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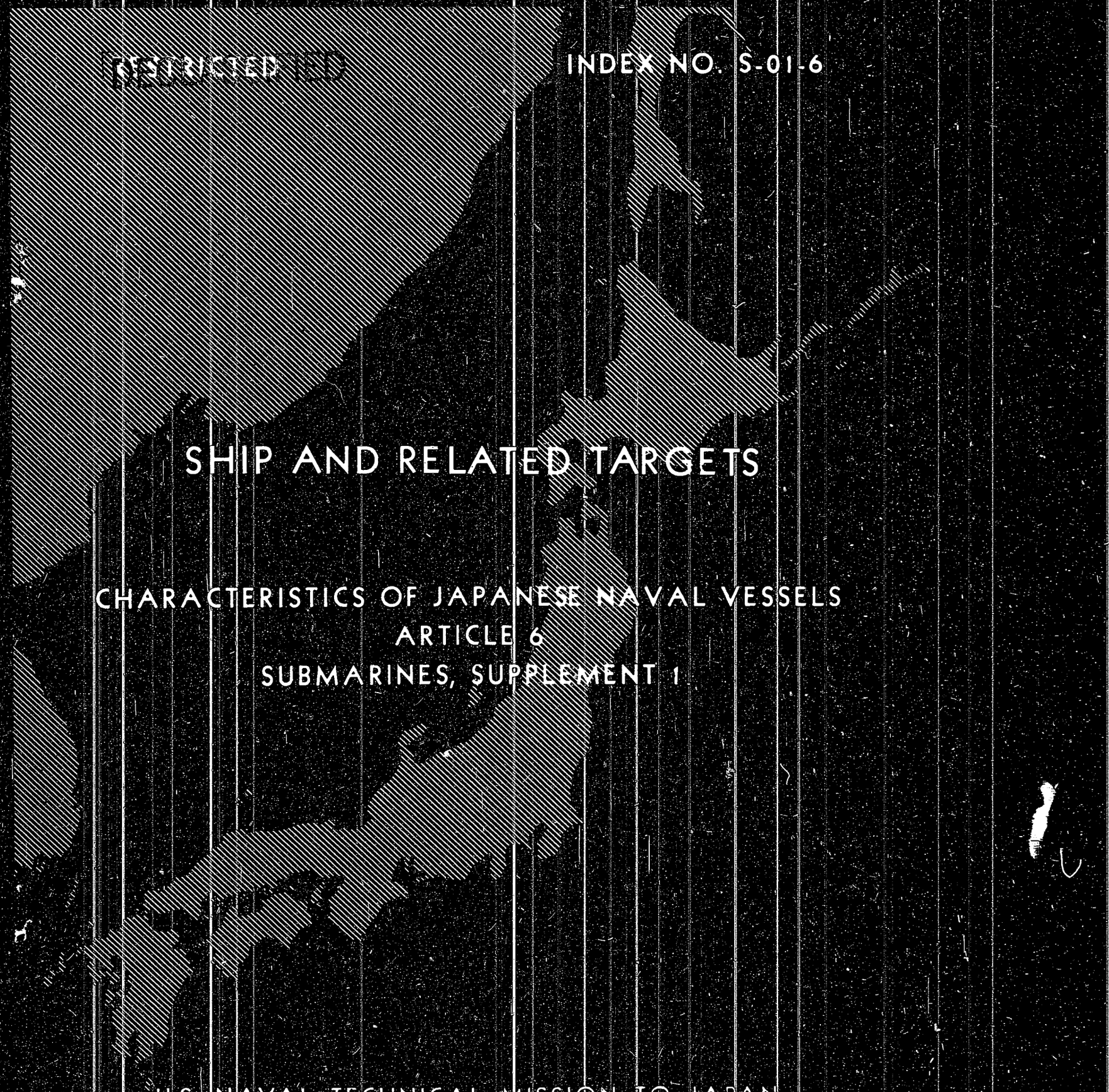
INDEX NO. S-01-6

SHIP AND RELATED TARGETS

CHARACTERISTICS OF JAPANESE NAVAL VESSELS
ARTICLE 6
SUBMARINES, SUPPLEMENT 1



U.S. NAVAL TECHNICAL MISSION TO JAPAN

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U. S. NAVAL TECHNICAL MISSION TO JAPAN
CARE OF FLEET POST OFFICE
SAN FRANCISCO, CALIFORNIA

8 January 1946

RESTRICTED

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

Subject: Target Report - Characteristics of Japanese Naval Vessels, Article 6.

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

1. Subject report, covering characteristics of Japanese submarines outlined by Targets S-01 and S-05 of Fascicle S-1 of reference (a), is submitted herewith.

2. The report was prepared by Comdr. T.H. White, USN, from information furnished by Comdr. R. Furze, RN, and Comdr. P.E. Greenwood, USN.

C. G. GRIMES
Captain, USN

31785

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S-01-6

CHARACTERISTICS OF JAPANESE NAVAL VESSELS
ARTICLE 6
SUBMARINES, SUPPLEMENT 1

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

SHIP AND RELATED TARGETS

JANUARY 1946

U.S. NAVAL TECHNICAL MISSION TO JAPAN

SUMMARY

CHARACTERISTICS OF JAPANESE NAVAL VESSELS
ARTICLE 6 - SUBMARINES, SUPPLEMENT I

This article is supplementary to NavTechJap Report, "Characteristics of Japanese Naval Vessels", Article I, Index No. S-01-1. The additional details supplied in this article are chiefly concerned with Japanese attempts to increase the submerged speeds of their submarines and the attempt to speed up the production of submarines by shifting to HA-201 class design.

Owing to the Japanese liberal use of technical terms, some data obtained during the basic investigation of this article does not agree completely, but as the result of cross-checking, it is felt that the data in the enclosures are the correct figures.

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REFERENCES

Classes of Submarines Examined:

I-201	RO- 62	All types
I-155	HA-101	of
I-361	HA-201	midget subs.

Japanese Personnel Interviewed:

At Sasebo Navy Yard:

Capt. MORIKAWA, IJN, Hull Constructor.
Capt. Y. OSHIMA, IJN, Machinery Officer.
Capt. K. YADA, IJN, Submarine Constructor.
Comdr. S. MORAKAMI, IJN, Hull Design Supt.

At Kure Naval Base many Japanese officers from the Engineering, Construction and Electrical Departments were interrogated, but their names were not recorded.

LIST OF ENCLOSURES

(A) List of HA-201 Documents Forwarded to the Bureau of Ships via ATIS ..... Page 13

(B) Profile and Sectional Views of I-201 Class ..... Page 15

(C) Profile and Sectional Views of KORYU Class ..... Page 17

(D) Profile and Sectional Views of KAIRYU and KAITEN Types ..... Page 19

(E) Statistical Table of Japanese Submarines (Midget and General) ..... Page 21

INTRODUCTION

The descriptions and data for this article are the results of the investigation by Comdr. Furze, RN, on behalf of the Commander in Chief, British Pacific Fleet, and by Comdr. P. E. Greenwood, USN. An attempt has been made to avoid duplication of material contained in Article 1, but some duplication will be found since the investigators and Capt. A.M. Morgan, USN, who prepared Article I, visited the same sites.

THE REPORT

PART I - SUPPLEMENTARY NOTES ON I-201 CLASS

A. Hull Form

The hull form is different from all other large submarines and closely similar to the KORYU and HA-201 class hull forms.

The vessel depends for her high underwater speed on carefully streamlined hull, large motors, and high-capacity battery. The high-capacity battery has an extremely short life, but this has been compensated for by installing a Schnorkel to permit submerged propulsion on the engine rather than the continued use of the battery while cruising.

The fundamental features of the hull form are that the pressure hull is carefully streamlined and of varying section throughout, without any parallel cylindrical portion; and that the maximum cross-section of the ship is the actual pressure hull plus the casing, as shown in Enclosure (B).

The arrangement of the main ballast tanks is such that they do not increase the cross-sectional area appreciably. The tanks are as follows:

#1 M.B.T. - built around the torpedo tubes.

#2 P. and S. - internal.

#3 P. and S.
#4 P. and S. } - inside the casing, very high up.

#5 M.B.T. - similar to #1 but built around the stern.

The space inside the casing, above and between the port and starboard main ballast tanks and buoyancy and fuel oil tanks, floods through openings along the sides of the casing. The streamlined flaps, to fair these openings when submerged, are not now fitted. The water in this space drains away through specially fitted pipes as the vessel surfaces.

B. Construction

Submarines of this class are the only large or medium-size Japanese submarines to have welded pressure hulls; in the smaller HA class and the midgets the hulls are welded, but in other large submarines only the external tanks and superstructure are welded.

The portable plate over the engine room is riveted.

Welding of the hull was done by hand, and about 5% of the length of welding was X-rayed.

An internal test by 35 lb/in^2 air pressure was carried out upon completion.

Since the sections of the pressure hull vary at every frame throughout the submarine, each plate had to be moulded to suit; hence, this hull does not lend itself readily to mass production or pre-fabrication. Considerable welding had to be carried out when the pre-fabricated sections were assembled on the ways.

Pressure hull plate thickness varies from an average of 22mm throughout down to 20mm and 18mm at the ends. The conning tower plate is 36mm thick.

The angle bulb internal framing of the hull in the center part of the ship is made with a varying depth of angle, having a web of considerably greater depth at the upper part of the hull where the plating is weakened by the access holes.

The forward bulkhead of the torpedo room is a casting, and the four torpedo tubes also are held in a single steel casting generally similar to the bulkhead, but of oval shape.

C. Diving Time

Diving time was quoted as being 50 seconds, whereas it was hoped, on designing, to obtain a diving time of 30 seconds. The addition of external fuel oil tanks above the water line and the practice of flooding the ballast tanks in the casing when on the surface reduced the diving time below 50 seconds, but no actual figures were available.

D. Automatic Trim Control for Depth Keeping

This installation was made in the earliest submarines of the class, but was discarded as impracticable for this size vessel. It is installed only in the midget submarines at present.

E. Forward Hydroplanes

This class submarine was originally designed without forward planes, but small planes were added during the building period. They improved control at slow speeds and while firing torpedoes, in addition to aiding in diving. These forward planes are rigged in or housed when operating at high speed while submerged.

F. Schnorkel

The Schnorkel is fitted for one main engine operation on propulsion or battery charge while submerged. This is an important factor in the design since it partially eliminates an undesirable factor of the high-capacity storage battery, namely its short life. By lessening the demand on the battery for slow speed cruising submerged, the life of the battery is extended considerably.

PART II - NOTES ON HA-201 CLASS

A. General Statistics

This is a small type submarine which was being built at the SASEBO Navy Yard at the war's end. Nine boats had been completed at that time.

Length overall	53 meters
Displacement - Normal surface	380 metric tons
- Submerged	440 metric tons
Speed - Surface	10.5 knots
- Submerged	13.0 knots
Complement	3 officers and 19 men
Torpedo tubes	2 tubes forward
Torpedoes	4; 2 in tubes, 2 in fwd room

This submarine was designed for mass production with a maximum amount of prefabrication. The pressure hull is cylindrical for a large portion of its length; it is welded throughout. There are six sections in the pressure hull: the bow, the center group of four, and the stern section. All shop welding is downhanded. This is maintained by mounting the sections on rolls.

Item A of Enclosure (A) is a sketch of the building area for the HA class submarine at the SASEBO Navy Yard. The building period for these vessels was 108 days. The first 12 days were used in assembling material and rolling plates. The next 12 days were spent constructing the hull in sections on railroad tracks in buildings at the head of the building ways. The following 12 days were devoted to fitting out the sections in tunnels. During the next 24 days the sections were assembled, and the engines installed on the marine railway on the building way. The earlier submarines had the forward and aft sections riveted to the all-welded middle section; however, the riveting was discarded for welding. The remaining 48 days were devoted to completion, fitting out, and trials.

The welds on the pressure hull were X-rayed. Most of the welding was done by 15 and 16 year old students. The test depth was 330 feet, but the depth gauges read up to 150 meters, and the Navy Yard Constructors insisted that this was a safe working depth.

B. Hull Form and Construction

The streamlining for underwater speed was obtained in much the same way as in I-201 class. The cross-section was kept as small as possible, and the main ballast tanks were arranged so that they hardly increased the cross-sectional area beyond the mid-section of the pressure hull. The maximum width of the hull was approximately only one foot greater than the diameter of the pressure hull. This did not include the span of the midship hydroplanes and the aft stabilizer fins.

The arrangement of the main ballast tanks is the same as in the I-201 class, one built around the bow, one around the stern, and two inside the casing on each side of the ship. There is no internal M.B.T. All kingstons and vents are hand-operated.

The casing and superstructure are carefully faired off, and fittings are recessed as much as possible. The bridge is narrow, with no anti-radar slope to increase the frontal area. No anti-radar coating is applied.

The interior of the submarine is one single compartment with domed bulkheads at each end. The number of fittings and the amount of equipment were reduced to a minimum to facilitate mass production.

C. Control of Depth and Direction

The aft hydroplanes are large and are fitted at the trailing edge of the extremely large stabilizer fins, which are considerably wider than the maximum hull width. The midship planes are small and are controlled by hand from the control room, where they are situated below the center of the hull. These planes cannot be housed and project out farther than the stabilizer fins.

No automatic features for control of depth or trim are fitted in this class submarine, but automatic steering is installed.

D. Machinery

Complete engine data is contained in the statistical sheet in Enclosure (E). The main engine is a low power unit of moderate performance, suitable for mass production and not requiring too highly trained operators. The engine is of monobloc construction with four-stud heads. Each head has two exhaust valve boxes which can be removed without removing the head, and two inlet valves built into the head.

The engine outboard exhaust valve has three operating gears. One shuts the valve; the second squeezes it tighter; the third jams it still tighter.

An auxiliary driving motor is fitted for very slow speed surface cruising at high efficiency and endurance. It drives through sixteen V-belts with a reduction ratio of about 3:1. The driving gear is clutched to the main shaft when in use.

Surface and submerged trial results are given in Tables I and II.

TABLE I

SURFACE CONDITIONS

Armature Circuit	Knots	RPM	Armature Total Amps.
Auxiliary Drive	2	126	
	3	167	
Series	4	208	240
	5	249	400
	6	290	570
	7	331	800
	8	372	1,140
	9	413	1,600
	10	454	2,200
Parallel	11	495	2,800
	12	536	3,450
	13	578	4,200
	13.5	595	4,600
	13.9	600	4,700

TABLE II

SUBMERGED CONDITIONS

Drive	Knots	RPM	Fuel Kg/Day
Auxiliary Motor 60 Amps.	2	100	
Diesel-Electric 73 Amps.	3	128	
118 Amps.	4	158	
Direct Drive by Engine	5	189	192
	6	220	312
	7	251	432
	8	281	576
	9	313	720
	10	345	912
	11	384	1,272
	12	430	1,872
	12.2	436	1,992

E. Torpedoes, Tubes, and Attack Instruments

Two 21" torpedo tubes of standard design are fitted forward. No torpedo derrick is fitted topside, but a skid is installed for loading torpedoes. Four torpedoes are carried: two in the tubes; two in the room. Equipment is provided for reloading.

The gyro setting equipment is manually operated by a setter who receives the angle from the control room on a follow-the-pointer system. No automatic spindle retractor is fitted. Tubes are fired electrically from the control room.

An angle solver is installed in the control room with all manual inputs except the periscope bearing, which is fed in automatically from a transmitter on the periscope.

The periscope is 23'4" in length and is monocular, bifocal (1.5 x 6), fitted with a sky search. The diameter of the tube is 160mm. The periscope is in the control room, running up through a dome which is a part of the pressure hull. A raised platform is provided so that the periscope observer may stand with his head in the dome and get the maximum height of scope.

PART III - BRIEF SURVEY OF MIDGET SUBMARINES

A. Principal Types

There are three different classes; each has different operational functions. In no type yet reported has there been any arrangement for divers to leave or re-enter the submarine underwater, as in the British X-Craft and "Chariots", to cut through nets, etc.

Class 1. True miniature submarines of conventional type with comparatively high surface and submerged performance. Armed with two muzzle-loading 18" torpedo tubes.

Class 2. These are much smaller, with shorter range and lower performance. They carry two 21" torpedoes slung in external slideways, pointing aft. They are usually fitted with a large warhead for making a suicide attack after launching their torpedoes.

Class 3. These are the human torpedoes, with very high speeds but only short endurance and unable to recharge or to patrol. They are fitted with a very large warhead and no other armament and are definite suicide-craft. (See NavTechJap Report, "Japanese Suicide Craft", Index No. S-02).

B. Types with Bow Tubes

The original pre-war types are described in former reports on the subject and in ONI 222-J under the names MATO and KO-HYOTEKI. A number of experimental types or models were built with the diameter and displacement gradually increasing. Various engines, drives, and tank arrangements were tried. At the end of 1944, the type had reached a stage where it was possible to standardize, and mass-production was started at KURE and YOKOSUKA. This is the KORYU class, of 59 to 63 tons displacement. The main features are external main ballast tanks, good streamline form, and high endurances. Direct-drive and diesel-electric drive were tried, but the standard type was diesel-electric. Single and double propellers were tried; the standard adopted being a single propeller with torque-correcting planes on the horizontal tailfins. Air conditioning is fitted. The battery has wooden chocking and bearers, and non shock-resisting mountings are fitted. It has been reported that at least one HA-101 class submarine (HA-108) was fitted up to service KORYU midgets, carrying ten 18" torpedoes for them and a tripod for hoisting their bows out of water so that their tubes could be reloaded.

C. Types with External Torpedoes and with or without Warheads

These were much smaller than the types described above. They were called KAIRYU class, and three variations of them were described in NavTechJap report "Characteristics of Japanese Naval Vessels, Article 7 - Submarines - Supplement II", Index No. S-01-7. The mass production model was the second type described in that report. These were made on a conveyor belt system at YOKOSUKA. The large midship tank was for main ballast and not for fuel as reported previously. The frame spacing was about 12" and not 21". The battery cells were protected from shock by being mounted on a 3/8" sheet of sponge-rubber; chocking was of wood. The engine was adapted from a commercial model which had a cone-type clutch. This was changed to eliminate the clutch. An end plate was bolted to the flywheel and, through a Crookes Joint, was attached to the shaft which connected directly to the gear box through another Crookes Joint. The engine clutch was incorporated in the gearing. The tail clutch was similarly incorporated in the gearing between the motor and the propeller. No radar was fitted, but a W/T aerial was fitted in some of the KAIRYU class.

ENCLOSURE (A)

LIST OF HA-201 DOCUMENTS FORWARDED TO THE BUREAU OF SHIPS VIA ATIS
(ATIS No. 3071)

NavTechJap No.		Description
ND10-2000.1	A	- Layout of Bldg. Area
ND10-2000.2	B(1)	- General Design Data (in Japanese)
ND10-2000.3	B(2)	- Translation of B(1)
ND10-2000.4	B(3)	- Engine Data
ND10-2000.5	B(4)	- Armament, Electrical, and Electronic Data
ND10-2000.6	C	- General Arrangement Plan
ND10-2000.7	D	- Displacement and Characteristic Curves
ND10-2000.8	E	- Displacement Calculations
ND10-2000.9	F	- Reserve Buoyancy Curves
ND10-2000.10	G	- Capacity and CG of Tanks
ND10-2000.11	H	- Control Room (side view, fully equipped as of 20 March 1945)
ND10-2000.12	I	- Arrangement of Officers' and Crews' Quarters
ND10-2000.13	J	- Torpedo Room Arrangement (Elevation)
ND10-2000.14	K	- Torpedo Room Arrangement (Plan & Section)
ND10-2000.15	L	- Auxiliary Engine Room (Side view)
ND10-2000.16	M	- Torpedo Loading Arrangement
ND10-2000.17	N	- Ballast Arrangement
ND10-2000.18	O	- Main Tank Flooding Piping Arrangement
ND10-2000.19	P	- Ventilation System
ND10-2000.20	Q	- Ventilation Duct Arrangement (Plan & Elevation)
ND10-2000.21	R	- Oxygen and Air Filter Arrangement
ND10-2000.22	S	- Main Tank, Vent Valve and Low Pressure Air Piping
ND10-2000.23	T	- Special Air Intake Cylinder for Battery Charging, General Outline of
ND10-2000.24	U	- Salt Water Piping - Schematic
ND10-2000.25	V	- Salt Water Piping - Arrangement
ND10-2000.26	W	- Fresh Water Piping - Schematic
ND10-2000.27	X	- Fresh Water Piping - Arrangement
ND10-2000.28	Y	- Voice Tube Arrangement
ND10-2000.29	Z	- 10,000 Calories/hr Freon Gas-Type Cooling System
ND10-2000.30	AA	- Steering Rudder Shafting Arrangement
ND10-2000.31	BB	- Horizontal Rudder & Fittings
ND10-2000.32	CC	- Diving Rudder
ND10-2000.33	DD	- Area Around Horizontal & Vertical Rudders
ND10-2000.34	EE	- Vertical Rudder & Fittings
ND10-2000.35	FF	- Details of Inner Hull #6 Block - Supplement (Horizontal Rudder Control Gear)
ND10-2000.36	GG	- Partial Revision of FF
ND10-2000.37	HH	- Inner Hull #6 Block - Supplement (Manual Control for Horizontal Rudder)
ND10-2000.38	II	- Details of Hull #9 Block - Supplement (Vertical Rudder Control Gear)
ND10-2000.39	JJ	- Plating Arrangement of Inner Hull
ND10-2000.40	KK	- Plating Arrangement of Outer Hull
ND10-2000.41	LL	- Torpedo Tube Casting & F7 Athwartship Bhd.
ND10-2000.42	MM	- Superstructure Details
ND10-2000.43	NN	- Ballast Keel
ND10-2000.44	OO	- Inner Hull Details No. 1 Block
ND10-2000.45	PP	- Inner Hull Details No. 2 Block
ND10-2000.46	QQ	- Inner Hull Details No. 3 Block, Battery Room
ND10-2000.47	RR	- Hull Details No. 4 Block, Aux. E.R., and Control Station
ND10-2000.48	SS	- Hull Details No. 5 Block, Main Engines and Main Motor
ND10-2000.49	TT	- Hull Details No. 6 Block, Aft End

ENCLOSURE (A), continued

NavTechJap No.		Description
ND10-2000.50	UU	- Hull Details No. 7 Block, Part of Torpedo tubes
ND10-2000.51	VV	- Hull Details No. 8 Block, Periscope, Radio Ant., Amm. Hoist
ND10-2000.52	WW	- Outer Hull Details No. 1 Block
ND10-2000.53	XX	- Outer Hull Details No. 2 Block - Supplement 1 - Hydrophone & Sound Gear
ND10-2000.54	YY	- Outer Hull Details No. 2 Block - Supplement 2 - Main Tank & Kingston Valve
ND10-2000.55	ZZ	- Outer Hull Details No. 2 Block - #1 Main Tank
ND10-2000.56	AAA	- Outer Hull Details No. 2 Block - Part Revised #1 Main Tank
ND10-2000.57	BBB	- Outer Hull Details No. 3,4,5,6,7,8, Blocks, Outer Hull Tanks and Fairwater
ND10-2000.58	CCC	- Outer Hull Details No. 9 Block

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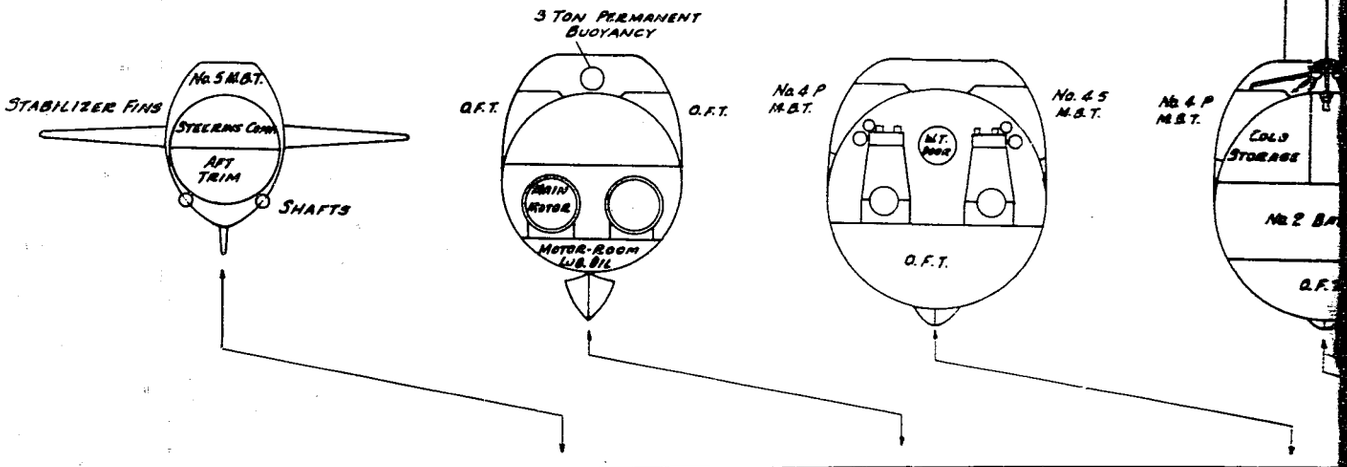
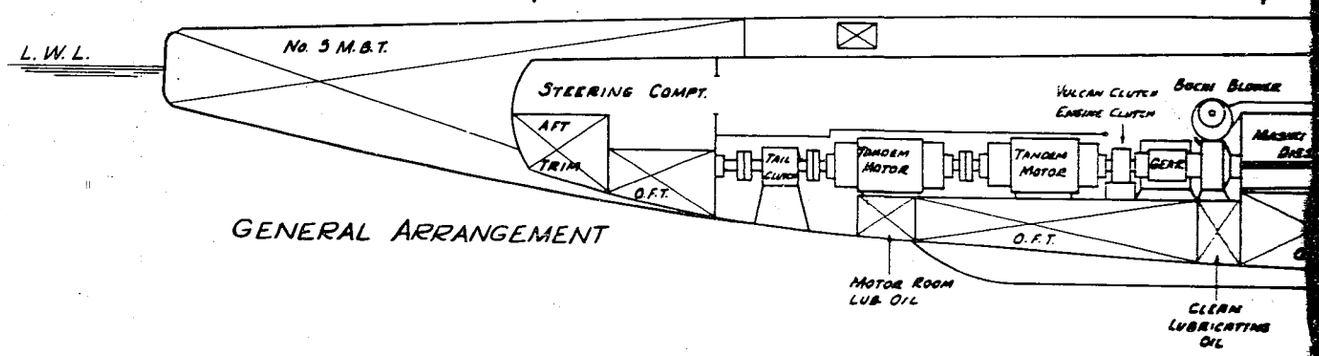
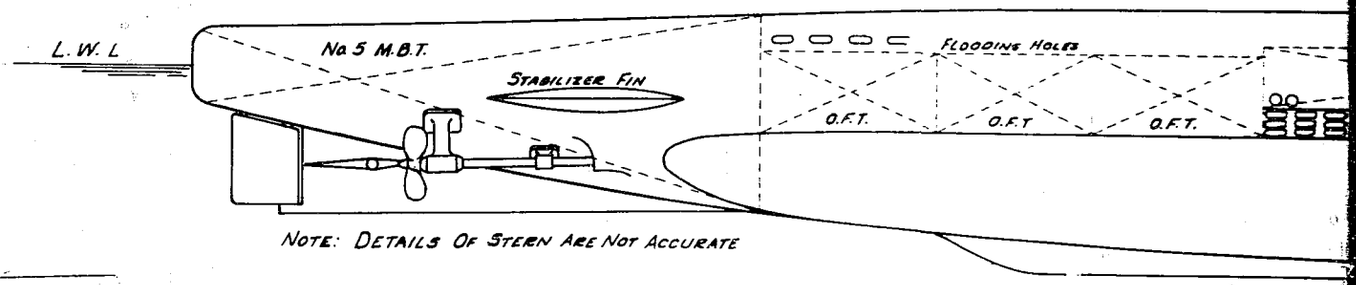
SECTIONAL VIEWS - LOOKING FORD.





GENERAL ARRANGEMENT

EXTERNAL PROFILE



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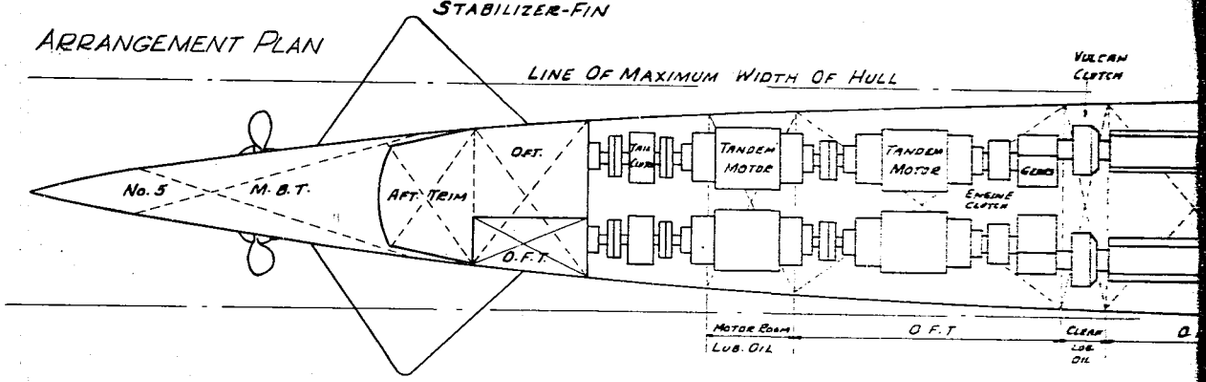
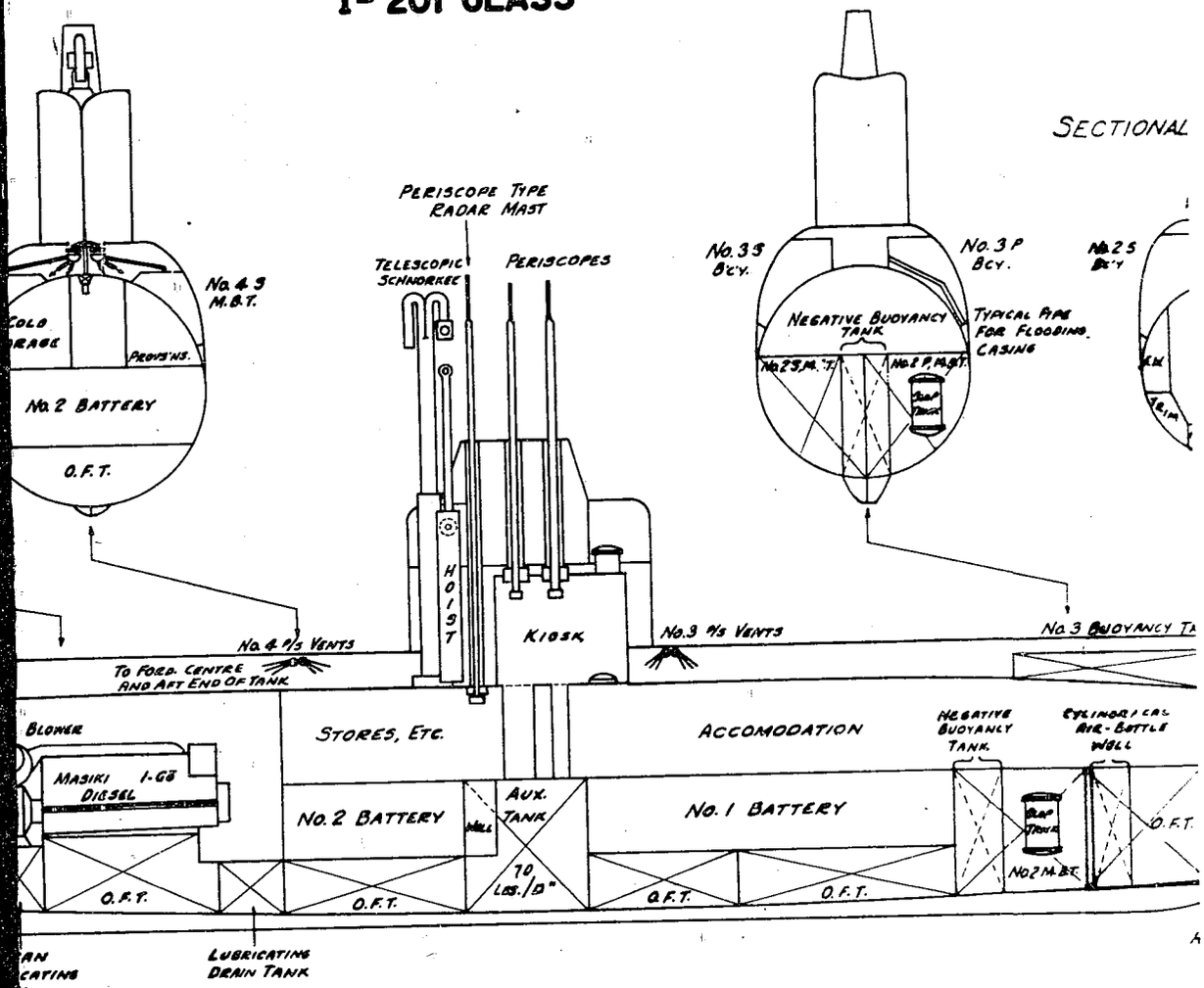
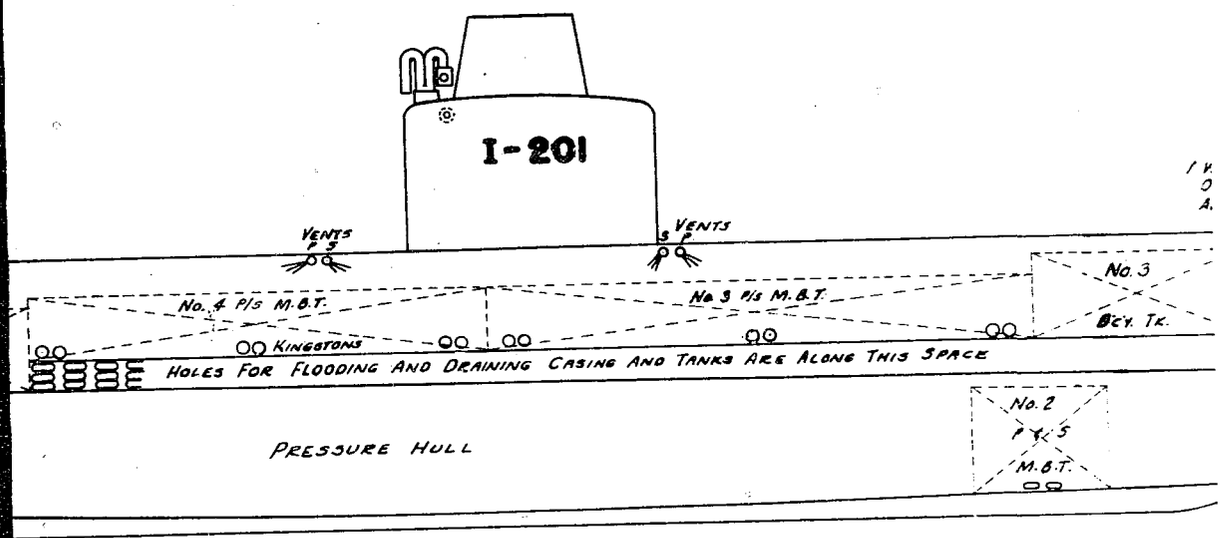
ARRANGEMENT PLAN

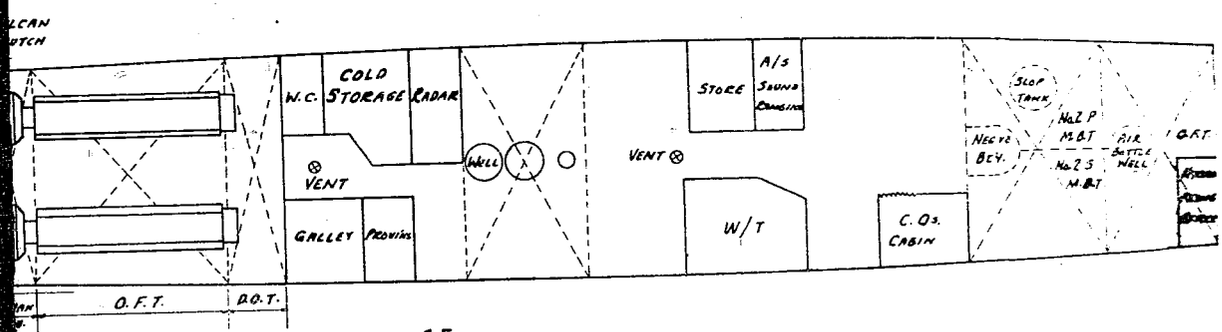


ENCLOSURE (B)

I-201 CLASS







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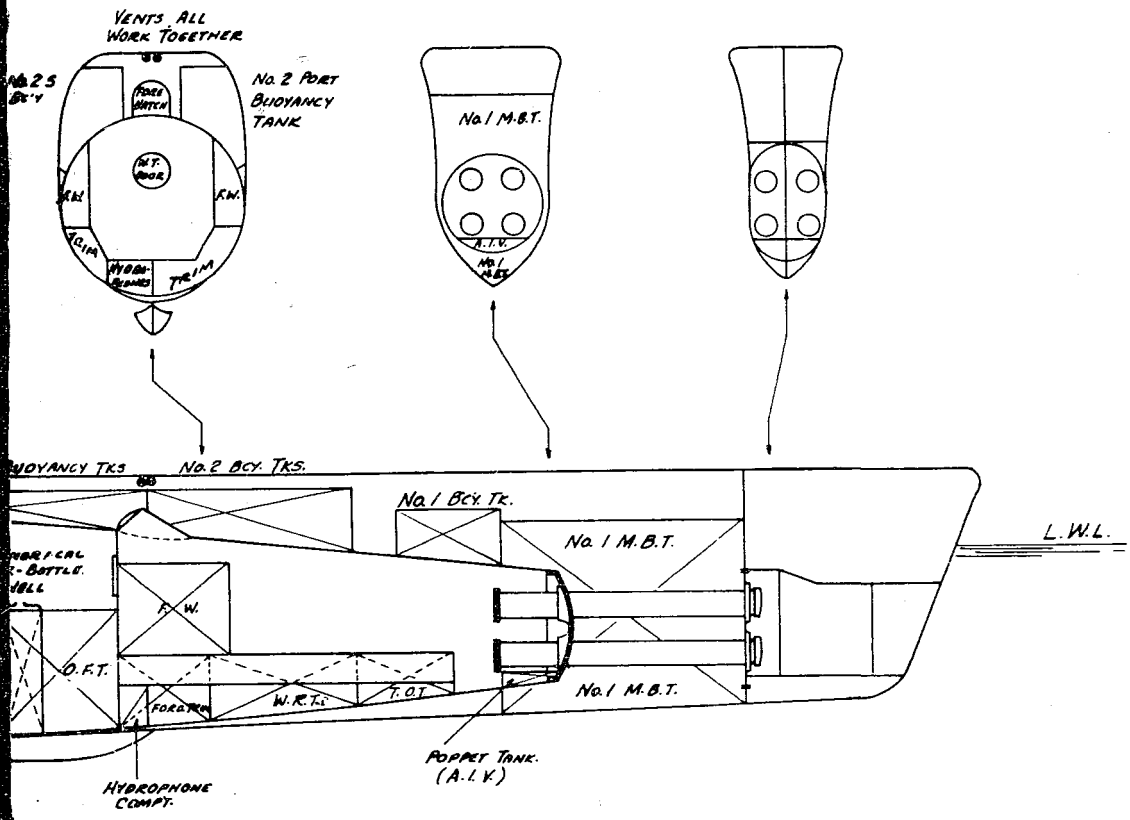

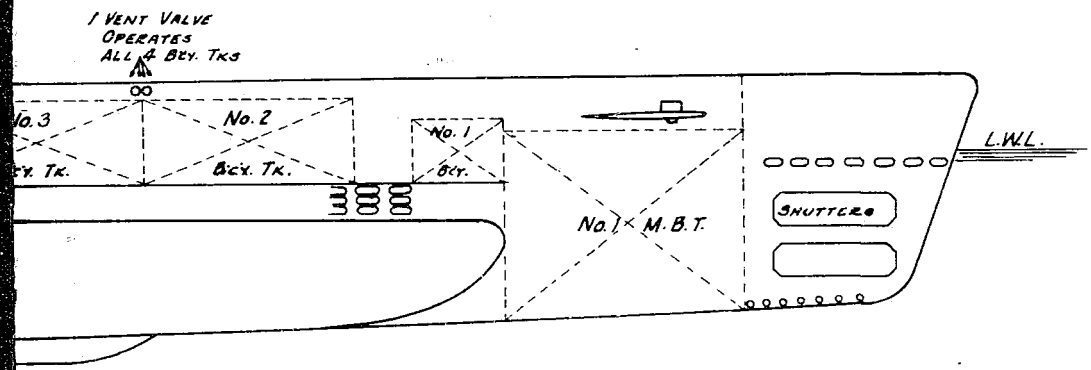

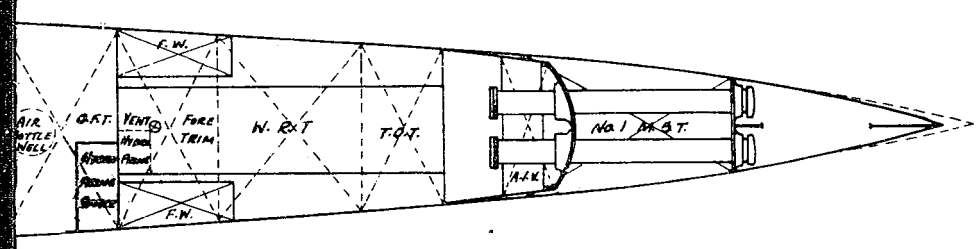

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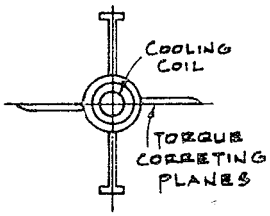
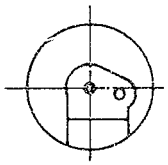
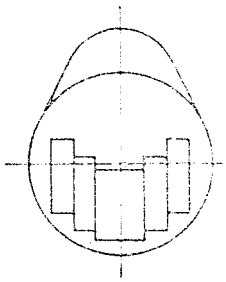
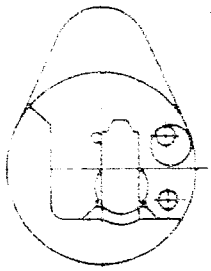
"KORYU" Cl









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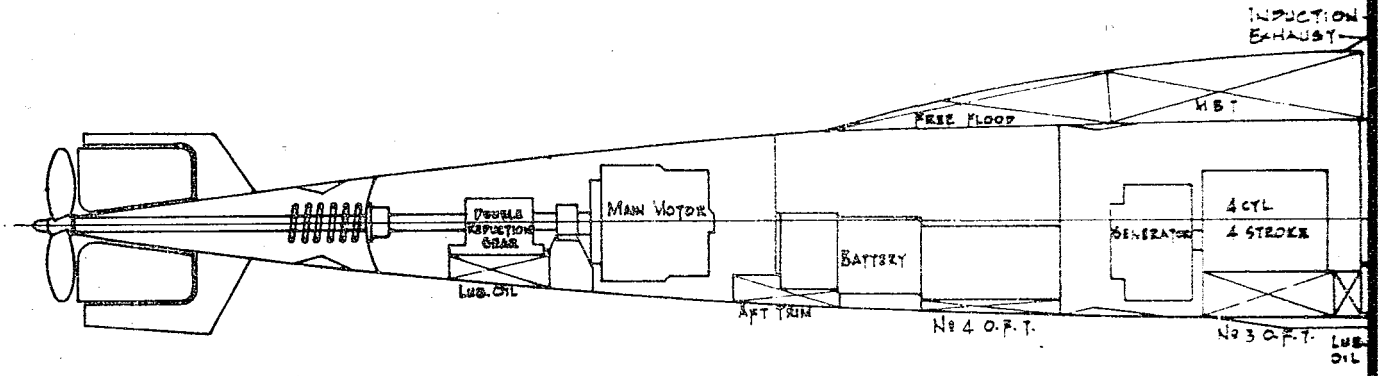
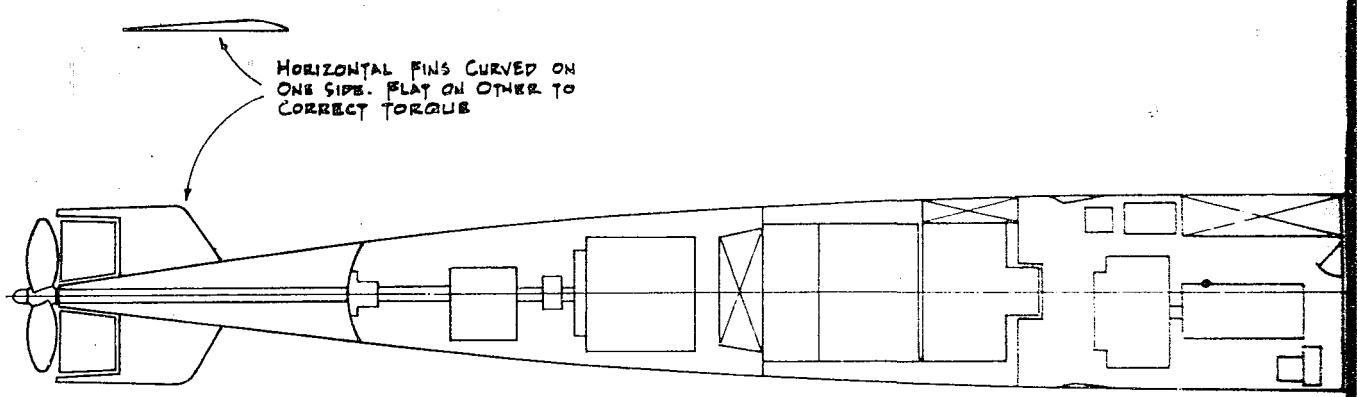
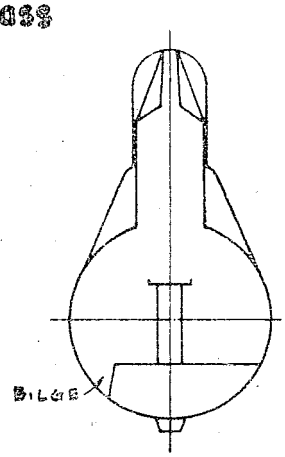
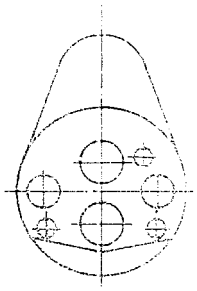
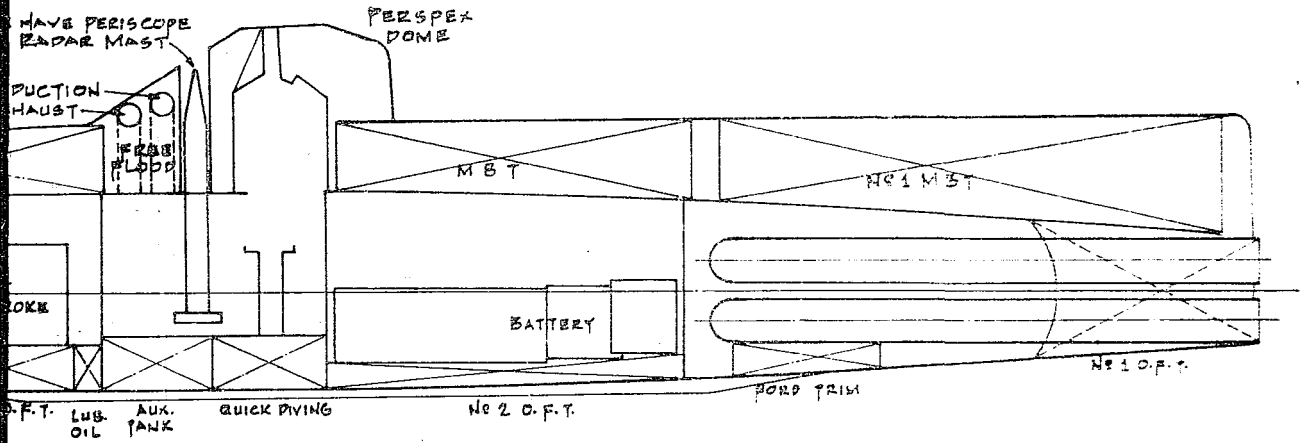


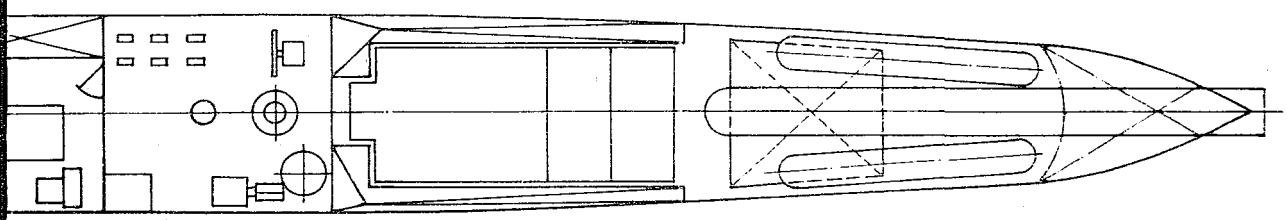




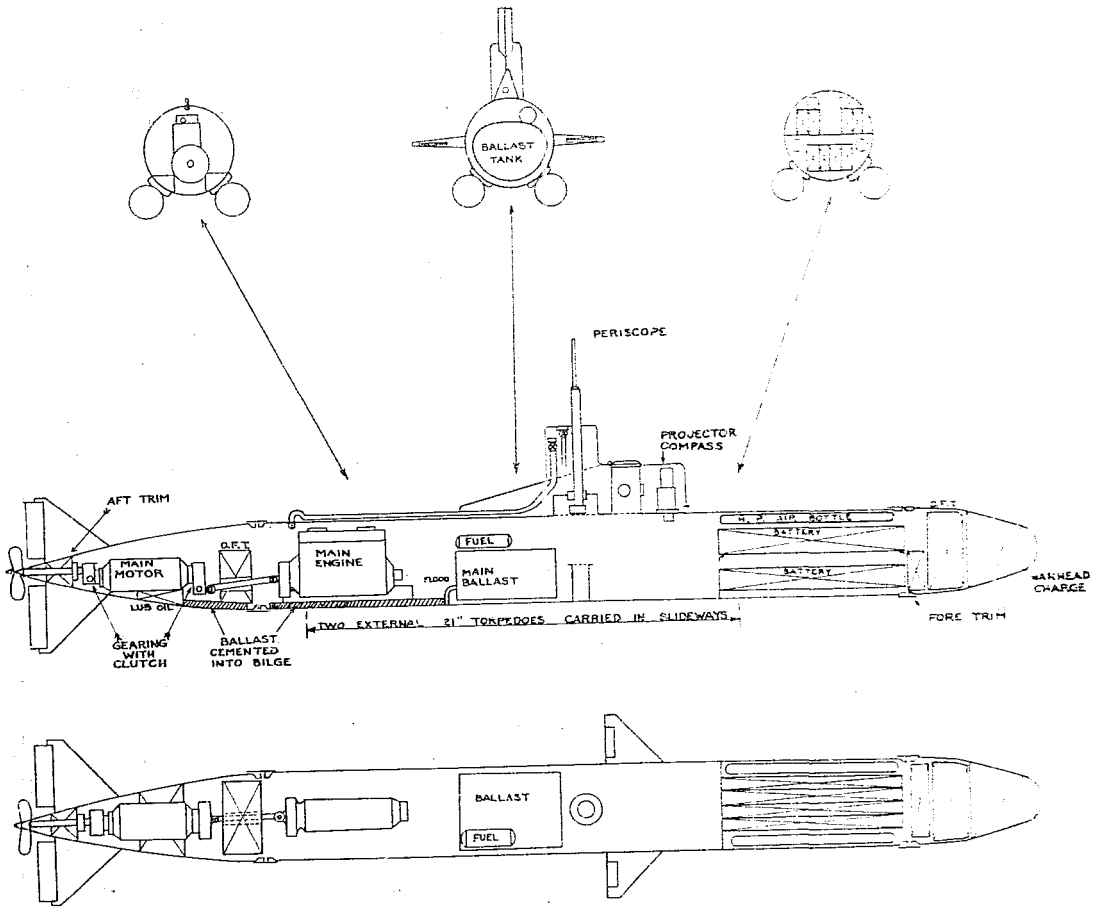


L LOOKING FORWARD

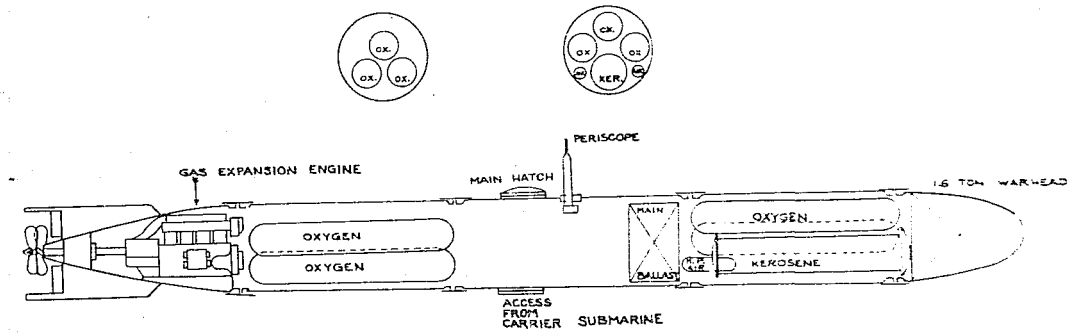




ENCLOSURE (D)



"KAIRYU" Midget Submarine



"KAITEN" OR LARGE HUMAN TORPEDO

Submarine No.	Subs of Class Now Remaining	General Type of S/M		Building Dates Started	Building Dates Finished	Displacement Standard (No Fuel) Tons	Displacement Normal Surf. Trim Tons	Displacement Reserve O.F.T. Full Tons	Submerged Tons	Leng all
I 121-124		Mine Layer Transport		1923	1927	1140	1170	1450	1860	2732
I 152-160 166-167		Medium Size and Speed Fleet Submarines		1925	1930	1635	1720	1900	2100	3
I 161-165				1926	1930	1635	1720	1900	2100	3
I 1-6				1928	1933	1635	1955		2500	3
I 168-175		Medium Size High Speed Fleet Submarines		1932	1936	1680	1780	1950	2440	
I 176-185				1934	1939	1630	1830	2130	2600	
I 7-8				1937	1940	1950	2325		3100	
I 15.17-19.20 25-40	I 36	Large Size High Speed Cruiser Submarines		1934	1941	2210	2610	3230	3650	
I 16.1820.22	I 47			1934	1942	2180	2550	3220	3560	
I 9-10	Nil	Large and very large, medium speed or slow S/M speed		1941	1943	2440	2420	3630	4150	
I 11-12	Nil		Carrier	1942	1944	2445	2955	3665	4150	
I 52-53 55			Supply	1941	1943	2100	2560	3140	3560	
I 54-56 58			Carrier	1942	1944	2140	2650	3180	3680	
I 13-14	I 14		Crusier	1943	1945	2640	3600	3890	4760	
I 351-356			Crusier	1943	1945	2650 2730	3520	3520	4290	
I 400-401 402	I 400-401		Cruiser	1944	1945	3560	4660	5400	6400	
I 361-370		Medium Size Transport Submarines		1942	1944	1470	1780	1870	2210	
I 371-372				1942	1945		1660	1930	2240	
I 201 class	I 201-202 203	High Speed Submerged		1944	1945	1070	1290	1310	1400	
RO 33-34		Smaller Coastal Short Range		1935		700	960			
RO 35-50	RO 50			1938	1944	965	1100	1190	1440	
RO 101-117				1942	1944	525	600	620	780	
RO 500		German 750 Tons High Speed Submerged Coast Defense		1942	1943	740	900			
HA 201 class				1944	1945	325	350	380	440	
HA 101 class		Small Cargo S/M	Naval	1944	1945	370	430		490	
YU class			Army	1944	1945	290			346	

ENCLOSURE (E), continued

Surface Propulsion and Main Machinery
General Type

Submerged Tons	Dimensions: Length Over-all feet	Length Between Perpendiculars	Maximum Dia. of Pressure Hull-ft.	Max. Width or Beam	Mean Draught Normal Surface	Mean Draught With Max. O.F.	Diving: Diving Depth (ft.) Tested/Working	Diving Time (Seconds)	Hull Form
1860	273?73	255?		24'-6"	14'-8"	20'-8"	250/200	60	Partial DH
2100	325	310?		26'	16'-8"		200/175	60	Partial DH
2100	325	310?		26'	16'8"		200/175	60	Partial DH
2500	325	310?		30'-8"	16'		300/250	60	Partial DH
2440	350	335?		27'-4"	15'-4"		300/265	60	Partial DH
2600	351	335?		27'-4"	15'-4"		350/265	45	Partial DH
3100	364	340		30'-4"	17'-6"		330/330	60	Partial DH
3650	362	340?		31'	17'-4"		350/ -	50	Partial DH
3560	364	340		30'-4"	17'-10"		350/ -	60	Partial DH
4150	375	365		31'-8"	17'-10"		330/330	60	Partial DH
4150	375	365		31'-8"	17'-10"		330/330	60	Partial DH
3560	362	365?		31'	17'-8"		330/ -	60	Partial DH
3680	362	345?		31'	17'-8"		330/ -	60	Partial DH
4760	375	365	19'	38'-4"	19'-3"	20'-8"	330/ -	50	Partial DH with bulges
4290	370	360	20'	33'-8"	20'-5"		300/350	50	Partial DH with double externals
6400	407	387	Not Circular	40'	21'-10"	24'-6"	330/330	60	Partial DH with thick upper part
2210	246	230?	18'-3"	29'-7"	15'-10"		250/250	50	Partial DH (exceptionally broad coarse lines)
2240	246	230?		29'-7"	16'-10"		330/330	50	Partial DH
1400	263	253	19'-4"	19'-4"	17'-6"	Width across stern fins 30'-9"	370/370	design 30 trial 50	Single hull saddle tank in casing & international MB tank
	243	230?		22'-4"	10'-10"		250/250	60	Partial DH
1440	268	255		23'-4"	13'-4"		265/265	50	Partial DH
780	203	180		20'	11'-8"		250/250	60	Partial DH
	Maximum width across stern fins or across midship hydroplanes is 17'-6"								
440	174	160?	12'	13'-4"	11'-4"	12'	330 claims to dive 500	30	Partial DH (1 compartment)
490	149	140	12'-9"	20'-4"	13'-6"		330/330	50	Saddle tank (3 compartments)
346	137			13'	10'		330?		Saddle tank

Hull							
Steel Used for Pressure Hull	Construction of Pressure Hull	Average Thickness of Pressure Hull	Frame Spacing	Metacentric Height GM(surface) Feet	Metacentric Height BG (submerged) feet	Tons per Inch Immersion Tons	Moment to C Trim 1" Tons
Medium	Rivetted						
Medium	Rivetted	.47"		27.5"	15.7"		
Medium	Rivetted	.47"					
Medium	Rivetted						
Medium	Rivetted						
Medium	Rivetted						
D Quality	Rivetted						
D Quality	Rivetted	.78"		31.5"	15.4"		
D Quality	Rivetted						
D Quality	Rivetted						
D Quality	Rivetted						
Medium	Rivetted			27.5"	14.5"		
Medium	Rivetted			22.7"	17.7"		
Medium	Rivetted	1.06"	23½"			Heavy Normal 17.3 18.4	138 14
Medium	Rivetted			44.0"		19.7	150
D Quality	Rivetted	1.06"	23½"	46.5"		24.5	196
Medium	Rivetted	.63"					
Medium	Rivetted						
Medium	All welded	.87"	20" to 25½"	13.5"	5.73"	5.8	61.5
Medium	Rivetted						
Medium	Rivetted						
Medium	Rivetted						
Medium	All welded	.68"	18"				
Medium	All welded	.625"		19.0"	10.0"		
Medium	All welded						

ull of l	Average Thickness of Pressure Hull	Frame Spacing	Metacentric Height GM(surface) Feet	Metacentric Height BG (submerged) feet	Tons per Inch Immersion Tons	Moment to Change Trim 1" Tons Ft.	Complement Officers & Men	Periscopes- Number fitted. Length
								2
	.47"		27.5"	15.7"			Designed 80 94	2
	.47"						Designed 80 94	2
							Designed 82 96	2
								2
								2
								2
	.78"		31.5"	15.4"			95	2
							95	2
								2
								2
			27.5"	14.5"			Designed 90 12 130	2 33'-4"
			22.7"	17.7"			Designed 98 14 132	2
	1.06"	23½"			Heavy Normal 17.3 18.4	138 143	Designed 108 14 135·112	2 40'
			44.0"		19.7	150		2
	1.06"	23½"	46.5"		24.5	196	21 174	2 40'
	.63"						11 75	1-30' 1-26'-9"
							11 75	2
d	.87"	20" to 25½"	13.5"	5.73"	5.8	61.5	7 45	2 26'-9"
								2
							9 64	2
								2
d	.68"	18"					Design 3 19 4 30	1 23'-4"
d	.625"		19.0"	10.0"			21	1 23'-4"
d							16 Army	1

Submarine No.	Bow Torpedo Tubes	Stern Torpedo Tubes	Reload Torpedoes	Number of mines	Particulars of Midgets carried	Number of Aircraft	Low Angle	25mm Guns	Passengers	Freight Solid cargo tons	Freight Gasoline and Liquid Tons
I 121-124	4-21"	2 mine tubes	4	42	Nil	Nil	1-140mm	1 or 2		20	20
I 152-160 166-167	6-21"	2-21"	8		Nil	Nil	1-140mm	1			
I 161-165	6-21"	2-21"	8		Nil	Nil	1-140mm	1			
I 1-6	4-21"	2-21"	14		Nil	Nil	1-140mm	1 or 2			
I 168-175	4-21"	2-21"	6		Nil	Nil	1-140mm	2 or 4			
I 176-185	6-21"		6		Nil	Nil	1-140mm	2 or 4			
I 7-8	6-21"	Nil	12		Nil	One	1-140mm	2			
I 15.17-19.26 25-45	6-21"	Nil	11		Nil	One	1-140mm	2			
I 16.18-20.22 24.46-47.48	8-21"	Nil	12	2 kaiten forward	1-? Kaiten Aft	Nil	1-140mm	2			
I 9-10	6-21"	Nil	12		Nil	One	1-140mm	2			
I 11-12	6-21"	Nil	12		Nil Nil	One	1-140mm	2			
I 52-53-55	6-21"	Nil	12		4 Kaiten Aft	Nil	1-140mm	1 twin			
I 54-56-58	6-21"	Nil	12		4 Kaiten Aft	One	1-140mm	1 twin			
I 13-14	6-21"	Nil	12		Nil	Two		2 triple 1 single			
I 351-356	4-21"	Nil	4				1-140mm	2 twin		120/180	365/450
I 400-401	8-21"	Nil	12		4 Kaiten Aft	3 Catapult 1 Stripped	1-140mm	3 triple 1 single			
I 361-370	Nil or 2-21"	Nil	Nil or 2		4 Kaiten Aft		1-120mm	1 or more	120 men	60 intr. 40 extr.	80
I 371-372	Nil						1-120mm	1		110	
I 201 class	4-21"	Nil	6					2-25mm (housing)			
RO 33-34	4-21"	Nil	6								
RO 35-50	4-21"	Nil	6					2			
RO 101-117	4-21"	Nil	4					1			
RO 500											
HA 201 class	2-21"	Nil							Limited by Volume Rather Than Weight		
HA 101 class	Nil							1 or 2	21? men	60	40
YU class							1-37mm		50 men	32 intr. 18 extr.	

Surface Propulsion and Main Machinery

Freight ld cargo tons	Gasoline and Liquid Tons	Main Batteries: Type & Model No. of Cell	Total Voltage	No. of Cells	Capacity per Cell (1 hr rate) Amp. Hr.	Total No. of Parallel Sections	Total Capacity (1 hr. rate) Amp. Hr.	Total Capacity (20 hr. rate) Amp. Hr.	Total Weight with Strapping Tons	Main Motors	Single or der Armat
20	20		240	480	1,250	4	5,000			2	Tandem
			240	240	2,500	2	5,000			2	Tandem
			240	240	2.500	2	5,000			2	Tande
			240		2,500	2	5,000			2	Tande
			240	236	2,500	2	5,000			2	Tande
			240	236	2,500	2	5,000			2	Tandem
			240	480	2,500	2	5,000			2	Tandem
		Mk13	240	240	5,000	2	10,000			2	Double
		Mk13	240	240	5,000	2	10,000			2	Tande
			240	240w	5,000	2	10,000			2	Tandem
			240	240	5,000	2	10,000			2	Tandem
		Type 1 Mk13e	240	240	5,600	2	11,200	22,400	180	2	Double
		Type 1 Mk13e	240	240	5,600	2	11,200	22,400	180	2	Tandem
		Type 1 Mk13e	240	240	5,600	2	11,200	22,400	180	2	Tandem
80	365/450	Type 1 Mk13e	240	480	2,800	4	11,200	22,400	180	2	Tandem
		Type 1 Mk13e	240	360	5,600	3	16,800	35,600	270	2	Tandem
r. r.	80	Type 1 Mk13e	240	240	5,600	2	11,200	22,400	740	2	Tandem
		Type 1 Mk13e	240	240	5,600	2	11,200	22,400	180	2	Tandem
		Special D.	232	4,176	660 (20hrs)	36	18,800	23,800	168.5	4	Tandem
		Type 1 Mk13e	240	240	2,800	2	5,600	11,200	90	2	Tandem
		Type 1 Mk13e	240	240	2,800	2	5,600	11,200	90	2	Tandem
		Type 1 Mk13e	240	120	5,600	1	5,600	11,200	90		
lume eight		Special e	240	120	6,200	1	1 hr 4250 8 hrs 6200	6,700	50	1	Tandem
	40		240	120	3,100	1	1 hr 2125 8 hrs 3100	3,350	25	1	Tandem
t. f.			228	228	2,000 ?	2	8 hrs 4000?			1	Geared

	Electric Propulsion			Submerged Performance			Surface Speed			
Single or Tandem Armature	Total S.H.P. of all motors	Type of Motor Motor HP	Auxiliary Drive	Full Speed (Knots)	Propeller R.P.M.	Cruising Endurance Knots-Miles	Full Speed (Knots)	Total S.H.P	Engine Model	Stroke
Tandem	1,200			6.5		5knts-20mi	14.5	2400	Type RA Mark 1	SA 4
Tandem	1,800			8	190	5-45	19	6000	Type RA	SA 2
Tandem	1,800			8.3	190	5-50	19	6000	Type RA Mark 2	SA 4
Tandem	1,800			8		3-65	17	6000	Type RA Mark 2	SA 4
Tandem	1,800			8		5-50 3-65	22.9	8900	Mark 1 Model 8	DA 2
Tandem	1,800			8		5-50 3-65	22.9	8900	Mark 1 Model 8	DA 2
Tandem	1,800			8		3-60	22.9	11400	Mark 1 Model 10	DA 2
Double	2,000	Type 5		8.7		3-100	23.9	12800	Mark 2 Model 10	DA 2
Tandem	2,000	Type 5		8.8		5-60	23.9	12800	Mark 2 Model 10	DA 2
Tandem	2,500	Type 8		8.8		3-90	23.9	12800	Mark 2 Model 10	DA 2
Tandem	2,500	Type 8		8.8		3-90	17.7	4700	Mark 22 Model 10	SA 4
Double	2,500	Type 8		7.5		3-100	17.7	4700	Mark 22 Model 10	SA 4
Tandem	2,500	Type 8		7.5		3-105	17.7	4400	Mark 22 Model 10	SA 4
Tandem	2,500	Type 8		5.5		3-108	17.0	4000	Mark 22 Model 10	SA 4
Tandem	2,500	Type 8		6.3		3-100	15.8	7700	Mark 22 Model 10	SA 4
Tandem	3,300			7	2900	3-60 (50rpm)	19.7	1900	Mark 22 Model 10	SA 4
Tandem	1,500		Not fitted	6.5		3-120	13.0	1900	Mark 23	SA 4
Tandem	1,500			6.5		3-120	13.0	2700	Mark 23	SA 4
Tandem	5,000			19 designed 16.3 to 17	600	5-100 3-150	15.5	2800	Type MA	SA 4
Tandem				8.48.4		3.5-90	18.9	4300		SA 4
Tandem	1,200			8.4		5-45	19.7	1100	Mark 22 Model 10	SA 4
				8		3-60	14.2	4400	Mark 24 Model 6	SA 4
							19-20	400 HP	MAN	SA 4
Tandem	1,250	Type EM-1 32	V-Belt 3-1	13.9 trial	600	2-100	12.2 trial	400 HP		SA 4
Tandem	150			5		2.3-45	10	200?		SA 4
Geared	355 to			4.5		4-18	11.5			

Submarine No.	Main Engines Fuel Injection System	Reversing or Non Reversing	License or General Design	Number of Cylinders	Bore (mm)	Stroke (mm)	Diameter of Piston Rod	
I 121-124	Blast	No Reverse	M.A.N.	6	450	420		
I 152-160 166-167	Blast	No Reverse	Sulzer	8	540	570		3
I 161-165	Blast	Reverse	M.A.N.	10	530	530		
I 1-6	Blast	Reverse	M.A.N.	10	530	530		
I 168-175	Blast	Reverse	Sulzer	8	470	490	170	3
I 176-185	Blast	Reverse	Sulzer	8	470	490	170	3
I 7-8	Blast	Reverse	Sulzer	10	470	490	170	4
I 15.17-19.20 25-40	Blast	Reverse	Sulzer	10	470	530	170	4
I 16.1820.22	Blast	Reverse	Sulzer	10	470	530	170	6
I 9-10	Blast	Reverse	Sulzer	10	470	530	170	6
I 11-12	Jerk	No Reverse	M.A.N.	10	430	450		6
I 52-53 55	Jerk	No Reverse	M.A.N.	10	430	450		A
I 54-56 58	Jerk	No Reverse	M.A.N.	10	430	450		A
I 13-14	Jerk	No Reverse	M.A.N.	10	430	450		A
I 351-356	Jerk	No Reverse	M.A.N.	10	430	450		A
I 400-401 402	Jerk	Reverse		10	430	450		A
I 361-370	Jerk	Reverse	M.A.N.	8	370	500		A
I 371-372	Jerk	Reverse	M.A.N.	8	370	500		
I 201 class	Jerk	Reverse	M.A.N.	10	300	380		
RO 33-34	Jerk							
RO 35-50	Jerk	No Reverse	M.A.N.	10	430	450		5
RO 101-117	Jerk	No Reverse	M.A.N.	6	310	380		
RO 500	Jerk							
HA 201 class	Airless Jerk	No Reverse	Japanese	6	300	350		
HA 101 class	Airless Jerk	No Reverse	Japanese	6	300	350		
YU class	Bosh	No Reverse	Japanese	6				

ENCLOSURE (E), continued

Surface Propulsion and Main Machinery

e	Diameter of Piston Rod	Supercharge Pressure	HP Requirement for Blower	M.I.P.	B.M.E.P.	Mechanical Effects Except Blower Motor (%)	I.H.P.	B.H.P.	Maximum Firing Pressure (lbs. "	Ex Te
				65	52	80	1500	1200	640	84
		3 lbs. "	Eng. driven	41	62	88	3400	3000	640	
				106	85	80	3750	3000	640	84
				106	85	80	3750	3000	640	84
	170	3 lbs. "	350	63	50	80	5550	4450	640	74
	170	3 lbs. "	350	63	50	80	5550	4450	640	74
	170	4 lbs. "	550	63	51	82	6950	5700	640	74
	170	4 lbs. "	750	63	53	84	7650	6400	640	74
	170	6 lbs. "	750	63	53	84	7650	6400	640	74
	170	6 lbs. "	750	63	53	84	7650	6400	640	74
		6 lbs. "	250	108	91	84	2800	2350	850	84
		About 5 lbs. "	250	108	91	84	2800	2350	850	84
		About 5 lbs. "	250	108	91	84	2800	2350	850	84
		About 5 lbs. "	250	100	81	81	2700	2200	850	80
		About 5 lbs. "	150	110	88	80	2500	2000	850	82
		About 3 lbs. "	250	100	80	81	2370	1925	850	77
		About 5 lbs. "		97	78	80	1180	950	780	71
				97	78	80	1180	950	780	71
			Eng. driven	110	97	90	1500	1350	850	
		5 lbs. "	250	100	82.5	83	260	215	850	81
				86	76	88	625	550	850	84
				75	60.5	81	445	400	780	72
				75	60.5	81	445	400	780	72
								100?	925	75

Exhaust Temp. (°F)	Piston Material	Piston Cooling	Circulating Water	Circulating and Lubricating Pumps	Vibration Damper	Total Weight (Dry) Tons	Weight Pounds Per B.H.P.
840		Uncooled	Salt				
		Uncooled	Salt				
840		Uncooled	Salt				
840		Uncooled	Salt				
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			54	27
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			54	27
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			67	26.3
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			75	29.3
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			75	29.3
740	Aluminum body 2 Steel crowns sf 49B	Oil cooled	Salt			75	29.3
840		Oil cooled	Salt	Engine driven & electric pumps		41.5	40
840		Oil cooled	Salt	Engine driven & electric pumps		41.5	40
840	Steel Crown sf 49B CI Skirt Fe 19B	Oil cooled	Salt	Engine driven & electric pumps	Oil pump type damper. (and vulcan clutch)	41.5	40
800		Oil cooled	Salt	Engine driven & electric pumps		41.5	43
820		Oil cooled	Salt	Engine driven & electric pumps	Oil pump type	41.5	46
770		Oil cooled	Salt	Engine driven & electric pumps	Oil pump type	41.5	48
710	CI Fc 19B	Uncooled	Salt	Engine driven	Vulcan oil and damper	16.5	39
710	CI Fc 19B	Uncooled	alt	Engine driven		16.5	39
	Aluminum or CI	Uncooled	alt				
810	Steel Crown CI Skirt	Oil cooled	Salt			41.5	4[illegible]
840	CI Fc 19B	Uncooled	Salt				
720	CI Fc 19B	Uncooled	Salt	Engine driven	None	4.7	26
720	CI Fc 19B	Uncooled	Salt	Engine driven	None	4.7	26
750		Uncooled	Salt	Engine driven	None		