinary one having a rectifying circuit in its last stage. For the recorder, we used a 3-element electro-magnetic oscillograph.

The sensitivity of the whole apparatus was so adjusted that the deflection of the light spot on the recording film was about 1cm/gr /cm^2 of pressure change.

B. As an actual sweeping apparatus, a rectangular flat plate of wood (span 10 m. x chord length 5 m.) was to be towed under water by a suitable ship; for example, an anti-submarine boat of wood with a speed of some 4 knots. At the model **basin,** a rectangular flat plate (span 70 cm x chord length 35 cm) was suspended with four steel wires from the truck and towed under water (Figure **1(E)**. The lengths of the wires were adjusted to suit the assigned angle of attack, i.e., 5°, 7.5°, 10°, and 14°. Towing speed ranged from 0.5 m/sec. up to 3.5 m/sec, the distance between the plate and the bottom being varied 30, 60, and 90 cms. Owing to the lack of time, the resistance of the plate was not measured but only estimated by some calculations.

ENCLOSURE (E), continued

The objects of the experiments were to check the results of calculations and to assure the stability of the plate while being towed.

The stability was very satisfactory.

The numerical values of the pressure changes obtained were about the same order of magnitude as the results of calculations, and the distribution of the pressure changes along the span did not differ much from theory. However, the time of duration of the pressure change greater than some given values, for example 1.0 gr./cm^2, was too short to actuate the pressure-sensitive mechanism of the mine successfully.

Some of the data obtained are reproduced in Figure 4(E) and Table I(E). The rest were lost.

C. The wing rotor was also tested. It consisted of two semi-circular **cylindrical** shells, two end plates connecting them, and axle. See Figure 2(E). When towed under water by the two steel wires connected to the ends of the axis, it rotated like a sort of wind-mill. It then produced pressure changes on the sea-bottom. But the pressure changes thus produced were quite different from those produced by the plate. The typical oscillograms for the two cases were something like Figure 3(E), and the maximum peak values of the pressure change at their corresponding speed are shown in Figure 5(E).

D. To investigate the effect of the ship's form upon the pressure changes produced by it on the sea-bottom, some ship models were towed. We were unable to distinguish the pressure changes due to the ship's body from those due to the surface waves. Evidently, the laws of similitude for the two cases are different, so we abandoned the experiments.

Table I(E)

TIME OF DURATION (IN SEC.) OF PRESSURE CHANGE GREATER THAN ONE GR/CM^2 AT POINT ABOVE WHICH MID-SPAN PASSES
(Estimated for the actual plate or rotor from the model experimental data)

Speed (m/sec)	D = 10 m		D = 5 m	
	wing rotor	flat plate*	wing rotor	flat plate*
0.5				
1.0			5.4	6.2
1.5	5.3		5.1	6.8
2.0	6.4		4.8	6.7
2.5	6.0		4.2	6.8
3.0	5.1	4.4	4.2	5.8

D = distance between the wing rotor (flat plate) and the bottom.
*angle of attack = 10°

ENCLOSURE (E), continued

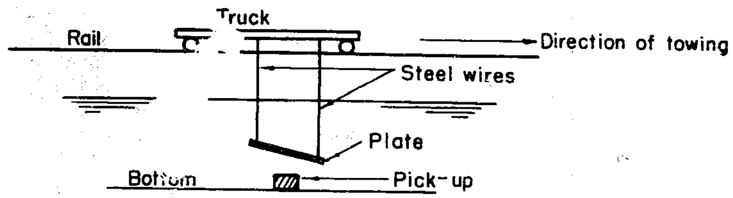

Figure 1(E)

PRESSURE PLATE EXPERIMENT DIAGRAM

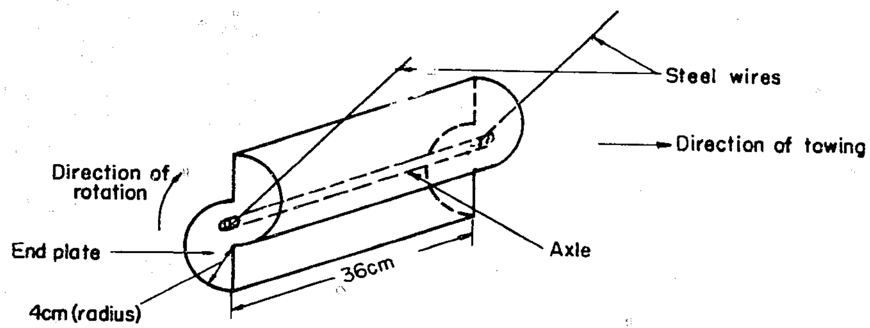

Figure 2(E)

WING ROTOR CONSTRUCTION DIAGRAM

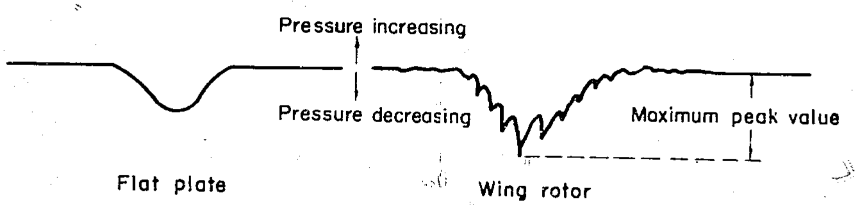

Figure 3(E)

OSCILLOGRAMS

ENCLOSURE (E), continued

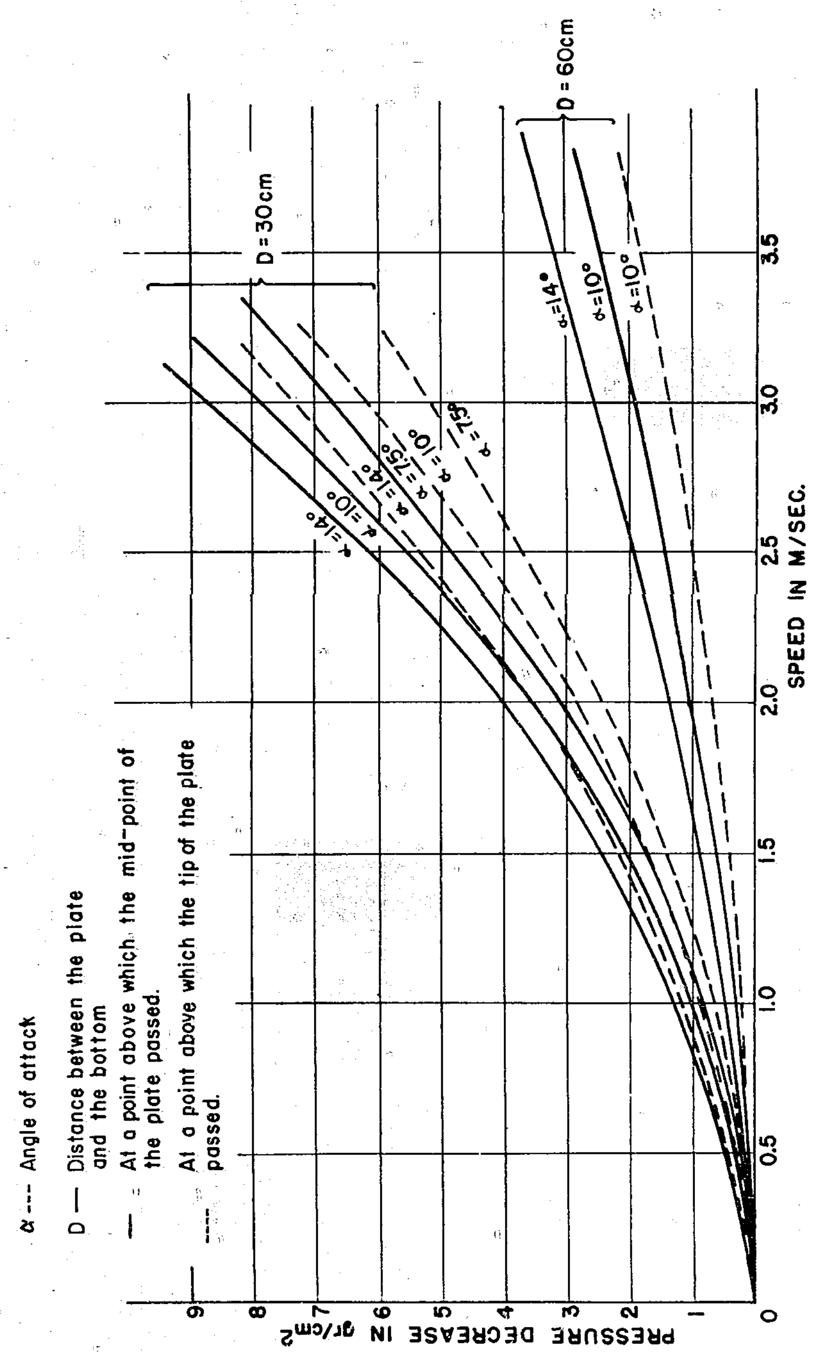

Figure 4(E)
THE RECTANGULAR FLAT PLATE

ENCLOSURE (E), continued

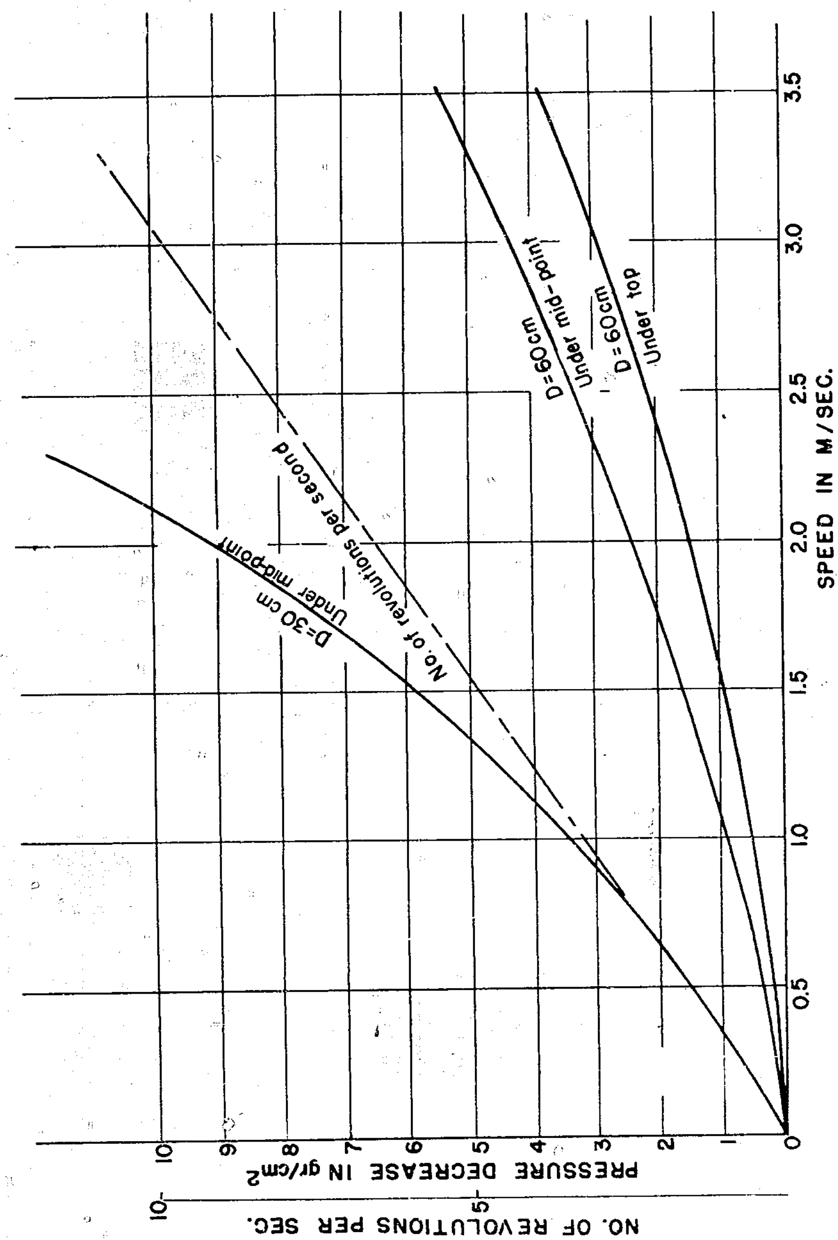

Figure 5(E)
THE WING ROTOR

ENCLOSURE (F)

SWEEPING OF THE MAGNETIC HYDRAULIC PRESSURE MINES

* * * * *

OSAKA MINOR NAVAL STATION

Tamae-hashi, Kita-ku, OSAKA.

October 10, 1945,

Rear Admiral Noble
U.S. Navy,
WAKANOURA.

Subject: Sweeping of the Magnetic Hydraulic Pressure Mines

Dear Sir:

I have the honor to inform you that I have got a definite program to sweep the magnetic hydraulic-pressure mines as mentioned below, after discussing it over with three members of the Mine Sweeping Committee of the Navy Ministry, TOKYO, who came down to OSAKA lately. They are Commander M. SAKI, Technical Lt. Commander M. HIGUCHI and Naval Engineer K. TANABE.

1. The sweeping net has been proved quite effective, provided there are no obstacles such as rocks, sunken ships, etc., at the bottom of the sea. This method can be used in some part of ISUMI-NADA, but not in and outside of OSAKA and KOBE harbors. I have not been able to find adequate nets at hand in the vicinity of OSAKA and KOBE, so I am now asking Maizuru Naval Station to get and send me 10 sweeping nets as soon as they can.

2. Hydraulic pressure plate towed by wooden ship powerful enough to make 5 knots and over is supposed to be theoretically effective. This method has not been put to actual use yet, and its effectiveness is a matter of future development. Moreover, powerful wooden ships to tow the plates are hard to get. I am taking every possible means to get them, and Commander S. MATSUYEDA is now seeking such ships in the Kure district. Three pressure plates will be ready on October 10, so as soon as we get wooden ships powerful enough to tow them, we will be able to use this method.

This method, however, is supposed to be dangerous for the towing ship at a depth under 20 meters.

3. A ship filled up with empty drums and lumbers in every available space, the crew of the ship being in shock-proof chamber, can be used to dispose of the hydraulic pressure mines. This is rather a dangerous method, may possible be fatal, once in a while, but was regarded as a prompt remedy to burst up all the mines during the war. Such ships have been under way of fitting up. Now the war is over and naturally we don't want to let the crews undergo such dangerous jobs, so we determined after due discussion to tow such ships with no one on board. Two ships for this purpose, SHINWA MARU and DAITO MARU, will be ready at the end of this month and next, respectively. These mine disposing ships will be towed by powerful tug-boats and equipped with a stabilizing rudder to follow the course of the tug. Some difficulties are expected in order to find out how powerful tugs should be to carry out this method.

ENCLOSURE (F)

SWEEPING OF THE MAGNETIC HYDRAULIC PRESSURE MINES

* * * * *

OSAKA MINOR NAVAL STATION

Tamae-hashi, Kita-ku, OSAKA.

October 10, 1945,

Rear Admiral Noble
U.S. Navy,
WAKANOURA.

Subject: Sweeping of the Magnetic Hydraulic Pressure Mines

Dear Sir:

I have the honor to inform you that I have got a definite program to sweep the magnetic hydraulic-pressure mines as mentioned below, after discussing it over with three members of the Mine Sweeping Committee of the Navy Ministry, TOKYO, who came down to OSAKA lately. They are Commander M. SAKI, Technical Lt. Commander M. HIGUCHI and Naval Engineer K. TANABE.

1. The sweeping net has been proved quite effective, provided there are no obstacles such as rocks, sunken ships, etc., at the bottom of the sea. This method can be used in some part of ISUMI-NADA, but not in and outside of OSAKA and KOBE harbors. I have not been able to find adequate nets at hand in the vicinity of OSAKA and KOBE, so I am now asking Maizuru Naval Station to get and send me 10 sweeping nets as soon as they can.

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ENCLOSURE (F), continued

4. The use of remote controlled mine disposing ships will be another method to sweep mines, but it will take several months to fix up such ships, may need ships and considerable repair work, which seems unpracticable.

In conclusion, I am now speeding up the preparation for two methods. One is the sweeping net-powerful tug method, the other is the disposing ship-powerful tug method.

Yours respectfully,

Vice Admiral ARATA OKA, I.J.N.
Commander in Chief
OSAKA Minor Naval Station

Copies sent as follows:

Commander of the Mine Sweeping Div. of the U.S. Navy at WAKANOURA.
Director of the Mine Sweeping Div. of the Bureau of Military Affairs.
Chiefs of Staff, YOKOSUKA, KURE, SASEBO, and MAIZURU Naval Stations,
Chief of Staff of the OMINA to MINOR Naval Station.

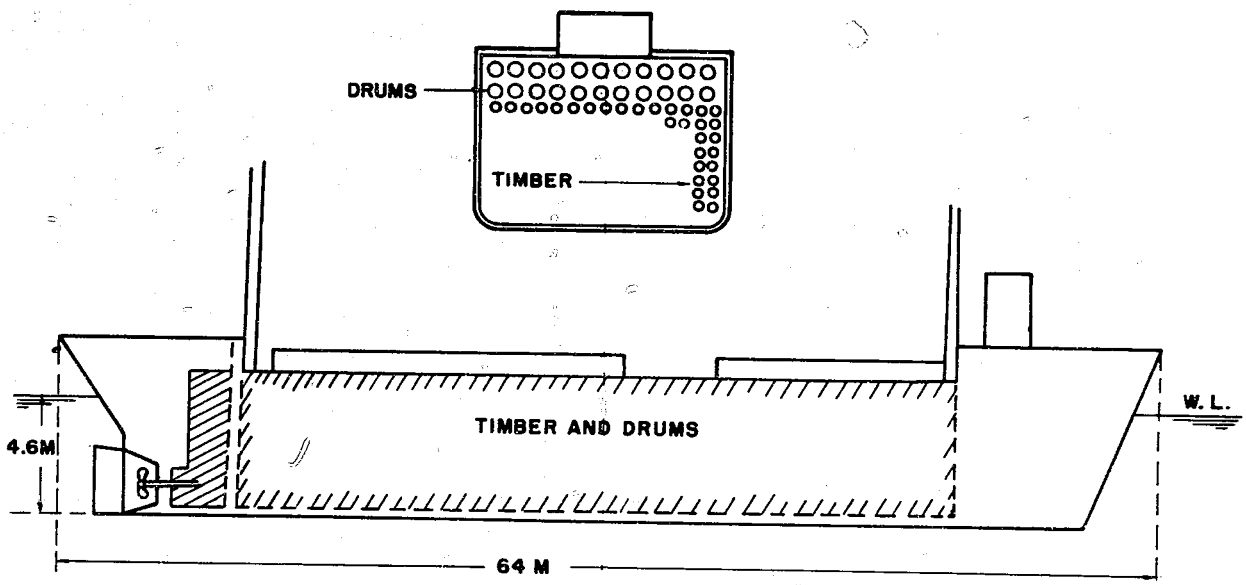
(Sketches appended)

ENCLOSURE (F), continued

MINE DISPOSING VESSEL AND BOARD CAUSING VARIATION OF WATER PRESSURE

I. MINE DISPOSAL VESSEL (CONVERTED FROM NEW "E" TYPE MERCHANT VESSEL)

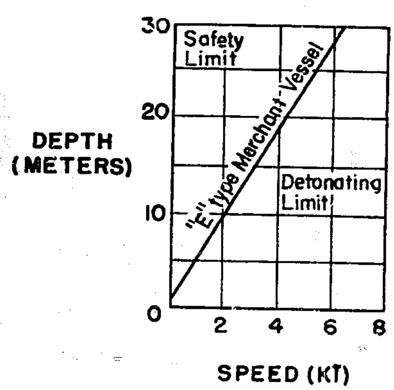
(A) ESSENTIAL PARTICULARS



GROSS TONNAGE	886 T
BREADTH	9.5 M
VERTICAL SECTION BELOW WATER LINE	43.6 M^2

(B) RESULT OF EXPERIMENT (CONDUCTED AT KURE NAVY YARD)

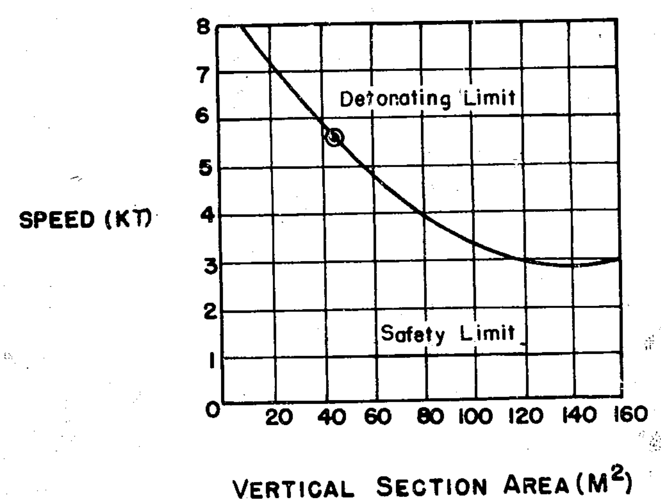
(I.) DEPTH AS RELATED TO SPEED



ACCORDING TO THIS EXPERIMENT NEW "E" TYPE MERCHANT VESSEL IS SAFE IF IT SAILS BELOW 3.5 KNOTS WHERE THE DEPTH IS 15 METERS.

ENCLOSURE (F), continued

(2.) SPEED AS RELATED TO VERTICAL SECTION BELOW THE WATER LINE



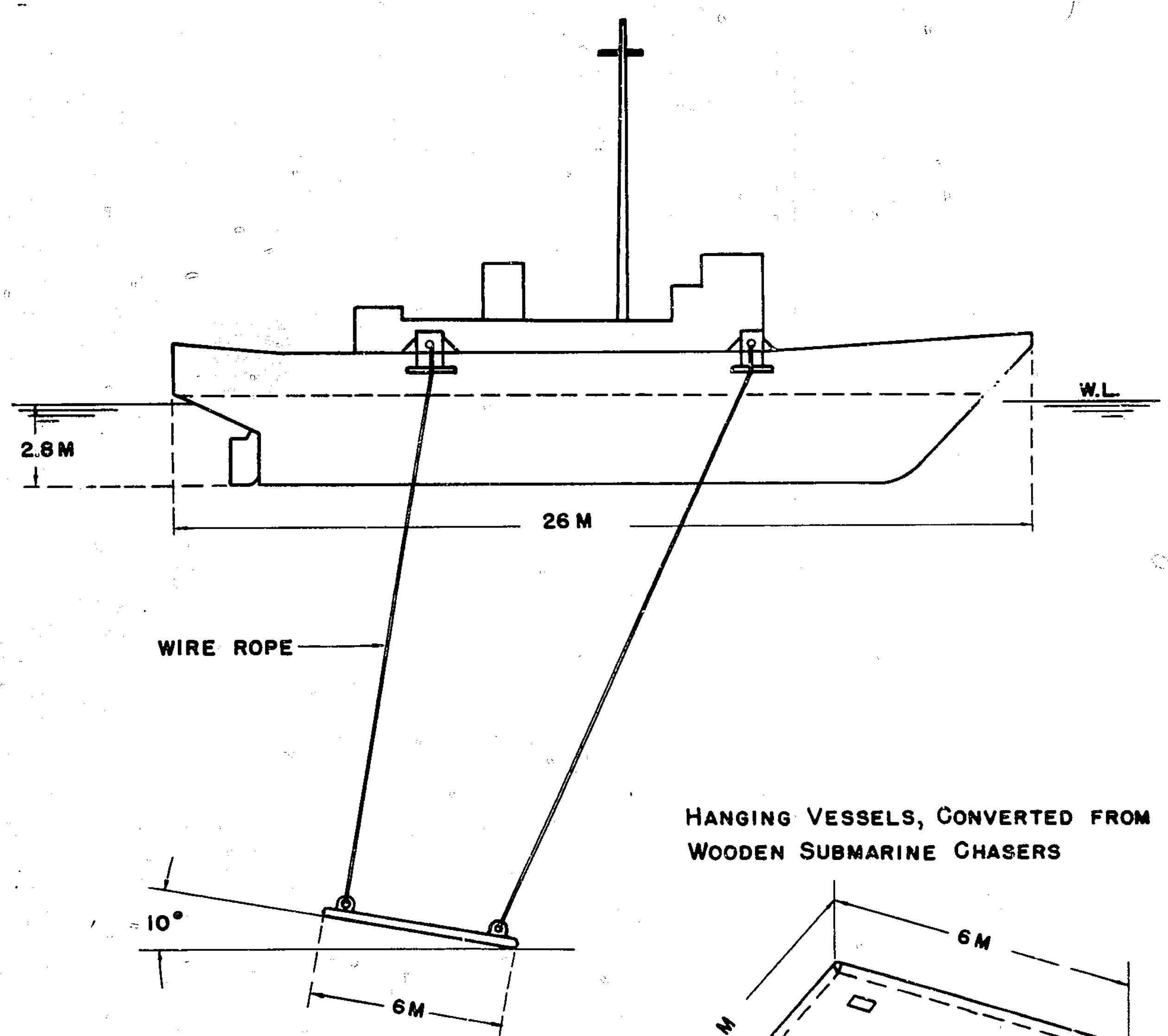
ACCORDING TO THIS EXPERIMENT, NEW "E" TYPE MERCHANT VESSEL (IF ITS DRAUGHT IS 4.6 METERS AND ITS SECTION AREA IS 43.6 M^2), IS SAFE FOR SAILING BELOW 5 KNOTS SPEED.

(C) VESSELS BEING CONVERTED TO MINE DISPOSING

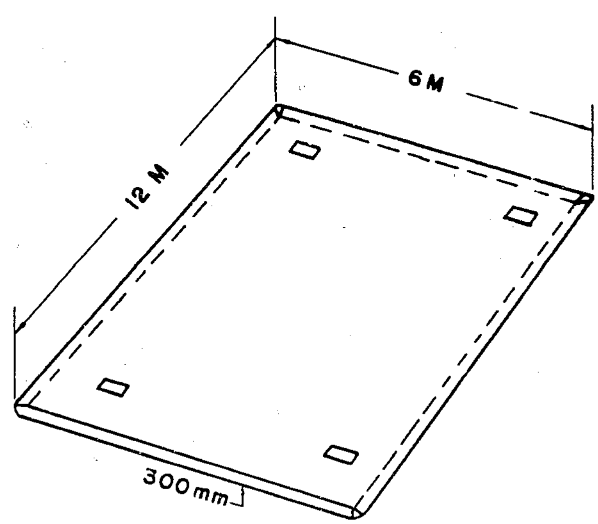
NAME	TONNAGE	PLACE	DATE OF COMPLETION
SHINWA-MARU	2000	OSAKA	1945-10-31
DAITO-MARU	886	OSAKA	1945-11-30

ENCLOSURE (F), continued

2. BOARD CAUSING VARIATION OF WATER PRESSURE
(A) ESSENTIAL PARTICULARS



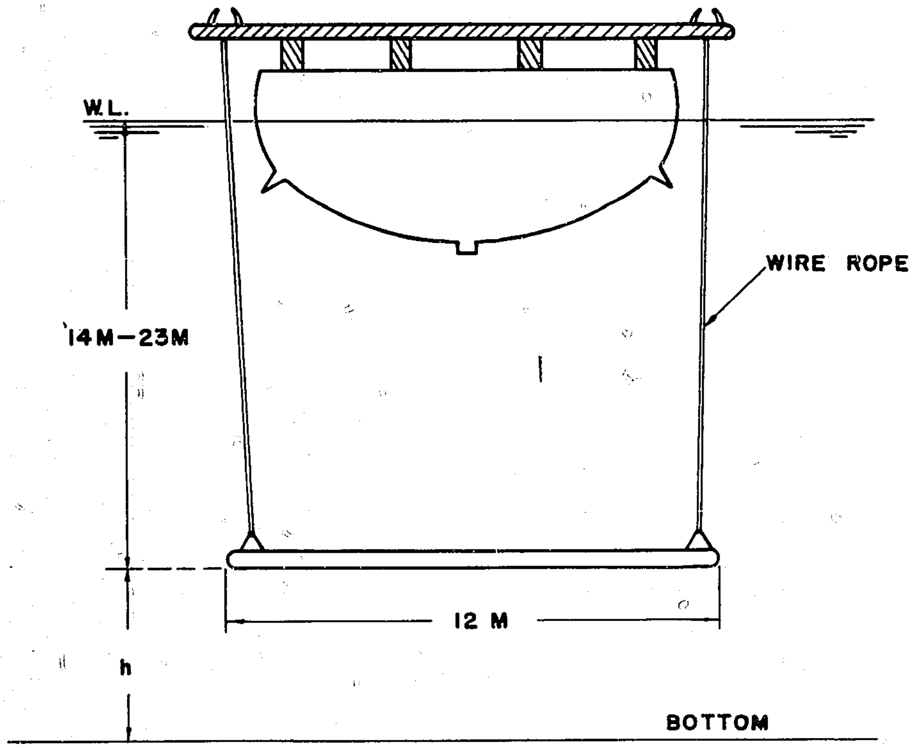
HANGING VESSELS, CONVERTED FROM WOODEN SUBMARINE CHASERS



MADE OF PLYWOOD AND FILLED WITH SAND

ENCLOSURE (F), continued

(B) RESULT OF EXPERIMENT (CONDUCTED AT KURE NAVY YARD)



"h" AS RELATED TO THE SPEED

"h" (M)	SPEED(kt.)	TIME FOR ACTION(sec.)
10	3	NONE
10	4	NONE
5	3	NONE
5	3.5	6.9
5	4.8	12.4
5	4.86	8.1

EXPERIMENT SHOWS THAT TOWING SPEED SHOULD BE ABOUT 5 KT WHEN "h" IS 5 METERS.

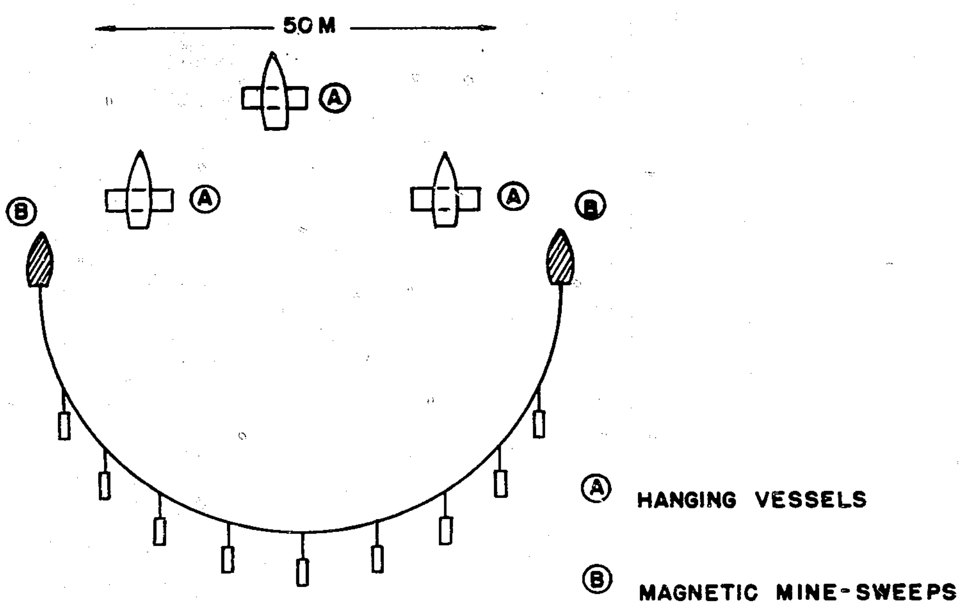
ENCLOSURE (F), continued

(C) BOARDS NOW UNDER CONSTRUCTION

NUMBER OF BOARD	PLACE	DATE OF COMPLETION
3	OSAKA	1945 - 10 - 10

(D) REMARKS

(1.) EXAMPLE OF SWEEPING OPERATION



(2.) HANGING VESSEL SHOULD BE SO CONSTRUCTED AS NOT TO INTERFERE WITH MAGNETIC POWER OF THE MINES BY THE POSITION OF THE BOARD. THE POSITION OF THE BOARD MUST BE ADJUSTED BY THE VESSEL SO AS NOT TO RISE OVER 5 METERS FROM THE SEA BOTTOM.

ENCLOSURE (G)

OBSERVATIONS ON JAPANESE MINE DESIGNS AND TEST METHODS

Part I
THE STATE OF JAPANESE KNOWLEDGE OF U.S. MINES AT THE CLOSE OF THE WAR

Prior to 27 March 1945, the Japanese had recovered samples of the following U.S. mine mechanisms and analyzed their characteristics: M-3 Mod 1, and M-4 (single look type). An M-11 mechanism recovered at CHICHI JIMA was so damaged that its response characteristics could not be studied. These studies, together with those on British induction mines, recovered at SINGAPORE and RANGOON, as well as information gained from the Germans on the British magnetic and acoustic mines and on their own, still left the Japanese quite unprepared for the B-29 mining campaign. Nevertheless, on the basis of this information, they had come to the following conclusions:

1. They could sweep the M-5 mechanism most easily of all the known types of influence mines because either moored or magnetic gear could be used. It was also ascertained that the mines would probably explode as a result of the impact of the moored sweep cable upon the mine mooring cable.

2. The M-3 Mod 1 was next in order of difficulty in sweeping because it differed from the M-5 only in that it lay on the ground.

3. The single look M-4 was next on the list because, being an induction mine, cross-sweeping was necessary to insure adequate coverage, and no interlook dead period was used.

The possibility of using explosive charges to induce magnetic looks in the M-4 mechanism was not appreciated, and no experiments in this direction had been peformed. Theoretical investigations of the nature of the magnetic field surrounding the typical aircraft sweep had been made, and such sweeping was considered to be effective against all U.S. magnetic mines recovered prior to 27 March 1945. The Japanese realized that the M-4 mechanism was originally designed as a multi-look random mechanism, but did not appreciate the purpose of the search coil-break as an anti-aircraft sweep device. They had surmised its purpose to be a protection to the sensitrol against excessively large currents induced in the search coil. Inasmuch as they had no grounds for suspecting that the interlook dead period might be greatly lengthened in future mines, the idea of the aircraft sweep was never given up until the first M-9 mechanisms were recovered and analyzed at KURE. No aircraft sweeps had ever been constructed, owing to the unavailability of aircraft and the lack of appropriate materials. The lengthening of this dead period did, however, hasten the advent of the double catenary bar magnet sweep and enabled them to successfully deal with this modification of the M-9.

Although the reverse-look idea had not appeared in any information in their possession before the B-29 mine attack, its use in U.S. mines was anticipated on the basis of research already underway on magnetic torpedo exploders. They failed to appreciate that its primary value was to prevent chain countermining, since the only reason for this feature that they were able to put forward was that it increased the percentage of lethal fires.

Nearly all the modifications in the sensitivity of the M-9 mechanism had been discovered, and sweeping procedures were altered accordingly, but the Japanese were uncertain as to whether the variations in sensitivity from one mechanism to another had been accidental or intentional. Nevertheless, after the first four or five mechanisms had been exhaustively analyzed, the succeeding M-9's recovered were immediately examined by local Bobatai organizations for interlook dead period stepper-switch connections, as this is a fairly simple matter. Most M-9's were reported to be set at 10.5 seconds, there being 3 times as many of these as of the 3-second modification. The resistors found had the values 20, 100 and ∞ ohms, although most of them were 20 ohms.

The Japanese found no differences in the sensitivities or in the interlook insensitive periods in the four M-11 mechanisms exhaustively analyzed at KURE, and subsequently never became aware of the modifications in these mechanisms. On the bases of tests (see Part III) on the mine, the interlook insensitive period was found to be 0.5 sec. and no appreciation of the dependence of the length of this period upon signal strength was exhibited. This was to be expected from their work on the Mk 13 mine. The absence of a search coil break did not suggest to them that aircraft sweeping could be effective against this mechanism, or that successful sweeping by a single catenary bar magnet sweep was thereby also fairly well assured.

A-3 mechanisms were recovered and analyzed by both the Army and the Navy, the latter having done a more prompt and thorough job. There were no features of the A-3 which were not quickly understood and rapidly taken advantage of. The Navy's analysis of the A-5 was equally accurate and expeditious and the countermeasure problem was immediately grasped, although no adequate solution was ever proposed. Acoustic sweeps in use at the end of the war were considered about 50% effective against A-3 mechanisms, and almost completely ineffective against A-5 mechanisms.

The state of the Japanese Navy's speculative thinking in this field is revealed by the fact that the use of the A-6 principle was a total surprise to them; and that, although they had fully expected us to come out with a supersonic acoustic mine, we surprised them by doing the opposite. Since they had up to that time carried out no research on the pressure signatures of ships nor on the nature of subsonic sound fields in water of minable depths, they suddenly found themselves in an extremely embarrassing position. A partial solution for the A-5 problem appeared in the use at intervals of a few seconds of explosive charges by ships which could thus be assured fairly safe conduct over A-5's owing to the ACM dead period which could be induced in them; however, they never succeeded in making and using such charges. The A-6, on the other hand, required a radically new departure in mine sweeping. The resourcefulness with which they attacked the problem and the competence of the personnel assigned to it resulted in the rapid development of an important countermeasure for the A-6 which, if the Japanese can be believed, had definite possibilities. This "pressure plate" type of sweep is described in detail in Part III of this enclosure, together with data upon which Japanese optimism is based. Theoretical calculations of the nature of the pressure signature to be expected below such a pressure plate indicated to the Japanese that the duration of the negative portion of this signature would be too short to meet the "time out" requirement of the A-6 mechanism. Actual trials at sea with this device on four pressure mines laid in a row proved to them that not only were they able to actuate the mines, but they could achieve a swept path of about 20 meters. Two ships were to be used in practice; one to provide the pressure impulse, and the other the magnetic. In this way the safety of the vessels could be assured. No pressure signatures of the plate were actually taken, although instrumentation for this purpose was being designed when the war ended. The Japanese were apparently unable to account for the discrepancy between their theoretical and experimental results on the effectiveness of the pressure plate. It is suggested that this matter could be studied to advantage in view of the amount of U.S. minesweeping still planned in Japanese waters. All the A-6 mechanisms examined were found to have the same magnetic sensitivity, as only the 100 ohm sensitrol shunt was found.

In studying the response of mines to ships, the Japanese laid one or more of each type in 22 to 24 meters of water and ran ships of various classes,

ENCLOSURE (G), continued

speeds, and states of degaussing over the mines in two mutually perpendicular directions. Leads were brought up from the mines which indicated their response on instruments located on a test ship anchored nearby. This did not, however, tell them how the mine response varied with depth below the keel, and consequently they had no data on the maximum depth at which a given U.S. mine would be effective against given types of ships, speeds, degaussing, etc. Instead, "safe depths" were calculated from the damage point of view, and it was believed that waters over 30 meters deep would be safe against all types of U.S. ground mines. The method by which this figure was arrived at remained obscure, and it would not be considered safe by U.S. Navy standards. Nevertheless, influence mine sweeping was consistently carried out in waters up to 50 meters in depth.

An attempt was made to study magnetic mine actuation depths against warships by taking the magnetic signatures of all warships (in the class of DD and up) at a given depth and extrapolating them mathematically for a number of other depths. From these results "safe depths" against actuating needle-type mines were believed to have been calculated accurately enough for most purposes. But they were of little value when applied to induction mines whose responses are complicated by the ship's speed, the shape of the signature, and the various "dead period" and "look" modifications of which these mines were capable. The Japanese never took the next obvious step of simulating the effect of ship's signatures on the mines in the laboratory, nor was such work thought necessary.

The same picture applied equally well to acoustic and pressure mines, except that mathematical studies of ship's acoustic and pressure fields were of no practical importance.

In field tests, instrumentation varied with the mine. The relay-type induction mine was tested with only the search coil in the mine case to whose terminals leads were tied and led through a waterproof cable to the M-9 mechanism on the test ship. If there were any "pickup" troubles in the cable, or other problems connected with having the sensitrol at a considerable distance from the mine, the Japanese had not been aware of them. In all such tests, the mines were planted on the bottom in three mutually perpendicular orientations. These tests were instrumental in the appearance of the double-catenary, reversed polarity, bar magnet sweep, and of having the current in their Type 5 sweep boosted from 220 to 370 ampere turns to take care of the 20-ohm shunt across the sensitrol. The behavior of the M-9 was noted as to the number of looks recorded, their direction, and their timing for various kinds of sweeps proceeding at several speeds in different directions. In the M-11 mechanism, only the detonator current could be observed. However, Helmholz coil tests (described in Part III) on mines containing the M-11 enabled the Japanese to learn its important response characteristics, and the results were applied with indifferent success to minesweeping procedures. This will be discussed in detail later.

It is surprising, in the light of these test methods, that the possibility of inducing magnetic looks through shocking the mine case mechanically had not been discovered. This information would have revealed the counterminability of the Mk 13 mine using small explosive charges properly timed. Actually their only effort in using the explosions against mines was for the purpose of crushing their cases. It was abandoned owing to small damage range.

From an examination of the circuit constants, the frequency response and the rate-of-change mechanisms were suggested for both the firing and the anti-countermining channels. The existences of the insensitive dormant period after actuation as well as the ACM dead period were also realized, and were confirmed by breadboard tests in the laboratory. However, the actual method necessary for successfully applying sound fields for sweeping purposes was determined through the barge tests described above, and agrees substantially with the duration of the linear build-up, the sustained signal, and the time-off periods prescribed by the U.S. Bureau of Ships. Thirteen sets of the Fessenden type noisemakers were designed on the basis of these tests and used since late April. They were effective in sweeping a total of 30 mines, presumably all A-3's. In this analysis of U.S. acoustic mines, a total of five A-3 and three A-5 mechanisms were used on a sand bottom in about 23 meters of water.

Barge tests on the A-6 were made at the same location, using leads from the float switch in the mine to instruments in the test ship, and the duration of its actuation under passing ships was studied. In this way the success of the pressure plate was ascertained.

Prematuring and chain countermining were noted by the Japanese to have been an important property of U.S. acoustic (presumably) mines in certain Empire waters, particularly at SHIMONOSEKI. Of 4000 mines exploding after laying, 1500 prematured and the remainder were swept. Of these a number chain-counterminded, and, in one instance, as many as nine mines (including the swept one) exploded simultaneously. The maximum ACM range was observed to be 15,000 meters. An interesting case of ACM between two mines, 2 to 3 kilometers apart and separated by a penninsula, was also mentioned, although no conclusions were forthcoming.

Part II
JAPANESE MINE DEVELOPMENT METHODS

Complete descriptions of the newer Japanese mines may be found in NavTech-Jap Report, "Japanese Mines," Index No. 0-04, and these will not be reported here. Rather, the Japanese organization of their research and development methods in mine warfare will be treated.

Nowhere in the Japanese Navy does an organization similar to the U.S. Navy Mine Warfare Operational Research Group exist. For this reason it was impossible to find one or two persons who could be relied upon to supply the complete picture on the state of Japanese knowledge of U.S. mines. For example, although the research activity at KURE was aware of the modifications appearing in the M-9 mechanism and was revising the official sweeping instructions accordingly, other personnel equally familiar with the details of U.S. mine design told us they had not heard of any such mine modifications.

The Navy did not encourage speculative work on advanced methods in mine warfare, and when it realized the need of it in April 1945, it was too late. Their high frequency (40-50KC) aircraft-laid acoustic mine was their only attempt at an "unsweepable" mine, and no other types were being considered. Indeed, if they had been, they never reached the drafting board. However, they did expect the U.S. to use a sharply tuned double-channel supersonic mine which would be difficult to sweep because they felt that the noise-makers then on hand would not emit sufficient energy to satisfy the narrow-band requirements of the mine. This would force them to guess at our frequency combination and construct narrow-band sound sources to accommodate them. As we could change the combination at will, they feared they would be considerably embarrassed in the ensuing game of "mine and countermine". They suspected that all our newer mine mechanisms were probably being laid by submarines.

In the design of their own mines, little systematic and quantitative test work was done to evaluate endurance under conditions usually encountered in assembly, transportation, handling, storage, shock-on-impact, and conditions to be encountered at sea. As a result, no test instrumentation cable for simu-

ENCLOSURE (G), continued

lating many of these conditions in the laboratory was ever developed. Consequently, failures in performance were either never detected, or their cause never systematically studied under controlled conditions. For instance, the K-2 drifting mine contained rubber cushioning to protect vital parts against damage, merely because this instinctively seemed to be a good idea. The size of the parachute was determined by the speed and altitude requirements of the aircraft as they related to mine damage on impact. Using a parachute whose terminal velocity (with the mine) was 13 meters/sec, the mine could be dropped without damage from 300 meters at 150 km. The tests were carried out at sea using pilot production models. However, the mass-produced models were only 50% operative due to damage from impact in identical tests. Owing to the pressure of events, they were issued for service nevertheless. The poor quality of the assembly-line product was laid to the heavy drain on industrial workers by the Army and the inexperience of replacement personnel.

They were able to gain some idea of the effect upon planting accuracy of the drift incurred by a parachute, from the fact that an average of 10% of our mines struck land. In places like TSURUGA and NANAO, the figure was as high as 30%. There seemed to be little knowledge on their part of the German high altitude mine, and they did not appear to have anticipated our using one. Again, none of our mines seemed to have detonated upon impact, from which they might have drawn valuable conclusions in their own efforts of mine design, had they not been so pressingly occupied with other matters.

On the subject of the life of moored mine fields, the Japanese had a qualitative understanding of the problems involved. The life of moored mines had been studied at both SASEBO and KURE, but the results were very conflicting owing to the differing conditions at the two locations. It was estimated, however, that within 2 to 3 months the anti-submarine field laid by them in the TSUSHIMA Straits would have lost half of its mines and that about 20% would have survived after a year's time. The case depths were 20 to 30 meters; 6mm cable was used. Shallower mooring depths, it was pointed out, would have made the life of the field even shorter. Usually the cables would part near the anchor fair-lead or at the mine case, owing to fatigue. Rubber and coiled spring buffers were used to offset this difficulty with undetermined success.

There was conflicting opinion as to whether moored mines were ever displaced appreciably from their planted positions, and whether the displacement, if it occurred, was a dragging of the anchor along the bottom, or a hopping movement of the anchor induced by the simultaneous presence of strong currents and large waves, especially for shallow moored cases. One interogee said he thought that such displacements might be as much as 1000 meters, while another suggested 15 to 20 meters, and still another opinioned that there was no significant displacement at all.

All published information on the dip of moored mines in tides and currents was burned early in August, but careful studies had been made on this effect using theoretical calculations, model studies, and actual field tests. As to the design and performances of safety features on Japanese mines, it was felt that they were entirely satisfactory.

On the whole, therefore, it appears that except for a few isolated instances, no attempt at lifting their research and development methods in mines, above the level of intelligent improvisation, had been seriously made by the high command. This was due almost entirely to the Navy's underestimation of the possibilities of the mine as an offensive weapon prior to 27 March 1945.

ENCLOSURE (G), continued

Part III
NOTES ON JAPANESE TEST METHODS ON U.S. MINES

A, LABORATORY TESTS

1. Magnetic Induction

a. Methods - A solenoid 2 meters long by 1 meter in diameter was used to determine the response of the mine to both sine wave and square wave fields. Curves were then plotted showing the relation between the smallest amplitude (H) of field charge which will produce firing, and the period (T) for which such firing occurs. Curves of the following general shape resulted:

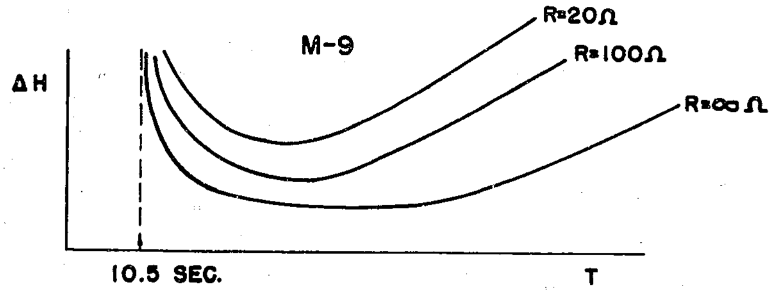


Figure 1(G)
MAGNETIC INDUCTION CURVES

The experiments were performed both with the completely assembled mine in the solenoid and with only the search coil. Slightly greater sensitivity was found using the latter method. The solenoid, which had been constructed for another purpose, was admittedly small for these tests, but this was not considered important. In addition to these tests, the sensitivity of the sensitrol was tested in each of as many as six positions.

b. Results

M-11

(1) Interlook dead period 0.5 sec. Its variation with signal strength, if observed, was ignored.

(2) Current required in Toroid secondaries to just record a look was not measured.

(3) Japanese questions about M-11:

(a) Why the varistor? Works well without it (the varistor mistaken by the Japanese for a condenser).

(b) Why the degenerative feedback connection? Appears unnecessary. (Japanese did not call it by that name)

(c) Why such a long search coil?

(4) Japanese comment on M-11:

(a) Mechanically simple, electrical complicated and "clever".

ENCLOSURE (G), continued

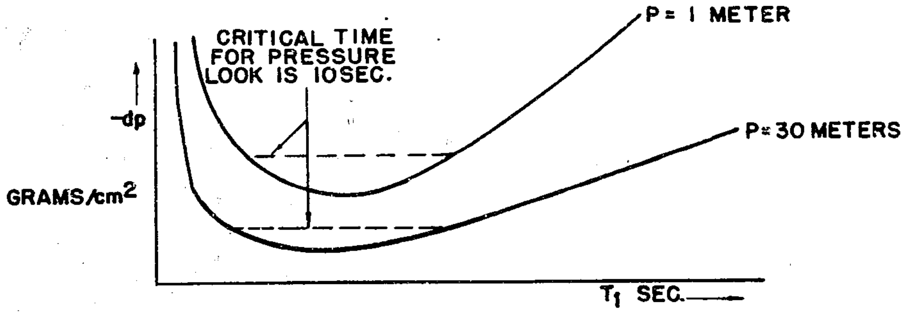


Figure 2(G)

PRESSURE CURVES

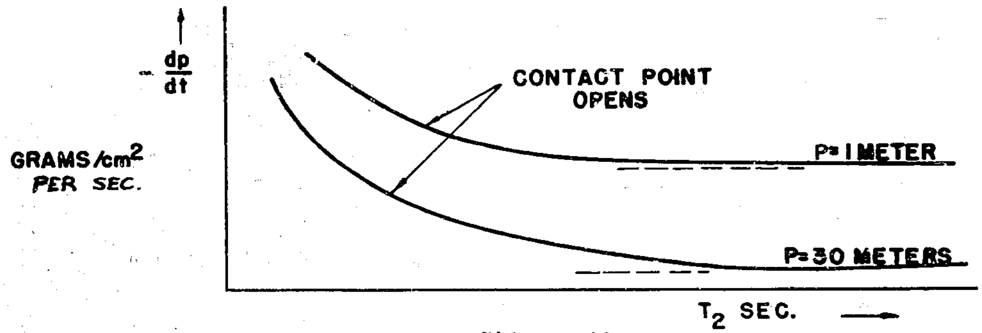


Figure 3(G)

PRESSURE CURVES

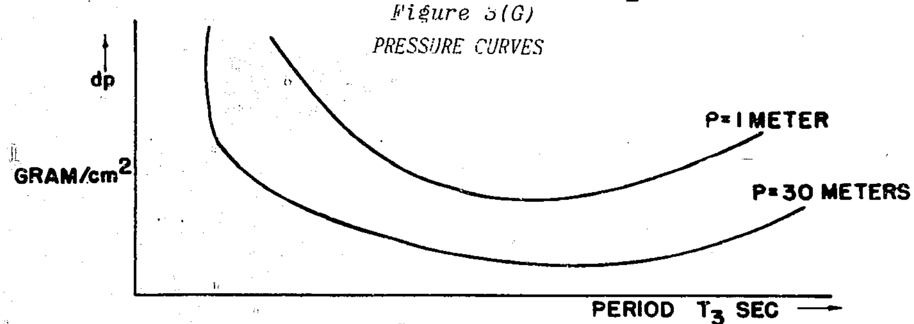


Figure 4(G)

PRESSURE CURVES

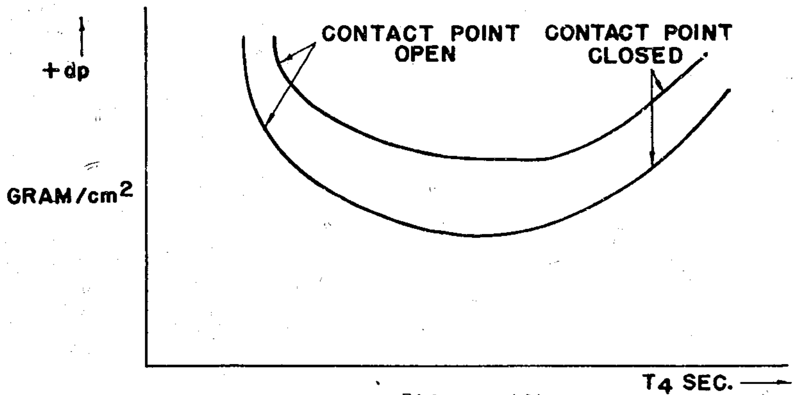


Figure 5(G)

PRESSURE CURVES

ENCLOSURE (G), continued

(b) The superiority of the M-11 over the M-9 lies entirely in the ease of mass production.

M-9

(1) Interlook dead period varied between 3 sec. in some mines to 10.5 sec. in others in a ratio 1:3.

(2) Sensitrol sensitivity about 1.5μamps (considered a rough guess).

(3) Sensitrol unbalance averaged a sensitivity ratio of about 2:1 on either side, but reached 4:1 in a few cases. Opined that impact shock was responsible.

(4) Sensitrol position sensitivity variations insignificant.

2. Acoustic.

a. Method: Except for preliminary circuit examination and bread-board test work, the significant information was gained from barge tests.

b. Results

A-5

(1) Frequency - subsonic.

(2) ACM dead period, correctly measured.

(3) Optimum rate of input build-up to fire, correctly measured.

A-3

(1) Frequency - 200 to 800 cycles.

(2) ACM dead period recognized and measured.

(3) Optimum build-up of input recognized and measured.

3. Pressure.

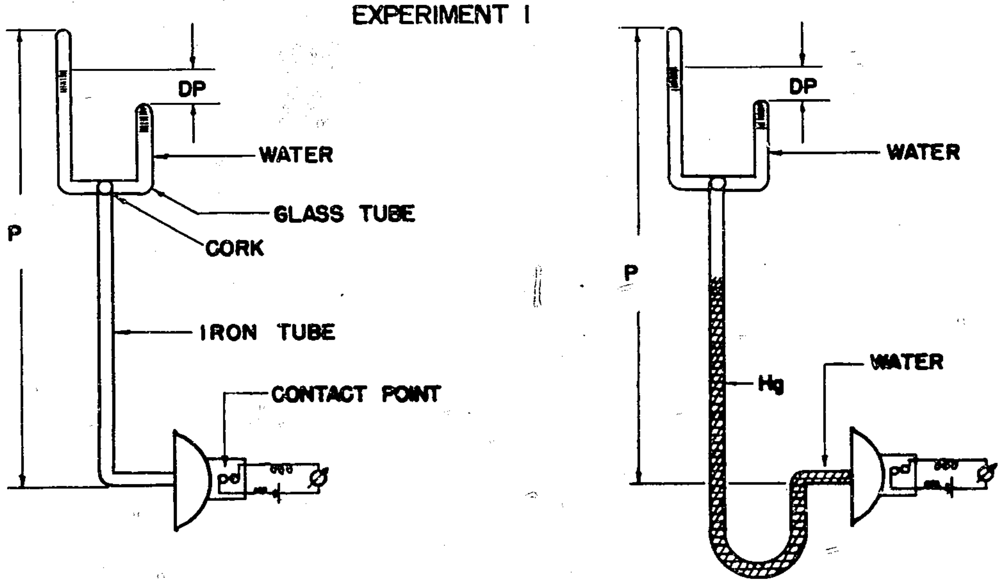
a. Method: Four experiments were performed on the A-6 to obtain the following information:

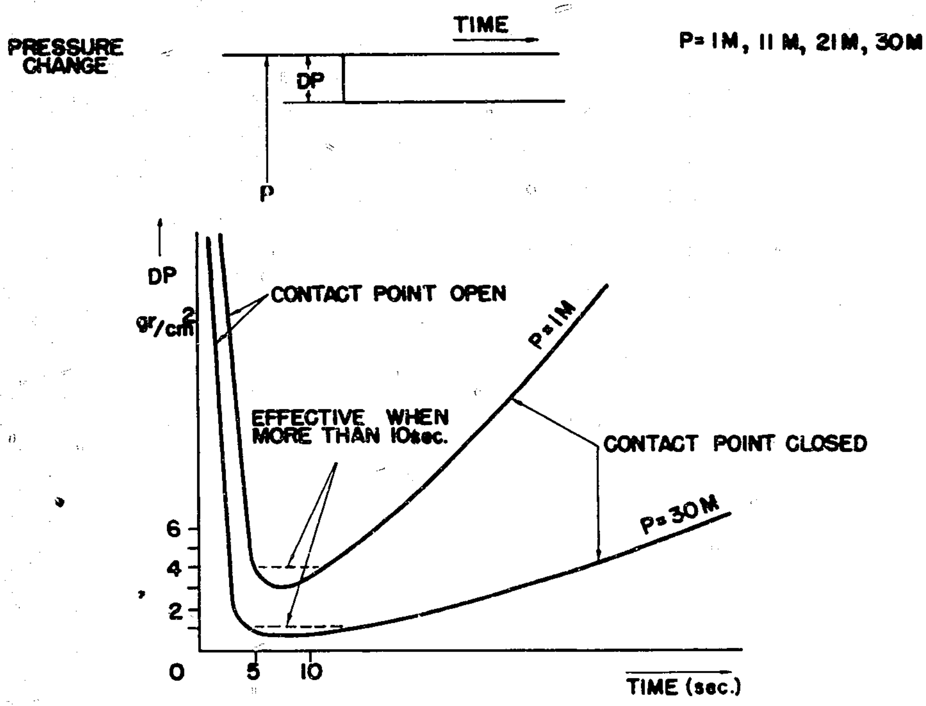
(1) Experiment I: (See Figure 6(G) The length of time (T_1) during which the float switch remains open as a function of the decremental pressure (-dp), for several biasing pressures corresponding to minable depths. Curves of the general nature shown in Figure 2(G) were obtained.

(2) Experiment II: (See Figure 7(G)) The length of time (T_2) required for the float switch to open as a function of the decrease in pressure ($-\frac{dp}{dt}$) at the diaphragm, for several biasing pressure corresponding to minable depths. Curves of the general nature shown in Figure 3(G) were obtained.

ENCLOSURE (G), continued

EXPERIMENT I





(THIS DATA IS DEPENDENT UPON TEMPERATURE)

Figure 6(G)

TESTING OF A-6 MECHANISM

ENCLOSURE (G), continued

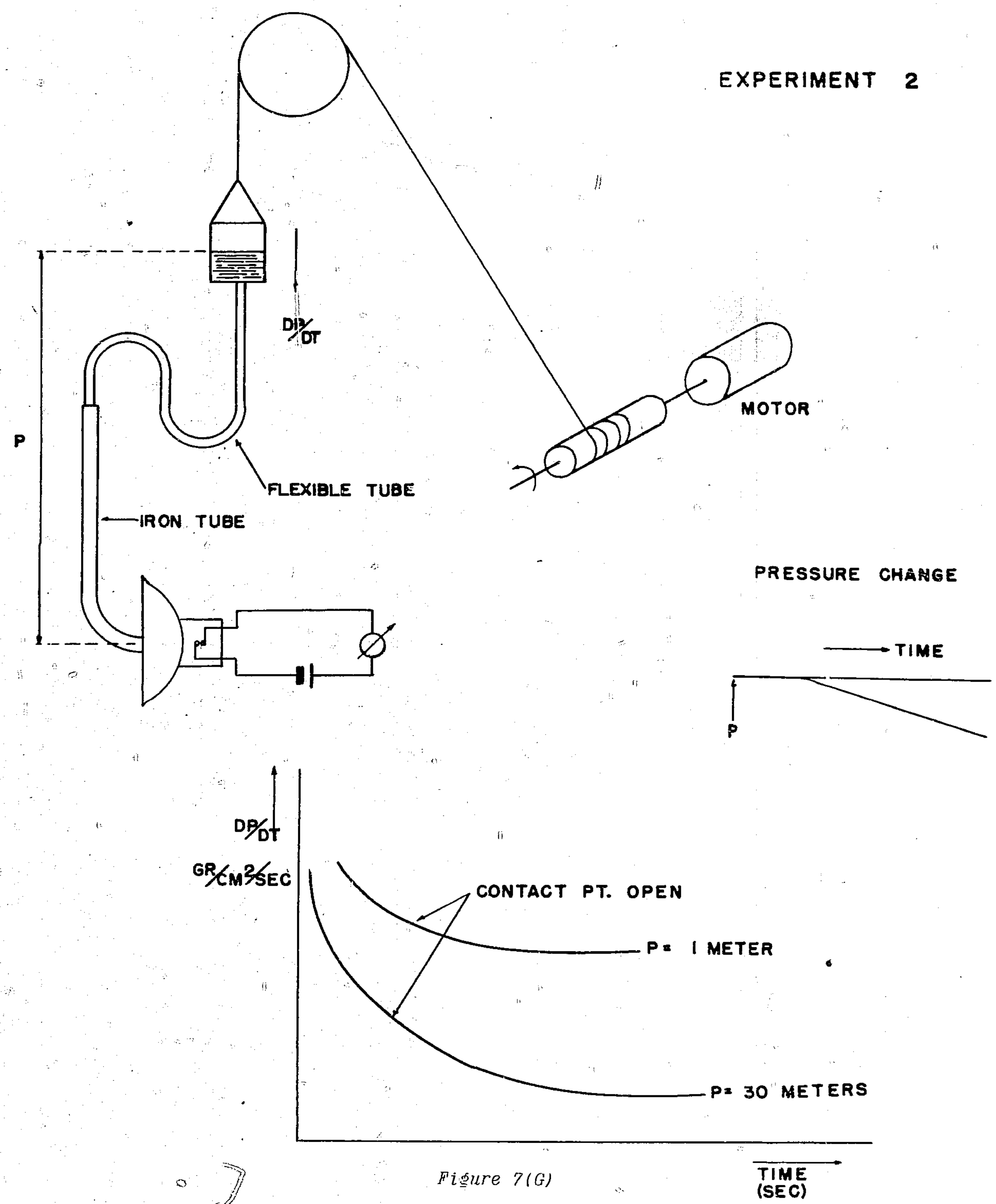


Figure 7(G)

TESTING OF A-6 MECHANISM

ENCLOSURE (G), continued

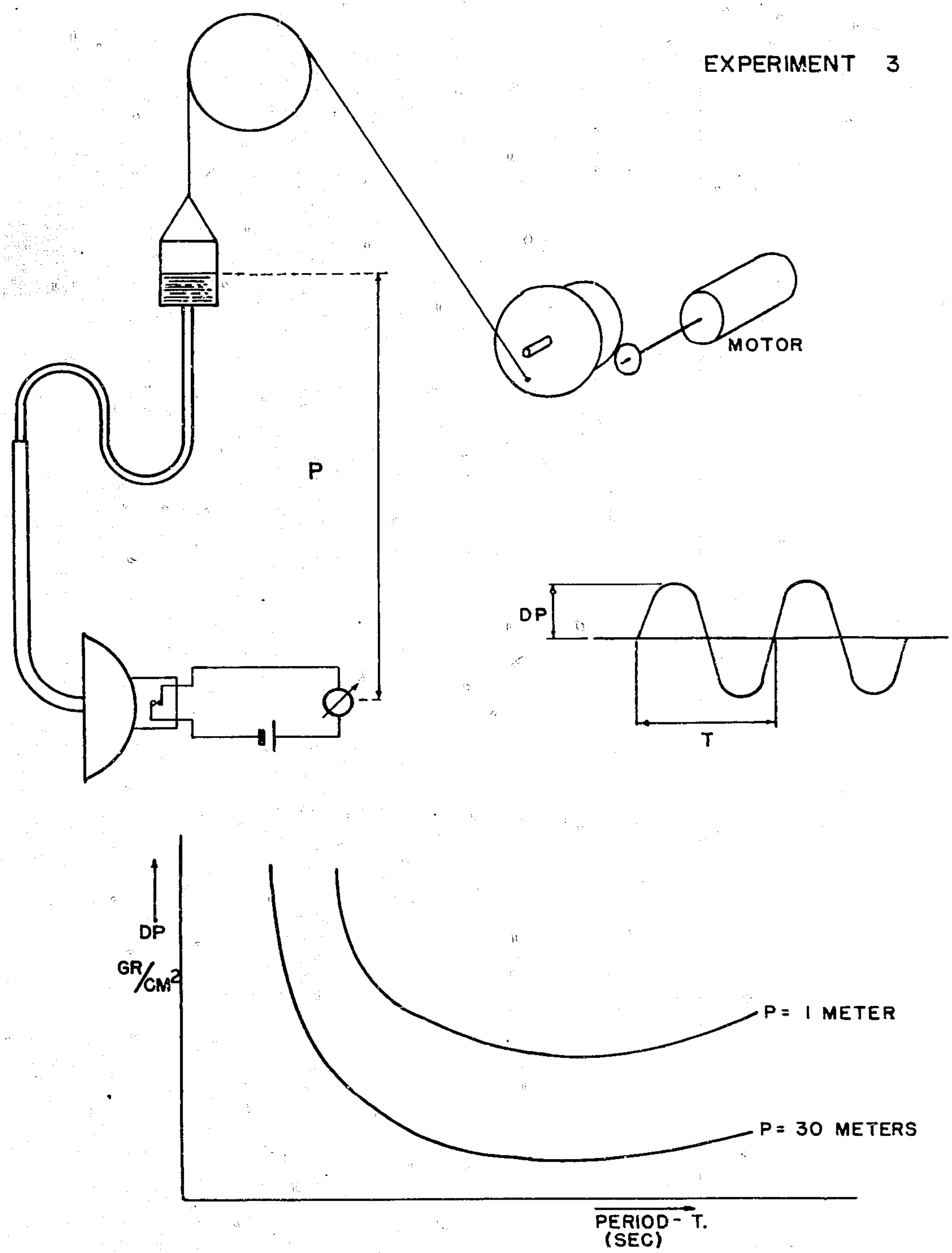


Figure 8(G)

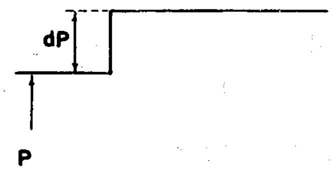
TESTING OF A-6 MECHANISM

ENCLOSURE (G), continued

EXPERIMENT 4

ARRANGEMENT THE SAME AS EX. I

PRESSURE CHANGE



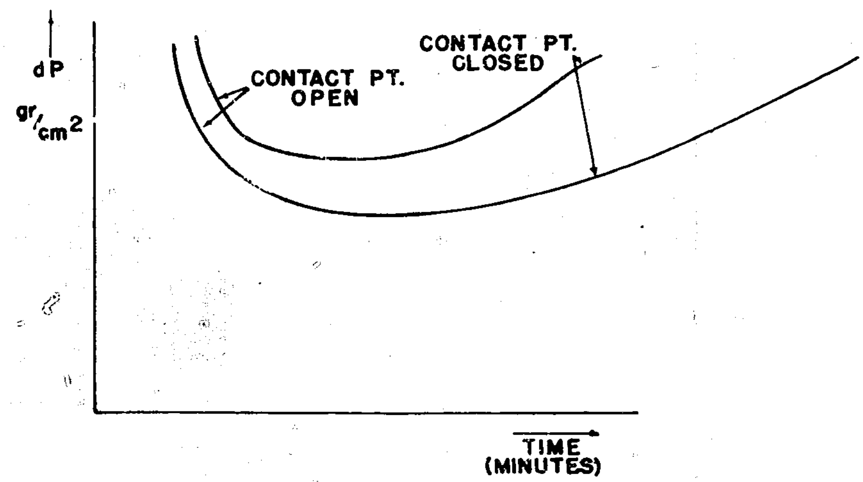


Figure 9(G)

TESTING OF A-6 MECHANISM

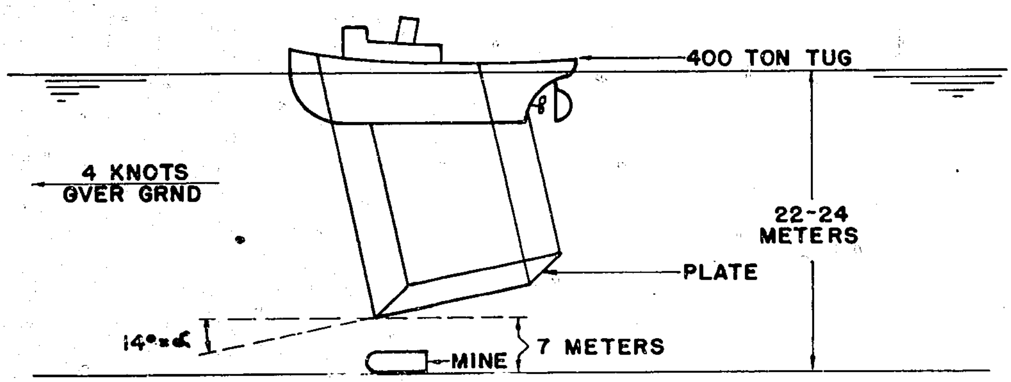


Figure 10(G)

PRESSURE PLATE EQUIPMENT DIAGRAM

(3) Experiment III: (See Figure 8(G)) The relation between the amplitude (dp) and period (T_3) of a sinusoidally varying pressure signal on the diaphragm, for several biasing pressures corresponding to minable depths. Curves like those shown in Figure 4(G) were obtained.

(4) Experiment IV: (See Figure 9(G)) The length of time (T_4) during which the float switch remains open as a function of the incremental pressure (+dp), for several biasing pressures corresponding to minable depths. Curves like those shown in Figure 5(G) were obtained.

b. Instrumentation.

(1) Experiments I and IV were set up identically. A mercury column was used to obtain a steady biasing pressure surmounted by a small head of water with a stop-cock arrangement so designed as to provide a sudden small change of pressure of either sign.

(2) Experiment II employed an iron tube containing mercury for the biasing pressure, surmounted by a rubber tube leading to a water filled bucket. The latter could be raised or lowered by an electric motor to provide any desired value of $\frac{dp}{dt}$.

(3) Experiment III employed the same set-up as experiment II except that the bucket was attached to an eccentric pin on a rotating wheel (motor driven). By using different size wheels and different motor speeds, any desired values of dp and T could be produced.

c. Results: Although the original data on these tests were destroyed, the soundness of these methods and the thoroughness of the work leaves little doubt as to the value of the information thus obtained. The biasing pressures used in all these experiments were 1m, 11m, 21m and 30m of water.

Japanese Test of the Pressure Plate (See Figure 10(G))

a. Data.

Plate dimensions .... 12m x 6m
Material .... Wood
Hung .... Four steel cables of 14 to 16mm wire
Angle of attack of plate during towing .... 14° ±
Depth of water .... 22-24 meters

b. Results: Float switch in mine held open (during above tests) for 12-13 seconds, thus indicating the soundness of this method for sweeping. Four mines were used. Swept path found to be about 20 meters.

ENCLOSURE (H)

JAPANESE MINESWEEPING IN THE SHANGHAI AREA

The information set forth below was obtained from the file of the Seventh Fleet Mine Sweeping and Intelligence officers, and by interview with the following Japanese officers:

Capt. S. IKEDA, of the staff of the Shanghai Naval Base
Comdr. T. SHIMURA, of the staff of the China Sea Fleet

The conditons described below prevailed in the SHANGHAI district, but they were probably much the same elsewhere in China. NavTechJap Report, "Evaluation of Effectiveness of Allied Offensive Mining Operations Against Japanese Shipping in Chinese and Southwest Pacific Waters," Index No. S-98(N), will also be of interest.

OPERATIONS

The Japanese apparently first learned that the YANGTZE River was mined on 16 February 1944, when a ship was sunk. There is a local legend that the Japanese believed that the ship was torpedoed and that no attempt at sweeping was made for over a month, while intensive anti-submarine measures were taken. However, the interrogation indicated clearly that the Japanese realized that the depth was too small for submarine operations. They had also been advised of the existence and general character of U.S. magnetic mines encountered in the Southwest Pacific and in HONG KONG and were to some extent expecting a mining attack.

The Japanese began expanding their small mine sweeping force and had, in the SHANGHAI district, a force of 18 to 24 sweepers and about 350 men. The sweepers were converted fishing boats or tugs of about 50 tons, with a length of about 15 meters and a speed of 7 knots. Both Type 3 and Type 5 magnetic sweeps were used. They did not use the Type 2 sweep; in fact, they were not at all acquainted with it. They also used Type 2 sound bombs.

GEAR

The Type 3 sweeps used were conventional. They received a small number of the 4cm x 80cm magnets from Japan, but most of the magnets used were made locally of inferior steel and were not very satisfactory. At first they used the single catenary sweep, and later changed to the double catenary. They apparently were instructed to make the spacing between the catenaries such that there was a time interval of 12 seconds, since U.S. mines had interlook dead period of from 4 to 12 seconds. They used 36 magnets per catenary, spaced one meter apart. The magnets dragged on the bottom. They had magnetometers for testing the magnets and solenoids for remagnetizing, as necessary.

The Type 5 gear was of local manufacture, as gear ordered from Japan never arrived. The arrangement was somewhat unusual in that they used 6 to 8 turns, with between 220 and 300 ampere turns. The generators were of 10 kw capacity. When the Type 5 gear was first used the current was continuous. In May 1945 they received instructions to reverse the current at 4 second intervals, which was later increased to 10 seconds.

The only acoustic gear used was the Type 2 sound bomb obtained from Japan. These were first dropped singly at 5 second intervals; later groups of 5 were dropped at 5 second intervals with a spacing of 250 meters between groups.

ENCLOSURE (H), continued

RESULTS

It appears that in the entire YANGTZE River the following losses occurred:

Ship Size	Sunk	Damaged
Over 3000 Tons	8	6
3000 to 1000 Tons	12	5
Under 1000 Tons	27	11

Of the vessels under 1000 tons, most were tugs or fishing boats of 100 tons or less. Some 175 mines were swept, the most being near HANKOW, and 22 exploded spontaneously. No acoustic mines are known to have been swept.

The port of SHANGHAI was closed by mines about five days out of every two months. Various portions of the river were closed for considerable periods. From KUIKIANG to SHIHHUIYAO the channel was closed to steel ships all of February and March 1945, and for eight days in May. The same channel was closed to wooden ships for nine days in April and two days in May, 1945. From KUIKIANG to ANKING the channel was closed to steel ships for five days in November 1944, for 16 days in February, 14 days in March, two days in April 1945, and to wooden ships two days in March, and two days in April 1945. Near WUHU the river was closed for eight days in August 1945. All these interruptions to river traffic were the cause of considerable embarrassment to the Japanese, and as one report puts it, "the bandits became rather brisk".

INTELLIGENCE

The Japanese mine sweeping forces in Chinese waters were very unfavorably situated for obtaining information. For instance, the handbook "Manual of Magnetic and Acoustic Mines and Sweeping Gear for the Same" was never received in the SHANGHAI area although it was well known in Japan. Officers trained in the use of Type 3 and Type 5 magnetic gear did not arrive from Japan until just before the surrender. Virtually the only information available was what could be sent by dispatch, and even that was not reliable. For example, the specification for the Type 5 sweep was changed from 220 to 390 ampere turns when the desensitized M-9 mechanisms were discovered, but no word of the change ever reached SHANGHAI.

MINE INFORMATION

Only one instance was known of a mine falling on land. This was near HANKOW. The mine was rendered safe and sent to YOKOSUKA, Japan, for examination, there being no laboratory capable of studying mine mechanisms available in all China. The Japanese think that about 10% of all mines dropped exploded spontaneously, some 3% exploding on impact, and 7% later. They did not associate the tendency for spontaneous explosions with stormy weather, but as most of their observers were withdrawn at such times their comments are of little consequence.

Prior to May 1945, the Japanese relied upon mine watches or patrol boats and gunboats detailed for the service. After that time, radar was used for tracking aircraft suspected of mine laying. They were neither able to detect the time of mine release, nor to get returns from the falling mine. Visual mine watchers relied on binoculars, or the naked eye to detect splashes, locating them by estimates of bearing and distance.

The SHANGHAI sweeping force was of the opinion that there were some four or five types of magnetic mines used against them, basing their opinion on the effects. Since they recovered no mines, they could not identify any types.

ENCLOSURE (H), continued

They thought that acoustic mines were being used, but the failure to sweep them with sound bombs made them doubtful. They were aware of the existence of the pressure mine, but had made no preparations for dealing with them. They had had some trouble with drifting mines brought down by the river, and thought that some of them might be of U.S. origin, but were not certain.

PLANNING

The channels were planned to be clear to a width of 400 meters although sweeping was extended to a width of 600 meters so far as practicable. Because of the strong current, navigational buoys were used at intervals of about a mile, marking one side only of the channel. They had no trouble keeping Japanese ships in the swept channel, but three or four Chinese ships were mined through failure to keep in the channel.

EVALUATION

The YANGTZE was the only important river to be offensively and heavily mined during the war. It presented peculiarly favorable conditions for the attack, because the channels are restricted and easy to identify. The sweepers' task was made difficult by the strong currents and tortuous channels. The Japanese found all these things to be true, and they felt that the attack was well planned and very successful.

This opinion is supported by the evidence that one ship was mined for about five mines planted. However, the Japanese sweeping was hampered more than could have been expected by lack of material and information.

The above information bears only on the defensive side. On the offensive, the Japanese mine fields of the YANGTZE estuary are well know, and need no further description. That they were forced to improvise mines using oil drums is another indication of their material poverty, but those mines have been described in intelligence publications. The improvised obstructions sketched in Figur[illegible] are, however not so well known and may be of some interest. They should not present any serious problem to a deep, well-armed sweep.

ENCLOSURE (H), continued

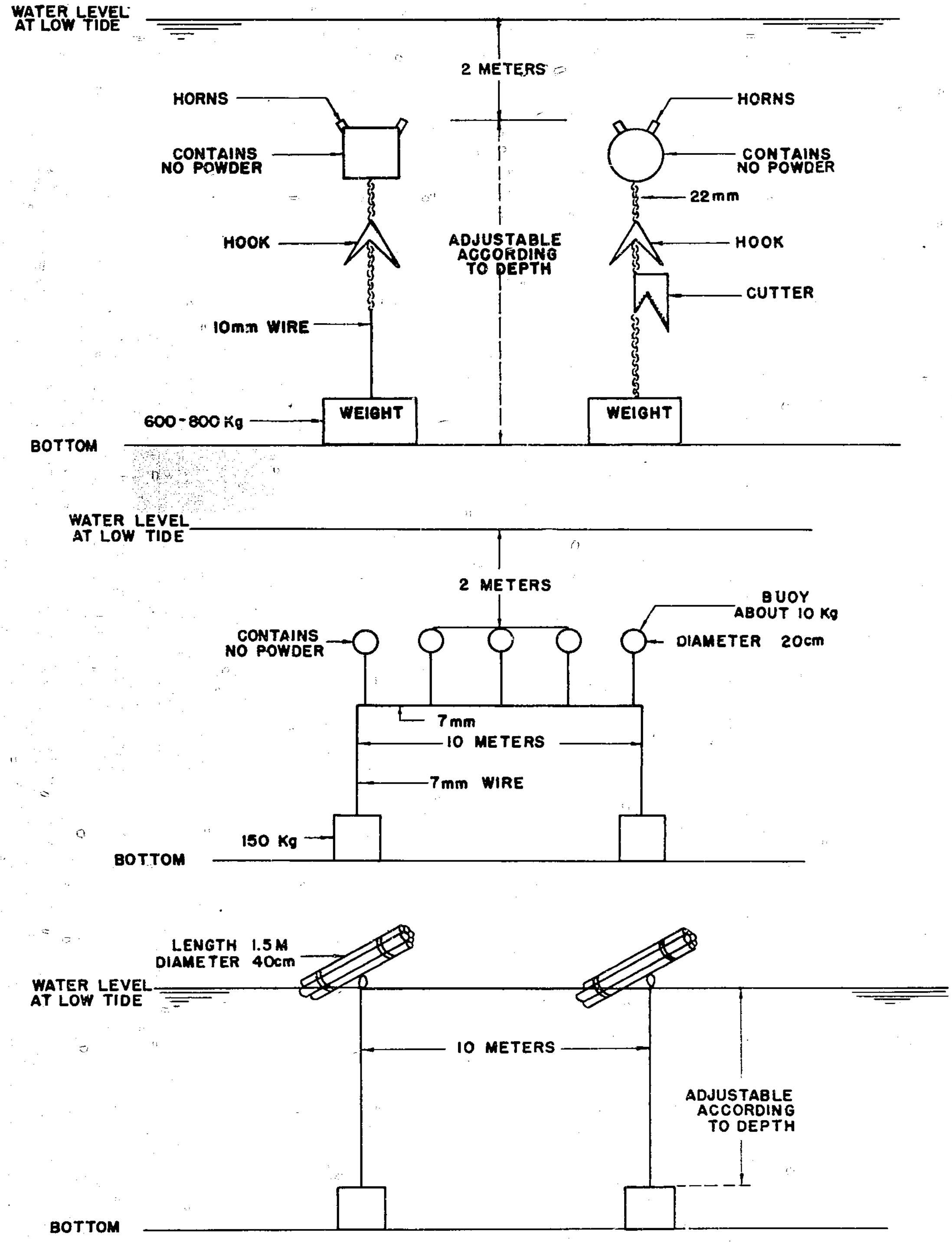
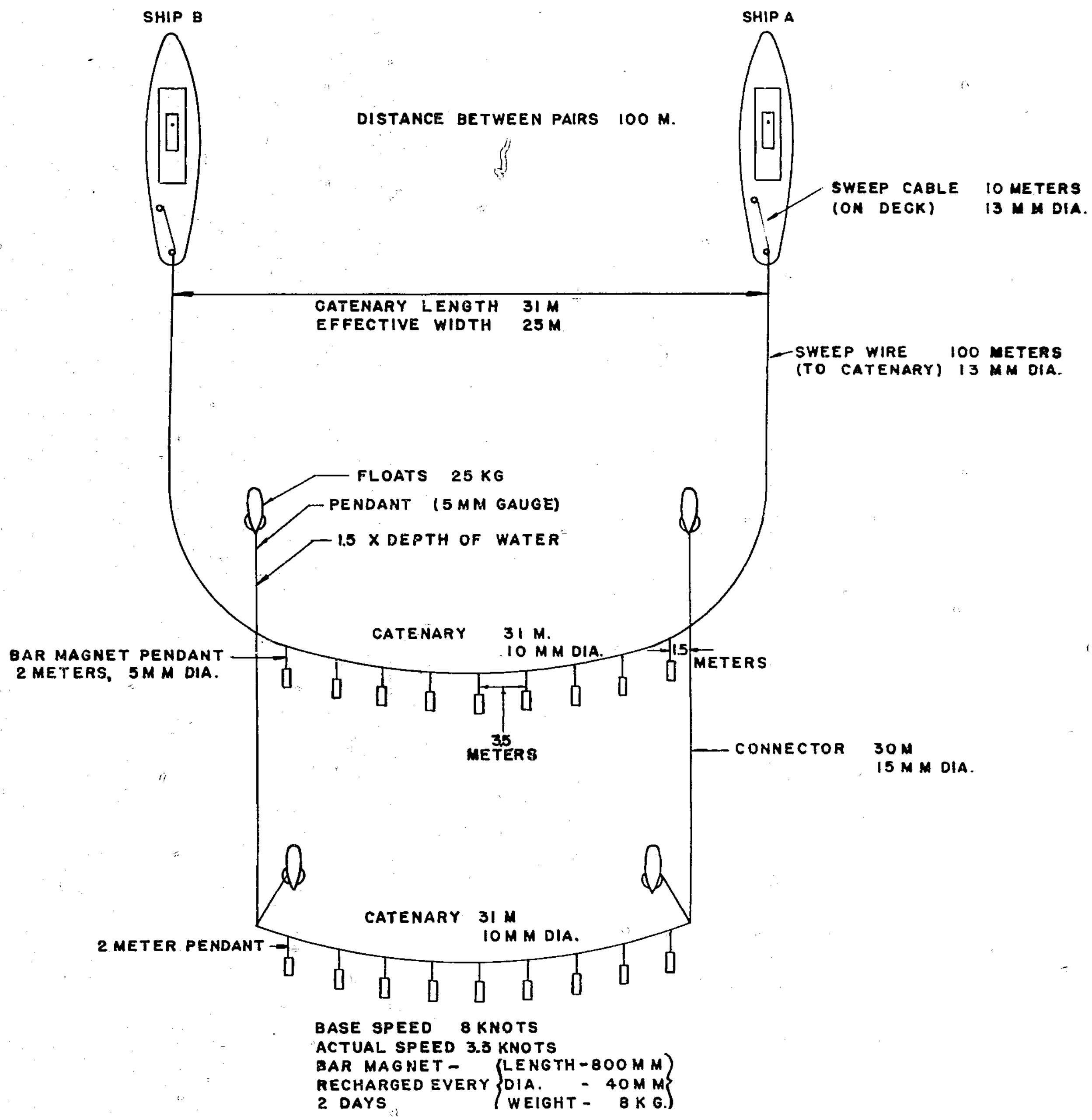


Figure 1(H)

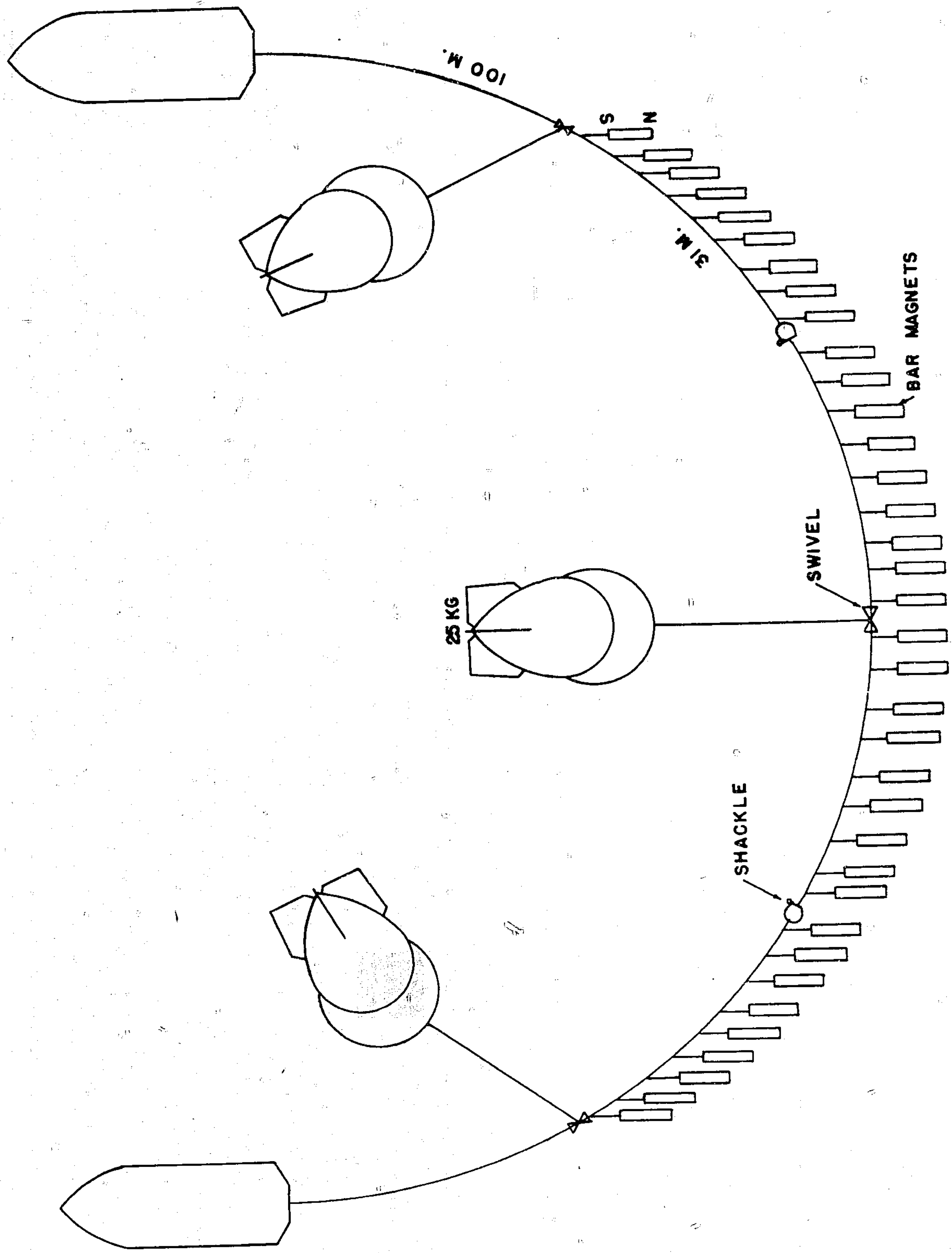
IMPROVISED OBSTRUCTIONS - YANGTZE RIVER

ENCLOSURE (1)



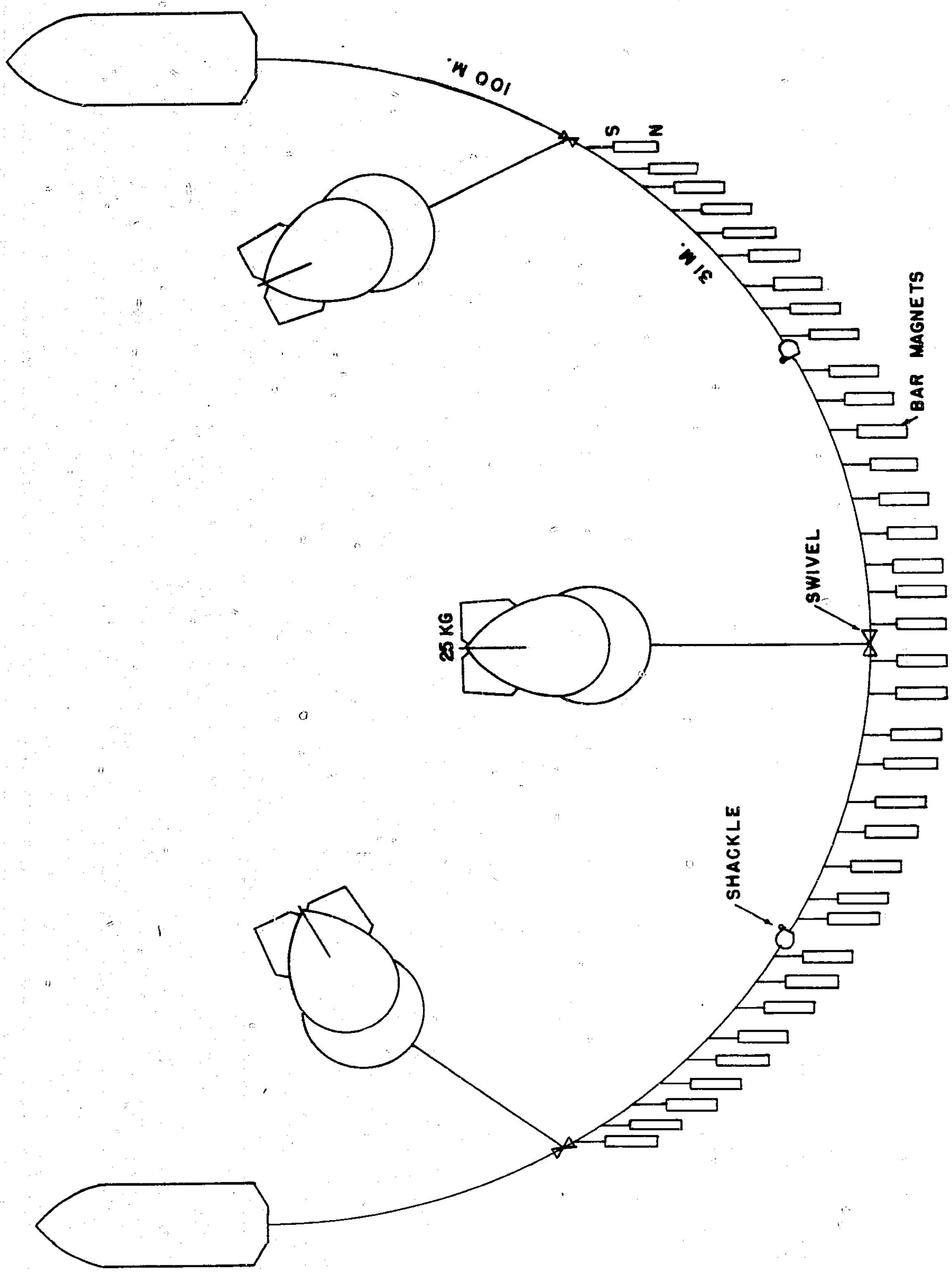
SKETCH OF DOUBLE CATENARY TYPE 3 MAGNETIC

ENCLOSURE (J)



SKETCH OF SINGLE CATENARY TYPE 3 MAGNETIC SWEEP

ENCLOSURE (J)



SKETCH OF SINGLE CATENARY TYPE J MAGNETIC SWEEP

ENCLOSURE (K)

Calibration Table and Sketches showing Principle of Magnetometer.

Department of Electrical Engineering.
KYUSHU Imperial University.
FUKUOKA, JAPAN.

FUKUOKA, JAPAN, December 4, 1945.

CALIBRATION TABLE OF THE MAGNETOMETER NO. 25013.

MAGNETOMETER READING	MAGNETIC FIELD INTENSITY IN OERSTEDS MEASURED	COMPUTED
5	8	8.31
10	16	16.74
15	25	24.45
20	34	34.58
25	43	44.3
30	54	54.85
35	65	66.5
40	80	79.71
45	95	95.0
50	113	113.1
55	133	135.6
60	162	164.5
65	203	203.3
70	-	260.3
75	-	354.5
80	-	538.7
85	-	1085.5

Calibrations are done by the ballistic method.
Computations are done by the empirical formula $H = 95' \tan \theta$ oersteds.

K. NODA /s/

ENCLOSURE (K), continued

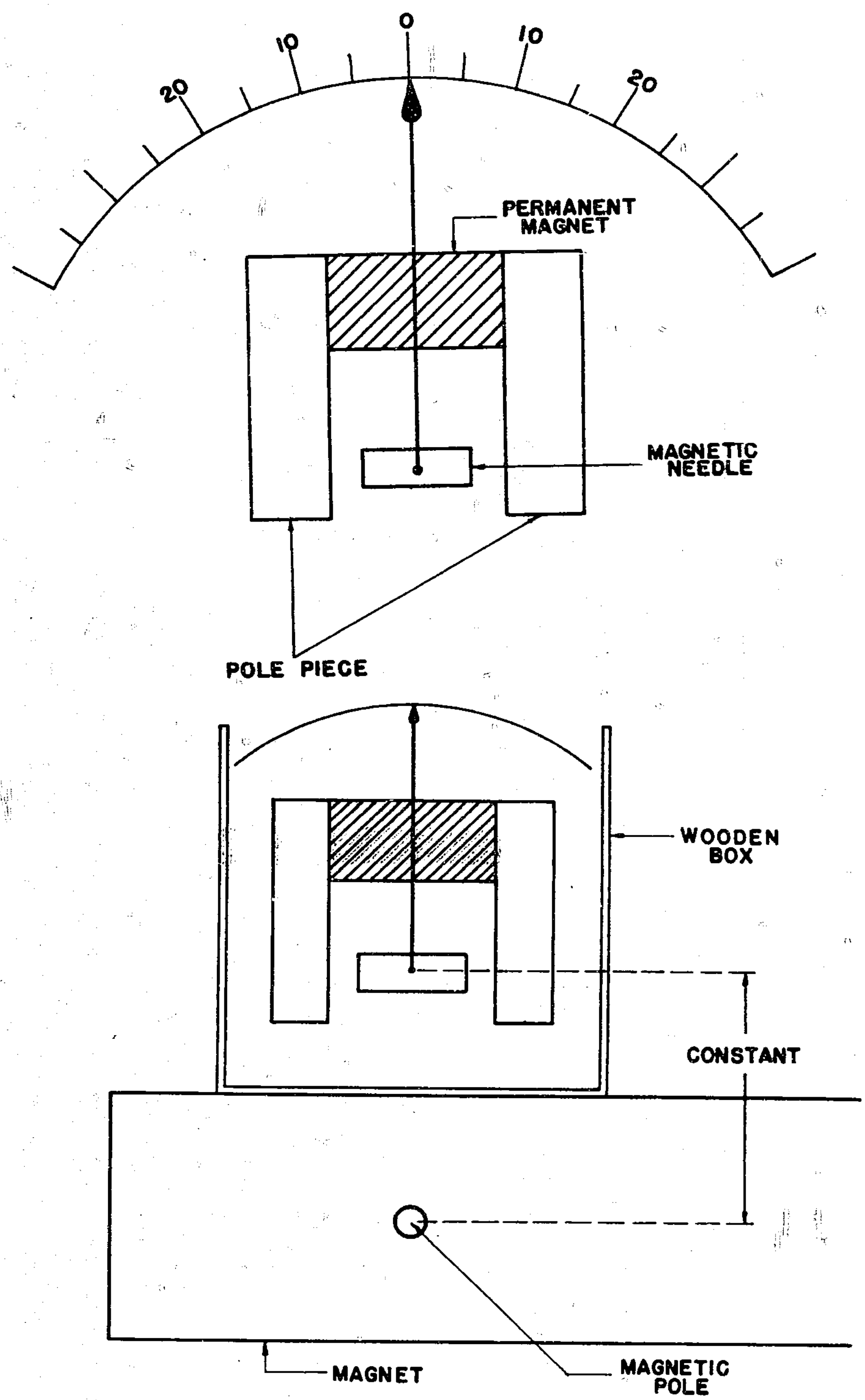
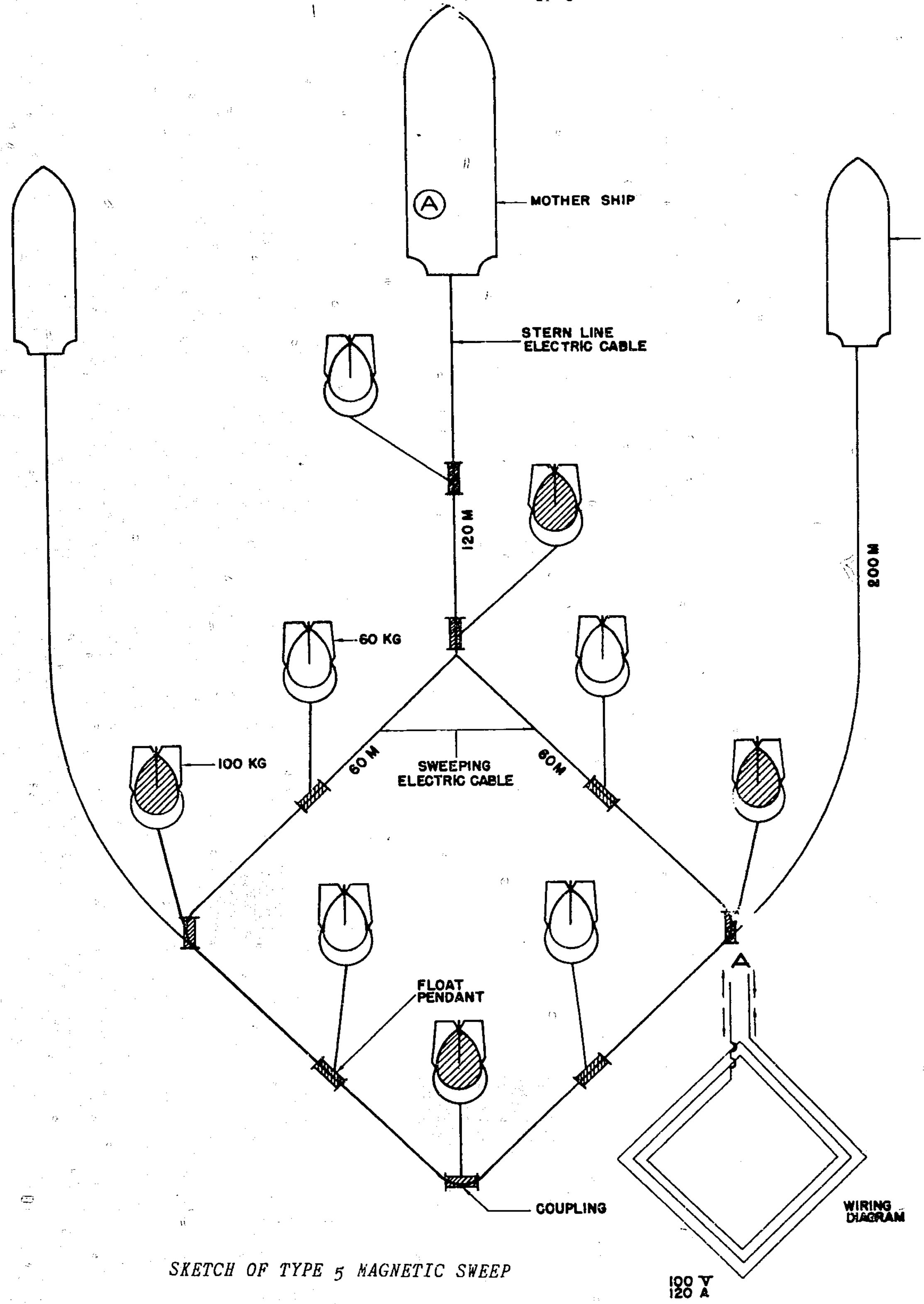


Figure 1(K)

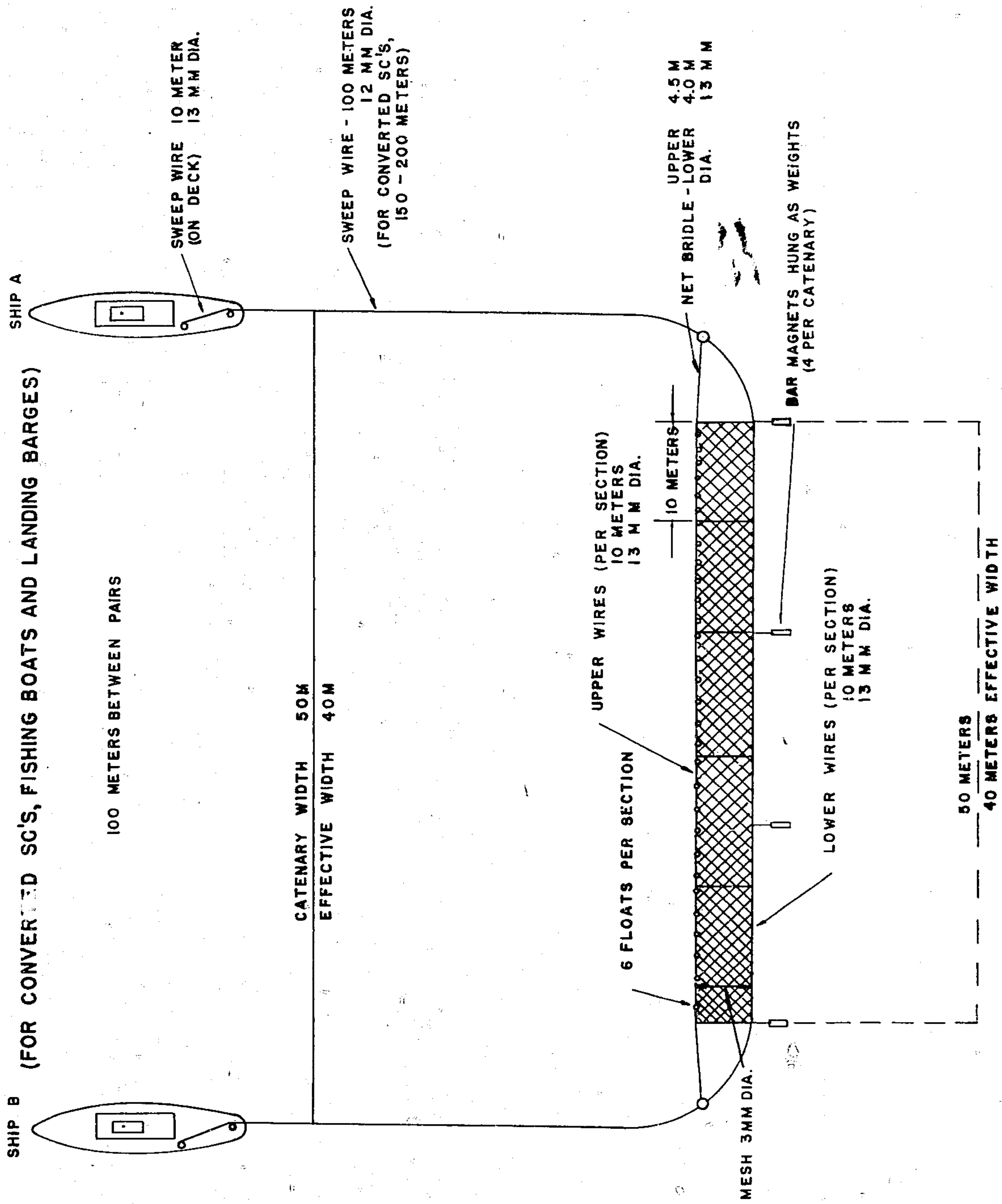
MAGNETOMETER

ENCLOSURE (L)



SKETCH OF TYPE 5 MAGNETIC SWEEP

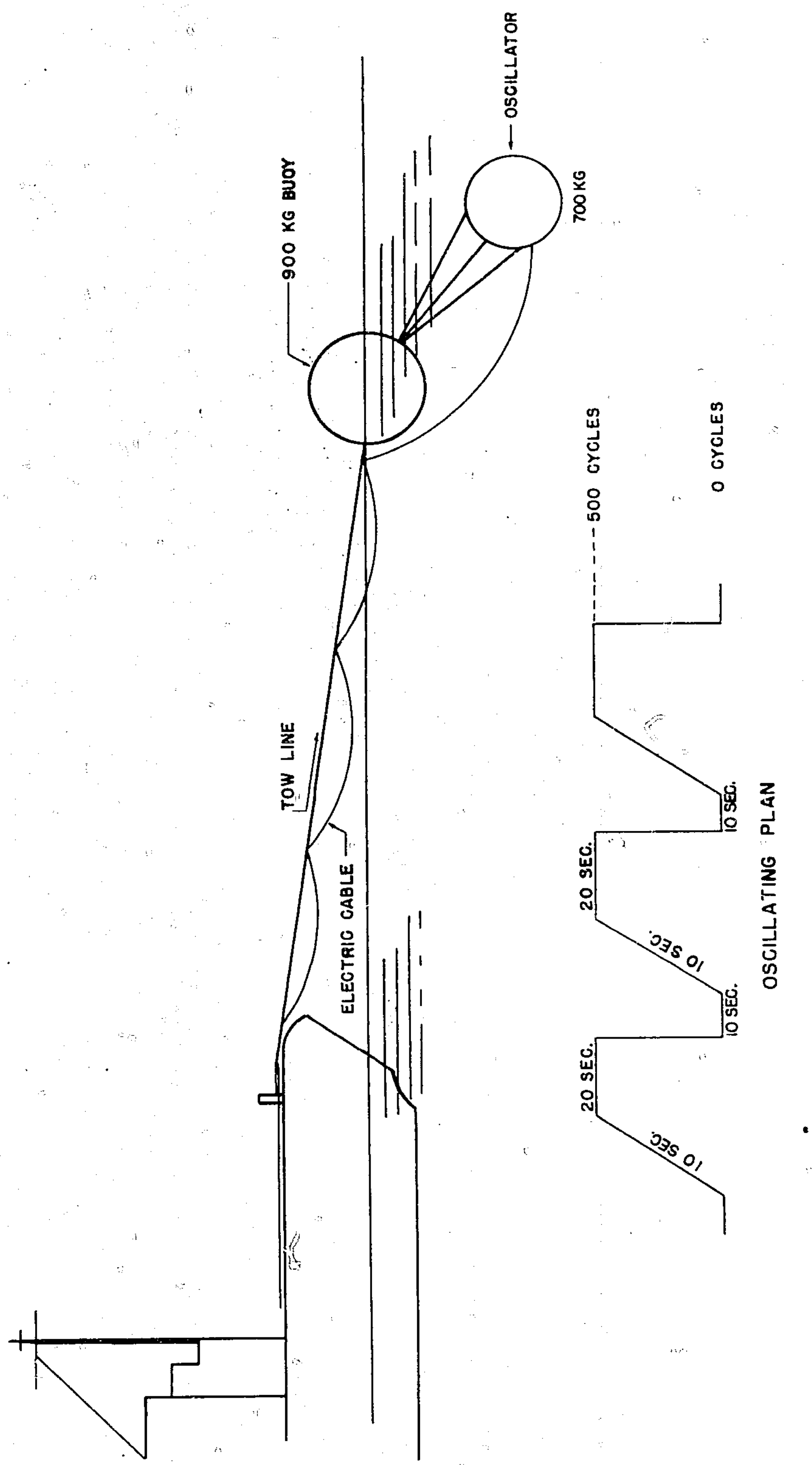
ENCLOSURE (M)



SKETCH OF TRAWL NET

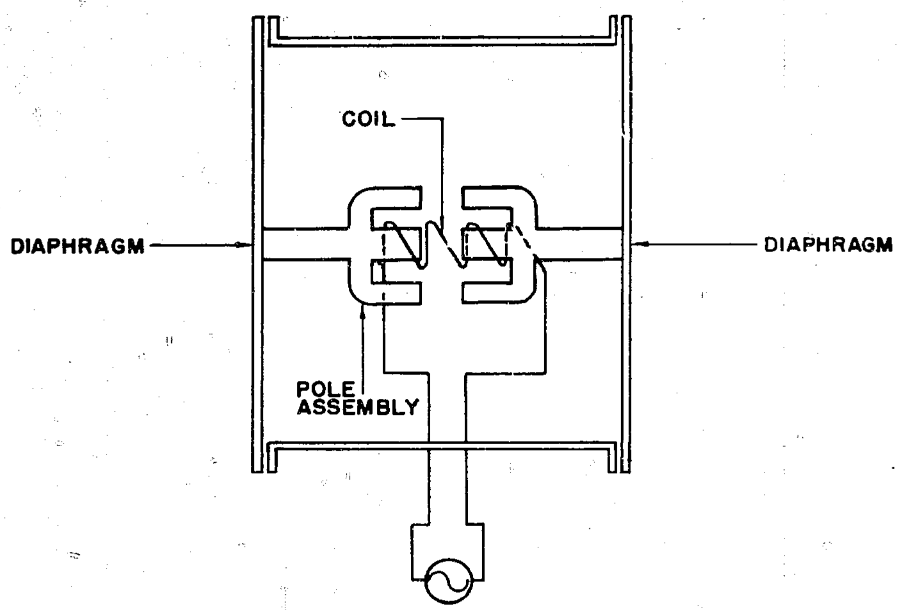
ENCLOSURE (N)

F (FESSENDEN) TYPE - MINESWEEPING GEAR

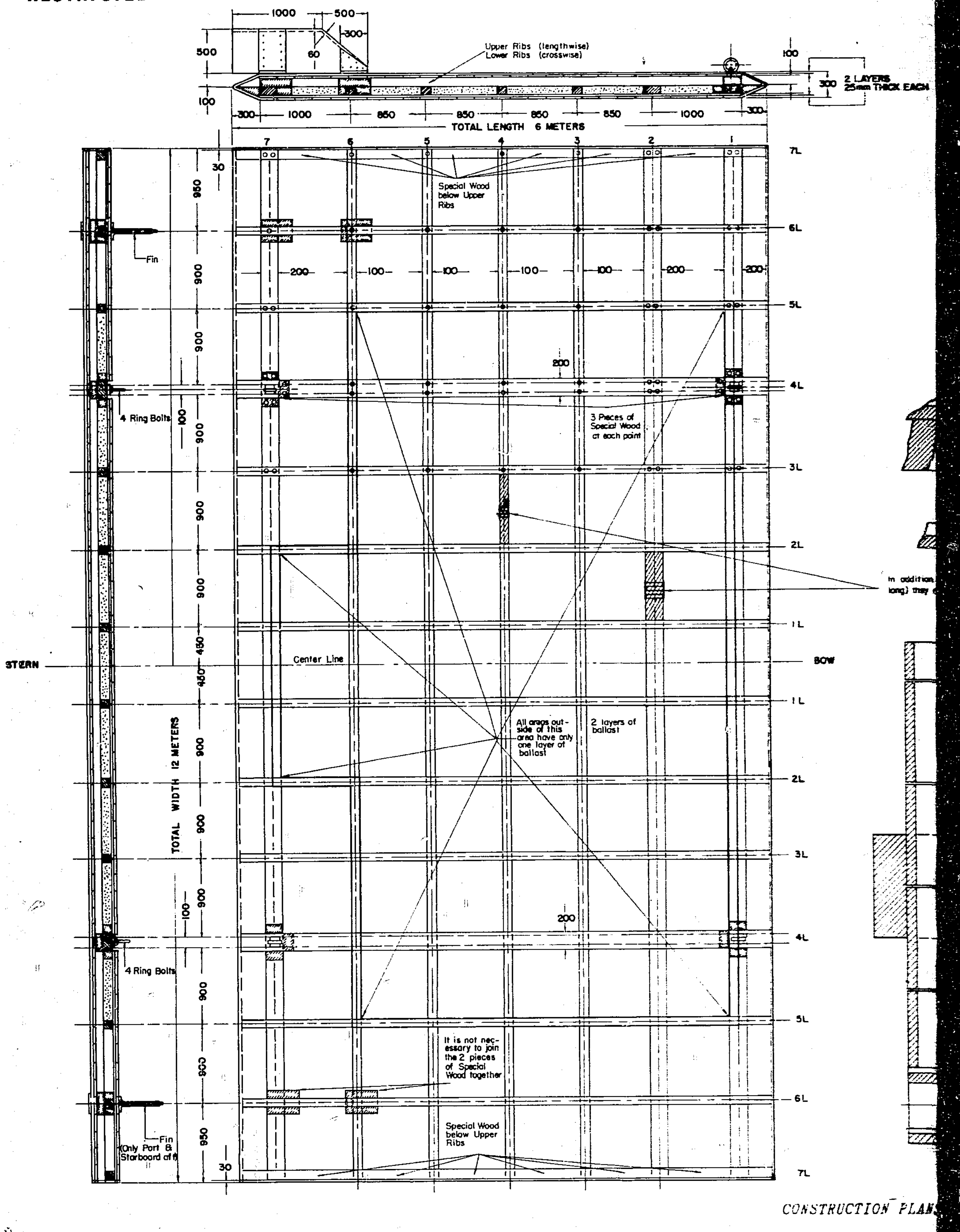


SKETCH OF FESSENDEN OSCILLATOR ACOUSTIC SWEEP

ENCLOSURE (O)



SKETCH OF TWIN DIAPHRAGM OSCILLATOR



CONSTRUCTION PLAN

2 LAYERS
25mm THICK EACH

LENGTH	TOTAL LENGTH = 6 METERS LENGTH EXCLUDING BOTH SIDE PIECES = 5.400 METERS
WIDTH	TOTAL WIDTH = 12 METERS WIDTH EXCLUDING SIDE PIECES = 11.940 METERS
LOWER RIBS (CROSSWISE)	200 X 100 (6.6 X 3.3) 100 X 100 (3.3) LENGTH = 11.940 METERS
UPPER RIBS (LENGTHWISE)	2 - 200 X 100 LENGTHS LEVEL PART ONLY 5.400 METERS 12 - 100 X 100 LENGTHS INCLUDING > ABOUT 5.190 METERS WHERE THE (BEAM) DOES NOT REACH > , A SHAPED SPECIAL WOOD IS USED " " " " " " > , A " " " " "
SPECIAL WOOD	USED AT FINS, RINGBOLTS, AND AROUND ENTIRE OUTER BALLAST CHAMBER AND AROUND INNER BALLAST CHAMBER
COVERING	UPPER AND LOWER SURFACES , 2 LAYERS 25mm THICK SURFACES IN CONTACT WITH WATER ARE PLANED SECTION = 30mm

CONSTRUCTION PLANS
FOR
PRESSURE PLATE

HAMAOA SHIPBUILDING CO.

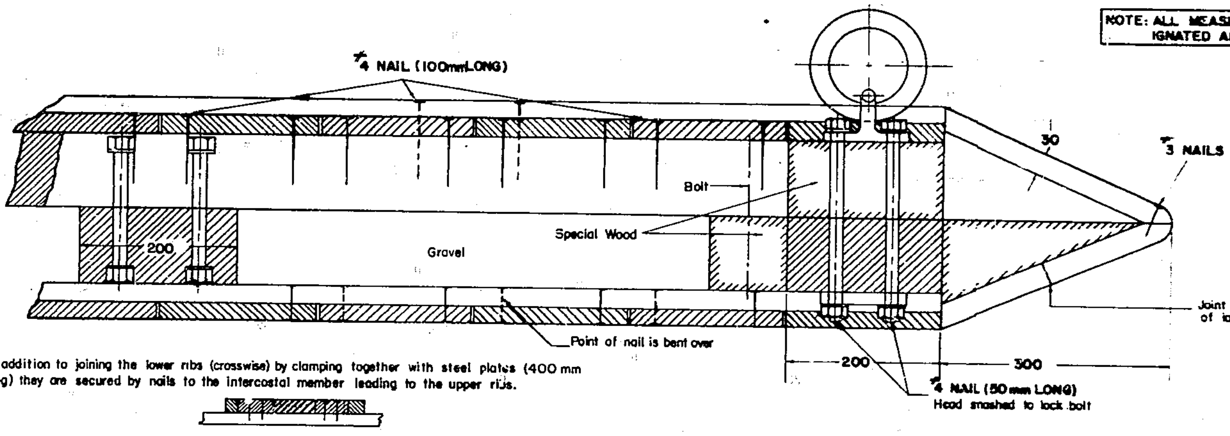
23 SEPTEMBER, 1945

(FOR CONSTRUCTION USE)

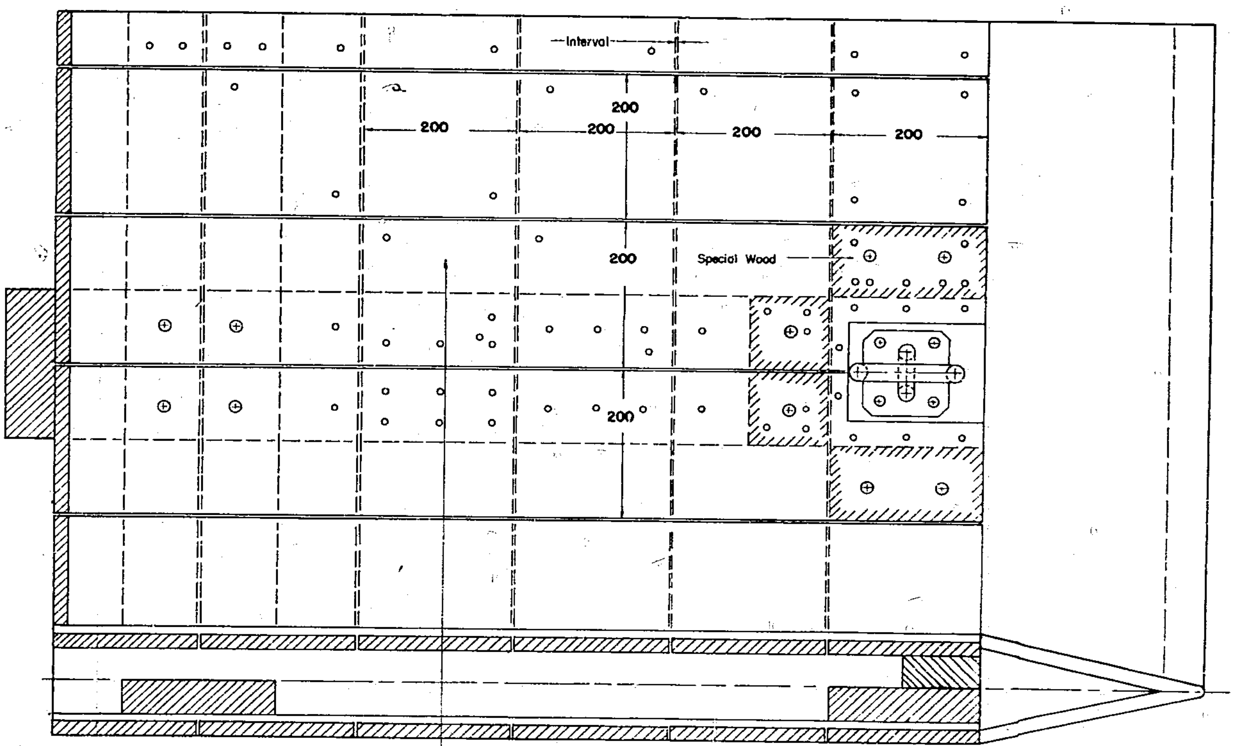
GRAVEL BALLAST 13.3 TONS

WOODS: PINE (INNER PART)
CRYPTOMARIA (TOP PLANKING)

NOTE: ALL MEASUREMENTS NOT DESIGNATED ARE IN MILLIMETERS



In addition to joining the lower ribs (crosswise) by clamping together with steel plates (400 mm long) they are secured by nails to the intercostal member leading to the upper ribs.



Separate by at least 1.700 meters the joint for each adjacent plate. The lower layer of the upper surface is joined at the center of the lengthwise ribs (upper ribs).

RUCTION PLANS FOR PRESSURE PLATE